Force concept inventory (FCI) representation of high school students (SMA & MA)

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Force concept inventory *(FCI)* representation of high school students (SMA & MA)

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Abstract: There have been profiling the level of understanding of physics concept (dynamics and kinematics) of students' (SMA and MA) in madiun region. Profiling is done by using the Force Concept Inventory test. Samples were taken from 120 students from SMA and MA in Madiun and Ponorogo. The results indicate that FCI test number 23 and number 16 is the most answered incorrectly by the students. Problem number 23 related to kinematics and test number 16 on Newton's third law. Only 24.16% of students answered correctly test numbers 23 and 25% of students answered correctly test number 16. Students SMA and MA do not understand the concept well and can't represent concept in another shapes. These results provide an indication that the learning concept needs to be implementation at SMA and MA.

Keywords: FCI; understanding concepts; kinematics; dynamics

1. Introduction

Understanding the concept is an important variable to be profiled before the learning begins. By knowing the level of understanding concept of students, teachers can choose appropriate learning models, so that the learning objectives can be achieved. Students' conception of kinematic and dynamic has been the subject of much research (Halloun and Hestenes, 1995; Thornton and Sokoloff, 1998; Hsu, 2001; Lee and Park 2011; Lee, 2013; Waldrip, Prain, and Sellings, 2013; Handhika J, et al (2015), Handhika, et al 2016). Profiled explanation of students, examines the subject of Newton's laws, evaluates students' concepts of force and motion, integrating the subject of kinematics and dynamics are research that has been conducted by researchers.

During this time, understanding the concept in senior high school is not a priority. Learning that used was leads to solve the problem. The understanding concept is important subject in physics at the college level. Newton's first and third laws are the most difficult concepts to understand by the students. Predicted, the difficulty is obtained from (1) Newton first Law was not found in everyday life, object moving at a constant speed can only be found in laboratories with various limitations, (2) Newton's third law is considered by students is another form of Newton first Law . Both of these predictions derived from the results of previous studies Handhika J, et al (2016).

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Knowledge initial concepts students can be obtained from various sources of external and internal conditions of the students. External sources include Teachers, peers, teaching resources, and even the environment, internal sources derived from the representation of students to the concepts derived from external sources (Figure1). Internal conditions that most affect students conception is the ability of critical thinking and intuition.

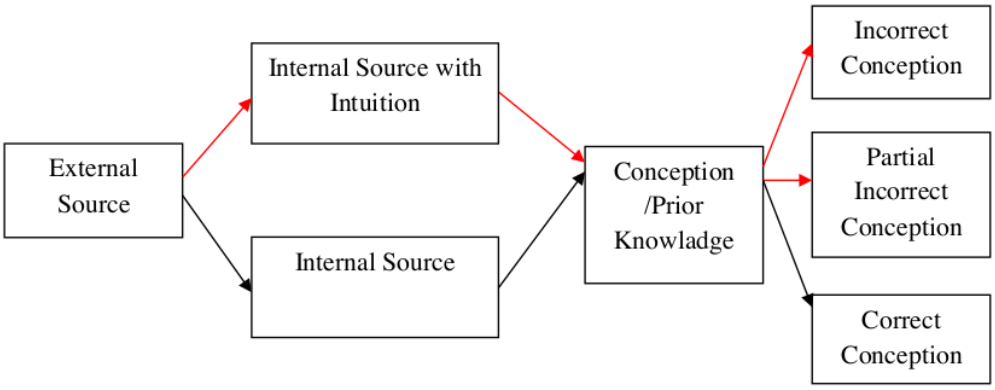
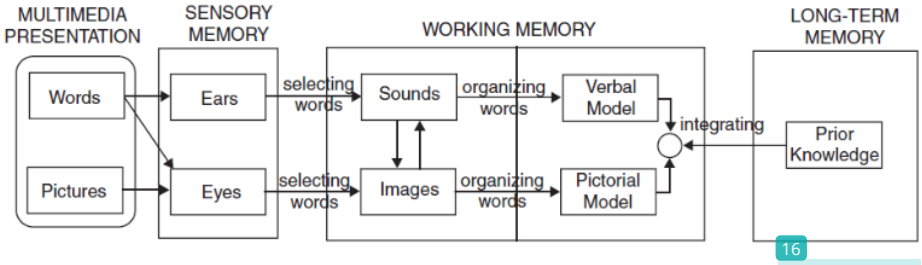


Figure 1. Flow chart of appearance student's conception

The initial conception or prior knowledge can be correct (as per the opinion of scientists) or it may be incorrect, and partly incorrect. Mayer (2009) explains that the information can be entered through two channels, words and images. Information in the form of words can be entered through the ear and the word (written) through the eyes. Images Information received by the eyes. The eyes and ears are the sensor memory. The process of representation occurs in the next step, where there is a selection process, organization, integration in the working memory to give birth early knowledge in long term memory (Figure 2).



(Mayer: 2009)

Figure 2. Cognitive Theory of Multimedia Learning

Force Concept Inventory (FCI) http://modeling.asu.edu as a part of the external representation of multimedia in Cognitive Theory of Multimedia Learning. Students are required to choose an answer in accordance with the understanding possessed. FCI

contain information about the words and pictures. It's just that there needs to be development, where in fact the students already have prior knowledge of the concepts that will be studied. In high school madiun regional areas, research in profiling conception in senior high school level has not been done. This study is a preliminary study which is expected to be used as a reference for high school teachers and equal regional Madiun for implementing the learning process. This research also can be used as the basis for IKIP PGRI Madiun FPMIPA Physics Department to developing learning Physics.

2. Method

Methods of this research is descriptive qualitative. The subjects of the research are SMAN 1 Kawedanan X.5 class totaled 32 students, a class X .1 SMAN 1 Slahung with 22 students, 29 students X MIA 4 SMA Muhammadiyah 1 Ponorogo, and X MIA 2 MAN 2 Madiun with 37 students. FCI is a diagnostic test designed to determine the level of students' understanding in physics concept, assessing the effectiveness evaluation at various levels as the introduction of the teaching of physics. FCI instrument consists of 30 questions.

Results and Discussion

From FCI results test, obtained information that the question numbers 23 and 16 are the most answered incorrectly by the students, while numbers 15 and 19 are the most answered correctly by students (Figure 3).

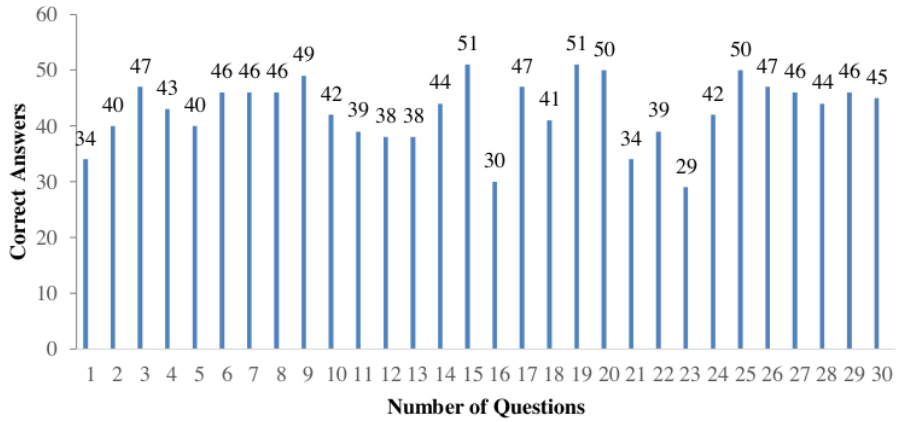


Figure 3. Number of correct answers each question item of FCI

Problem number 23 is a test related to kinematics. To understand about the number 23, students must understand concept of motion in a straight line at constant speed and uniform acceleration. Mathematical equations of motion in a straight line at a constant speed can be changed into a uniformly accelerated motion if acceleration is equal to zero. (eq. 1.1 and 1.2)

$$x_f = x_i + v_{xi}t + \frac{1}{2}a_x t^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1.1)$$

If $a_x = 0$,

$$x_f = x_i + v_{xi}t \quad \text{..... (1.2)}$$

Equation (1.2) is the equation of motion in a straight line at constant speed. If students understand the concept of motion in a straight line at constant speed and acceleration uniform, then the question numbers 23 and 21 must be correct. The results show that the data description to Question 21, many students are also incorrect. Details of the correct answer for question number 23 as follows: SMAN 1 Kawedanan of 32 students, nine students answered correctly (28.12% of students answered correctly), SMAN 1 Slahung of 22 students, five students answered correctly (22.72% of students answered correctly), SMA Muhammadiyah 1 Ponorogo of 29 students, 8 students answered correctly (27.58% answered correctly), MAN 2 Madiun of 37 students, 12 students answered correctly (32.43% of students answered correctly). Number of students answered correctly was 34 students (28.33% of students answered correctly) of the total sample of 120 students. Problem number 21 with the following details: SMAN 1 Kawedanan of 32 students, 8 students answered correctly (25% of students answered correctly). SMAN 1 Slahung of 22 students, four students answered correctly (18.18% of students answered correctly). SMA Muhammadiyah 1 Ponorogo of 29 students, six students answered correctly (20.68% answered correctly). MAN 2 Madiun of 37 students, 11 students answered correctly (30% of students answered correctly). Number of students answered correctly was 29 students (24.16% of students answered correctly) of the total sample of 120 students.

It can be concluded that more than 70% of students partially understand the concept of kinematics. Students should understand the various representations of concepts were presented in the kinematics (constant speed and uniform acceleration). Students not only understand and apply the definition of equality that exist, but should be able to evaluate the existing equation and adapted to the given problem. In order to strengthen this argument, about the number 19 and 20 on kinematics can be used to determine the student understanding. Unique results obtained in test numbers 19 and 20, where 51 students (number 19) and 50 students (number 20) answered correctly.

Problem number 19 and 20 using the external representation of verbal-visual with verbal representations choice answers, while the question numbers 21 and 23 use the question of external representation of verbal-visual and mathematical representation of the choice of answers (Figure 2). This result leads to the tendency of students to understand the concept only partially. Visual representation of the number 19 and 20 is more easily understood by the students because of several factors (1) the student has done experiments with visual results presented in external representation in question, (2) only requires a one stage process of thinking. Point number two is the assumption of those found in this research. Verbal-visual representation of the number 19 and 20 (Figure 4) presents images that can be obtained directly physical quantities and time position, whereas the question numbers 21 and 23, the amount of kinematics indirect information can be obtained. Students should understand the concept of "constant force" that affects the "constant acceleration". The magnitude of this acceleration is characteristic of uniformly accelerated motion. Hierarchy materials in Indonesia do not connect between kinematics and dynamics, students have not been able to find a

relationship between the two concepts as taught separately. Based learning concept and the concept of integration is recommended to begin to be taught in high school and on an equal level.

Question number 16 related with Newton's third law. External representation used in Question 16 is a verbal representation. External representation used requires analysis and synthesis capabilities of students, not only the definition of the concept. The integration of concept dynamics-kinematics is also used to mislead the students' answers (The word "pushing the truck" and "moving with constant velocity"). For students who have misconceptions Newton's law, Problem number 16 also directs students to answer "no force acting on both cars" because there is a constant speed information, the impact of acceleration equal to zero consequentially force is zero. Recommended for teachers to emphasize the external representation "pushing the truck" gives the sense that the object is still in contact Events, so the Newton law applicable to this question is Newton's third law.

In question number 15, presented verbal representation leads directly to the physical quantity acceleration, making it easy for students to link it with force. External visual representation of the image in question number 15 clearly provide the information that the two objects are touching, consequently Newton III law applies to this question. Question number 15 more correct answers compared with the number 16. It can be concluded that students who can answer questions 15 and 16 correctly, then these students understand the concept, while the incorrect answer, or just one correctly, it can be concluded that the students understand partially or have misconceptions.

3. Conclusion

Two or more external representation presented in the test can help students understand the problem or even make it difficult. If the representation is presented is already known by the students, it will be easier for students in deciding the correct answer (question number 15), but the external representation that require the integration concept, it is difficult for students to understand because they are used to understand the subject separately. Verbal representation would be difficult for the student when the student has not been able to integrate with the verbal representation of prior knowledge (number 16). Recommended subject to teach physics kinematics-dynamics must be integrated, or emphasis on the relationship of the subject to minimize errors in analyzing problems.

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