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The application of real experiments video analysis in the CCBL model to remediate the misconceptions about motion's concept

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Abstract. Many studies have revealed that the concepts of motion are common misconceptions, either by students and teachers. In general, misconception occurs because prior knowledge obtained by the students when interacting with nature before they enter school institutions. Misconceptions tend to be resistant until they are graduate if not done remediation. This article analyzes student misconceptions about the motions and efforts to remediate it using cognitive conflict-based learning (CCBL) model through the application of real experimental video analysis. The research method used is survey research, experiment research, reviewing literature through searching national and international journals and presenting the results of the workshop on real experiment video analysis. The results of this study explain that misconception occurs in the concept of motion, both straight, circular and parabolic motion. Students can not relate between the concepts of motion with the equation that explains the concept. This study also explains the potential of the CCBL model through 4 syntax in enhancing concept understanding and remediating the misconceptions about motion through the application of real experimental video analysis. The role of the real experiments video analysis is needed in the third syntax of the CCBL model, namely the discovery of concepts and equations. Real experimental video analysis is required to remediate the student misconceptions about motion through Tracker program. The real experiment provides a real experience for students to conduct trials like a scientist. Students build the concept of motion and relate it to the equation. Real experimental video analysis in the implementation of the CCBL model has the potential to improve understanding of concepts and remediate student misconceptions about the concept of motion.

1. Introduction

Many studies have revealed misconceptions in physics, especially mechanics. Wandersee, Mintzes, and Novak, states, from 700 studies misconceptions in physics, there are 300 who studied mechanics [1]. Mechanics is the study of physics that studies the motion of an object, either motion ignores the force causes of motion (called kinematics), and the motion which takes into account the force of cause of motion (called dynamics). Mechanics is an important study in physics because the underlying physics, as according Soedojo that the mechanics are essentially the beginning and the underlying physics [2]. The concepts of motion in mechanics associated with displacement, velocity, acceleration, force, effort, energy, and momentum. Those concepts are difficult to understand the students because most of the concepts are abstract and often leads to misconceptions. The misconception occurs when students understand the concept of motion based on intuition and common sense they are often incompatible with scientific concepts. Problems also arise when students have trouble reading the graph, analyze the problem and apply them in the equation of motion. The phenomenon of misconceptions occurs almost at every level of education. Wilardjo states that although the quantity of students who have misconceptions tends to decrease with their age, and their education level is higher, but most of them still have misconceptions to college even after they become scholars [3].

The first-year student misconceptions can affect learning physics in subsequent years. In the first year, students study the basic physics of matter that is discussed in general, which are summarized in the course Fundamental Physics or General Physics. Misconceptions of students in the course Fundamental Physics will cause difficulties for students in understanding the physics in advanced courses. Additionally, misconceptions by student as candidate teachers can passing on misconception to their students later when they become teachers

The cause of the misconception and the difficulty of students understanding the concept of physics is teacher-centered learning. Teacher centered learning means that teachers dominate learning, while students have not been actively involved in constructing physical concepts, including the concept of motion. Motion concepts such as force, work and energy, in general, have been conceived as one of the students as they interact with the environment before they enter the institution. This condition will continue if the learning physics lectures and discussions dominated activity, and only a small portion experimental activities that involve students in the invention concept. Experiments carried out in learning still tend to be practicum (practical cookbook), namely students only follow the instructions to prove a physics equation. Students have not been required to think deeply, to find and construct concepts or equations in physics. In general practice activities that have been conducted so far have not provided a solution to the problems of student misconceptions.

One solution to increase understanding of physics concepts and remediate misconceptions about motion is using cognitive conflict-based learning (CCBL) model through the application of real experimental video analysis. This study aims to reveal student misconceptions in particular on the concept of motion and explain the potential of experiment real video analysis to improve concept understanding and remediate misconceptions through the CCBL model.

2. Methods

This article describes the results of research on the concept of motion in the General Physics course. Survey research was conducted to find out students' conceptual understanding and misconceptions about the concept of force using the FCI (Force Concept Inventory) instrument. The study was also supported by a literature study from national and international journals about the misconceptions of the motion concept by junior high school students, high school students and collage students. Experimental research was conducted to determine the effectiveness of cognitive conflict-based learning (CCBL) models in improving understanding of concepts and remediating misconception. The sample in this study consisted of an experimental class that was treated with learning the CCBL model, while in the control class traditional learning was conducted namely lectures and discussions. In both classes given a concept test at the beginning and at the end of the lesson. The instrument used is a static fluid concept test. The results of the workshop activities on experiment real video analysis that have been followed by the authors, also become references to the writing of this paper. In addition, the results of research from international journals on real video analysis experiments, especially the Tracker program will also enrich the study of misconceptions about the concept of motion remediation.

3. Results and Discussion

3.1. Research Results about Misconception of motion's concept

Results of research Mufit against the first-year students who have taken the course of General Physics, it was found that the understanding of the concepts of physics students is low (≤ 50%) and occurred misconceptions related to the topics: (1) the force on the vertical motion, (2) the force on circular motion, (3) the resultant force and the velocity vector, (4) force on the parabolic motion, (5) the force on the simple pendulum motion [4]. The results of the research also revealed that the majority of these students (81%) find it difficult to solve the problems of physics even though they understand the concept of topics related to the problem. Most students (47%) felt that the equations of physics do not support their ideas in understanding concepts of physics equations required only for a matter of course.

Isnaini explains that the misconception of the most widely experienced by students on the concept of motion is: "(1) In the stationary objects resultant force is not zero (2) the average velocity is equal to the average speed, (3) cannot distinguish between acceleration and velocity, (4) the normal force is always equal to gravity and always a straight line, (5) on a stationary object no force anything done ". The misconception mechanics is also experienced by high school teachers [6,7] who found misconceptions on teacher to the concept of vertical motion, parabolic motion, circular motion, work and energy, as well as objects equilibrium [5].

Taufiq reported the identification of misconceptions are quite high by physical education students in the sixth semester, and his mistake was not on mathematical calculations but also college students have misconceptions related to the concept of motion and force with different levels. Based on the results of intensive interviews revealed that the cause of the misconception that experienced by students on the concept of motion and force are the fault of the language, film show, thinking ability, family background, parallel conceptions and misconceptions beginning students [8].

Meanwhile, misconceptions mechanics at the high school level was also revealed through research Masril, which explains that high school students experiencing misconceptions about the kinematics of rectilinear motion of 32.50%, dynamics of rectilinear motion of 47.50%, motion mixing 50.74%, uniform circular motion of 48.94%, friction of 40.08%, gravity of 53.33%, effort and energy of 51.82%, as well as impulse, momentum and collisions of 48.61% [9]. Students also had difficulty reading the graph associated with the concept of motion as velocity versus time graph in the vertical motion [10]. Research results also found that misconceptions about the motion experienced by middle school students, the concept most experienced misconceptions is the concept of gravitational influence on the velocity of the object in motion free fall (84%) [11]. Student misconception that 'heavier objects fall faster than lighter objects' is also found in several studies [4,12]. Some results of these studies indicate misconceptions about the concept of motion experienced by secondary school students, high school and college students. Misconceptions include motion kinematics and dynamics, both in straight motion, circular motion or parabolic motion

Misconceptions need to be remediated, for whatever reason, misconceptions can impede new learning (Kuhn, 2001b; Reiner et. Al., 2000; Rooth & Anderson, 1998; in Ormrod[13]). Misconceptions also be resistant, meaning that if not given action to correct misconceptions, the misconceptions can survive in the student until they graduate, even after becoming a teacher. Some research suggests misconceptions in college students [8, 14-17], at the middle school students [11,18], as well as the teacher ([6, 19-21]

3.2 Research results about Real Experiment Video Analysis with Tracker Program

Real experiment video analysis is an appropriate alternative in overcoming misconceptions and increase understanding of the concept of the student about motion's concept. Not merely a demonstration or computer simulation, the activities of the 'real experiment video analysis', students obviously do experiments like scientists. For examples on the movement of free fall (vertical motion), the concept of a common misconception by both students junior high, high school and college students is that heavier objects fall earlier than lighter objects if dropped simultaneously from the same height. Difficult to do experiments to remediate these misconceptions, because the motion is fast, so hard to

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catch the eye. But through the 'real experiment video analysis', students can test the truth of their misconceptions with the help of video cameras and analyzing motion of objects in video using Tracker program.

This experiment was recorded by students through a video camera, with a contrasting set the background that the movement of the ball can be seen clearly. Then students used the Tracker program to analyzes video to see the traces of balls fall within a certain time interval. Through this analysis, students can actively plot the graph of displacement, velocity, acceleration, and energy, according to tracking the ball at every stage movements.

Tracker program has easy steps in analyzing the motion of video recordings. The steps in analyzing the video [22] are: a) to enter the video recordings in the program Tracker, b) determine the mass of the object, c) Determine the coordinates xy axis as the frame of reference of a moving object, d) Determining the scale of distance or displacement of objects. e) Track the motion of objects within a certain time interval, f) Plot the graph is needed. The results of video analysis in the form of video footage to track the movement of objects at the same time the motion of objects on each graph desired.

3.2.1. Free Fall Motion. Misconception on free fall motion can be remediated using an experiment real video analysis. Real experiments conducted by dropping two balls of the same size, but different mass from the same height simultaneously, as shown in Figure 1a [22]. The dropping simultaneously (Figure 1a), has a displacement and velocity graphs as in Figure 1b. In the graph shows that the two balls (whose mass is different) has the same displacement and velocity.

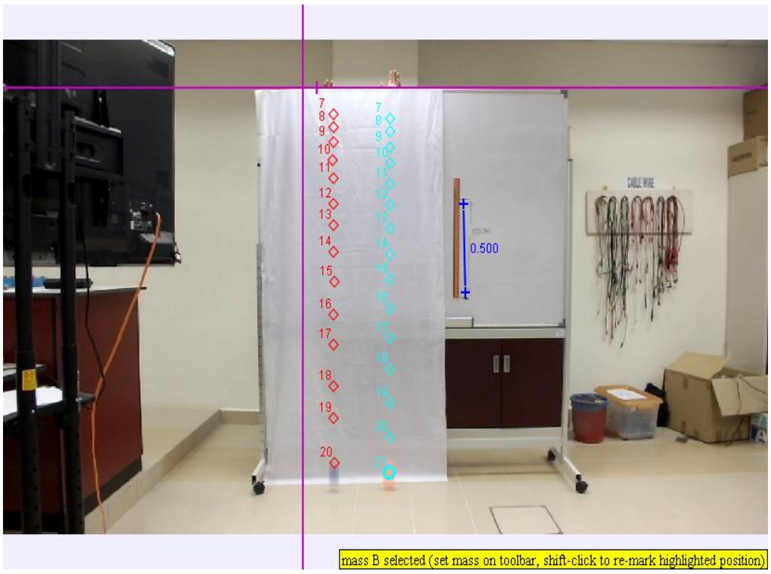


Figure 1a. Tracking Two balls of equal size, a different mass, free fall from the same height simultaneously. (Video contribution Jaafar, 2016 at the workshops)

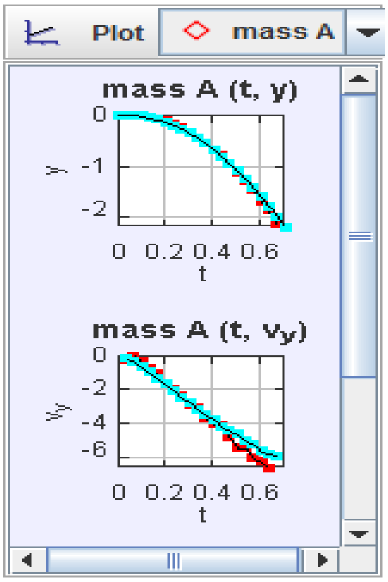


Figure 1b. Displacement and velocity graphs two balls of the same size, different masses, the free fall of the same simultaneously

3.2.2. Collision. Real experiment video analysis on the movement of two colliding objects that can be seen in Figure 2 [22]. The concept of velocity and momentum of the ball can be analyzed through graph in Figure 2. The difficulties and misconceptions of students about the concept of momentum can be remediated through this real experiment video analysis.

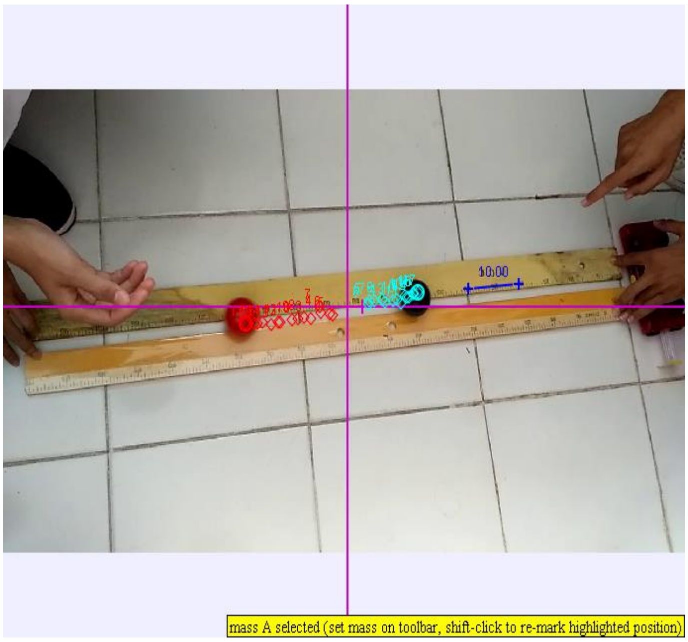


Figure 2a. Video recording of the collision two balls

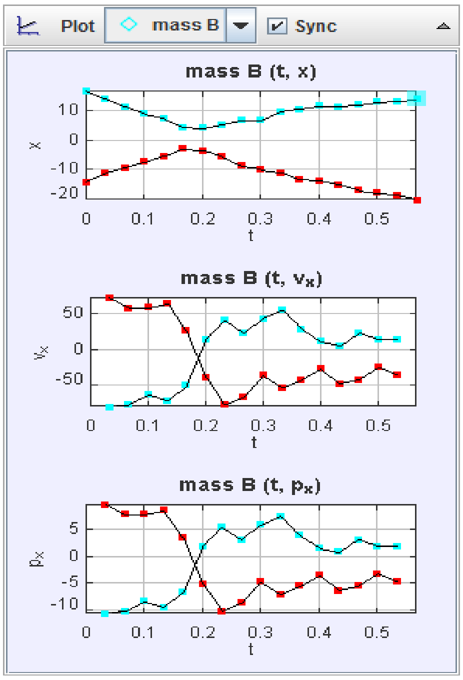
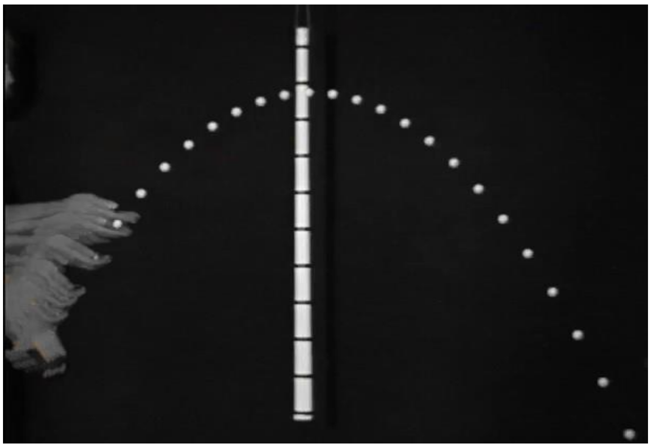


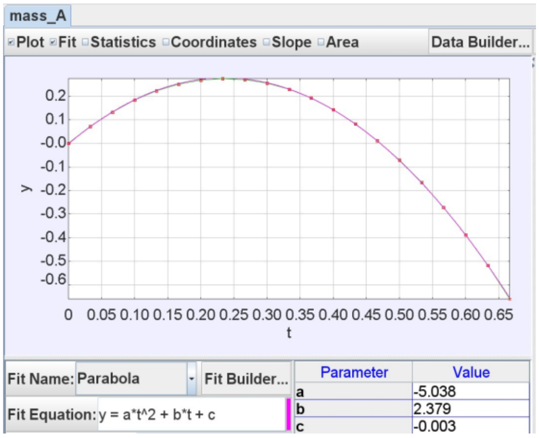
Figure 2b. Graph of the position, velocity and momentum are two balls that collide.

Through the graph (Figure 2b) which has been produced from video analysis, students will think deeply in discovering the concepts of motion identical balls that collide. The graph shows the position of the initial position of the ball that moves away, then approached, and back away after colliding. Through the velocity graph, students will also find that the velocity herded negative value means that the velocity of the ball toward the opposite direction of the original motion. Through the momentum and velocity graphs, students will also find the concept that the velocity of the ball has the same direction as the momentum of the ball. Both the velocity and momentum is a vector quantity. Graph the results of video analysis can also lead students find formulas or equations of physics that describe relationships between concepts. Experiment real video analysis can unify the concept of motion physics students with physics equations that describe the concept.

3.2.3. Projectile Motion. Difficulties and misconceptions students on parabolic or projectile motion, can be remediated with real experiment as in Figure 3. The ball is thrown to form a certain angle so as to produce a parabolic trajectory. Through Tracker program, students analyze the video footage by tracking the motion of the parabola. Graph tracking the results can be seen in Figure 3. Through the graph in Figure 3, the students gain experience and understanding of the combined uniform rectilinear motion (on the horizontal motion) and a uniformly accelerated motion (on the vertical motion) that form a parabolic motion (projectile motion). This concept is difficult to understand the student without doing real experiments. At material of projectile motion, Wee found video modeling pedagogy is suitable for active and deep learning because the students can be predicting by keying certain values, observing by comparing the real data with the current proposed model [23].

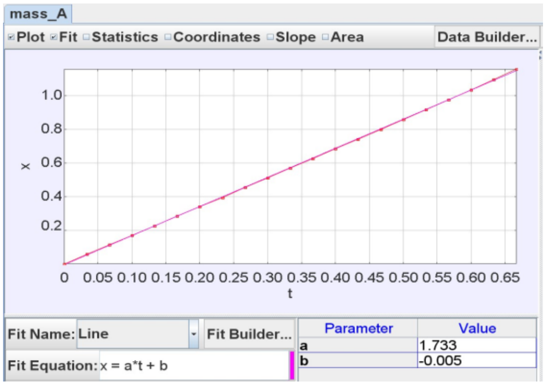


(a)



(b)

Figur. 3. Video recordings of the ball thrown form a parabolic trajectory (a). Graph object position against time on projectile motion, which indicates that the projectile motion is a combination of vertical motion (b) and horizontal motion (c). [23]



(c)

3.3 Cognitive Conflict Based Learning (CCBL) Model

Some experts have conducted research on the advantages of cognitive conflict strategies, especially in overcoming misconceptions or conceptual changes, both at national [24-27] and international [14,19, 28-32] levels. Through research design/development, Mufit [33-35] developed a model of Cognitive Conflict Based Learning (CCBL), as an effort to improve understanding of concepts and to remedy misconceptions. The CCBL model consists of four syntax, namely (1) activation of preconceptions and misconceptions; (2) presentation of cognitive conflict; (3) discovery of concepts and equations; and (4) reflection. The principle of reaction to cognitive conflict-based learning models requires student-centered learning, and is oriented towards the learning process, and facilitates students to deep thinking. The social system in implementing the model requires cooperation between students and the need for scaffolding from lecturers according to the needs of students, and multi-directional interaction between students and students and lecturers is needed.

Experimental research has been conducted to see the effect of applying the CCBL model on understanding student concepts in static fluid material. The results of the study indicate that the CCBL model can improve understanding of concepts and remediate student misconceptions on the concept of static fluid [33-34]. Table 1. shows an example of the application of the CCBL model syntax to the concept of free fall motion aided by cognitive conflict-based students' jobsheet.

Table 1. Example of the application of the CCBL model syntax to the concept of free fall motion.

Syntax of CCBL Model
1. Activation of Preconception and Misconception
Problem 1. Two metal balls are the same size but one weighs twice as much as the other. The balls are dropped from the roof of a single story building at the same instant of time. The time it takes the balls to reach the ground below will be: (A) about half as long for the heavier ball as for the lighter one. (B) about half as long for the lighter ball as for the heavier one. (C) about the same for both balls. (D) considerably less for the heavier ball, but not necessarily half as long. (E) considerably less for the lighter ball, but not necessarily half as long. The teacher activates students' prior knowledge, especially activating misconceptions by giving concept questions.
2. Presentation of cognitive conflict
Student representatives demonstrated by dropping two balls of the same size, but different masses. Both balls are dropped from the same height simultaneously, as in Figure 1a. The lecturer gives several questions that trigger cognitive conflict about the demonstrations that have been observed by students. The lecturer also conducts question and answer with students about students' answers to the first syntax.
3. Discovery of concepts and equations
Each group of students conducted a real video analysis experiment about free fall motion as in figure 1. Students discussed finding the concept of free fall motion by observing the footprint of the ball on video recording. Then the students discussed finding the equation for free fall motion by analyzing the graphs of the video recordings.
4. Reflection
One group representative presented their findings. Lecturers lead class discussions and provide confirmation. At this syntax, students express ideas, share ideas and restructure ideas in building conceptual understanding.

The third syntax of the CCBL model requires that experiments be carried out by students to find concepts and then find equations that explain the concept. Real experimental video analysis is applied to the syntax of the three CCBL models, namely the discovery of concept and equation syntax. In addition to the concept of free fall movement, real video analysis experiments can also overcome low conceptual understanding and misconception of other motion concepts, such as vertical motion, parabolic motion, circular motion, movements during collisions and other movements.

The application of a real video analysis experiment to the third syntax plays an important role in achieving a long-lasting conceptual understanding in student memory. Conceptual understanding is obtained when students conduct an analysis of the motion of the object recorded by video and relate it to various physical motion quantities such as displacement, speed, acceleration, momentum, and energy, organized in graphical form. Through graph analysis, students are guided to find equations that explain the concept of motion. The process of finding concepts and organizing them in the form of equations is an effort to achieve conceptual understanding (conceptual understanding). Ormrod [13] states that when students form many logical relationships between various specific concepts and principles, they get conceptual understanding. In addition, this stage also plays a role in improving the negative attitude of students towards learning physics, which assumes that between the equations of physics and the concepts contained therein is something separate [4]. Students no longer see that the equation of physics as a mathematical operation that stands alone, which is only memorized without knowing the physics concept contained in it.

The syntax of discovering concepts and equations through the application of experimental real video analysis is done in groups or in collaboration with students. Ormrod [13] states that socially constructed knowledge carried out by two or more people simultaneously will be better than the construction of individual knowledge. Constructing knowledge socially by involving students to work together actively to get a better understanding of the concept of motion.

The activity of this discovery, in accordance with the theory of constructivism, which states that students must find themselves and transform complex information, check new information with old rules and revise it if the rules are no longer appropriate [36]. In the process of this discovery, students build new knowledge and connect it with prior knowledge in the form of preconceptions and misconceptions. Thus, the application of experiment real video analysis in the CCBL model has the potential to improve understanding and remediate students' misconceptions about the concept of motion.

4. Conclusion

Low understanding of concepts, and misconceptions in the concept of motion, is a problem that is often experienced by middle school students and college students. The best solution in achieving conceptual understanding of the concept of motion is to involve students actively in the process of discovery through real video analysis experiment activities. The application of experiment real video analysis in the syntax of the three CCBL models has the potential to improve understanding of concepts and remediate physical misconceptions in the concept of motion. Through the implementation of the CCBL model in learning, students are systematically guided to find concepts and equations of motion by conducting experiments like scientists. Therefore, educators are advised to use the CCBL model in learning about motion by applying a real video analysis experiment.

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