

Students' Conception on Momentum and Impulse toward Higher Order Thinking Skill

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Abstract. The developed competences refer to the idea of 21st century skills. One of them is the economy development based on science, technology and art. It effects on the need of human resources who have several skills on high and complex thinking, communication and good cooperation. The purpose of this research is to analyze the influence of students' conception towards high thinking skill. This research belonged to descriptive research with 48 students of XI MIA as the subjects of the research. The sampling selection used random sampling technique. Data of research was collected from essay test with 10 questions and interview. The result of students' HOTS in 11th grade of MIA in Sragen regency is still low with 19,01 % in very low HOTS category. The analysis result shows that the highest percentage of students' high thinking skill on subtopic of collision is 30,56% in low HOTS category and the lowest one is on subtopic of law conservation of momentum with 2,08% in very low HOTS category. This result reveals that teachers do not optimize in giving questions of representation. The representation consists of verbal, picture, mathematic, and bar diagram. Therefore, teachers need to improve the students' cognitive and psychomotor domain in learning process effectively.

Keywords: Students' Conception, Higher Order Thinking Skill, Momentum-Impulse

INTRODUCTION

Hayat and Suhendra [1] state that literary level of science (PISA) students in Indonesia can only memorize the facts, terms, and scientific law and use it in making scientific and simple conclusion in daily life. The achievement shows that Indonesian students find difficulty in answering the essay questions that need intellectual activity. That case may emerge because the students are accustomed to memorizing and do the multiple choice questions.

The students' early knowledge influence the construction of new physics knowledge. Students enter the class with their conception of life. The students' conception that is not suitable with society is called misconception. Misconception is usually found in physic, especially in the topic of mechanics. The topic becomes the highest level of misconception [2]. Material of momentum, impulse, and collision are topics in mechanics. Therefore, there are still many misconceptions in these materials.

Students' quality can be better if there are question components with higher order thinking skills (HOTS). All students can think, but most of them need great encourage and guidance in the process of high thinking [3]. Higher order thinking skills can be taught and learned. All students have a right to study and to apply the thinking skill as well as other knowledge. Skill of high thinking skill is determined by the freedom of using the thought to a new challenge. HOTS is significant for students and teachers especially in the institution of high education [4].

HOTS includes critical, logical, reflective, meta-cognitive and creative thinking. Meanwhile, category of higher order thinking skills consists of several aspects such as 1) analysis, evaluation, creation, 2) logical activity or logical

reason, 3) decision and critical thinking, 4) problem solving, 5) creativity and creative thinking [6]. Level of HOTS consists of 3 aspects namely analysis, evaluation and creation [7].

Impulse momentum is basic concept of physics that becomes an important part in physic learning [8]. There are many students, college students, and teachers to be who find difficulty in implementing momentum as vector quantity [9]. They cannot solve the problem of momentum correctly. In the concept of impulse, students do not understand the relation of impulse and the change of momentum on an object [11]. Students consider that the force given by the object hitting the surface only relates to the early speed, not the change of speed and momentum [9]. In learning the law conservation of momentum, students find difficulty in implementing the principle of conservation [12] concerning with “where” and “when” the conservation implemented [9]. Students think that conservation momentum of an object does not review the total system. Students also tend to ignore the internal and external force in law conservation of momentum and collision. Students’ conception on science topic can influence the students’ achievement and students’ thinking skill as well as the process of higher order thinking skill.

This research focuses on the influence of students’ misconception on momentum and impulse towards the higher order thinking skill. The result of the research can be used for the next research to know the best learning method in improving the higher order thinking skill and students’ conceptual understanding.

METHODS

This research belonged to descriptive research with the purpose to know the process profile of higher order thinking skill. The subjects of the research with 48 students of XI MIA in academic year of 2017/2018. The sampling election used technique of random sampling. Technique of collecting data used essay test and interview as students’ conception data and its higher order thinking skill. Data consisted of students’ test result to analyze the achievement on each indicator. Indicators of HOTS consisted of analysis, evaluation and creation [7]. Model of essay test in learning evaluation is an important instrument to know the level of students’ development in mastering the material. Essay test has the advantage to measure cognitive aspect, to develop language skill, to train the organized thinking and logical activity and to develop problem solving skill [13]. The giving of essay questions must be more intensive than objective questions. It is conducted to supervise the students’ cognitive skill. It is also used if the group is small and the test will not be used repeatedly [14].

RESULTS AND DISCUSSION

In this research, each student’s answer was analyzed by giving the score that had been made. The analysis of the students’ answer was conducted by using descriptive approach. The score was given to the correct answer. The result of the measurement was analyzed in descriptive way to know the level of students’ achievement of HOTS and category of HOTS. The division of subtopic on each question can be seen at Table 1, and the category of HOTS can be seen at Table 2. Besides that, the achievement percentage of HOTS is presented at Table 3.

Table 1. The division of sub topic on each question

No	Sub Topic	Number of question
1	Impulse	7 and 8
2	Momentum	2, 3, and 4
3	Law conservation of momentum	1 and 5
4	Collision	6, 9, and 10

Table 2. The category of High Order Thinking Skills (HOTS)

Scale (%)	Category of HOTS
$X \leq 26$	very low
$26 < X \leq 46$	low
$46 < X \leq 66$	medium
$66 < X \leq 86$	high
$86 < X$	very high

Table 3. The achievement percentage of HOTS

No	Sub Topic	Percentage of correct answer (% correct)	Percentage of wrong answer (% wrong)	Category of HOTS
1	Impulse	21,88	78,12	Very low
2	Momentum	21,53	78,47	Very low
3	Law conservation of momentum	2,08	97,92	Very low
4	Collision	30,56	69,44	Low
	Average	19,01	80,98	Very low

Table 3 shows the achievement percentage of students' HOTS. The analysis result shows that the highest percentage of students' high thinking skill on subtopic of collision is 30,56% and the lowest one is on subtopic of law conservation of momentum with 2,08%. While the HOTS category shows that the collision subtopics fall into the low HOTS category, but the results are better when compared to the HOTS category on sub topics other than collisions. The students' HOTS on sub topic of law conservation of momentum has the lowest percentage. It is because the students rarely practice to solve the concept of law conservation of momentum. Based on the data, to increase students' higher order thinking skill in subtopic the law conservation of momentum, teacher can optimize the question with multi representation. The multi representation skill consist of verbal, numerical, and diagram. Therefore, teachers need to improve students' cognitive and psychomotor domains effectively in the learning process, by means of students having to do more laboratory experiments [16]. The achievement percentage of students' HOTS is presented in Figure 1.

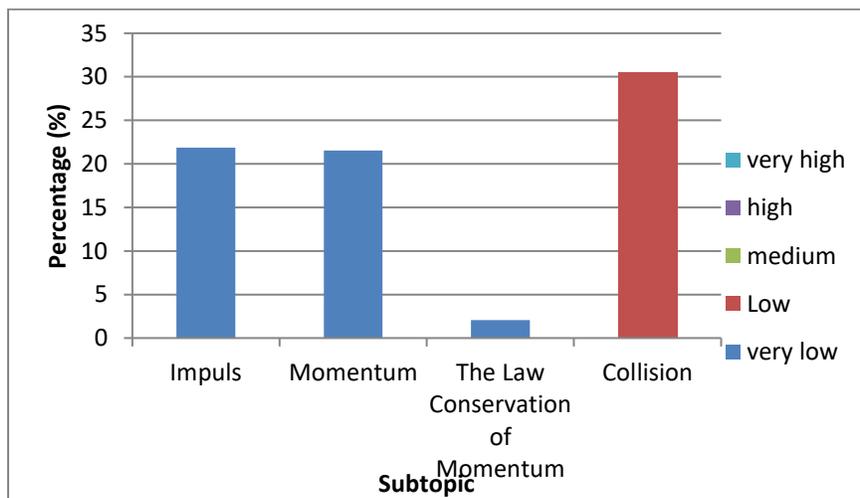


Figure 1. The achievement of students' HOTS

Besides Figure 1, Figure 2 also shows the result of students' answer in subtopic of law conservation of momentum, such as in number 1. The answers are as follows;

Dari 2 peluru identik bergerak secara horizontal dengan kecepatan sama menumbuk balok yg massanya sama, satu balok berbentuk kayu dan satu balok terbuat dr tembaga. Dari peristiwa tsb balok yang memiliki kecepatan besar sth tembakan yaitu balok yg berbentuk kayu, karena pd saat peluru ditembakkan pd balok yg berbeda tetapi massanya sama, peluru tsb langsung menembus balok kayu tsb. Sedangkan kalau balok dr tembaga yg sifatnya elastis ataupun lentur secara ~~ada~~ lempung peluru tsb setelah ditembakkan, akan terpental / tidak tembus pd balok dr tembaga tsb.

Figure 2. Students' answer on topic of law conservation of momentum

“From 2 identical bullets move horizontally at the same rate of mashing the same mass beam, one wooden beam and one beam made of copper. from the event the beam that has a great speed after the collision of the wood-shaped block, because at the time of the bullet fired on a different beam but the same mass, the bullet directly penetrate the wooden block. whereas if the beam of copper that is elastic or flexible, the bullets directly after the shot will bounce on the copper block”.

Based on the result of data analysis on sub topic of law conservation of momentum at number 1, students thought that the bullet embedded on wood beam had faster speed because kinetic energy could show that the bullet could break through the wood beam. This thinking belongs to misconception. Misconception is a mistake in understanding abstract idea [15]. Misconception can be detected if the students do not know if conservation momentum reviews the whole system not each object. This is consistent with previous research in which the explanation of the concept of mass and velocity for which the correct answer indicates the percentage of students' response is only 1.4% and only 7.2% of the student responses provide a scientifically correct response to the law of conservation of momentum [16]. The law of conservation of momentum can not be fully understood, as 38% of students have difficulty regarding the law of conservation of momentum [17]. Based on these studies proves that there are still many difficulties regarding the concept of momentum and impulse that appear and faced by students. This indicates the lack of mastery of student concepts. The lack of student conceptualization can be overcome by learning that can lead students to understand in depth the basic concepts in physics and to familiarize students using the concept to solve relevant problems. The problems of physics that are presented must be directly related to life. This is not only because it corresponds to the nature of physics to explain nature, but also because context-rich and real issues can improve students' problem solving abilities [18].

Below is the students' answer on sub topic of collision at number 6. It is shown in Figure 3.

b) Momentum A dan B :

$$P_A = m_A \cdot v_A = (1500)(25) = 37.500 \text{ kg} \cdot \text{m/s}$$

$$P_B = m_B \cdot v_B = (2000)(20) = 40.000 \text{ kg} \cdot \text{m/s}$$

Resultan momentum : $P = \sqrt{P_A^2 + P_B^2}$

$$= \sqrt{(37.500)^2 + (40.000)^2}$$

$$= 62.500 \text{ kg} \cdot \text{m/s}$$

a) Arah resultan momentum :

$$\tan \theta = \frac{P_B}{P_A} = \frac{40.000}{37.500} = \frac{4}{3} \Rightarrow \theta = 53^\circ$$

b) $v_{gabungan} = v_f$

$$37.500 = 4000 v_f \cos \theta$$

$$37.500 = 4000 v_f \cos 53$$

$$37.500 = 4000 v_f \cdot 0,6$$

$$37.500 = 2400 v_f$$

$$v_f = \frac{37.500}{2400}$$

$$v_f = 15,625 \text{ m/s}$$

Figure 3. The students' answer on sub topic of collision

Based on the result of data analysis on sub topic of collision at number 6, it was shown through the calculation application to determine the quantity of angle and speed of the object after the collision. It was known that the students' answers were mostly correct because they understood more if it was compared with the concept understanding of collision in physics. This is in accordance with previous research that the results of student responses with correct answers on the sub topic of the collision showed a high response of 24.4% [16].

Generally, the result analysis on all sub topic in material of momentum and impulse shows that students' HOTS obtains low category with the average percentage of 19, 01%. This condition shows that teachers have not optimized the HOTS in learning process. The students' learning result is low related to the low of teachers' skill in mastering HOTS. Besides that, students got the low score in the test of HOTS because the representation treatment was not usually given. The giving of representation in physic learning supports the success in solving the problem [19]. The previous research shows that the difficulty in producing ideas will emerge technical problem in finishing their task [20]. It becomes the main factor that influences students' achievement. Therefore, students need to learn HOTS to solve the difficulty in producing ideas. The first aspect to be studied in HOTS is that students understand and master the concept first by getting used to work on a representative problem so that students learn HOTS becomes important because it can help students to complete the task. As a result, students must be helped to obtain HOTS, both through conventional learning and learning environment or individual task. In this research, other influences of thinking skill development through science are increasing the students' motivation, interest, and curiosity of a phenomenon, encouraging the development of scientific concept by relating the students' knowledge obtained in the school and in their daily life [21]. Another research suggests using inquiry approach. The result shows that the research can improve concept, technique, and skill to maximize the students' potential in learning and utilizing high order thinking skill such as analysis, evaluation, and creation [22].

CONCLUSION

In this research, the investigation had been conducted to determine students' high order thinking skill in the material of momentum and impulse. The result of students' HOTS in 11th grade of MIA in Sragen regency is still low with 19,01 % in very low HOTS category. The analysis result shows that the highest percentage of students' high thinking skill on subtopic of collision is 30,56% in low HOTS category and the lowest one is on subtopic of law conservation of momentum with 2,08% in very low HOTS category. This result reveals that teachers do not optimize in giving questions of representation. The representation consists of verbal, picture, mathematic, and bar diagram. Therefore, teachers need to improve the students' cognitive and psychomotor domain in learning process effectively.

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