The implementation of problem-based learning modules to decrease misconception on Newton’s law topic

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Abstract. Misconception of physics learning among senior high school students caused the lack of understanding about the physics itself. The purpose of this research was to find out whether the problem-based learning modules can decrease misconception and improve students’ learning outcomes on Newton’s law. Meanwhile, the research method used in this study was quasi experiment. This research was conduct at grade ten-E as experimental group and grade ten-D as control group. Diagnostic test used as the research instrument. Students’ misconception was analyzed using CRI Three Tier. The research showed that the level of students’ misconception in experimental class having implemented the modules decreased 70%. The misconception in control class after direct instruction applied also lessened by 37%. This proves that the decrease of misconception in experimental class outnumbers than in control class. Furthermore, students’ learning outcomes after the treatment given revealed that $t_{count} > t_{table}$ which are 7.64 > 1.68. It means that there are significant differences on students’ learning outcome average after implementing problem-based learning modules. In conclusion, the implementation of problem-based learning modules can decrease students’ misconception and improve students’ learning outcome.

1. Introduction

Physics is one of sciences in which we learn about nature phenomena and all interactions in the world. However, physics lesson is still less interesting to students since they think that physics is so difficult to understand. That is why many of students have very low learning outcomes. Teachers have important roles to succeed students in physics learning. The teacher commonly explains physics concept using direct learning in which students are rarely involved in various classroom activities. As a result, there are students who do not understand about explanation from the teacher. This proves that misconception can occur due to the improper learning activities that were carry out by the teacher. Teachers or tutors can also be the cause of misconception if they have poor physics understanding [1].

Based on the school data gathered from the results of national examination and learning, the score of physics subject from one of senior high school students in 2016/2017 academic year was 41, 19. At the province level 31, 09 and 33, 45 were at the level of regency/municipality and 38, 89 was obtained in one of senior high schools in Aceh Besar. Besides, the last examination score from one of students in XA 2017/2018 academic year was 60, 59. It can be concluded that the score of physics subjecting either national examination or last examination is still very low.

The learning outcomes of physics lesson still low in senior high school proved by the lack of facilities and learning media in the school. One of them is that learning process is solely based on
textbooks and do not use other learning media. From results of observation and interview also showed that there was lack of understanding of physics concepts. In addition, students’ interest in learning physics was also low. Students used physics concept not based on actual theory, so there were misconceptions. One of the most topics in physics that often gets misconception is Newton's law.

The misconception that happens in senior high school especially in Newton’s law lesson requires the media that can improve the understanding about this topic. Moreover, in previous studies also showed that many misconceptions were found in other physics topics. One of misconceptions in Newton's law material is that the objects that are moving at constant speed do not work in balanced forces. Even if students think that, two objects that interact with each other through a style of action and reaction that are not as great.

Some researchers tried to discuss misconceptions on topics of physics. Misconception that occur on elasticity and Hooke’s law concept [2], temperature and heat [3], substances article arrangement, particle movement as heat intermediary and particle arrangement changes caused by heat [4], and basic concepts related to temperature and heat, heat influence on things (expansion, temperature change, form changing), and heat transfer are the difficult concepts to students [5].

Based on the problems in relation to the misconceptions faced by students, one method to overcome it and to reduce its difficulties by implementing a learning module in which conceptual descriptions of physics structured systematically. This module can also arrange in various techniques such as modules in the form of problem-based learning steps, which include formulating problems, formulating hypotheses, collecting data, testing hypotheses and formulating problem solving recommendations. Problem-based learning being chooses because it can stimulate high-level thinking [6]. Modules can also apply based on the mapping concept, because it is easier for students to understand the concepts in science [7]. Modules are also learning tools that contain lessons, methods, boundaries and ways of evaluating systematically and interestingly designed to achieve competencies expected accordance with the level of complexity [8]. The use of modules is expected to support the learning process independently so that the structured activities in the module can also increase students’ creativity and thinking skills needed in the 21st century today [9]. PBL is a teaching method where relevant problems introduced at the beginning of the instruction cycle and used to provide context and motivation in ongoing learning. Problem-based learning also teaches students to be responsible for the learning [10].

2. Methods
This research is taken in one of senior high schools in Aceh Besar. The research method was quasi experimental with pretest posttest group control design. The research sample taken from two classes, which grade ten-D consisted of 24 students, and grade ten-E comprised 28 students. The research in control class used direct instruction, meanwhile; in experimental class, the problem-based learning modules were used. Furthermore, the sample in this research was chosen using purposive sampling technique.

Misconception was analyzed to know the level of students’ understanding at a senior high school in Aceh Besar. Misconception in students’ answers was analyzed using CRI three-tier test [12]. The misconception was seen based on answers and 20 multiple-choice questions.

3. Results and Discussion
Based on the research that had been done, the achievement of misconceptions from both classes can be seen on the topic of Newton’s Law I, Newton’s Second Law and Newton’s Third Law. This can be seen on the following Table 1.
### Table 1. Misconception on Newton’s Law topic

| Class               | Topics         | Misconception Level | Achievement of Change |
|---------------------|----------------|---------------------|-----------------------|
| Controlled Class    | Newton’s Law I | Pretest: 30, 2%     | 8, 5%                 |
|                     |                | Posttest: 21, 7%    |                       |
|                     | Newton’s Law II| Pretest: 30, 6%     | 11, 1%                |
|                     |                | Posttest: 19, 5%    |                       |
|                     | Newton’s Law III| Pretest: 35, 8%    | 16, 8%                |
|                     |                | Posttest: 19, 0%    |                       |
| Experimental Class  | Newton’s Law I | Pretest: 42, 2%     | 33, 3%                |
|                     |                | Posttest: 9%        |                       |
|                     | Newton’s Law II| Pretest: 45, 8%     | 27, 0%                |
|                     |                | Posttest: 18, 8%    |                       |
|                     | Newton’s Law III| Pretest: 48, 8%   | 38, 0%                |
|                     |                | Posttest: 10, 8%    |                       |

Based on Table 1, misconceptions in the experimental class decreased after problem-based learning modules applied. Learning is carried out on the topic of Newton's Law. The results of the study also showed that the topic that successfully reduced misconceptions in the experimental class were Newton’s first law and Newton’s Third Law. Moreover, the topic of Newton’s Second Law was difficult to reduce misconceptions. In addition, the results of analysis that dealt with question data can be seen in detail on chart 1 and 2.

![Figure 1. Misconceptions analysis of control class questions per item](image)

Figure 1 can be seen the level of students' misconceptions in the control class during the learning process. The results of analysis of the level of misconceptions then can be seen in the experimental class before the treatment of the implementation of problem-based learning module was done. The chart also indicated how big the students' misconception that can be seen on chart 2.
Figure 2. Misconception analysis of experimental class questions per item

Based on chart 2, it can be seen that the overall percentage of misconceptions experienced by students in Newton's law material. The analysis also revealed that, there were students who cannot understand the concept correctly, and it brought a misconception in the material.

Misconceptions can also be found both in experimental group and control group. The results of analysis were carried out using CRI with the aim of knowing the level of misconception in the pretest and posttest questions. Apart from this, there were misconceptions that occurred among students that were identified as; (a) the normal force on an object was always the same as the weight of the object, (b) reaction force acts on the same object, (c) the mass of the object is equal to the weight of the object, (d) Objects that have a large mass then the force produced is also great. This proves that in physics matter, there are still students who experience misconceptions [13]. The results of this CRI analysis can be seen on chart 3.

Figure 3. CRI Analysis on the Level of Students' Concept Understanding

Based on chart 3 clearly appeared that this research was conducted in two classes namely the control class and the experimental class. In learning control group taught by using direct instruction learning model and experimental class group implemented problem-based learning modules. The results of overall data analysis showed that having applied a module on problem-based learning could reduce students' misconceptions on Newton's law material.

Furthermore, students’ learning outcomes based on statistical tests revealed that there were differences in learning outcomes of students after problem-based learning modules implemented. Moreover, the results of analysis regarding the average difference from two classes are shown in Table 2 and Table 3.
Table 2. Recapitulation of the Pretest of Experiment Class and Control Class

| Group      | Average | \( t_{\text{count}} \) | \( t_{\text{table}} \) | Interpretation | Conclusion |
|------------|---------|-------------------------|-------------------------|---------------|------------|
| Experimental | 48.39   | 0.51                    | 1.68                    |               | Indifferent|
| Control     | 46.67   |                         |                         |               |            |

Table 2 presented the pretest score of experimental class and control class obtained with \( t \)-value was 0.51. If the \( t_{\text{count}} \) is smaller than \( t_{\text{table}} \) means, there is no significant difference between the two classes [14]. The statement can be concluded that before treatment was given, the conditions of two classes were the same. It means that there are no differences on students learning outcomes from both classes.

Table 3. Recapitulation of the Posttest Test and Experiment Class and Control Class

| Group      | Average | \( t_{\text{count}} \) | \( t_{\text{table}} \) | Interpretation | Conclusion |
|------------|---------|-------------------------|-------------------------|---------------|------------|
| Experiment | 78.93   | 7.64                    | 1.68                    |               | Different  |
| Control    | 55.63   |                         |                         |               |            |

Based on Table 3, the number of \( t_{\text{count}} > t_{\text{table}} \) is 7, 64 > 1, 68. It can be concluded that there are differences on the average of students’ learning outcomes between the group taught problem based learning modules and the one taught by direct instruction learning models. It proves that the implementation of problem-based learning modules in the experimental class is more effective than learning using the direct instruction model in the control class.

Having employed learning process by means of problem-based learning modules, it can be concluded that the learning can reduce the problem of misconception related to Newton's law topic. It proves that the problem-based learning module can teach students how to learn independently. In addition, this learning module can link problems in the topic of Newton's Law to the phenomena of daily life so that students can understand the topic correctly. Aside from this, the module also uses complete language and lessons.

4. Conclusions

Based on the results of the research, it can conclude that problem-based learning modules can decrease misconception in experimental class up to 70%, while in control class problem in which learning modules are not implemented, the misconception only decreases 37%. Furthermore, students’ learning outcomes after implementing the modules show that \( t_{\text{count}} > t_{\text{table}} \) is 7, 64 > 1, 68. As a result, there is difference on students’ learning outcomes. It can conclude that problem-based learning implementation increases students’ learning outcomes more than the use of direct instruction method.

5. References

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