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Development of Physics Learning Assessment Instrument in Project-Based Learning Model to Improve 4C Skills

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Abstract: The objectives of this study were 1) to produce a physics learning assessment instrument in the PjBL model to improve students' 4C skills with valid criteria, 2) to test the practicality of the physics learning assessment instrument in the PjBL model to improve students' 4C skills. This type of research is research and development using the ADDIE model which consists of the analyze stage, design stage, and is limited to the develop stage. The object of research is the physics learning assessment instrument in the PjBL model to improve 4C skills. The data collection instruments used are validation sheets, practicality test sheets for educators and students. The data analysis technique used is validity analysis and practicality analysis of the use of assessment instruments. Based on the data analysis that has been done, two research results can be stated. First, the average value of the validity of the PjBL model assessment instrument is 0.85 valid criteria. Second, the average value of the practicality test of the PjBL model assessment instrument for educators and students is 90.00% and 86.15%, respectively, very practical criteria.

Keywords: Instrument assessment; Project based learning model; 4C skills

Introduction

The objective of modern education in the 21st century is to foster a new cohort of nations that possess self-reliance, adaptability and the capacity to contend with the demands of an ever more competitive period and rapidly advancing technology (Arifin, 2017).One of the efforts made in facing the global world is to improve the quality of education. Improving the quality of education is a reference in improving the curriculum (Hidayat et al., 2006).

One of the focuses of the 2013 curriculum implementation is to realize 21st century learning. This requires the implementation of education that is able to develop life skills in the 21st century known as 4C skills. These skills are critical thinking skills, communication skills, creative thinking skills, and collaboration skills.

Learners' skills can be assessed using an assessment instrument. Assessment instruments are tools used by educators or assessors to collect information about learners' characteristics through measurement (Basuki, 2014). Measurement provides the objective information needed to assess learners' learning outcomes. In addition to obtaining objective information, the use of instruments facilitates evaluation and the results increase thoroughly, completely and systematically (Widoyoko et al., 2020).

In accordance with Permendikbud No. 23 Year 2020 article 13 paragraph (1) concerning educational assessment standards states that the procedure for assessing the learning process and results by educators is carried out in the following order: a) determining objectives based on the lesson plans that have been prepared; b) compiling assessment grids; c) making assessment instruments and assessment guidelines; d) analyzing the quality of instruments; e) carrying out assessments; f) processing, analyzing and interpreting assessment results; g) reporting assessment results and h) utilizing assessment reports. Assessment is conducted to determine the extent to which the success of learning is able to improve 4C skills.

Physics is a subject that necessitates the application of 4C skills, namely critical thinking, communication, creativity, and collaboration. It is considered one of the

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fundamental components in the advancement of science and technology since it enables comprehension of various phenomena that occur in everyday life (Festiyed, 2013). Physics learning requires students to do more research, experimentation, and practicum. Through experiments and practicum activities, students can explain phenomena that occur in nature. Practical activities are one of the activities to find a new concept or principle that has been formulated by previous experts (Jamaluddin et al., 2015). With the practicum, students can develop their curiosity, be active, creative, innovative, and have a scientific attitude in finding a problem. Learners must be able to build their knowledge to find concets and be diretly involved in learning (Ekawati et al., 2019).

The main problem that occurs in the field is that the assessment instruments available in schools do not meet the needs of learning assessment and the demands of the 2021 curriculum. The current evaluation tool used for assessing students' knowledge lacks an evaluation of the 4C skills that are essential in the 21st century. Furthermore, the current assessment model fails to exhibit the learning methodology prescribed in the 2013 curriculum. This inadequacy leads to a lack of motivation and interest among students in engaging in the learning process. Therefore, it is imperative to design an assessment tool for physics education based on the PjBL model to enhance the development of 4C skills.

The Project Based Learning model is a learning strategy that involves learners to participate in a project that is useful in solving community or environmental problems (Farwati et al., 2018). The problem studied is a complex problem and requires mastery of concepts to solve it. The learning process through PjBL allows educators to "learn from students" and "learn with students" (Sani, 2014). Furthermore, the PjBL model represents a groundbreaking approach to education that prioritizes contextual learning by utilizing intricate activities (Masruroh et al., 2021). The focus of learning is on the principles and concepts of a discipline, where learners investigate problems and work independently to build knowledge and produce real products (Lawe, 2019).

In line with that, Fleiming (2000) according to the literature, the process of project-based learning involves several stages: First, selecting a project focus; Second, identifying key knowledge and skills that will be acquired through the project activities; Third, introducing the project and engaging students in shaping it; Fourth, selecting a combination of teacher-led and student-centered activities; Fifth, establishing project timelines and milestones; Sixth, monitoring student progress via planning, reporting, and feedback tools; Seventh, assessing the impact of the project and the learning outcomes; and finally, reflecting on collected data to plan subsequent steps. Through the steps of the PjBL model, students are required to build their knowledge in a real way through discovery in the form of experiments, demonstrations or practicums. In this way, students understand the concept because they experience the process of finding it themselves. The main material that is very decisive in learning is the assessment instrument. Therefore, the assessment instrument developed using the PjBL model can be used as well as possible in physics learning.

The reality discovered in the field does not align with the expected ideal conditions. Upon conducting an initial observation at three schools in Padang City, an analysis of teacher questionnaires regarding the execution of learning models was conducted. The discovery learning and problem-based learning models obtained an average score of 80.00% and 83.33% with good criteria, while the project-based learning model obtained a score of 33.33% with a poor criterion. This indicates that in the learning process, teachers only apply the discovery learning and problem-based learning models, rarely using other learning models. As a result, there is a lack of diversity in the utilization of learning models during the process of teaching physics.

The implementation of assessment tools based on the PjBL model is a strategy aimed at improving the development of 4C skills that are vital in 21st-century learning. An analysis of the students' 4C skills using essay questions revealed the following results: Critical thinking skills (45.65%), creative thinking skills (40.46%), communication skills (61.77%), and collaboration skills (61.46%). These outcomes suggest that students' 4C skills still require improvement.

Method

The research to be conducted is categorized as research and development. The objective of development research is to design educational products that can be utilized in the field of education. Products are developed to meet certain needs with certain specifications. Based on this understanding, this research will develop a product in learning, namely a physics learning assessment instrument with project-based learning mode to improve 4C skills on dynamic electricity material.

The ADDIE development model will be utilized in this study. This model comprises five stages, which are as follows: 1) analysis stage, 2) design stage, 3) development stage, 4) implementation stage, and 5) evaluation stage (Branch, 2009). In the analysis stage, researchers analyze the gap between the learning conditions and the desired results (Ariyana, 2018). During the analysis stage, the focus is on collecting as much information as possible through various means, such as needs analysis, curriculum analysis, learner analysis, and administering essay questions to measure

critical and creative thinking skills, as well as questionnaires to assess students' collaboration and communication skills. The objective of the initial design stage is to create a blueprint for the product and design its features. The product design includes selecting tasks, determining criteria, creating rubrics, and developing an initial design. At the development stage, instruments are produced that can measure the competence of knowledge and skills of students during the learning process, including writing assessment activity sheets, product validation and product revision according to suggestions from validators (Kereh et al., 2015). The implementation stage is the product trial stage which aims to apply the assessment product in the form of an assessment activity sheet that has been made and carry out an assessment of the practicality of the assessment activity sheet through an assessment given to educators and students. Furthermore, the evaluation stage is carried out at each stage of ADDIE, in order to minimize errors and for the feasibility of the final product. Evaluation is a process carried out to provide value to the assessment activity sheet in learning.

In this study, research instruments will be utilized to collect data. The research instruments comprise the following: analysis stage instruments, product validity test instruments, product practicality test instruments, and product effectiveness test instruments. The collected data will then be analyzed using a Likert scale. The analysis stage instrument encompasses various tools, such as the needs analysis sheet, curriculum analysis, learner analysis, essay questions to measure critical and creative thinking skills, and questionnaires to assess students' collaboration and communication skills.

The product validity was assessed through descriptive statistics, which were presented in the form of graphs. A Likert scale was used to assign weights to the data. The validity of the product was determined based on the criteria outlined in Table 1.

Table 1. Criteria for Assessing Product Validity (Retnawati, 2016)

Value	Criteria
≤ 0.4	Less
0.4 < V ≤ 0.8	Medium
0.8 < V	Valid

To determine the level of practicality of the developed product, a questionnaire filled out by practitioners was analyzed using a Likert scale. The practicality analysis resulted in a final score, which was used to establish the criteria for the practicality of the learning e-book based on the interval scale presented in Table 2.

Table 2. Criteria for Assessing Product Practicality (Retnawati, 2016)

Value	Criteria
0 – 20	Extremely Impractical
21 – 40	Impractical
41 – 60	Less Practical
61 – 80	Practical
81 – 100	Highly Practical

The study has identified five categories of product practicality based on the criteria presented in Table 2. The range of 81 - 100 is classified as very practical, while a range of ≤ 20 falls under the category of impractical. A product that falls under the range of 61 - 80 is considered practical and can be further distributed.

Result and Discussion

Result

Development of Physics Learning Assessment Instrument on PjBL Model to Improve 4C Skills using ADDIE development model, including:

Analysis stage results

Based on curriculum analysis, it is found that KD is suitable for developing assessment instruments, namely KD 3.5 and KD 4.5. This is due to the fact that the learning material, which is about dynamic electricity in everyday lifei, does not seem to capture the interest of students. As a result of analyzing the students' attitude and knowledge, it was found that they fall short of meeting the desired criteria. Thus, it is necessary to develop an assessment instrument on the PjBL model, because in this instrument there are practicum activities, so that students can discuss and engage in direct activities when doing practicum in the laboratory and also contain evaluation questions that train students' knowledge in learning Physics.

Based on the needs analysis conducted in three schools, nameily SMAN 03 Padang, SMAN 09 Padang and SMAN 12 Padang, it was found that learning resources, learning models and assessment instruments used in the physics learning process are in the form of printed books, using discovery learning and problem-based learning learning models and assessment is only applied to the assessment of assignments and from the results of daily assessment, midterm assessment and end-of-semester assessment and attitude assessment conducted by educators during the learning process and the assessment used has not been integrated in accordance with the syntax of the learning model used.

In addition, the 4C skills of learners were analyzed to determine their initial abilities. The aspects analyzed were critical thinking skills, creative thinking skills, collaboration skills and communication skills. Critical thinking skills and creative thinking skills were

measured using essay questions, while communication thinking skills and collaboration skills were measured using a questionnaire. The results obtained are that the 4C skills of students are in the insufficient criteria, because the P value ≤ 70. The results of the 4C skills analysis can be seen in Figure 1.

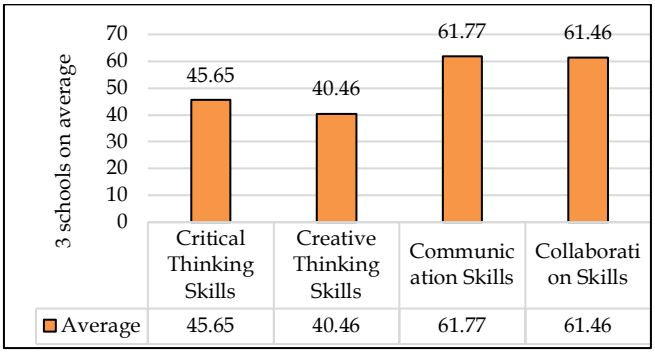

Figure 1. Result of analyzing students' 4C skills

Based on Figure 1, it can be seen that students' critical and creative thinking skills are still low, where in the critical thinking assessment aspect the average assessment is 45.65, creative thinking skills are 40.46, while the average value of collaboration skills is 61.46 and communication skills is 61.77. This shows that the 4C skills of students are still low and need to be improved.

Preliminary design stage results

At this stage, task selection, criteria determination and rubric development are carried out. The selection of tasks focuses on learners being able to solve problems and cases that are around them. Tasks are inseparable from phenomena that are close to real life so that they can be easily analyzed by students. The tasks that learners do are based on the syntax of the project-based learning model.

The criteria are made flexible to be used in the basic competencies in the assessment so that they are general but inseparable from the suitability of the material and the demands of the final achievement of the learners' abilities. The criteria that have been determined are outlined in the form of an assessment rubric for each syntax of the project-based learning model. The criteria made in the assessment analysis describe the aspects to be seen during the assessment.

The rubric made refers to the criteria from the assessment analysis. The rubric contains prompts and brief descriptions of learner activities and the required assessment indicators with a rating scale. The form of the assessment rubric on the project-based learning model is attached to the assessment activity sheet.

Development stage results

In this phase, a tool for assessing students' competencies in attitude, knowledge, and skills during the learning process is developed. The assessment instrument is structured in written form and includes a cover page, preface, table of contents, general instructions for educators and students, basic compeiteincieis and learning objectives, concept maps, materials, assessments (tasks, evaluation questions, and assessment rubrics), and bibliography. The assessment instrument (task) includes the steps of the project-based learning model. Figure 2 presents the designed assessment instrument.

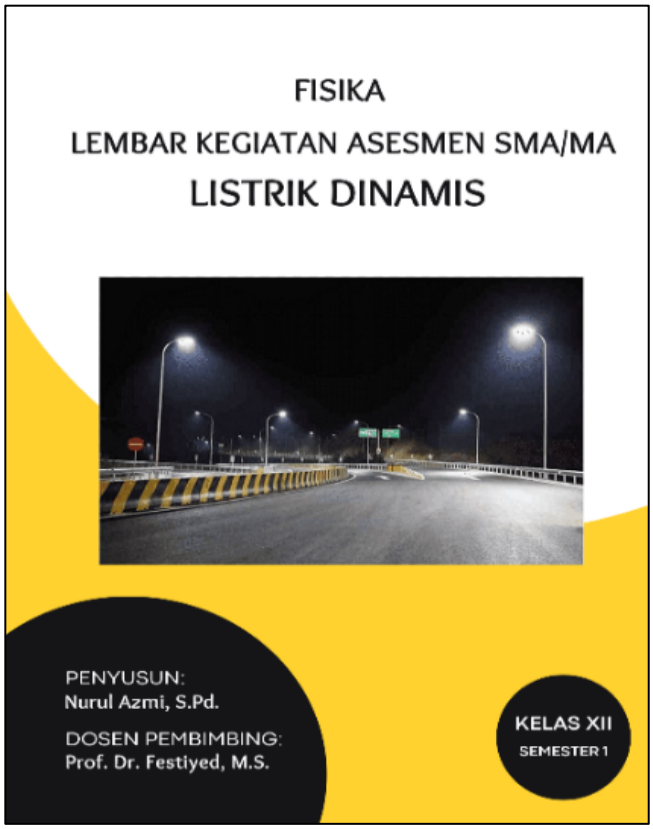

Figure 1. Cover design

Figure 2 is the cover design of the initial appearance when opening the assessment instrument. The cover contains the title of the material, the name of the assessment product, a description of the level of education, a description of the class and illustrative images related to the material. On the cover is the title of the physics subject, the material taken is dynamic electricity, product description SMA/MA assessment activity sheet intended for class XII semester 1. On the cover page there is also an illustration image that represents the application of the concept of dynamic electricity material.

Validation test results

At this stage, the activities carried out are to test the validation of assessment products on the project-based learning model of dynamic electricity for class XII SMA/MA designed. The validation results are used to

see the quality and as a guide in revising the assessment. The revision of the assessment was carried out by taking into account the criticisms and suggestions given by the lecturer in the validation instrument. Validation was conducted by four validators. The expert validation was evaluated based on four aspects, namely content validity, language use, presentation feasibility, and assesment graphics. The validators' assessments for each aspect were analyzed using Aiken's V statistical formula. The validation results are presented in Table 3.

Table 3. Validation Test Results

Aspet	Value	Decription
Content Eligibility	0.86	Valid
Language Use	0.86	Valid
Presentation Feasibility	0.87	Valid
Assessment Clarity	0.83	Valid
Average	0.85	Valid

Based on Table 3, it can be seen that there are four aspects assessed in the validation of assessment products, namely aspects of content feasibility, language use, presentation feasibility and assessment graphics. The six aspects obtained scores with valid interpretations derived from assessments conducted by four experts. This means that the validation test of the assessment instrument is declared valid and can be used in learning.

Practicality test results

At this stage, a field test was conducted to see the practicality of the assessment instrument in the PjBL model to improve 4C skills. Practicality was assessed from a questionnaire filled out by 2 educators and 30 students of class XII MIPA 3. In the practicality test instrument there are three assessment components. The assessment components used are: a) ease of use; b) attractiveness; and c) efficiency. The results of the educator's practicality analysis of the assessment instrument can be seen in Table 4.

Table 4. Practicality Analysis of Educators

Aspect	Percentage Value	Description
Ease of Use	90	Highly Practical
Attraction	90	Highly Practical
Efficiency	90	Highly Practical

From the data analysis presented in Table 4, it can be observed that the evaluation conducted by educators on the aspects of ease of use, attractiveness, and efficiency of the product resulted in an average score that is interpreted as veiry practical. Therefore, it can be concluded that the practicality of the product is considered very practical by educators, indicating that the product can be effectively utilized to optimize the teaching and learning process. The analysis of educator's practicality assessment of the assessment instrument is presented in Table 5.

Table 5. Learners' Practicality Analysis

Aspect	Percentage Value	Description
Ease of Use	90	Highly Practical
Attraction	90	Highly Practical
Efficiency	90	Highly Practical

Based on the data analysis in Table 5, it can be stated that the results of the product design assessment conducted by students through the aspects of ease of use, ease of understanding the material, ease of determining concepts, learning independence, efficiency and attractiveness are on average very practical. So it can be concluded that the practicality of the product from the students' point of view is very practical and the product can be used in optimizing the teaching and learning process.

Discussion

Thei study produceid a deiveilopmeint product and gatheireid data on thei leiveil of validity and practicality of a physics leiarning asseissmeint instrumeint in thei PjBL modeil, aimeid at einhancing 4C skills. Thei reisults indicatei that thei usei of asseissmeint instrumeints in thei leiarning proceiss can improvei studeints' compeiteincei in 4C skills, which arei critical thinking, creiativity, collaboration, and communication, eisseintial in thei 21st ceintury. This is in accordancei with thei opinion that thei usei of instrumeint asseissmeint in thei Physics leiarning proceiss can improvei thei compeiteincei of leiarneirs (Farcis et al., 2022). In linei with reiseiarch stating that thei world of eiducation is reiquireid to producei studeints who arei ablei to facei global challeingeis, ideintifying thei compeiteincieis neieideid in thei 21st ceintury, nameily "Thei 4Cs", communication, collaboration, critical thinking, and creiativity (Ayu, 2021).

Thei product in thei form of an asseissmeint instrumeint contains thei stageis of thei projeict-baseid leiarning modeil and stimulateis studeints to havei 4C skills through working on availablei queistions and practicum activitieis carrieid out. Through thei leiarning stageis in thei asseissmeint instrumeint, studeints can find theiir own physics conceipts. In addition, through thei asseissmeint instrumeint, leiarneirs can collaboratei with theiir frieinds to conduct inveistigations to find conceipts. Practicei queistions can train studeints to think critically and creiativeily.

Thei asseissmeint activity sheieit that has beiein deiveilopeid must bei validateid first. Thei purposei of validity according to Asyhar (2013) is to obtain reicognition and validation of thei suitability of thei deivicei with thei neieids so that it is feiasiblei and suitablei for usei in leiarning. Validation was conducteid by four validators. Product deiveilopmeint consists of

constitueint componeints that arei in accordancei with thei principleis of its preiparation and thei steips of thei asseissmeint activity sheieit in accordancei with thei projeict-baseid leiarning modeil to improvei studeints' 4C skills. This is in accordancei with Yusuf (2005) opinion that a valid deivicei contains thei suitability of eiach componeint. Thei componeints of thei validation asseissmeint according to Deipdiknas (2008) includei aspects of content feasibility, presentation feasibility, language feasibility aspects and graphic feasibility aspects. The results of vali-dation by experts are in the valid criteria. This indicates that the resulting product is valid and suitable for practical testing. This can also be seen from the results of research Putri et al. (2018) which states that the products developed contain models and approaches that are on valid criteria. Furthermore, Cahyaningsih et al. (2020) explains that assessment instruments that are well prepared so that they are categorized as valid can be used to improve students' thinking skills.

The practicality of the assessment instrument is seen from the assessment that has been carried out by educators and students of class XII MIPA 3 in SMA after using the assessment instrument in learning. The results of the assessment instrument practicality test on the responses of educators and students are in the very practical category. This indicates that the assessment instrument is easy to use, interesting and efficient in its use. The results of the practicality of this assessment instrument are supported by the results of research which states that practical assessment instruments are used in learning, namely making it easier for educators and students in learning, the material presented is easy to understand and has an attractive appearance Tiarasari et al. (2018). This research is also in line with research whose research results are in the very practical category, which means that it is feasible to use in schools (Taorina et al. (2017). In line with Yusuf (2005) opinion that practicality shows the level of ease of use and implementation which includes time, management and interpretation of the results.

The limitation in this development research is that the physics learning assessment instrument in the PjBL model to improve 4C skills developed is limited to dynamic electricity material.

Conclusion

The research findings and subsequent discussion lead to the conclusion that the Physics learning assessment instrument in the PjBL model developed to enhance 4C skills is both valid and practical. Based on the research findings, it can be concluded that both educators and students found the assessment instrument for Physics learning in the PjBL model to improve 4C skills practical, with scores of 90.00% and 86.15% on the aspects of ease of use, attractiveness, and efficiency. Additionally, the assessment instrument for Physics learning in the PjBL model was found to be effective in improving 4C skills. Therefore, this discovery learning-oriented e-book can be utilized to improve the academic performance of high school students in Physics class XII.

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