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Increasing Critical Thinking Skills and Interest in Learning Physics for Class X High School Students through the Implementation of Problem-Based Learning

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Abstract: *The research aims to increase critical thinking skills, interest in learning physics, and alternative energy materials through the PBL model. This type of research applies classroom action research (CA) with the subject of research being class X.5 students at SMA 4 Pekanbaru, totaling 36 students. CA is carried out in 2 cycles with the stages of each cycle consisting of planning, action, observation, and reflection. Data collection uses observation sheets, tests of critical thinking skills, and learning interest questionnaires. Data on critical thinking skills and interest in learning were analyzed descriptively through data obtained in cycles 1 and 2. The results of the research were: 1) students' critical thinking abilities increased from cycle 1 to cycle 2, based on observation results, it increased from the sufficient category in cycle I to the good category in cycle II and test results increased from middle category in cycle I to high category in cycle II, 2) students' interest in learning increased with a score of 76.08 in cycle I to 79.75 in cycle II with the same category, namely high. It was concluded that the application of worksheet students with the PBL model was able to improve the critical thinking skills and interest in learning of class X.5 students at SMA 4 Pekanbaru in learning physics about alternative energy materials.*

Keywords: *alternative energy, critical thinking skills, learning interest, problem-based learning*

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Meningkatkan Keterampilan Berpikir Kritis dan Minat Belajar Fisika Siswa Kelas X SMA melalui Penerapan *Problem Based Learning*

Abstrak: Tujuan kajian untuk meningkatkan keterampilan berpikir kritis serta minat belajar pada pembelajaran fisika, materi energi alternatif melalui model PBL. Jenis kajian menerapkan penelitian tindakan kelas dengan partisipan kajian siswa kelas X.5 SMA 4 Pekanbaru yang berjumlah 36 siswa. PTK dilaksanakan 2 siklus dengan tahapan setiap siklus terdiri dari perencanaan, tindakan, observasi dan refleksi. Pengumpulan data menggunakan lembar

observasi, tes keterampilan berpikir kritis, dan angket minat belajar. Data keterampilan berfikir kritis dan minat belajar dianalisis secara deskriptif melalui data yang diperoleh pada siklus 1 dan 2. Hasil penelitian didapatkan: 1) kemampuan berpikir kritis siswa mengalami peningkatan dari siklus I ke siklus II, berdasarkan hasil observasi meningkat dari kategori cukup pada Siklus I menjadi kategori baik pada Siklus II dan hasil tes mengalami peningkatan dari kategori sedang Siklus I ke kategori tinggi pada siklus II, 2) minat belajar siswa mengalami peningkatan dengan skor 76,08 Siklus I menjadi 79,75 pada Siklus II dengan kategori sama yaitu tinggi. Disimpulkan bahwa bahwa penerapan LKPD dengan model PBL mampu meningkatkan keterampilan berpikir kritis dan minat belajar siswa kelas X.5 SMA Negeri 4 Pekanbaru pada pembelajaran fisika materi energi alternatif.

Kata Kunci: energi alternatif, keterampilan berpikir kritis, minat belajar, problem-based learning

Introduction

Physics is part of natural science. Physics is a science that studies natural phenomena and the interactions within them (Aththibby, 2015). Physics teaching is intended to understand and use scientific methods, master physics concepts, apply a scientific attitude, meet personal and societal needs, and be aware of future careers (Annisa et al., 2022).

Most physics learning in schools tends to be informative and merely transfers knowledge from teacher to student, without being actively involved in showing why this knowledge is important to learn. It is difficult for students to be active in the learning process, so they think of physics as a difficult subject and contains formulas and theories, without knowing how to apply it in everyday life. Even though it should be very closely related to everyday life, such as learning alternative energy material (Ady, 2022; Wangchuk et al., 2023).

One aspect that can encourage students to successfully study physics is the need for interest in learning. Interest is a person's awareness of something and what encourages a person to focus attention on something accompanied by feelings of satisfaction and pleasure (Hamdi & Rahim, 2020). Interests are not inborn but can be acquired later. Interest is a form of liking and interest in something or an activity that is done without anyone telling you (Yosefa & Benge, 2017). Interest in learning can be aroused by connecting lesson material with sensational news that most students already know (Arni et al., 2022). For example, news about hail that occurred in the Pekanbaru City area. Before teaching about global warming, teachers can ask what causes hail. Then the news is linked to the lesson topic gradually. Apart from that, teachers play a very important role in fostering interest in learning. Teachers must foster interest in learning in students continuously so that student interest becomes higher (Husna et al., 2022).

Learning that can involve students actively, especially in mental activities, is one factor that can help develop critical thinking skills. Critical thinking skills are the skills to think logically and systematically in making decisions or solving a problem. Activities in critical thinking include 1) clarifying statements received or proposed, 2) looking for additional information, 3) looking for what is implied from what is written, and 4)

evaluating statements based on the results of previous activities. The indicators of critical thinking are: a) providing simple explanations, b) building basic skills, c) making inferences, d) making further explanations, and e) organizing strategies and techniques (Rachmawati et al., 2015).

Critical thinking skills are included in the assessment of the comprehensive international survey program (PISA). The achievements achieved by Indonesian students in PISA are still below the average of OECD countries. So the quality of Indonesian education needs to be improved. One effort that can be made is to increase students' critical thinking skills in Indonesia (Putrawangsa & Hasanah, 2022).

Critical thinking skills be able to stimulated by implementing the Problem-Based Learning (PBL) learning model (Khairunisa et al., 2020). PBL includes a learning model that is awareness-based, solving problems that are linked to real life and can improve students' problem-solving skills (Munawaroh & Sholikhah, 2022). The relationship between PBL model learning and critical thinking skills, according to the stages, can train students' critical thinking skills. So it can be seen that there is a plan to stimulate critical thinking skills by developing learning tools using the PBL model (Apriyani et al., 2017). Therefore, you can use SW which is prepared and designed to attract interest and train students' critical thinking skills in learning.

Student Worksheets (SW) are a learning resource in the form of sheets containing assignments that students need to complete. Student Worksheets contain a set of basic activities that must be carried out by students to maximize understanding to form basic abilities by the achievement indicators taken (Trianto, 2011). The preparation of the SW must also meet several requirements. Requirements that must be met include: 1) didactic requirements, meaning that the SW follows the principles of effective teaching and learning, 2) construction requirements, namely using language, language structure, vocabulary, level of difficulty, and level of clarity according to the student's level of development, to make it easier to use the SW. , 3) technical requirements by paying attention to appropriate writing, images, and appearance of the SW (Khairunisa et al., 2020).

The results of interviews with physics teachers at SMA 4 Pekanbaru revealed that the assessment of students' critical thinking skills was not optimal. Critical thinking skills are only assessed through observing student activities in learning. Based on information from teachers, the critical thinking skills of class X.5 students at SMA 4 Pekanbaru are still relatively low and most of them have difficulty mastering physics material. The results of identifying the causes include, among other things, that X.5 students' interest in learning and curiosity are still low. They do not have a very high awareness of looking for learning material from other sources, apart from textbooks and teachers. Based on the results of the questionnaire distributed before the research was carried out, it also showed interest in studying physics for class X.5 students the overall average score was only 74.31, which is in the high category but has not an impact on the results of high critical thinking skills.

Therefore, it is important to carry out classroom action research for class X.5 students at SMA 4 Pekanbaru using worksheets that apply the problem-based learning

model as teaching materials to be able to understand physics, especially alternative energy materials well. The teaching materials used aim to increase students' interest in learning and critical thinking skills in studying physics material, especially alternative energy.

Research Methods

This research is classroom action research (CAR) which involves teachers in the physics learning process in one of the high school classes. The research participants were students in class X.5 SMA 4 Pekanbaru with a total of 36 students. The research lasted for 6 months in semester 2 of the 2022-2023 academic year. The research procedure was carried out in two cycles, namely cycle 1 and cycle 2, referring to the Kemmis & Mc classroom action research model. Taggart (Kemmis et al., 2014). Each cycle consists of 3 face-to-face meetings and each cycle carries out 4 stages, namely the planning stage, action implementation, observation, and reflection according to Figure 1.

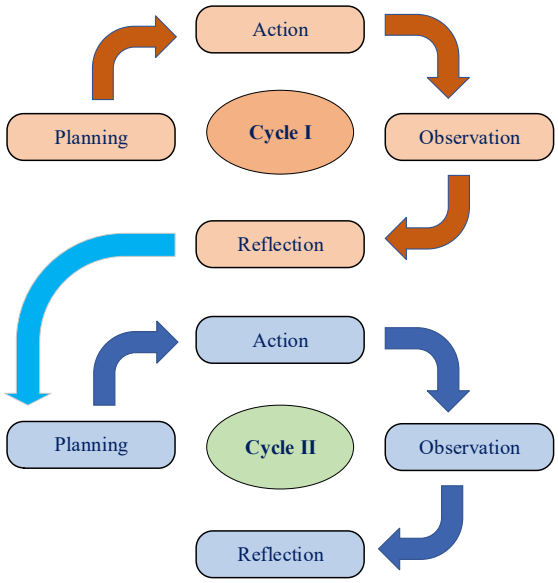

Figure 1. Spiral Classroom Action research model (Kemmis et al., 2014).

The first stage: is planning, starting with observations to identify student problems, compiling teaching modules, compiling learning outcomes tests, compiling questionnaires, compiling student observation sheets, and also worksheets according to learning objectives. The second stage: implementing actions, and carrying out the learning process in class according to the teaching modules and worksheets that have been prepared previously. Learning activities include 1) preliminary activities, 2) core activities, and 3) closing activities. The third stage: is observation, carried out simultaneously during the implementation of learning by making observations during the implementation of the action. Observation activities were assisted by 2 observers. Fourth stage: reflection, carried out after carrying out learning for corrective action at the next meeting so that better results can be obtained than the previous cycle.

Data collection techniques used were observation and critical thinking skills tests as well as administering learning interest questionnaires. Observations during the learning process are adjusted to indicators of critical thinking, namely: expressing opinions, considering instructions appropriately, reporting results, providing simple explanations, taking responsibility for discussion results, and writing conclusions. Assessment uses a rubric adapted from studies (Dewi & Mitra, 2014; Karmila, 2023). Observers carry out observations and notes related to the implementation of learning in the classroom, as well as behavior and activities related to critical thinking skills during the teaching and learning process without disturbing learning activities. Categorization of observation results according to Table 1.

Table 1. Categories observations of critical thinking skills

Range	Category
3,51 - 4,00	Very Good
2,51 - 3,50	Good
1,51 – 2,50	Enough
1,00 – 1,50	Less

Source: (Kemendikbud, 2014)

The critical thinking skills test consists of 12 questions for cycle 1 material and 12 questions for cycle 2 material, where the preparation of questions is based on indicators of critical thinking ability. The tests are taken by individual students and carried out at the end of cycle 1 and cycle 2. The results are analyzed to determine the test scores for student learning outcomes. Critical thinking skills test indicators refer to Ennis' theory (Ennis, 2011; Septiara, S., & Nurita, T. (2021).) namely: 1) being able to provide simple explanations, 2) concluding, 3) building basic skills, and 4) provide further explanation.

The interest questionnaire was given 3 times to measure students' level of interest in learning physics before treatment and after cycles 1 and 2. An interest questionnaire was used which was valid with a Cronbach's Alpha value of 0.878 which had been developed (Rahmad, 2018). The questionnaire assessment uses a 1-4 Likert scale, where the items consist of positive and negative statements. The questionnaire results were processed descriptively statistically by looking at the calculated average value (mean) to determine the range of values for categorizing learning interests. The number of items on the interest in learning instrument consists of 26 items with 4 alternative answer choices (strongly disagree, disagree, agree, strongly agree). The scores given are 1, 2, 3, and 4. Students' critical thinking skills and learning interests are determined by category according to Table 2.

Table 2. Categories of critical thinking skills and student interests

Interpretation	Category
$81{,}25 < X \leq 100$	Very high
$71{,}5 < X \leq 81{,}25$	High
$62{,}5 < X \leq 71{,}5$	Middle
$43{,}75 < X \leq 62{,}5$	Low
$0 < X \leq 43{,}75$	Very Low

Source: Adaptation (Setyowati, 2011).

Results and Discussion

The results of classroom action research (CA) were carried out in 2 cycles, namely cycle I and cycle II to increase students' critical thinking skills and interest in studying physics in class X.5 SMA 4 Pekanbaru. In the planning stage in cycle 1, teaching modules, worksheets, and media related to alternative energy were prepared for 3 meetings. In the implementation stage, learning is using the Problem-Based Learning model. The observation stage is carried out in the learning process to observe the learning process and students' critical thinking skills. The reflection stage is to identify learning implementation and administer critical thinking skills tests and student interest questionnaires. This stage is the basis for improving the modules and devices used in cycle 2. For cycle 2 the next material.

1. Results of analysis of critical thinking skills

The observation analysis related to critical thinking skills obtained an average overall score in cycle I, namely 2.47, in the sufficient category, and in cycle II, the average overall score for students was 3.22, in the good category. This means that there is an increase in critical thinking skills by 0.75 or 18.75%.

The results of the students' critical thinking skills test at the end of the first cycle meeting showed that 19 students had completed it, while 17 students had not completed it, the percentage of completion was 52.77%. The highest score obtained for cycle I was 83.33, and the lowest was 58.33 with a class average of 71.66. Thus, the average critical thinking skills of class X.5 students in cycle I are in the high category. There are 3 students with critical thinking skills in the very high category, there are 16 students in the high category, 16 students in the middle category, and 1 student in the low category.

The test results at the end of the second cycle meeting showed that 33 students completed it while 3 students did not complete it, the completion percentage was 91.66%. The highest score obtained for cycle II was 83.33, and the lowest was 66.66 with a class average of 78.24. Thus, the average critical thinking skills of class X.5 students in cycle II fall into the high category with 17 students in the very high category, 16 students in the high category, and 3 students in the middle category. Critical thinking skills are shown in Figure 2.

Based on Figure 2, it is known the value of critical thinking skills for class X.5 students in indicator 1 (able to provide a simple explanation), the value increased from cycle I to cycle II, namely 7.4 with the middle category in cycle I to the high category in cycle II. Indicator 2 (concludes) there was an increase in value of 16.67 with the high category in cycle I becoming the very high category in cycle II. Indicator 3 (building basic skills) increased by 16.67 with the low category in cycle I becoming high in cycle II. Meanwhile, indicator 4 (providing further explanation) experienced a decrease of 13.89, which was in the high category in cycle I and in the middle category in cycle II.

Cycle 1 students' critical thinking skills were obtained: Indicator 1: able to provide simple explanations given 3 multiple choice questions. A total of 20 students answered question number 1 incorrectly, which was a question about illustrating the effect of height

on the potential energy of an object. For question number 2 regarding the infographic presented, all students answered correctly, and for question number 3 regarding fossil energy sources, 12 students answered incorrectly.

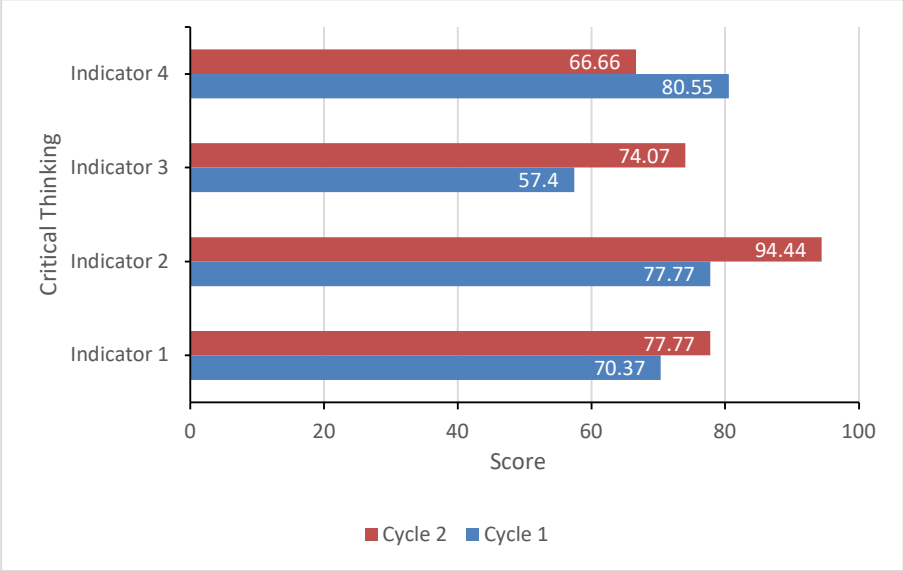

Figure 2. Critical thinking skills test results.

Indicator 2: concludes given 3 multiple choice questions. A total of 22 students answered question number 4 incorrectly, namely the question regarding the business a person undertakes, question number 5 regarding power plants that can be developed in a region, only 1 student answered incorrectly and question number 6 regarding renewable energy that can be developed in a region also only 1 student who answered incorrectly.

Indicator 3: building basic skills given 3 multiple-choice questions. A total of 15 students answered question number 7 incorrectly, which was about the amount of energy in a roller coaster track. In question number 8 regarding kinetic energy in the trajectory of a ball kick, 13 students answered the question incorrectly. Furthermore, on question number 9 regarding mining materials, which are energy sources, 16 students answered incorrectly.

Indicator 4: provides further explanation and also provides 3 multiple choice questions. A total of 5 students answered question number 10 incorrectly regarding the application of the law of conservation of energy in the event of an apple falling, 13 students incorrectly answered question number 11 regarding the effect of force on the amount of work, and question number 12 regarding the use of energy wisely, as many as 3 students answered incorrectly.

Cycle 2 students' critical thinking skills were obtained: Indicator 1: able to provide simple explanations given 3 multiple choice questions. Question number 1 regarding the main obstacles in building a nuclear power plant only 1 student answered incorrectly. Question number 2 regarding the advantages of geothermal power plants had 2 students incorrectly and question number 3 regarding energy changes in water mills had 21 students answer incorrectly.

Indicator 2: concludes given 3 questions. Question number 4 regarding alternative energy that can be developed from natural resources only 1 student was wrong. Question number 5 regarding observing waterwheels was all students correct and question number 6 regarding physics concepts applied to waterwheels was 5 students who answered incorrectly.

Indicator 3: building basic skills given 3 questions where question number 7 determines the greatest potential energy contained in a water wheel, all students answered correctly. Question number 8 determined the greatest kinetic energy contained in a water wheel, only 1 student was wrong. Question number 9 determines the greatest mechanical energy contained in a water wheel, 27 students answered incorrectly.

Indicator 4: provides further explanation given 3 questions. Question number 10 regarding the explanation of the scheme presented was 5 students answered incorrectly. For question number 11 regarding the meaning of the message conveyed in the article, all students answered correctly, and for question number 12 regarding calculations based on the article presented, 31 students answered incorrectly.

The results of data analysis found that many students still answered incorrectly on potential, kinetic, and mechanical energy concept questions, and also on calculation questions. The questions given are related to literacy questions from infographics and articles. It can be seen that the majority of students are quite thorough in reading literacy questions and analyzing questions, as this is proven by the large number of students who answered correctly.

The fourth indicator of critical thinking skills, namely providing further explanation, actually decreased from cycle I to cycle II as seen in the graph Figure 1. This means that many students made mistakes in answering question number 12 in the cycle II test and the students' ability to do so was limited. count operation. These results indicate that the PBL model used needs to emphasize the need for sufficient practice in solving calculation problems. This is to the test results obtained from the study by Annisa et al., (2022) where students' critical thinking skills increased as in class X.5 SMA 4 Pekanbaru.

Cycle II learning is carried out by solving the problem of how to develop alternative energy. Students solve the problem in groups and all members look enthusiastic and involved in solving it. This is what improves critical thinking skills in cycle II.

2. Student Learning Interest

The analysis of students' learning interest in Cycles I and II is shown in Figure 2 where the average obtained for Cycle I was 76.08 in the high category. This can be seen from the learning carried out showing that the majority of students have participated quite actively in learning and completing the worksheet. This means that class X.5 students' interest in learning in cycle I still needs to be increased.

Cycle II, obtained questionnaire results with a calculated average of 79.75 and this value is still in the high category. However, there was an increase of 3.67 compared to interest in cycle I. This means that most of the learning interest scores of class X.5 students in cycle II were still in the same category. It can be seen that student interest in cycle II increased, with only 16 students whose interest scores increased in cycle II.

Several students experienced a decrease in interest in learning because, in cycle II, learning was carried out by solving problems related to the application of conceptual and mathematical calculations related to alternative energy. Students experience a decrease in interest in learning because they feel they lack the ability to analyze mathematical questions.

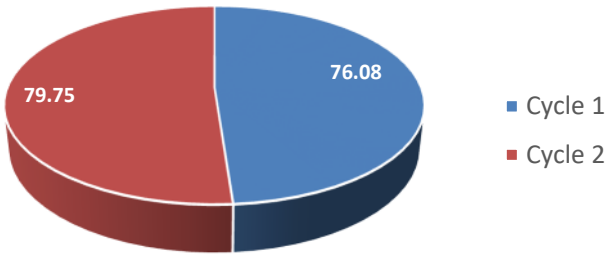

Figure 3. Results of learning interest.

Figure 3 shows a graph of student interest in learning which has increased from cycle 1 with a score of 76.08 to 79.75 to cycle 2 with the same category, namely the high category. Even though the increase is not yet optimal, these results show that the use of the PBL model can increase students' interest in studying physics in class X.5 SMA 4 Pekanbaru such as research (Karmila, 2023) that the application of the PBL model assisted by worksheets can increase students' interest in learning physics.

Students' critical thinking skills in learning activities after implementing the Problem-Based Learning model succeeded in improving students' critical thinking skills where the observation results increased from the fair category to the good category and the overall critical thinking skills test results increased from the middle category to the high category, while their interest in learning was only experienced a slight increase in the same category between cycle I and Cycle II, namely the high category.

The results of observations and tests of student's critical thinking skills using Worksheets PBL were proven to be able to improve the critical thinking skills of students in class X.5 SMA 4 Pekanbaru on alternative energy materials. These results are in line with research from (Payadnya et al., 2024; Juniarti, 2014). The PBL learning model can be used as a solution in the physics learning process to develop students' scientific knowledge and critical thinking skills, as research conducted by Sari et al., (2023), shows that the application of PBL has an influence on students' critical thinking skills and also research (Muslim et al., 2015) where PBL can significantly improve high school students' mastery of concepts and critical thinking skills.

Although the implementation of this class action has succeeded in increasing the critical thinking skills and interest in learning of Class X.5 students at SMA 4 Pekanbaru, however, there were still obstacles in Cycle I related to learning time management, where not all groups had the opportunity to present the results of their discussions because the time allocation was not appropriate. However, this condition can be resolved at

subsequent meetings. Meanwhile, in cycle II, the obstacle encountered was the lack of practice in solving analytical questions that required mathematical analysis, resulting in a decrease in the critical thinking indicator aspect and this also had an impact on increasing interest which was not yet optimal. Sufficient training guidance is needed for mathematical calculation problems so that critical thinking skills and interest can be maximized.

Conclusion

The classroom action research that has been carried out, it is concluded that the use of worksheets with the implementation of the Problem-Based Learning model in learning physics about alternative energy materials can increase students' critical thinking skills through observation, increasing the good category and through tests also increasing to the high category in cycle 2. Interest in learning students also experienced an increase from cycle 1 to cycle 2, but their category remained in the high category. The use of LKS based on problem-based learning has succeeded in increasing creative thinking skills and interest in learning in Class X.5 SMA 4 Pekanbaru students.

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