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Feasibility Analysis of Subject Specific Pedagogy Physics Learning Module Based on Project Based Learning Integrated with Merdeka Curriculum on Alternative Energy Material

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Abstract: This study aims to analyse the feasibility of Subject Specific Pedagogy Physics tools based on Project Based Learning (PjBL) integrated with Merdeka Curriculum on alternative energy material for grade X high school students. This research uses the Research and Development (RnD) method with the 5D model (Define, Design, Develop, Disseminate, and Evaluate) which is limited to the devalope stage. The Define stage includes needs analysis and identification of competencies that must be achieved by students. The Design stage includes designing learning module in the form of modules and student worksheets. The Develop stage includes the development and validation of learning modules by experts in the aspects of material, learning, language and limited testing. The results showed that the PjBL-based Physics Subject Specific Pedagogy device integrated with the Merdeka Curriculum on alternative energy material for grade X high school students had high feasibility based on expert review in terms of material, learning, and language aspects. In addition, students also gave positive responses to the developed learning module. Therefore, the learning module is suitable for use in the Physics learning process in high school.

Keywords: Alternative energy; Feasibility analysis; Project based learning; Subject specific pedagogy

Introduction

One of the issues that requires significant attention from the Indonesian government is the state of education, particularly the quality of education. In comparison to other countries, Indonesia's education quality lags significantly behind (Maslan & Rahman, 2016). It is worth noting that the success of a country's education system is one of the indicators of the government's success or failure (Hakim, 2018; Prastuti & Suwartono, 2018).

The Covid-19 pandemic has caused widespread difficulties and setbacks across various sectors and fields worldwide, as all countries have been impacted by its outbreak. The education sector has been particularly affected by this pandemic, as the government has implemented measures to restrict face-to-face interactions. Consequently, teaching and learning activities that were previously carried out in schools have been shifted to online platforms and taken place at students' homes (Siahaan, 2020; WHO, 2021).

Significant transformations took place in the Indonesian education system in 2013 when the KTSP curriculum, which had been implemented since 2006, was replaced by the K-13 curriculum (Pawero, 2018). Subsequently, the Indonesian government introduced a new curriculum known as the Merdeka curriculum, which is an optional curriculum designed to reinvigorate learning after the Emergency Curriculum was implemented in response to the Covid-19 pandemic (Anggraena, 2021; Jojor & Sihotang, 2022).

The implementation of merdeka curriculum was based on the need for a new alternative curriculum after the emergency curriculum was implemented (Heryahya

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et al., 2022; Ramadan & Imam Tabroni, 2020). This is certainly important because of the failure of an education, one of which is influenced by a curriculum that is unable to meet the demands of the times (Bangkara et al., 2022).

The curriculum structure in the Merdeka Curriculum is divided into two main activities (Jannah & Irtifa'Fathuddin, 2022), namely: (1) intracurricular learning activities which are routine and scheduled activities based on structured lesson content, and (2) learning activities through projects to strengthen the profile Pancasila students. The projects can be subject-based or as integrated units of study of two or more subjects. This project was designed as an effort to strengthen the development of the Pancasila student profile with its six dimensions: faith, fear of God Almighty and noble character, independent, global in diversity, mutual cooperation, critical thinking, and creative (Anggraena, 2021).

Physics is one of the important subjects in secondary school, because it provides a basis for understanding the natural world and various scientific phenomena (Llinás et al., 2020). However, many students often find it difficult to understand physics concepts due to the abstract nature of the subject matter (Tong et al., 2020). To overcome this problem, various approaches have been developed to improve physics learning, such as Subject Specific Pedagogy (SSP) and Project Based Learning (PBL). SSP emphasizes using appropriate methods to understand physics concepts (Rahayu & Suparwoto, 2019) whereas PBL focuses on experiential learning through real-life projects or assignments (Wan et al., 2022).

The Merdeka curriculum emphasizes the integration of technology and real-life problems into the learning process (Susanti et al., 2023). Alternative energy is a relevant and significant topic for today's world, and integrating it into the physics curriculum can increase students' understanding of the subject and its real-life applications (Supriatna et al., 2021).

SSP mediates between the development of subject mastery and changes in the environment for teaching (Handayani & Wilujeng, 2017; Prastyo, 2020). This is of course the development of SSP is very necessary to deal with change, in this case the change in question is the change in curriculum from the K13 curriculum to the Merdeka Curriculum. SSP in general can be defined as the packaging of a field of study into a comprehensive and solid learning tool that includes competency standards, sub-competencies, materials, strategies, methods, media, and evaluation (instruments for assessing learning outcomes) (Purwita & Rosana, 2020). Good SSP components include: syllabus, Learning Implementation Plan (RPP), teaching materials, student worksheets, and test items (posttest and performance tests) (Hidayat & Rizki, 2019).

The reality that occurs in the field is that students have not become the main focus in learning activities. Models and teaching methods accepted by students tend not to be varied. RPP which is prepared for the sake of convenience in the implementation of learning is also not yet integrated with value education. Teachers also have not carried out SSP analysis, especially including character education as an indicator of achievement of learning outcomes (Purwanti, 2016).

Project-based learning usually lasts for various periods of time, it can be one week but it can also last for one semester depending on the objectives, scope and complexity. Therefore, the time allocation for lesson hours for projects to strengthen the profile of Pancasila students is set annually, so that the education unit can arrange the time allocation for holding two projects (SD, SMP) or three projects in a year (SMA) (Anggraena, 2021).

Project Based Learning is an educational approach that employs projects or activities as a means of instruction (Falloon et al., 2020). It involves students in carrying out exploration, assessment, interpretation, synthesis, and information gathering to create diverse forms of learning outcomes. PjBL initiates the inquiry process by posing a guiding question and guiding students in a collaborative project that integrates various subjects in the curriculum (Daryanto, 2014).

The initiative to enhance the Pancasila student profile through a project-based learning approach is a notable innovation within the Merdeka curriculum, particularly since the government had not previously regulated this method, leaving it up to teachers to implement it (Nahdiyah et al., 2022; Setiyaningsih & Wiryanto, 2022). However, developing project-based learning activities can be a complex and challenging task (Zulkarnain et al., 2023).

Of course, the implementation of the merdeka curriculum is a challenge for teachers because there are not many teaching materials or modules that implement the merdeka curriculum as a reference and have not included projects to strengthen the profile of Pancasila students (Amir et al., 2022). So that teaching materials or modules are needed that contain all learning components with an merdeka curriculum as a reference and implement projects to strengthen the Pancasila student profile (Nurhayati et al., 2022).

Based on the description above, the researcher intends to conduct research to develop learning Modules to improve the profile characteristics of Pancasila students to think creatively in the modern curriculum, with the project based learning model for class X high school students on alternative energy material.

Method

This research is a Research and Development (RnD) type of research that applies the Five-D development model which has been adapted from Cennamo and Kalk (Brian Bowe et al., 2016). This model consists of five stages of development, namely Define, Design, Develop, Demonstrate and Delivery. However, this research only reached the Develop stage. Figure 1 shows the stages in this due diligence.

The define stage is the first step in developing learning tools that aim to identify the characteristics and needs of students, set specific learning objectives, determine indicators of success, determine the expected final product, strategy for testing program effectiveness, and product (Hidayat et al., 2018).

Meanwhile, the design stage is the next step which aims to design the basic components of learning tools such as syllabus, lesson plans, worksheets, assessment sheets, and handouts (Shabrina & Kuswanto, 2018) . In the design process, components of learning tools such as syllabus, lesson plans, worksheets, assessment sheets, handouts, and validation sheets are arranged (Dasilva et al., 2019). By following the define and good design stages, it is hoped that the developed learning module will meet students' needs and be effective in increasing their understanding of the material being studied (Mandagi et al., 2021).

The product valuation stage was carried out by seven experts consisting of four lecturers and three high school physics teachers to see the aspects of learning, material, and language. The subjects of this research were 36 students of class X SMA N 1 Sragen. Data collection techniques were carried out using a questionnaire consisting of a Likert scale with five alternative answer choices, namely Very Good, Good, Moderate, Not Good, and Very Not Good for validation tests, product feasibility readability test.

In this study, the data analysis technique used is a quantitative descriptive technique (Kusairi et al., 2020). The results of expert assessments and students' readability (response) tests were translated into certain categories (Guan et al., 2022). Content validity was determined using the Aiken formula (Aiken, 1985; Wright, 2011). V Aiken was used to evaluate agreement between several raters in non-test assessments such as learning tools or teaching materials. The Aiken test is carried out by comparing the answers or ratings from each assessor to each item being assessed. The results of the Aiken test can provide an overview of the consistency or agreement between raters in giving an assessment of an item (Malcolm, 2019).

$$V = \frac{S}{[n(c-1)]} \text{ with } S = \sum ni\,(r - lo) \quad (1)$$

Information:

V = validity index of Aiken
c = Number of categories/criteria
l_o = The lowest category
n_i = Number of raters who have criterion i
r = Criterion i
n = total number of appraisers

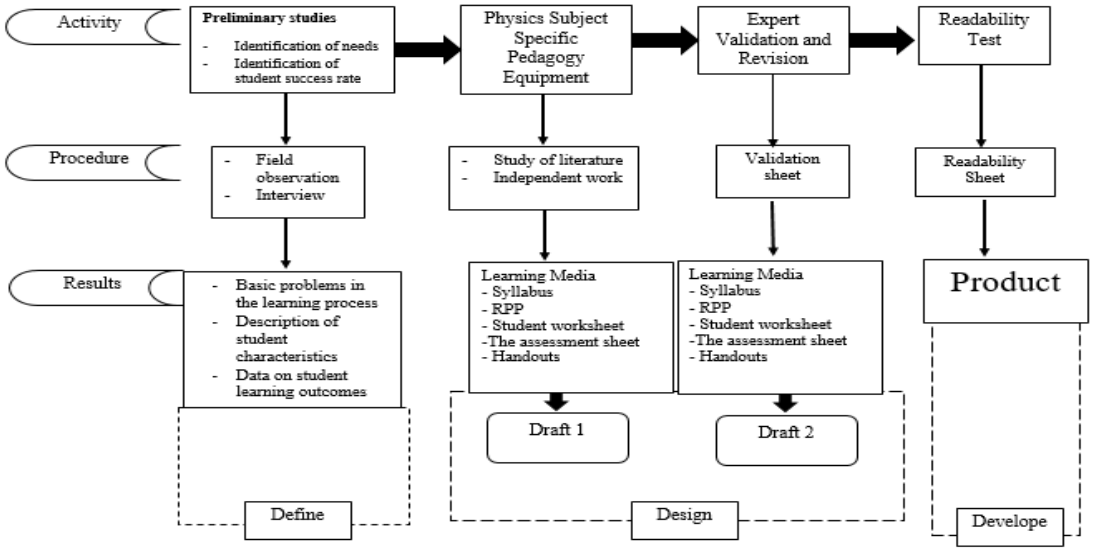

Figure 1. Stages of development of integrated project based learning subject specific pedagogy physics

Based on the number of raters and validation assessment categories, it was found that an item is said to be content valid if it has a validity value greater than 0.75 (Putranta & Supahar, 2019).

The data analysis technique uses a quantitative descriptive technique. The assessment categories from experts on the material, learning and language aspects as well as the readability test (student response) can be

seen in tables 1 and 2. The results of calculating the validity of which percentages are known can be matched with the criteria according to Akbar (2013), as presented in Table 1.

$$Percentage\ of\ agreement = \frac{R}{SM} \times\ 100\% \quad (2)$$

Information:
R = Number of Scores Obtained
SM = Maximum score

The results of the readability test for which the percentage is known can be matched with the criteria according to Millah et al. (2012) in Table 2.

Table 1. Category of Expert Judgment

Percentage (%)	Validity Category	Information
81.1 - 100	Very good	Very good to use
60.1 - 81	Good	May be used with minor revisions
40.1 - 60	Moderate	May be used with major revisions
20.1 - 40	Not good	Should not be used
0.0 – 20	Not very good	Should not be used

Table 2. Categories of Student Responses

Percentage (%)	Criteria
81.1 - 100	Very good
60.1 - 81	Good
40.1 - 60	Moderate
20.1 - 40	Not good
0.0 – 20	Not very good

Results and Discussion

Testing the feasibility of physics module is very important before being used in the learning process, because module that are not feasible can have a negative impact on students' understanding and motivation in learning (Yanti & Hufri, 2020). The feasibility test aims to assess the extent to which the device can facilitate the learning process properly, including aspects of language, clarity of material, use of media, and others (Rofidah et al., 2020). Test feasibility can also help improve the quality of device learning through input and suggestions from experts involved in the assessment process (Amalatus et al., 2021). Therefore, the feasibility test of physics module is very important to ensure that the module used in the learning process can help students understand physics concepts better (Sharif et al., 2018).

Based on the results of the feasibility analysis, it can be concluded that the Project Based Learning (PjBL) physics learning tool that is integrated with the Merdeka curriculum on Alternative Energy Materials for Class X High School Students is feasible and has a very good level of validity and readability. Based on the results of Aiken's V calculations on physics learning tools, Aiken's V value is 0.90. Because this value is above 0.75, it can be concluded that the physics learning tool has a fairly good level of validity according to Aiken's criteria. That is, the learning device is considered valid by the experts who carry out the assessment (Putranta & Supahar, 2019).

This expert's assessment can provide an overview of the quality of a learning tool from an educational perspective (Offenberger et al., 2019). In addition, by paying attention to the assessment of experts, learning device developers can improve weaknesses in learning tools so that they can be more effective in helping students achieve the desired learning goals (Songkram, 2015; Yoon et al., 2019).

Table 3 describes the results of the assessment by experts in aspect material, learning experts, and linguists carried out at the development stage of the SSP Physics toolkit. The results of the assessment indicated that the SSP Physics studied met the eligibility criteria in terms of material, learning and language. The assessment of learning experts shows that SSP Physics has an attractive design, clear teaching materials, and an easy-to-understand display. Products in the form of teaching module are shown in Figure 2.

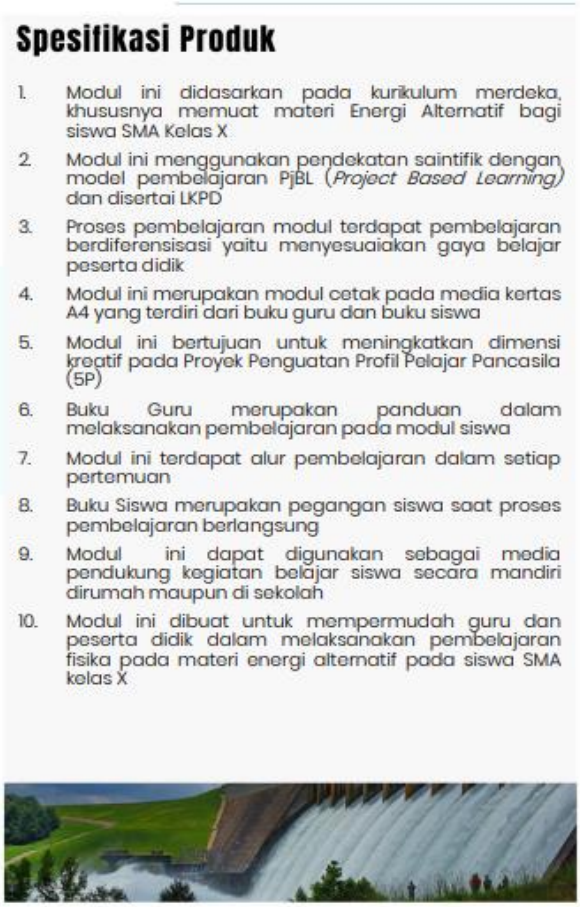

Figure 2. Project based learning physics subject specific pedagogy products

Figure 2 shows an example of the product display of the Project Based Learning Subject Specific Pedagogy Physics that has been developed. This tool uses a project learning approach as the main strategy in delivering material alternative energy. There are several features that can be seen on the display of the device, including the main menu, materials menu, and project menu. On the material menu, there is a sub menu that contains explanatory material, assignments, and practice questions. While on the project menu there are several projects that students can choose to work on in accordance with the material being studied. An attractive and user-friendly display design is expected to increase students' interest and motivation in learning physics material, especially about alternative energy.

Table 3. Feasibility Analysis Results by Experts

Assessment Aspects	Percentage (%)	Validity Category	Information
Material	91	Very Valid	Very good to use
Learning	95	Very Valid	Very good to use
Language	90	Very Valid	Very good to use

Table 3 shows that the results of the product feasibility test from experts are very good with a percentage of 90% so that this tool can be used in learning.

According to experts on the learning aspect, it shows that the device has a good layout, uses appropriate media, and is easily understood by students. Based on table 4 showing the learning aspects, the learning tools developed obtained very good ratings from material and learning aspect. Learning objectives, learning materials, learning models, learning methods, learning media, learning assessments, and learning formats get very good ratings from experts. This shows that the developed learning tools fulfill important aspects of the learning process and are considered appropriate for use in teaching physics on alternative energy materials for class X high school students.

The physics module that has been developed pays close attention to the language aspect. The language used in the module has been adapted to the understanding abilities of students so that it is easy to understand and not too technical. In addition, the grammar used in the module has also been maintained so that it is not too complicated and difficult to understand. This is also supported by the use of pictures and tables which help students understand the physics concepts presented in the module. In terms of vocabulary, this module has also used technical terms that are relevant to the material presented. So, overall this module can be considered good from the aspect of language in the context of learning physics. The complete results of the assessment by experts can be seen in Table 5.

Table 4. Percentage of Learning Aspects

Learning Aspects	Percentage (%)
There is a Teaching Module Title	96
There is the author's name	96
There is a Level	96
There are phases	93
There is Class	96
General Description	93
Cover Image	96
Elements of Learning Outcomes	96
Learning objectives	89
Dimensions of the Pancasila Student Profile	93
Total Allocation of Lesson Hours Per Teaching Module	100
Learning Mode	96
Facilities and infrastructure	96
Competency Prerequisites	93
Meeting Title	93
Allocation of Lesson Hours Per Meeting	96
Details of Learning Activities	93
Supporting Material	96
Material Reference	96
Exercise/Assessment	96
Reflection Instrument	89

Table 5. Percentage of Language Aspects

Learning Aspects	Percentage (%)
Using the EYD rule.	86
Using good and correct Indonesian rules.	89
Consistent use of symbols or icons.	96
Accurate sentence structure.	86
sentence effectiveness.	93
terminology.	86
Understanding of messages or information.	89
Ability to motivate students.	93
Ability to encourage creative and critical thinking	96
Conformity with the intellectual development of students.	93
Appropriateness with the level of emotional development of students.	93
Grammatical accuracy.	79
Spelling accuracy.	86
Consistency in use of terms.	93
The language used is simple, straightforward and easy for students to understand.	93

The percentage of language in table 5 is an important indicator in assessing the quality of a learning tool. This is because the language used in the module will affect students' understanding of the material presented. In assessing the feasibility of this physics device, the percentage of language modules is analyzed by linguists. Based on the analysis results, the percentage of the device language is very good, which is more than 90%. This means that the language used in the physics learning module is quite clear and easily understood by students, so as to increase the effectiveness of learning. Therefore, the percentage of language modules is an important aspect that must be considered in the development of physics learning tools.

The material expert's assessment shown in table 6 shows that SSP Physics has material that is in accordance with the curriculum, relevant to social conditions and student character, and easy for students to understand. The results of the feasibility analysis by material experts show that the device meets the criteria of correctness and clarity of physics concepts. The material aspects of the physics SSP tools that were assessed by experts included accuracy, completeness, depth, and suitability with the standard curriculum. Material experts consider that this physics module has good accuracy and completeness of material, and has sufficient depth in explaining physics concepts in alternative energy materials. In addition, this module is also assessed in accordance with applicable curriculum standards. Material experts also provide some suggestions for improvement such as adding several sub-chapters to increase the depth of students' understanding and adding examples of the application of physics concepts in everyday life to facilitate students' understanding.

Table 6. Percentage of Material Aspects

Learning Aspects	Percentage (%)
The material presented in this teaching module is valid	82
There is no wrong concept in the material presented in this teaching module	82
The breadth of the material in this teaching module is in accordance with the learning outcomes to be achieved by students	86
The depth of the teaching module material is in accordance with the elements of learning outcomes to be achieved by students	89
The material for this teaching module is up-to-date, in accordance with developments in science and technology	96
The material for this teaching module is aligned with the values prevailing in Indonesian society	93
The depth of the material in this teaching module is suitable for the level of students in this phase	89
The concepts and theories described in this teaching module are intact, according to the field of science/subject	93
The presentation of this teaching module material is coherent, systematic, and logical so that it is easy for students to follow	93
Illustrations, examples and non-examples used in this teaching module:	
a. Help understand the concept	93
b. Relevant to the material	89
c. Clear	93
d. Interesting	93
Process assessment is suitable for measuring the achievement of the learning achievement elements specified in this teaching module	89
Formative tests are suitable for measuring the achievement of the learning achievement elements specified in this teaching module	96
Bibliography included in this teaching module:	
a. Relevant to the substance of the module	96
b. Sophisticated in their field	86

Student responses to the developed SSP Physics also show that SSP Physics has good eligibility. This can be seen from the results of the SSP Physics legibility test given by students using a questionnaire. Table 7 shows the legibility of the device according to student responses. Student response to learning tools is an important factor in evaluating the effectiveness of these tools. The more positive the student's response, the more likely the device is more effective in helping students learn (Zuniasih et al., 2018). In addition, student responses can also be important input in the development of learning tools in the future (Li, 2022).

Table 7. Student Response Results

Aspect	Percentage (%)	Criteria
Criteria	94.17	Very good
Material Presentation	91.92	Very good
Benefit	94.79	Very good

Student responses to the physics learning tools developed through a project based learning approach were very positive. Of the 36 students who were respondents in this study, 91.50% gave a response that strongly agreed with the use of the physics learning device. This shows that the developed project based learning physics learning tools can attract students' interest and attention in learning physics. In addition, the integration of the merdeka curriculum on alternative energy materials is also considered to provide added value to physics learning that is more relevant to the needs of students and the world of work in the future. Therefore, project-based learning physics learning tools and an merdeka curriculum on alternative energy materials are appropriate for use in physics learning in high schools.

The good level of legibility in table 7 also shows that learning tools can help students understand the material being taught more easily and effectively. These results indicate that the subject-specific physics pedagogy based on project-based learning that is integrated with the Merdeka curriculum on Alternative Energy Materials for Class X SMA students is a feasible and effective physics learning tool.

The findings of this study support the previous research conducted by Hidayat et al. (2019), which suggests that implementing SSP in high school physics education can significantly enhance students' problem-solving abilities. The results indicate that students who received SSP-based instruction performed better in solving physics problems compared to those who received traditional instruction. Another study by Lestari et al. (2019) also demonstrated that SSP could foster students' interest in physics and increase their motivation to learn. This study has contributed significantly to the development of innovative and relevant physics learning tools aligned with the current curriculum, which can ultimately improve the quality of physics education in Indonesian schools.

Conclusion

Based on the evaluation results from learning experts and material experts, it is known that the project-based learning physics pedagogy product specific subject integrated with the merdeka curriculum on alternative energy material has very good criteria and can be used in learning, with an assessment percentage from learning experts of 95%. from material experts by 91% and from language experts by 90%. In addition, the media product readability test was also given to 36 students who gave a very good response to the existence of the product, with a percentage of more than 90%. These findings indicate that a project-based learning-based device that is integrated with the Merdeka Curriculum on alternative energy material for class X SMA students can be used as a suitable physics learning tool. Furthermore, this product will be implemented in learning physics on a wider scale and its effectiveness will be measured in the learning process.

Author Contributions

Muhtar Husnadi: Preparation of research concepts and designs, module development, data collection, data analysis, manuscript writing and editing. Sri Budiawanti: Guidance during research and manuscript writing. Elvin Yusliana Ekawati: Guidance during research and manuscript writing.

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Conflicts of Interest

The authors declare that there are no relevant conflicts of interest related to this research.

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