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PBL Model Experiment with Character Value Approach to Improve Cognitive, Affective, and Psychomotor Competencies in Physics Learning

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Abstract

This study aims to examine the effectiveness of Problem-Based Learning (PBL) model integrated with character values on improving students' cognitive, affective, and psychomotor competencies in physics learning. The research was conducted using One Group Pretest-Posttest experimental design on class X students at SMAN 1 Jeneponto, South Sulawesi. Data were collected through cognitive tests, psychomotor observation sheets, and affective questionnaires. The results of the analysis showed that the application of PBL-NK model significantly improved all three aspects of student competence. The highest average score was achieved in the psychomotor aspect (86.5), followed by the cognitive (84.6) and affective (80.5) aspects. This improvement was proven through paired t-test with significant results on all variables ($p < 0.05$). These findings indicate that PBL-NK not only improves the understanding of physics concepts, but also supports the formation of student character in accordance with the Pancasila Student Profile. This model proves to be relevant in answering the challenges of 21st century education through the integration of competency-based learning and character values. It is recommended that teachers receive special training to apply this model, and the development of PBL-NK-based teaching materials is carried out to support the implementation of Merdeka Curriculum in various subjects.

Keywords: Problem-Based Learning, character values, cognitive, affective, psychomotor

Introduction

21st century learning demands an approach that not only focuses on cognitive aspects, but also involves affective and psychomotor aspects. In the context of physics learning, conventional approaches are often only oriented towards knowledge transfer or teachers focus on improving cognitive abilities only, without paying attention to the development of critical

thinking skills, attitudes, and practical skills (psychomotor and affective aspects). This leads to low student learning outcomes that cover all three domains. Therefore, it is necessary to innovate learning models that are able to integrate the three aspects of competence holistically. Teachers are very important in choosing the right learning model to achieve learning objectives and follow the curriculum (Mariani et al., 2025).

Some previous researchers studied the Problem Based Learning (PBL) model, so this learning model is an effective learning model in improving students' critical thinking skills and problem solving abilities. However, in some previous studies, there have not been many studies that adopt PBL integrated with character values to form a Pancasila learner profile according to local needs and global challenges, and in accordance with the Merdeka Curriculum which is the curriculum implemented in Indonesia. Therefore, it is very important for educators and educational practitioners to explore more deeply the potential of the Problem Based Learning (PBL) model which not only focuses on cognitive problem solving, but also integrates character values relevant to the Pancasila learner profile. With the implementation of the Merdeka curriculum, which emphasizes learning that is more contextual, innovative, and based on developing competencies as a whole, PBL integrated with character can be an effective solution to overcome educational challenges in the 21st century. This approach is expected to improve the quality of physics learning, strengthen critical thinking skills, and form the attitudes and practical skills needed by students to face global challenges and still appreciate local wisdom.

In addition, this learning model can also have a positive impact on the wider community, because it does not only focus on academic learning outcomes, but also on character building that reflects the noble values of the Indonesian nation. Psychomotor aspects refer to physical skills that involve body movements in performing a task or activity. In the context of physics education, psychomotor includes practical skills such as laboratory experiments, the use of physics tools, and other motor skills that support the understanding of physics concepts. The application of psychomotor aspects in physics learning can help students not only understand the theory, but also master practical skills that are useful in everyday life. Meanwhile, affective aspects are related to the development of students' emotional attitudes and values (Anderson & Krathwohl, 2001). According to the Pancasila learner profile, education must form learners who have a positive attitude, this is illustrated in the Pancasila Learner Profile which is an ideal description of the character of Indonesian learners who are expected to be able to face global challenges without forgetting the nation's identity and culture.

The main elements in the Pancasila learner profile include six main characters. First, Believing, Fearing God Almighty, and Having Noble Character, namely learners who have strong spiritual beliefs, perform worship well, and show respect, honesty, and care for others. Second, Global Diversity, which is the ability to appreciate diversity, understand other cultures, and uphold national values. Third, Gotong Royong, reflecting the spirit of cooperation, solidarity, and care in solving common problems. Fourth, Independent, i.e. learners who are able to take responsibility for their learning process, think critically, and make wise decisions. Fifth, Critical Reasoning, which includes the ability to analyze, evaluate, and solve problems logically and creatively. Sixth, Creative, which is learners who are able to generate new,

innovative, and relevant ideas to the needs of society. By developing these elements, learners are expected to become individuals who are not only academically intelligent, but also have noble character according to the values of Pancasila. Psychomotor and affective integration in accordance with the Pancasila learner profile will form learners who are not only intellectually intelligent, but also have a strong character, ready to face global challenges, and respect local wisdom (Kemendikbudristek BSKAP, 2024).

SMAN 1 Jeneponto in Jeneponto district, South Sulawesi province, which is the research site, has challenges in improving the quality of education, especially in physics. The learning results of students in this subject show that there are still gaps in the achievement of the three aspects of competence. Therefore, this study aims to examine the effectiveness of the PBL model with a character value approach to improving students' cognitive, affective, and psychomotor competencies in physics learning. The importance of learning outcomes lies not only in academic achievement, but also as a foundation for the formation of students' personalities to be ready to face future challenges with the provision of knowledge, skills, and superior character. With proper implementation, including setting clear learning objectives and creating a collaborative environment, PBL can be optimized to achieve maximum results in supporting student learning success in various subjects. Therefore, this PBL model will be tested in improving cognitive, affective and psychomotor competencies in physics learning at SMAN 1 Jeneponto, South Sulawesi, Indonesia.

Literature Review

Problem Based Learning Model

Problem-based learning (PBL) is an approach that focuses on problem solving as the main method to achieve learning objectives. In this approach, students are faced with real problems related to the subject matter, which they then solve through research, group discussions, and application of the concepts they have learned. The purpose of PBL is to develop critical thinking, problem-solving, and collaboration skills, as well as providing a more in-depth and context-relevant learning experience. PBL also encourages students to be more independent in their learning process, while increasing their participation and motivation. Some of the previous studies that examined the research problem by applying PBL include PBL has been shown to be effective in increasing students' interest and engagement in natural science. This approach helps students develop critical thinking skills and problem-solving abilities. Research shows that PBL can improve student learning outcomes in science, but to implement it successfully, educators need to get adequate training and professional development (Aulia et al., 2024). Research on the application of the Problem-Based Learning Model (PBL) has shown significant results in improving students' creative thinking skills

A quasi-experimental study involving 70 students divided into experimental and control groups found that the application of the PBL model significantly improved students' creative thinking skills in the experimental group, with an n-gain value of 0.72, which was higher than the control group which only showed an n-gain of 0.14 ($p<0.05$) (Zulkarnaen et al., 2022).

These results are in line with other studies showing that the PBL model not only improves students' cognitive skills, but also stimulates their creativity in solving problems. In this study, data regarding creative thinking skills were collected through an essay test measuring creativity indicators, which were then analyzed using the n-gain formula and ANOVA test. This finding strengthens the argument that PBL model can be an effective approach in enhancing students' creativity, and shows the importance of proper training and implementation to get optimal results. In addition, other research states PBL enriches students' learning experience, allowing them to connect various concepts and disciplines in a broader context. PBL has proven to be invaluable in facilitating a deeper understanding of topics involving knowledge modeling and representation (Manuel & Jorge, 2024).

Furthermore, other research states that the Problem-Based Learning (PBL) model is increasingly being applied in various circles, including by teachers, lecturers, and students. The results of the analysis of 12 articles show that the application of PBL in mathematics learning has a significant effect, helping students to explore the material better and improve the effectiveness and overall learning outcomes (Yasin et al., 2024). This is in line with research which states that the application of the Problem-Based Learning (PBL) model in learning mathematics shows very strong results. PBL not only helps learners to explore the material better, but also improves the effectiveness and overall learning outcomes. Despite using various article selection criteria and meta-analysis approaches, the results show that PBL has a significant positive impact in the educational context (Edy et al., 2024). In line with these findings, the application of the Problem-Based Learning (PBL) model also shows very strong results in learning mathematics. This approach not only supports students in exploring the material better, but also significantly improves overall learning effectiveness and outcomes. This further strengthens the relevance of PBL as a method that can be integrated in the Merdeka Curriculum to develop 21st century skills in various subjects (Mulatsih, 2021). The PBL model supports the development of 21st century skills through a self-paced curriculum. PBL is proven to improve students' critical thinking, problem-solving and motivation, making it an effective pedagogical approach.

However, challenges such as teacher training needs, customization of assessment strategies, and integration with existing curricula need to be addressed. With the implementation of best practices, such as setting clear learning objectives and creating a collaborative environment, PBL can be optimally implemented to support successful learning (Alifatun Ni'mah et al., 2024). In other studies, it is stated that the Problem-Based Learning (PBL) learning model is effective in improving various student abilities. At the elementary school level, PBL can improve critical thinking skills and learning motivation, while at the junior high school level, PBL helps improve science literacy and learning independence (Ainun & Maryati, 2024). Various studies on the application of the Problem-Based Learning (PBL) model show that this approach is effective in improving various student abilities. PBL is proven to improve students' critical thinking skills, creativity, and learning motivation, as well as enrich their learning experience by connecting concepts in a broader context. In addition, PBL is also proven to improve science literacy, learning independence, and overall learning outcomes, especially in science and mathematics subjects, and optimal implementation of PBL

can support the development of 21st century skills in various subjects and its relevance to the Merdeka Curriculum.

Character Value

The character value approach is a method that emphasizes the importance of developing moral and ethical aspects in the learning process. This approach aims to form students who not only have academic intelligence, but also have good attitudes, behaviors, and habits, such as honesty, responsibility, cooperation, discipline, and respect. Through this approach, students are expected to become a person with noble character and be able to be responsible for themselves, others, and the environment.

The application of the character value approach in learning is very important to create a positive educational atmosphere and support the formation of excellent individuals. In addition, this approach does not only aim to master knowledge and skills, but also to shape students to live a life based on moral values that help them face the challenges of life. This approach can be integrated with various learning models, such as Problem-Based Learning (PBL), to create a more relevant and meaningful learning experience, which supports the holistic development of student character, including cognitive, affective and psychomotor aspects. In implementing character education, a breakthrough was made to establish six Pancasila learner profiles (Aziz & Hasanah, 2022). Character is the psychological characteristics, behaviors, and basic values of a person that are formed through experience and learning (Amalia & Najicha, 2023). Character values are personality qualities that include attitudes, behaviors, and moral values that guide individuals in interacting with themselves, others, and the environment. Character value development is very important in the formation of a young generation that is not only academically intelligent, but also has noble character and the ability to contribute positively to society.

In the context of education in Indonesia, character values are closely related to the Pancasila Learner Profile, which is the main goal in shaping the character of students in accordance with the values of Pancasila. The Pancasila Learner Profile consists of six main dimensions: faith, devotion to God Almighty, noble character, mutual cooperation, independence, critical thinking, and creativity. Each of these dimensions reflects important aspects in the life of the nation and state, which must be instilled early in education (Kementerian Pendidikan dan Kebudayaan Republik Indonesia, 2020).

Education that integrates Pancasila character values aims to form students who not only excel academically, but also have high morality, are able to adapt to the times, and always uphold the common good. Therefore, characters that include honesty, responsibility, social care, as well as mutual respect and tolerance become a solid foundation in shaping the next generation of quality nations.

In Indonesian education, character values are closely related to the Pancasila Student Profile, which includes six main dimensions: faith, piety, noble character, mutual cooperation, independence, critical reasoning, and creativity. Education that integrates Pancasila character

values aims to form a young generation that is not only intelligent, but also has high morality and can contribute positively to society.

Learning Outcomes

Learning outcomes are one of the important aspects in the education system that describes the level of competency achievement of students after participating in the learning process. Learning outcomes not only include cognitive aspects, but also include psychomotor and affective aspects, all of which interact with each other in supporting the overall development of learners. The process of assessing learning outcomes begins with developing a clear and structured evaluation plan. The next step is to collect relevant data, which must then go through a verification process to ensure its accuracy. After that, the verified data is compiled and collected for further analysis. The results of the analysis are then interpreted and summarized to provide a deeper understanding of student achievement. Finally, follow-up evaluation is conducted to plan the necessary remedial or reinforcement measures to support the improvement of student learning outcomes in the future (Rosfiani et al., 2023). This is closely related to everything that a person achieves through the process, resulting in changes in behavior, mindset, and abilities (Basri & Akhmad, 2022). In summary, learning outcomes are an important aspect in the education system that reflects the overall achievement of learner competencies, including cognitive, psychomotor, and affective aspects. The process of assessing learning outcomes is carried out systematically, starting from evaluation planning, data collection, verification, analysis, to interpretation. These steps aim to provide a deep understanding of student achievement as well as a basis for planning improvements or strengthening to support improved learning outcomes in the future. This whole process plays a role in encouraging positive changes in students' behavior, mindset and abilities.

Cognitive

The cognitive domain, first introduced in the educational taxonomy by Bloom (1956), is one of the essential elements in the learning process. This domain involves various levels of thinking ability, starting from basic levels such as memorizing information to higher levels, including analysis, evaluation, and creation. In the context of physics learning, cognitive aspects have a significant role because students are required to understand scientific concepts, analyze experimental data, and apply theory to solve various problems. Anderson and Krathwohl (2001) revised the cognitive domain into six levels that describe the thinking process from the simplest to the most complex. The first level is Remembering, which is the ability to memorize or recall information that has been learned. Next is Understanding, which means being able to capture the meaning of the information or concepts received. The Applying level involves using concepts or knowledge in new situations or everyday life. At the Analyzing level, a person can break down information into small parts and understand the relationship between these parts. Then, Evaluating is the ability to provide judgment based on certain criteria. Finally, Creating is the ability to combine various ideas or elements into something new and innovative (Anderson et al., 2001).

Affective

The affective domain relates to an individual's attitudes, values, emotions and responses to learning (Krathwohl, D. R., Bloom & Masia, 1964). This domain is one of the important aspects in education because it reflects how learners accept, respond to, and internalize the values taught. In physics learning, the development of affective domain can be done by encouraging students to appreciate the scientific process, have high curiosity, and show a responsible attitude towards the environment and society. In physics learning, the development of affective aspects can be done by encouraging students to appreciate the scientific process, foster curiosity, and show responsibility for the environment and society. In the context of the Pancasila Student Profile, affective aspects in physics learning need to be integrated with six main characteristics. First, Faithful, devoted to God Almighty, and noble, which can be realized by encouraging gratitude for natural phenomena and maintaining a balance between knowledge and morality. Second, Global diversity, by teaching students to respect differences and understand intercultural interrelationships. Third, Independent, by designing learning that builds independence in solving scientific problems. Fourth, Mutual cooperation, through activities such as group experiments that train cooperation. Fifth, Critical reasoning, by encouraging students to analyze, evaluate, and solve problems. Finally, Creative, by providing space for students to create innovative solutions that are relevant to real life (Kemendikbud, 2020).

Psychomotor

The psychomotor domain in education focuses on developing physical skills that involve coordination between body and mind. In learning, psychomotor consists of several levels of skills that develop gradually. At the first level, imitation, students follow the movements or steps taught, such as imitating how to do a physics experiment shown by the teacher. Next, manipulation is the ability of students to perform tasks or experiments based on the instructions given, although they still need instructions. At the precession level, students are able to perform experiments more precisely and efficiently, following procedures more accurately. Articulation involves students' ability to combine learned skills to perform more complex tasks, such as combining different experimental techniques to solve more complicated physics problems. Finally, naturalization is the highest level where skills become automatic, and students can perform physics experiments or procedures independently without needing to think hard or rely on instruction anymore (Simpson & J., 1972).

Research Method

This study used a One Group Pretest-Postest experimental design. This study aims to determine the effect of applying the Problem Based Learning (PBL) model integrated with character values on improving students' cognitive, affective, and psychomotor competencies in physics learning.

The data collection instruments in this study consisted of four main components, namely cognitive tests, psychomotor observation sheets, affective questionnaires, and self-reflection. Cognitive tests are written tests designed to measure the understanding of physics concepts of students, with questions that are in accordance with the topics studied, namely forms of energy and energy transformation. Cognitive tests use essay questions that aim to assess the understanding of concepts and the application of physics in everyday life. The Psychomotor Observation Sheet is used to assess the practical skills of students in carrying out physics experiments, for example in experiments on kinetic and potential energy. The assessment criteria are carried out by observing students' abilities at each stage of the skills they master. At the imitation stage, the assessment is done by looking at the extent to which students can follow the experimental steps taught by the teacher, although they still depend on instructions. At the manipulation stage, students are assessed based on their ability to perform the experiment or task following the instructions given, although sometimes they still need help. At the precession level, students are assessed based on their accuracy and efficiency in following the experimental procedure with few errors. At the articulation level, assessment is done by looking at students' ability to combine learned skills to complete more complex tasks, such as more elaborate experiments. Finally, at the naturalization level, students are assessed on their ability to conduct experiments independently without assistance or instruction, and to do so automatically and precisely. The Affective Questionnaire is used to measure students' attitudes and character values, which are in accordance with the elements of the Pancasila learner profile. This questionnaire uses a Likert scale to measure the level of activeness and attitude of learners towards PBL-based learning integrated with character values. Finally, Self Reflection asks learners to write down their personal experiences during PBL-based learning that integrates character values. This reflection aims to explore their understanding of the material learned and how they feel the character learning applied in the process.

The sample of this research is the X grade students at SMAN 1 Jeneponto. The sampling technique in this study used purposive sampling, which is to select class X students at SMAN 1 Jeneponto who meet certain criteria. The criteria are students who have never participated in learning using the Problem Based Learning (PBL) model that integrates character values in physics learning. The selection of samples with this technique aims to ensure that the samples involved in the study really do not have experience with the learning model being tested, so that the impact of the application of the PBL model with a character value approach can be more clearly measured.

The data collection procedure in this study begins with the preparation stage, namely compiling teaching modules based on the Problem Based Learning (PBL) model integrated with character values, as well as compiling and validating data collection instruments such as cognitive tests, psychomotor observation sheets, and affective questionnaires. In the learning implementation stage with the application of the Problem Based Learning (PBL) model integrated with character values, the material of energy forms and energy transformation is given. Data collection is carried out through several steps, starting with a pre-test, where students fill out an affective questionnaire and take an initial cognitive test before learning begins. At the end of each learning cycle, cognitive tests and psychomotor observations were conducted to assess students' practical skills. At the end of the study, learners filled out an

affective questionnaire to assess changes in attitude and character values achieved during the learning process. Data analysis was conducted using descriptive analysis to calculate the average score of cognitive tests, psychomotor observation sheets, and affective questionnaires, as well as to see the development of attitudes, skills, and concept understanding based on self-reflection. For inferential analysis, t-test was used to compare the results between cognitive pre-test and post-test, as well as affective questionnaire and psychomotor observation sheet, the analysis was conducted with the help of SPSS VERSION 30.0.

Result

Data analysis was conducted using descriptive analysis to calculate the average score of cognitive tests, psychomotor observation sheets, and affective questionnaires, as well as to see the development of attitudes, skills, and concept understanding based on self-reflection. For inferential analysis, t-test was used to compare the results between cognitive pre-test and post-test, as well as affective questionnaire and psychomotor observation sheet. The data obtained are as follows:

Table 1. Mean and Standard Deviation of Cognitive Test Scores, Psychomotor Observations, and Student Affective Questionnaires

Variable	Average	Standard Deviation
Cognitive Test	84,6	5,2
Psychomotor Observation	86,5	4,8
Affective Questionnaire	80,5	5,0

Based on the data above, it can be seen that the highest average score is in the Psychomotor Observation which is 86.5, followed by the Cognitive Test which is 84.6, and the Affective Questionnaire which is 80.5. This shows that the application of the PBL-NK model has a significant positive impact on students' practical skills in physics experiments. Furthermore, the results of the analysis of significant differences between pre-test and post-test on the Cognitive Test, as well as changes in attitudes and skills based on Affective Questionnaires and Psychomotor Observations, were carried out paired t-test. The following are the results of the t-test:

Table 2. Comparison of Pre-Test and Post-Test Results on Cognitive Tests,Psychomotor Observations, and Affective Questionnaires with t Tests

Variabel	Pre-Test	Post-Test	t count	t table Significance	Significance
Cognitive Test	70,02	84,6	8,5	2,03	0,000
Psychomotor Observation	75,3	86,5	9,2	2,03	0,000
Affective Questionnaire	70,1	80,5	7,8	2,03	0,000

The t-test results show that the t-count value is greater than the t-table on all variables, with a value of less than 0.05. This indicates that there is a significant difference between the

pre-test and post-test on the Cognitive Test, as well as a significant increase in the Psychomotor Observation and Affective Questionnaire after the application of the PBL-NK model. Thus, it can be concluded that the application of PBL-NK model is effective in improving students' cognitive, affective, and psychomotor competencies in physics learning.

Discussion

Based on the analysis, the highest average score was obtained in the Psychomotor Observation (86.5), followed by the Cognitive Test (84.6), and Affective Questionnaire (80.5). These findings indicate that the application of the Problem Based Learning model integrated with character values (PBL-NK) has a significant positive impact on students' practical skills in physics experiments or in this case significantly on students' psychomotor competence. The PBL-NK model encourages students to learn actively and be involved, not only in understanding the material (cognitive), but also in physical skills (psychomotor) and attitudes (affective). The findings are obtained by obtaining higher scores on Psychomotor Observation because PBL-NK gives students the opportunity to directly engage in physics experiments that involve physical skills, such as observation, measurement, and use of tools. This is in line with Simpson's theory (1972) which explains that motor or psychomotor skills are easier to master when students are directly involved in practical activities (Simpson & J., 1972). In addition, the results on the Cognitive Test show that students not only understand the theory, but can also apply it in solving physics problems. This supports Gagné's (1985) theory which emphasizes that well-structured learning helps students understand concepts more deeply (Gagné & M, 1985).

Furthermore, the affective aspect in PBL-NK reflects students' positive attitude towards learning and the way they demonstrate character values in accordance with the Pancasila Learner Profile. The Pancasila Learner Profile emphasizes the importance of building strong characters, such as a sense of responsibility, cooperation, creativity, and the courage to think critically. Therefore, education that integrates these character values is important in forming deep affective attitudes, not only in theoretical understanding, but also in decision-making and action. In PBL-NK, students interact with the subject matter while working in groups, which requires them to cooperate, respect each other, and take responsibility. This learning encourages character development that is closely related to the dimensions of the Pancasila Student Profile, such as mutual cooperation, critical thinking, independence, and creativity. In the context of PBL-NK, Piaget's theory is relevant to explain how students through interaction in problem-based learning can develop moral understanding and affective attitudes in accordance with Pancasila values (Piaget & J., 1972).

Conclusion

This study proves that the PBL-based learning model integrated with character values is able to significantly improve student competence in physics learning. The three aspects of competence improved include psychomotor, cognitive, and affective competence.

Psychomotor competence, which includes students' practical skills such as conducting physics experiments, achieved the highest average score of 86.5. Cognitive competence, which reflects students' understanding of concepts and ability to solve problems, achieved an average score of 84.6. Meanwhile, affective competence, which involves positive attitudes and character values in accordance with the Pancasila Student Profile such as cooperation, independence, and critical thinking, obtained an average score of 80.5. These results show that the PBL model that integrates character values not only helps students understand the material more deeply, but also supports their character building. This approach is in line with the objectives of the Merdeka Curriculum, which emphasizes contextual learning and the development of students' abilities as a whole. Therefore, it is recommended that teachers be trained to use this model effectively, and PBL-NK-based teaching materials be developed in various subjects. In addition, further research with a wider population coverage is needed to test the benefits of this model in various educational contexts.

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