An investigation of students’ misconceptions about momentum and impulse through interactive conceptual Instruction (ICI) with computer simulation

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Abstract. Learning of physics always related to conceptual understanding. In the learning process, there can be a difference in conceptual understanding that causes misconceptions. Misconceptions can occur in a variety of physics material, including on momentum and impulse. The purpose of this study was to investigate students’ misconceptions about momentum and impulse through Interactive Conceptual Instruction with computer simulation. This study was conducted to 10th grade consists of 30 students. The sampling technique is purposive sampling. The method used is quasi-experimental with research design is one group pre-test and post-test. The instrument used to investigate students’ misconceptions is form four-tier diagnostic test. The result shows that misconceptions before treatment higher than after treatment. It can be concluded that Interactive Conceptual Instruction with computer simulation is better in facilitating student learning process on momentum and impulse.

1. Introduction

Physics is the science that studies the concepts based on phenomena that occur in everyday life. In the process of learning often occurs a difference of understanding the concept of belonging to students. This is because students are having a different experience in understanding the concept. The difference this understanding is often referred to as a misconception.

Misconception is a term that refers to the difference between the concepts of thinking that belong to students with the concepts that have been defined by experts [1]. Misconceptions can obstruct the learning process of physics because physics concepts interconnected to each other so when it happens, misconceptions would obstruct the process of understanding the concept.

To overcome misconception needed model of teaching and learning media effectively and efficiently. One of the learning models appropriate to overcome student misconceptions are Interactive Conceptual Instruction (ICI). Interactive Conceptual Instruction (ICI) has four phases; 1) conceptual focus 2) use of text 3) research based materials 4) classroom interactions.

The first phase (Conceptual Focus); takes account of teacher’s activities: explanation the purpose of learning, showing physics phenomena through simulation or animation, and inspiring students to contribute actively during the learning process. The second phase (Use of Texts); involves teacher’s activities: asking students to read textbooks or e-books then asking them to create concept map related to concept that they have learned. The third phase (Research Based Materials); includes teacher’s activities: asking students to build a group consists of four to five students, encouraging students to gather the information which is required in order to analyze experimental result of worksheet and guide
the students to explore according to their conceptions level with an exploration sheet. The fourth phase (Classroom Interactions); involves teacher’s activities: supervising students discussion and helping the students to solve their problems by explanation the exploration sheet [2].

In the physics learning process also required the media to describe or demonstrate physics phenomena. This media will help students understand a concept. Media be able to create the things that can only be found outside the class be accessible inside the class [3]. One of the media that can be used is computer simulations. Computer simulations show a combination of text and graphics, using dialogue and question to guide students in learning [4]. Computer simulations can be used to demonstrate or practice phenomena that are difficult to be shown in the classroom.

Based on following opinion of Sekercioglu [5], momentum and impulse are considered simple but the fact is abstract concept. Because momentum and impulse are abstract concepts, many students experienced th misconception. Momentum is a difficulty to stop an object. The magnitude of the momentum of an object shown in equation 1.

\[ \vec{p} = m \vec{v} \]  
(1)

Based on equation 1, the magnitude of the momentum is based on the mass and the velocity of the object. While impulse is the multiplication between force and time interval as shown in equation 2.

\[ \vec{I} = \vec{F} \Delta t \]  
(2)

Based on Newton’s second law, impulse are changes momentum so the equation is as follows.

\[ \Delta \vec{p} = \vec{F} \Delta t \]  
(3)

In everyday life, many phenomena’s regarding the concept of momentum and impulse. One of them is a karate athlete who needs a force to break several layers of ice cubes like Figure 1. The karate athlete needs a very short time interval so that it can produce a very large force.

The purpose of this study is to investigate students’ misconceptions about momentum and impulse after implementing Interactive Conceptual Instruction (ICI) with computer simulation.

2. Methods

2.1 Research design
The method used is quasi-experimental with research design is one group pre-test and post-test. The design is shown in Table 1.
2.2 Participant
This study was conducted at one of senior high school in Bandung. This data were obtained from 10th grade. The group consists of 30 students. The sampling technique that research using purposive sampling method.

2.3 Instrument
The instrument utilized to investigate student’s misconception is form four-tier diagnostic test which consists of 15 questions.

2.4 Data analysis
To find out student misconception, it’s needed to analyze result of student’s answers. The result will be grouped into five categories; 1) misconceptions (M) 2) sound understanding (U) 3) no understanding (NU), 4) Partial Understanding (PU), No Coding (NC) like shown in Table 2 [1].
The score for each student's conception.

### Table 3. Student’s criteria concept score.

| Student’s criteria concept       | Score |
|----------------------------------|-------|
| Sound Understanding (SU)         | 2     |
| Partial Understanding (PU)       | 1     |
| Misconceptions (MC)              | 0     |
| No Understanding (NU)            | 0     |
| No Coding (NC)                   | 0     |

To calculate the percentage of category conception use the formula below

\[
\text{misconception category (\%)} = \left( \frac{\text{number of misconceptions categories}}{\text{the total number of answers}} \right) \times 100\% \tag{4}
\]
3. Result and Discussion

Profile conception students are obtained after analyzing each item about momentum and impulse. Profile of a conception before treatment to be shown in Figure 3.

As seen in Figure 3, students’ misconception is 39.7%, sound understanding is 4.9%, partial understanding 24.2%, not understanding 25.1%, and not coded is 6.1%. Before the treatment, many students not understanding the concept of momentum and impulse and students experience the misconceptions. Misconceptions happened because students just guessing the correct answer.

As seen in Figure 4, students misconceptions is 25.7%, sound understanding is 32.6%, partial understanding is 19.3%, no understanding is 18.5%, and no coding is 3.9%. The result of post-test shows there were changes at each category conceptions. Based on these results, the biggest percentage value is sound understanding but there are still misconception. Result pre-test and post-test of the group shows decrease in misconception is 14% and increase in sound understanding is 27.7%. This means the learning model used can overcome misconceptions of the students.

The result of this study are same as the result of previous studies that Interactive Conceptual Instruction (ICI) with computer simulation can reduce misconceptions and provide a positive influence for student [2,6,7,8].

Figure 3. Profile of a conceptions about momentum and impulse before treatment.

Figure 4. Profile of a conceptions about momentum and impulse after treatment.
Based on the post-test result, misconceptions found on the concepts of momentum, impulse, conservation momentum, and collisions. Students misconceptions about momentum and impulse is shown in Table 4.

| Concepts            | Misconception                                                                                                                                                                                                 |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Momentum            | Momentum is only influenced by velocity and mass is not important.                                                                                                                                           |
|                     | If an object has a bigger mass then the object has a bigger momentum and velocity is not important.                                                                                                         |
|                     | Momentum is not a vector.                                                                                                                                                                                     |
| Impulse             | The velocity of an object affects the magnitude of the impulse.                                                                                                                                              |
|                     | Impulse is momentum.                                                                                                                                                                                         |
| Momentum Conservation| If soft objects collide with other objects then momentum doesn’t converse.                                                                                                                                     |
|                     | In the momentum conservation, objects must experience perfectly elastic collision.                                                                                                                           |
| Collision           | When two objects with the same mass collide there will be a perfectly elastic collision.                                                                                                                     |
|                     | The difference in mass of two objects when colliding is an inelastic collision without regard to the collision. restriction coefficient produced after the collision.                                               |
|                     | If two objects where one of the objects has velocity and the other is static after colliding, then collision is perfectly inelastic collision.                                                              |

4. Conclusion
Based on research data found misconceptions decrease 14%. The result of this study can be concluded that Interactive Conceptual Instruction (ICI) with computer simulation is better in facilitating student learning process on momentum and impulse.

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