Diagnosis of Student’s Misconception on Momentum and Impulse Through Inquiry Learning with Computer Simulation (ILCS)

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Abstract. Misconceptions often happen to the concept of momentum and impulse. A learning model that is considered appropriate to overcome misconceptions is the inquiry learning model. Computer simulation is using in this research for help inquiry learning model. The purpose of this research is to know the profile of student misconception after applying inquiry learning. This research uses descriptive analytics. The study was conducted on 28 high school students (12 boys and 16 girls) of class X in Bandung. Misconceptions are detected using the Momentum and Impulse Four-Tier Test (MIFT) instrument. Based on the results of the study, it is found that there are still 15.56% of students experiencing misconceptions about the material momentum and impulse.

1. Introduction

The world becomes a vast place for students to learn and collect information either formally through school or informally through everyday experiences, based on which students tend to shape their own opinions [1-3]. Because of this concern, possible if students have thinking that is not well-matched with scientific facts [4]. That is called misconceptions. Misconceptions are conceptions that dispute the scientifically believed theories [3, 5]. In physics studies, misconception often found in almost all material [6,7, 8]. This research focused to identify student’s misconception in motion especially at momentum and impulse matter. Momentum and impulse based by some research are the one of the most difficult subjects to learn and to teach in physics education [9, 10]. The momentum and impulse equations are represented by Equations (1) and (2).

\[ p = mv \]  
\[ I = \vec{p} \Delta t \]

Additional research shows that a third of the 192 students were able to describe the concept of momentum properly and less than 25%, which describes the concept of impulse properly [11]. These results further indicate that momentum and impulses are difficult to learn and teach so often cause misconceptions. One example of student’s misconceptions is students cannot recognize the mathematical relations compliant the relation among the second law of Newton and momentum-impulse and relations between concepts related to subjects [10]. This is because students think that momentum and impulses only talk about collisions. That misconceptions are difficult to change because misconceptions are well entrenched in student’s mind schema [7, 12, 13]. Even after learning, misconceptions are often still detected in students.
The learning used in this study is inquiry learning with computer simulation. Using inquiry learning model, subject matter that students have gotten will be most easy to remember, durable, is more easily applied to different conditions, improve the mastery of concepts, advance scientific attitude, bring up the motivation to learn, and advance students a deep accepting of science concepts [14]. Inquiry learning raises conceptual change by fetching students in exploring the given tasks that are expected to prime them to state hypotheses, carry out experiments, create models and theories, and evaluate them as scientists do [15]. At the same time, computer simulations are used to help students to visualize objects and processes that are normally beyond the user control in the natural world [15, 16]. Have much research to prove that inquiry learning and computer simulation is effective to resolve misconceptions [14-20].

2. Research methodology
This research was conducted by using descriptive analytics method. The study was conducted among 28 students (12 boys and 16 girls) 10th grade of MIPA at one school in Bandung city. The sample was selected by using the cluster sampling technique because all 10th graders have not studied the momentum and impulse material so that it can be chosen randomly. The study was conducted in the academic year 2016/2017. The identification of misconception has been conducting after inquiry learning with computer simulations. The test instrument that uses is Momentum and Impulse Four-tier Test (MIFT). The example of the MIFT question is shown by Figure 1.

| 2.1 Two cardboard boxes containing books which each have the mass of 10 kg and 20 kg, in a quiescent state. Then the two cardboard was driven for 3 seconds. By giving the same force on both boxes, the big comparison of momentum finally is .... |
|---|---|
| a. 1:4. | d. 2:1. |
| b. 1:2. | e. 4:1. |
| c. 1:1. | |

2.2 The sureness level for the tier 2.1:
|---|---|
| a. Sure. | b. Not sure. |

2.3 The reason for the tier 2.1:
|---|---|
| a. The great momentum is not only influenced by the masses. |
| b. The great momentum is not only influenced by the time interval. |
| c. The momentum will be even greater if the object's mass increases. |
| d. The momentum will be even greater if the object's mass is smaller. |
| c. .................................................................................................................. |

2.4 The sureness level for the tier 2.3:
|---|---|
| a. Sure. | b. Not sure. |

Figure 1. The example of MIFT

The MIFT instrument is made in the four-tier test. The first tier (2.1) is a question of the concept of momentum and impulse. Question is made in the form of multiple choices with 5 choices of answers that have been provided. The second tier (2.2) represents the confidence level of the answer on the first tier, there are two choices: "Sure" and "Not sure". The third tier (2.3) is the scientific reason for the answer selected for the first tier. The third tier (2.3) contains the scientific reason for the answer on the first tier of multiple choices with four reasons to choose from and one open-ended reason. The fourth tier (2.4) contains a level of confidence for the value assigned to the third tier of the "Sure" and "Not sure" options. Instruments in the form of four-tier can identify misconception more accurately [21].
3. Result and discussion
Data collection is done after inquiry learning with computer simulation in momentum and impulse matter. The instrument used is MIFT as many as 14 questions. Students’ answers to the MIFT instrument contained 17 possible combinations of answers. The combination of student answers is then categorized into 5 categories of conceptions as shown in Table 1. The category was developed from the category of conception for the three-tier instrument in the research of Samsudin et al [22].

| Number | Category                      | Option | Sureness Level | Reason | Sureness Level |
|--------|-------------------------------|--------|----------------|--------|----------------|
| 1      | Misconceptions (M)            | false  | sure           | false  | sure           |
| 2      | No Understanding (NU)         | false  | sure           | false  | unsure         |
| 3      |                               | false  | unsure         | false  | sure           |
| 4      |                               | false  | unsure         | false  | unsure         |
| 5      | Sound Understanding (SU)      | true   | sure           | true   | sure           |
| 6      | Partial Understanding (PU)    | true   | sure           | true   | unsure         |
| 7      |                               | true   | unsure         | true   | sure           |
| 8      |                               | true   | unsure         | true   | unsure         |
| 9      |                               | true   | sure           | false  | sure           |
| 10     |                               | true   | sure           | false  | unsure         |
| 11     |                               | true   | unsure         | false  | sure           |
| 12     |                               | true   | unsure         | false  | unsure         |
| 13     |                               | false  | sure           | true   | sure           |
| 14     |                               | false  | sure           | true   | unsure         |
| 15     |                               | false  | unsure         | true   | sure           |
| 16     |                               | false  | unsure         | true   | sure           |
| 17     | No Coding (NC)                | If false one, two, three or all not answer |

After the student’s answer is categorized based on Table 1, it will get the student's conception profile on the momentum and impulse matter after inquiry learning with computer simulation. The student’s conception profile is shown in Figure 2.

![Figure 2. Conception profile](image.png)

Inquiry with computer simulation was able to make 37.24% of students are the category of sound understanding. It proves that inquiry with computer simulation can help students understand the concept; this is consistent with those obtained in previous researches [14-20]. However, there are still 15.56% of students with misconceptions. Misconceptions experienced by students are spread over
three sub-matters momentum and impulse that is momentum, impulse and the relationship between momentum and impulse. The number of students experiencing misconceptions in the three sub-matters is shown in Figure 3.

![Figure 3. Misconceptions profile](image)

The relationship of momentum and impulse becomes sub-matter with the number of students experiencing misconception. It means that students have difficulty in relating concepts to momentum and impulse matter. The misconceptions detected in the three sub-matters are shown in Table 2.

| Sub-matter         | Misconceptions                                                                 |
|--------------------|--------------------------------------------------------------------------------|
| Momentum           | The momentum change is the difference between the final momentum and the initial momentum of things but is not influenced by the initial velocity  
|                    | The momentum on the object momentum will be smaller if the greater mass of the object regardless of the effect of the velocity, so that the range between two objects is different  
|                    | The larger mass of the object will cause the kinetic energy of the object is great regardless of the velocity  
|                    | Momentum has the same direction as the direction of gravity acceleration  |
| Impulse            | The impulses are not influenced by the direction of motion of objects so that the reflection will cause a small impulse  
|                    | The impulse having the opposite direction to the resultant of the force  
|                    | The contact time is proportional to the impulsive force  
|                    | To deliver a powerful punch (ached at the opponent) takes a large impulsive force with long intervals of time  |
The relationship between Momentum and Impulse

- The contact force on an object is proportional to the contact time
- When the initial state of stationary objects, the momentum is only influenced by the mass of the object without knowing the relationship between momentum changes and impulse
- The momentum changes are not equal with great momentum impulse, so the force affects the range
- The kinetic energy is inversely proportional to the mass of the object

4. Conclusion

Based by the result, the student’s conception profile after inquiry learning with simulation computer is divided into five categories: misconception (M), sound understanding (SU), partial understanding (PU), no understanding (NU), and No Coding (NC). Misconceptions are identified in the sub-material of momentum is 16.07%, impulses is 6.55%, and the relationship of momentum and impulse are 28.57%. So, the average student misconception after inquiry learning with computer simulation is 15.56%.

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