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Improving the Quality of Education to Strengthen the Global Competitiveness: A Response to the Current Curriculum

Presented by :

Palembang, May 16-18, 2014

Chief Editor: Hartono

Faculty of Teacher Training and Education
Sriwijaya University
South Sumatra - Indonesia

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ANALYSIS OF PHYSICS EDUCATION DEPARTMENT STUDENTS' MISCONCEPTIONS ON OTHER INFLUNCES ON MOTION

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Abstract

It has been conducted a research to identify and to analyze the kinds of students' misconceptions on the dimensions of other influences on the motion. The instrument consists of 19 of 30 items of the FCI was given to students of Physics Education Department, Faculty of Teacher Training and Education, Sriwijaya University. In addition, data were also collected through learning observation. The result was the mean score was 18.0%, indicated that the respondents had serious misconceptions. Based on the analysis found ten kinds of misconceptions experienced by the respondents, i.e. 1)hevier objects fall faster (79,45%), 2) mass makes thing stop (75,34%), 3) gravity increases as objects fall (47,95%), 4) motion when force overcomes resistance (47,26%), 5) resistance opposes force/impetus (26,03%), 6) grafity acts after impetus wears down (21,92%), 7) existence of centriugal force (18,15%), 8) air pressure-assisted grafity (16,44%), 9) obstacles exert no force (10,37%), and 10) grafity intrinsic to mass (4,79%). It is recommended to conduct future research to find the causes of the misconceptions and to apply learning strategies based on conceptual changes to remediate the misconceptions.

Keyword : misconceptions, forces, motion.

INTRODUCTION

Misconceptions, or sometime called alternative conceptions, are commonly experienced by people. A number of alternative conceptions appear across a wide variety of culture, countries, and ages (Grayson, 2004). In a variety of science topics, a growing number of studies have shown that students from different ages have a wide spectrum of alternative conceptions (Yürük, 2007). Research so far also has shown that the same misconceptions are held by students from different countries and cultures. It is known that students of all ages (elementary, secondary, and undergraduate) can have alternative conceptions in all areas of science (Pinarbaşi, Canpolat, Bayrakceken, & Geban, 2006) even thought to teachers. It is apparent that students enrolling in a college physics course do have misconceptions concerning force, and traditional instruction (by any instructor) does little to challenge them (Zukoski, 1996). So, it is needed an effort to identify the misconception that students have.

Misconceptions refer to person understanding about a concept that does not coincide with scientific view or is not accepted by scientist in spesific field. For example, there is a student says that when a person is moving an object from a pace to another place, the person is doing a work. It is reasonable to the student to say that because the person is looked so tired and get sweat. But, indeed in this case, the person is not doing a work because he is moving the object in direction perpendicular to the force direction acting on the object, the weight of the object. The misconceptions can in terms of pre-concept, wrong connection among concepts, intuitive idea or naïve views. Lawson (1994) defined misconceptions as conceptions that are inconsistent with or even contradictory to modern scientific views. Meanwhile, Hasan, Bagayoko, and Kelley (1999) stated that misconceptions as strongly held

cognitive structures that are different from the accepted understanding in a field and that are presumed to interfere with the acquisition and knowledge. In a simple one, Stein, Barman, and Larrabee (2007) uses the term misconception to refer to students' ideas that are different from the ones generally accepted by scientist. To summarize, misconception is a conception that is not match with scientific definition or not the same with scientist conception in the same field.

The concept of motion is a very important subject-matter in physics. Almost all of the topics in physics depend on the concept of motion. Other topics such as thermodynamics, electricity and magnetism, optics, atomic and nuclear physics have any part that implement the concept of motion. Therefore, as part of the mechanics, motion is usually learned in the early learning of physics. Because mastery of the concept is very important, it needs to be viewed carefully how students' conceptions about motion as a basic for the future learning. The purposes of this study were 1) to investigate what the conceptions of physics education department students where this study conducted to the other influnces on motion, and 2) to identify whether there is a misconception that the students experienced related to the other influences on motion, and if there is what the rates are and what the major misconceptions that the students hold. So, the research questions are 1) what is the conceptions of physics education department students about other influences on motion based on taxonomy of misconceptions, and 2) is there any misconception experienced by the students in other influences on motion, and if yes, what are the main misconceptions, and what are the percentage of the misconceptions.

To answer the above research questions, data were collected based on student answers to 19 of 30 items of FCI and learning observation. The 19 items of FCI are relating to other influences on the motion (see Tabel 1). The 19 items are items number 1, 2, 3, 4, 5, 6, 7, 11, 12, 13, 14, 15, 16, 17, 18, 25, 26, 27, 1nd 29. FCI is a-multiple-choice-conceptual test consists of five options. Based on the taxonomy tabel of misconceptions by Hestenes, Wells, and Swackhamer (1992) for FCI items that probe misconceptions on other influences on motion is as the following table.

Tabel 1. A taxonomy of misconception probe by the FCI based on Table of taxonomi by Hestenes, Well, and Swackhamer (Rev. 1995).

Other Influences on Motion	
Centrifugal force	5E; 6C,D,E; 7C,D,E; 18E
Obstacles exert no force	4C; 5A; 11A,B; 15E; 16E; 18A; 29A
Resistance	
mass makes thing stop	27A,B
motion when force overcomes resistance	25A,B,D; 26B
resistance opposes force/impetus	26B
Gravity	
air pressure-assisted gravity	3E; 11A; 17D; 29C,D
gravity intrinsic to mass	3D; 11E; 13E; 29E
heavier objects fall faster	1A,D; 2B,D
gravity increases as objects fall	3B; 13B
grafity acts after impetus wears down	12D; 13B; 14E

In Table 1, the left column is about kinds of misconceptions that may be on other influences on the motion and the right one is about numbers of items in FCI and their options that show the misconceptions. FCI is a standard test that has been used many times in various countries. Therefore

its validity and reliability is no doubt. The process of translation into Indonesia was also conducted in a procedure that guarantee the validity of the translation, namely in terms of the same meaning and the same result. Interviews and learning observation are used to dig deeper student understanding about other influences on motion.

RESULT AND ANALYSIS

Based on analysis of respondent answers on conceptual-test it is obtained that mean score of physics education students conceptual understanding on dimension of kinds of force is 18.0 (18.0%). This indicates that respondents conceptual understanding of other influences on motion is very low. In other words physics education department students where this study was conducted experiencing a serious misconception on this dimension. To see more what is and what level (percentage) of the misconceptions are, analysis was conducted on the respondent choices on 19 items of the problem given. Based on the analysis it is obtained that misconceptions experienced by students of physics education department and its percentage as in Table 2 below.

Tabel 2. Students' Misconception on Dimensi Other Influence on Motion based on Table of Taxonomi by Hestenes, Well, and Swackhamer.

Misconceptions	Number of Respond.	% or % mean
Other Influences on Motion		
Centrifugal force	53	18,15
Obstacles exert no force	53	10,37
Resistance		
mass makes thing stop	55	75,34
motion when force overcomes resistance	69	47,26
resistance opposes force/impetus	19	26,03
Gravity		
air pressure-assisted gravity	48	16,44
gravity intrinsic to mass	14	4,79
heavier objects fall faster	116	79,45
gravity increases as objects fall	70	47,95
grafity acts after impetus wears down	48	21,92

Table 2 shows that the student highest misconception is about weight or mass of an object affects the speed of the objects fall, in other words heavier objects fall faster. The next high misconceptions are "the increase of gravity of the object during the fall" and "an object can move when its force overcomes resistance". The following discussion will analysis deeper respondent conceptions. The analysis are supported by the data of observations and interviews.

There is Centrifugal Force in Circular Motion

The existence of centrifugal force is indeed a lengthy polemic in learning physics in Indonesia. Various physics textbooks in the schools refers to curriculum see the centrifugal force as a real force as a kind of force. This makes the concept of centrifugal force have embedded strongly from generation to generation in the education system in Indonesia. Most of the students agreed that there is a centrifugal force on circular motion in addition to other forces. The most dangerous misconception is

considering the centrifugal force is equal and opposite to the centripetal force, or centripetal force and centrifugal force is an action-reaction pairs.

On the identification of misconceptions with the FCI only 18.15 % of the respondents who have concept of centrifugal force. There are five items were used to uncover these misconceptions. Here, we find discrepancy between the experiences and result of identification with the FCI. There are two reasons why the level of misconceptions about centrifugal force is lower detected. Firstly, such questions do not directly ask about centrifugal force. It just a matter of asking respondents where an object moving after escaping from trajectory. There are many reasons can be used by students to describe the movement of objects, including their imagination. The respondents' answers to the motion of objects after the escape of the trajectory does not necessarily reveal about the concept of centrifugal force alone. Secondly, on such questions, with five options provided, they can reveal several misconceptions beside the centrifugal force. Respondents were first trapped in an easier form of their conception. So there is a weakness of the instrument to reveal whether respondents have trapped in the understanding of centrifugal force or not. In other countries, especially where this instrument was made, it perhaps appropriate instrument to reveal that misconception, but in Indonesia it has not fully appropriate because of different physics curriculum related to centrifugal and centripetal force.

Various cases that are often encountered related to the centrifugal force are a vehicles cornering, an object tied with ropes and rotated horizontally or vertically in a circle motion, pelanet motion, and the motion of electrons around the nucleus.

The easiest way used by teachers to promote centrifugal force to students ask students to imagine what happen when they riding vehicles in cornering. When cornering to the right the passenger will be pushed to the left, and vice versa. Because children really experience something like that, then they are sure of the existence of centrifugal force. Thus the picture of the trajectory of the object when the rope broke as in Question 7 is:

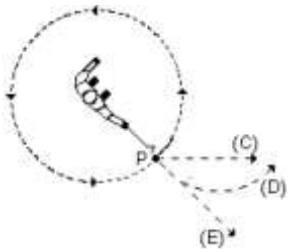
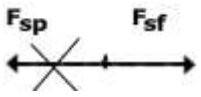


Figure 1. The trajectory of an object when the rope is broken (Figure of FCI item #7).

Tracks E is taken by the object because centripetal force that leads it to the center of the circle is lost.



The only one force acting later is centrifugal force. Students apply the concept of "the last force acting that determine the motion of objects" (other kind of misconception). Answer D is the trajectory corresponding to the conception of "initial impetus of object may be lost or recovered" (other kind of misconception). While the path C, where the centrifugal force in accordance with the concept of "force a compromise that determines the motion of objects" (other misconception). The same thinking will give the ball trajectory after it exits from a channel (Question 6) as the trajectory C, D, and E below.

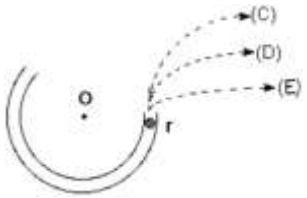


Figure 2. The trajectory of an object after it exist from a chanel (Figure of FCI item #6)

While the existence of centrifugal force itself can be seen in items numbers 5 and 18, which states there is a force pointing outwards from the center of the circle.

Figure 3. The direction of centrifugal force outwards from the center of the circle.

This image is aplication of forces acting on a circular motion that gave rise to the centrifugal force.

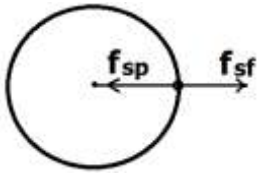


Figure 4. F_{sf} is equal to F_{sp}. In some sistem F_{sp} are $F_g=G.M.m/r^2$ in planet motion, and $F_c=k.Q_1.Q_2/r^2$ in electron move around nucleus

Obstacles Do not Eexert any Force

There are 10.37 % of respondents considered that the barriers to a moving object does not exert any force on the object. Suppose a moving car that hit a tree. Here it is said that both the car and the tree did not give force each other. So uprooted tree hit by a car, while the car stopped because it was blocked by tree.

> Stem Question 4 is "A bigger truck head collided with a small car. At the time of the collision, ... ". The students with this conception chose answer C to complete the sentence, i.e. "no force is exerted by trucks to the car and vice versa; the car so ruined just because a truck blocks the road". The case of item number 4 in line with cases for number 15 and 16, where car pushed the broken truck. Here, respondent argues that in the event of "no force exerted, both from car to truck and from truck to car. Truck pushed ahead because blocking the car "existence of centrifugal force.

Different cases are shown in Question number 5, 11, 18, and 29. On Question 5, respondents simply choose that the only force acting on the ball is the gravitational force. They are not capable to apply the effect of force against the motion of objects, where the force can change the velocity of the object (magnitude and/or direction) . If this is well understood, they would think there is one force that has

always worked on the ball that makes the ball change its direction that eventually form a circular motion. The only thing that might give this force is the wall where the ball rested. So there must be a force that is always given by the wall "blocking" the ball and direct it back to the center of the circle. This force is perpendicular to the plane where the ball touch the wall that appeared as a concept of action-reaction force. So there are forces acting on the wall due to the insistence of the ball (this force works on the walls instead of the ball, so it is not a centrifugal force). The reaction of the wall is a force acting on the ball that leads it to the center of the circle. It Clear that barriers exert force on the object, in contrast with the understanding that holds misconceptions.

The same explanation applies to problems numbers 11 , 18 , and 29. From the above discussion, it appears that the wrong understanding of the barriers to a moving object is a failure in applying Newton's second law, the action-reaction pairs of force.

The Mass of an Object Can Cause the Objects to Stop

This kind of conception is clearly contrary to the basic laws of mechanics. According to Newton's first law, an objects will remain rest or will keep moving at a constant velocity, except there are external forces that work on it. It is clear that mass of an object has nothing influence to its motion. The conception that the mass of the object can make it stop can be born because of the daily life of students look more difficult to carry objects with large masses moving than the small one. A large number of respondents, 74.34 %, chose such conceptions. Student answers that reflect misconceptions like this is the answer A and B to Question 27. Respondents answered that the box will immediately stop or keep moving for a moment and then stop, if the person stops pushing the box. Things that makes a box stop here is because the box has mass or weight. Though weight acts perpendicular to the direction of displacement. Then the component of gravity is equal to zero in the direction of the movement of the box. The influence of the mass of object to the motion is not just like this misconceptions. In the next point will appear again in the case of a free falling body.

Object Will Star Moving If Its Force Overcome the Resistance

A total of 47.26 % of respondents hold this conception, namely respondents who chose option A, B, and D for question number 25 and option B for question number 26. For problem number 25 in the case of a woman is excerting a constant horizontal force on a large box, the box will move with a constant speed of v_o if the force done according to the respondents is equal to the weight of the box; greater than the weight of the box; or greater than the total force against the motion of the box. For the number 26, where the woman is increasing force doubled, then according to the respondents here the box will move with constant speed of greater than v_o at the problem number 25, but not necessarily doubled. For Question 25 options A and B indicate the respondents also embraced the concept that weight affects the motion of objects. So in the question number 25 box weight is classified as force against the motion of objects. Therefore the choice of number 26, the speed should not be doubled because some of the force is used against other force before contributing to increase the box speed.

Resistance Opposes Force

Besides force firstly must resist any force that hinders object moves, respondents also believe that obstacle will continue fighting the force "impetus" that exist on the object while the object moving. There are as many as 26.03% of respondents who have this kind of conception. It can be detected with the choice B for Question 26.

Air Pressure-Assisted Gravity

The next misconception is a form of air pressure adds to the magnitude of the force acting on the object downward in addition to force of gravity. In other words, the force of air pressure and the force of gravity acting on the body point downward. This is a wrong conception as well attributed to Archimedes law (buoyancy by air) and the concept of air friction forces that inhibit the movement of objects. If the object moves up the air friction points downwards, and if the object moves downward the frictional force points up.

Questions relating to this is number 3 with option E, 11 with option A, option D of number 17, and number 29 choice C and D. Problem number 3 option E "stone dropped from a multi-storey building fell down to Earth's surface due to the combined influence of gravity force and air pressure force that push the stone down. So it seems that from the problem the air is considered pushing the rock down, instead of slowing down or floated upward (buoyant force here is not significant, although conceptually there is the force exerted by the air). The same case with Question 3, at Question 17 also said forces acting on the elevator that moves up there is downward force of gravity and the force by the air downwards. In question number 29 option C and D, it is said the forces acting on the stationary chair on the floor is a net downward force that comes through the air in addition to the other forces such as the force of gravity and the upward force that carried out by the floor. A total of 16.44 % of the respondents have misconceptions about the effect of the air pressure.

Gravity Intrinsic to Mass

Form of misunderstanding here is assumes no gravitational forceexternally acting on object. That objects fall to the earth because of the nature of objects that have always wanted to be in the earth. So the objects fall due to the intrinsic properties of the objects that always heading to earth. The questions that reveal this is number 3 option D, 11 choices E, 13 option E, and option 29 E. Examples of statements for such misconceptions are "none of the forces acting on the stone is thrown straight up; stone falls back to earth as a natural tendency of objects to remain rest in the earth.

Hevier Object will Fall Faster

The misconception that heavier object fall faster is a common mistake both for physics students or other students and for people in general. From various occasions writers often ask questions about the case to a group of teachers in training and in classroom activities. The answer obtained is always the same, that the heavier object or the bigger one will fall faster. Development of a way of thinking that heavier objects fall faster not far from the reality of daily activities that bigger one will win the conflict, the strong one has power, and so on.

The occurrence of these misconceptions in students of physics does not mean they do not understand the free-falling object lesson. The reality is they are very familiar with this topic. When they are faced with the problem of objects being dropped from a certain height, and then asked how much time it takes the object to reach the ground, the students can quickly determine that the time required is $t = \sqrt{2h/g}$. It is funny, they know from the formula that the mass or weight of the object is not a variable that determines the time it takes the object to fall, but at the same time they believe that the heavier object will reach the ground first. It is 79,45% respondents hold this misconception.

Graavity Increases as Object Fall

This misconception arises because students observe the longer objects falling the faster it is. So here it is also associated with the condition that can not differentiate betwee acceleration and force

or in accordance with misconceptions "acceleration illustrates the increase of force". Consider the proposition of Question number 3 with its answer B that uncovers this conception "a stone that fell from the top of a storey building to the earth's surface becomes faster during its way due to the growing gravitational pull along with the more close the stone to earth. Similar propositions will also occur at number 13 with option B. There are 47.95% of respondents chose this answer.

Gravity Acts after Impetus Wears Out

Respondents who have this kind of misconception think that the trajectory of objects are

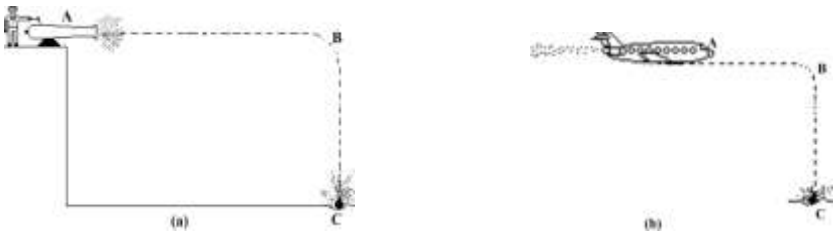


Figure 5. Trajectory of object for respondents who have conception gravity acts after impetus wears out for Question number 13 and 14 of the FCI.

Figure (a) is the trajectory of a bullet fired from a cliff (Question 13), while image (b) is the trajectory of a bowling ball that fell from a plane flying horizonatal at constant speed. Starting from position A (the bullet come out of the cannon/bowling ball left the plane) up to point B, the trajectory follow this line because the impetus of object is still there. Object continues to move forward with a horizontal trajectory, because there is no force that influence it. After impetus discharged at point B, the force of gravity began to work, so that the trajectory of the object down as described above.

Another example that shows this conception is such a proposition in item number 13 with option B, i.e. the forces acting on the ball thrown vertically upward are upward force decreases regularly from the ball loose from hand till reach the highest point; when the ball moves downward, the downward gravitational force that increases uniformly ...."It is clear that when the object moves upward force acting on it is "upward force" of impetus given by the hand of the child on the ball. The impetus continues to perch on the ball and will be drained continuously along with the position of the ball. The impetus depletion is described by more and more slowly the ball moves, until the ball stop at its highest point. Starting from the ball lefts hand until the ball reaches its highest point the gravitational force does not work, because there is still a ball impetus. Gravity works when the ball began to fall from the highest point. The number of respondents who hold such misconceptions is 21.92 %.

Based on the description above it can be seen the forms of misconceptions in terms of other influences on motion experienced by physical ducation epartment studnets. The findings of this resesrch are also similar with findings of relevan research in some countries. Gönen (2008) found student teacher have experienced misconception with regard to the concept of gravity, gravitational acceleration, and weight. Narjaikaew (2013) stated that respondens generally have had misconceptions about impetus and velocity of a falling object. Luangrath and Vilaythong (2010) have obtained a low understanding of the student in mechanics area.

CONCLUSION

Based on the analysis and discussion above it was concluded that the conceptual understanding of physics education students in dimension of *kind of force* is very low, i.e. 18.08%.

The findings of this research are revealed 10 kinds of misconceptions that occur in physics education students in terms of *other influences on the motion*, i.e. respectively from the highest percentages 1) hevier objects fall faster (79,45%), 2) mass makes thing stop (75,34%), 3) gravity increases as objects fall (47,95%), 4) motion when force overcomes resistance (47,26%), 5) resistance opposes force/impetus (26,03%), 6) grafity acts after impetus wears down (21,92%), 7) existence of centriugal force (18,15%), 8) air pressure-assisted grafity (16,44%), 9) obstacles exert no force (10,37%), and 10) grafity intrinsic to mass (4,79%).

It is recommended to conduct future research to find the causes of these misconceptions, and to use some strategies in learning that refers to conceptual change in order to overcome the misconceptions.

REFERENCES

Gönen, S. (2008). A Study on Student Teachers' Misconception about Mass and Gravity. Journal of Science Education Technology,17, 70-81. doi:10.1007/s10956-007-9083-1.

Grayson, D. J. (2004). Concept substitution: A teaching strategy for helping students disentangle related physics concepts. American Journal of Physics, 72(8), 1126-1133. doi: 10.1119/1.1764564.

Hasan, S., Bagayoko, D., & Kelley, E. L. (1999). Misconceptions and the Certainty of Response Index (CRI). Physics Education, 34(5), 294-299.

Hestenes, D., Wells, M., & Swackhamer, G. (1992). Force Concept Inventory. The Physics Teacher, 30(3), 141-158.

Lawson, A. E. (1994). *Science teaching and the development of thinking*. Belmont, California: Wadsworth Publishing Company.

Luangrath, P., & Vilaythong, T. (2010). An Analysis of the Students' Perceptions of Physics in Science Foundation Studies at the National University of Laos. Canadian and International Education/Education canadienne et internationale, 39(1), 32-40.

Narjaikaew, P. (2013). Alternative Conceptions of Primary School Teachers of Science about Force and Motion. Procedia Social and Behavioral Sciences, 88, 250-257.

Pinarbaşi, T., Canpolat, N., Bayrakceken, S., & Geban, O. (2006). An investigation of effectiveness of conceptual change text-oriented instruction on students' understanding of solution concepts. Research on Science Education, 36, 313- 335. doi:10.1007/s11165-005-9003-4.

Stein, M., Barman, C. R., & Larrabee, T. (2007). What Are They Thinking? The Development and Use of an Instrument That Identifies Common Science Misconceptions. Journal of Science Teacher Education 18, 233–241. doi: 10.1007/s10972-006-9032-5.

Yürük, N. (2007). The effect of supplementing instruction with conceptual change texts on students' conceptions of electrochemical cells. Journal of Science Education Technology,16, 515–523. doi: 10.1007/s10956-007-9076-0.

Zukoski, A. T. (1996). Initial misconceptions and change in misconceptions through traditional instruction, and their relationship to students' learning styles and achievement in first semester college physics (Doctoral dissertation). Available from ProQuest Dissertation and Thesis database. (UMI No. 9718201).