The role of picture of process (pp) on senior high school students’ collision concept learning activities and multi-representation ability

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Abstract. The objectives of the study are to describe the effect of PP collision concepts to high school students’ learning activities and multirepresentation abilities. This study was a quasi experimental with non-equivalent post-test only control group design. The population of this study were students who will learn the concept of collision in three state Senior High Schools in Indonesia, with a sample of each school 70 students, 35 students as an experimental group and 35 students as a control group. Technique of data collection were observation and test. The data were analyzed by descriptive and inferensial statistic. Student learning activities were: group discussions, describing vectors of collision events, and formulating problem-related issues of impact. Multirepresentation capabilities were student ability on image representation, verbal, mathematics, and graph. The results showed that the learning activities in the three aspects for the three high school average categorized good. The impact of using PP on students’ ability on image and graph representation were a significant impact, but for verbal and mathematical skills there are differences but not significant.

1. Introduction

Mechanics is a part of physics, the science that studies about nature and its phenomenon, especially nature related to motion and equilibrium of objects [1]. One of the materials discussed in mechanics is the concept of a collision. The findings of mastery of high school mechanics for the concept of a collision, including momentum and impulse, with the implementation of learning that, is not supported by process activities to review the concept is still not encouraging. This is shown from the results of research on a sample of 200 students of grade 12 State Senior High School 4 of Jember in one district in Indonesia, only 76% of students can write and use the formula concepts correctly. The next time they are asked to explain the velocity vectors, momentum, or impulses that occur in the event of the collision, not more than 10% of them can explain correctly. A further search on the question of vectors found in the collision events of several physics teachers in the area still found some physics teachers who have not been able to describe the vectors present in the collision event. This field data shows that learning mechanics, especially on the concept of collision cannot be said to work well. Learning the concept of a collision has not been able to make the students can master the concept completely or in multi-representation ability, they're average new strong in the concept of the verbal and mathematical only.

The multi-representation of students’ collision concepts can be demonstrated when capable of displaying collision concepts in the form of images, verbal, mathematical, and graphics. In relation to the impact learning data on collision concepts in some high schools, indicating that most new students master the concepts of verbal and mathematical scrambling, it can be expected that the implementation of collision concept learning in some Senior High School is less supported by experimentation,
demonstration or modeling related to the process how the concepts on the collision event. Visual representation types such as images can help to facilitate illustration of something students learn. Many visual learners state that to remember content is more effective if the content is expressed in the form of images student [2,3]. Learning completed with a complete picture can make it easier for students to understand difficult concepts [7]. Learning with images can improve retention of the ideas presented [2,5]. Images as visual representations can be enabled to communicate the concept of learning materials including the concept of science [6,7]. Based on these opinions, it can be said that the image can function as a visual-based media to facilitate learning of science, including learning the mechanics of the concept of a collision.

Learning in principle is a practice activity. Practicing is the process activity to achieve a change from the form of achievement to the behavior. Behavior is divided into three domains: the domains: cognitive, psychomotor, and [10,11]. Individuals in learning are said to have mastered the material cognitively well if the individual has mastered the material taxonomically, i.e. at the level of knowing, understanding, applying, analyzing, evaluating, and creating [10]. The nature of taxonomy in this cognitive domain provides the understanding that, in the cognitive content of the material always begins with mastery at the level of knowing, understanding, and so on. Knowledge according to Information Processing and Memory theory is explained that all information entering through individual sensing on memory processing is selected into short-term memory and long-term memory, short-term memory immediately is forgotten or lost and long-term memory stored in the form of coding as knowledge [12]. This view reinforces the notion that essentially explanations of something as information in any form when it is stored as knowledge will always be altered by the function of the brain in the form of codes. The formation of these codes is actually a visual imagery or concealment of the contents of the incoming information [13]. Errors in the formation of coding, visual depiction, or individual conclusions about the contents of information coming into him and the next will be stored in his memory that often leads to misconceptions about information or concepts in the individual [14]. This explanation reinforces the view that the delivery of information in the form of images can minimize the occurrence of misconceptions [15].

The process is a change of events or events in the development or sequence of actions, manufacture, or processing that produces the product. Understanding the process is a sequence of steps starting from stimuli in the environment and ending with an interpretation of the stimulus [16]. The process is a description of the flow of a system. The process is a series of activities or steps taken to achieve an expected result [1]. Thus, the process can be said to be a stage of states, events, precarious conditions that must exist or occur from the initial conditions of the process began to be observed or performed until the final conditions of the target process were observed. The explanation of the process is basically an explanation of the state or condition at each stage of the whole process. Explanation or condition is the visualization of events at that time. Visualizations can be poured in the form of images.

An image is a visual representation or modeling of an object, condition, phenomenon, or even imagination or idea in a two-dimensional medium or field such as paper, cloth, wall, and the like [17]. The picture is a visual representation of an object or something, such as a person or a scene, produced on a surface, as in a photograph, painting, etc. which is poured in a two-dimensional medium or a plane that can be perceived by the sense of sight [10]. By this, the sequence of states or conditions present in a process event can be poured in the form of successive drawings. The collection of drawings that one with another sequentially describes a series that occurs in an inner event called the processed image. The picture of process is an image that contains a series of pictures of the initial conditions to the final state of the object, event, or phenomenon, which the picture of condition one with the picture of the next condition always contains a difference, but the difference in the image is seen as a sequence or sequence of previous state or condition [12]. Opinions about the drawings of this process when associated with a description of the definition of the image and the meaning of the previous explanatory process, PP can be understood, as a series of object modeling images, events, or phenomena, which between the images relative to each other condition, position, form, or combination which as a whole describes a coherent stage and is a unified whole.
Mechanics basically discusses the concept of motion and its phenomenon. Observing motion basically observes the process occurrence, i.e., observing the object at the initial condition or position is observed to the next condition until the final condition is observed. Observing the phenomenon of motion, meaning observing the event in motion not only the condition of objects that can be seen in real or easy, but also observe the things that cause the object to move. Factors that cause the motion of an object is not uncommon that is abstract, complex, and or not easy to observe directly. The phenomenon in motion that cannot be observed in the event of mechanics including the occurrence of collisions is what often leads to misconception. In relation to the description that the picture can theoretically minimize the occurrence of misconceptions, it develops information about every phenomenon existing in the process of motion in mechanics, such as the concept of collision, in the form of pictures of each phenomenon condition can minimize the occurrence of misconceptions in studying the phenomenon of the process in the concept collision. With the understanding of the drawing process is a picture of each condition of the process sequentially and is a unity of circumstances, the processed image can function as a medium to facilitate in learning the concepts that exist on the collision. An example of a process image display to explain the collision event and the vectors present in the event can be seen in Figures 1A, 1B, 1C, and 1D.

![Figure 1A, 1B, 1C, and 1D](image)

Figure 1. Examples PP of collision incident and the vectors.

Based on the above description, the effect of PP collision concepts to high school is students' learning activities and multi-representation abilities.

2. Research method

This study is a quasi-experiment with the design of non-equivalent post-test only control group. The sample selection is done by random class. The population in this study is students who will learn conception collision mechanics in three Senior High Schools in Indonesia, with the sample of each school 70 students, or total sample 210 students. Samples in each school were divided into two groups, i.e., as a group of 35 students and as a control group of 35 students. The experimental class group in the implementation of mechanical learning of collision concepts is equipped with the media "Process Drawing (PD)" while the control group of learning implementation is done as previously done.

Overall research is divided into three stages: preparation, data collection, and data analysis. The preparatory stage includes: [1] composing the media for complete PP-based impact conception mechanics (see Figure 1), and [2] training on the use of PP-based media in learning of physics test teachers and assistant observers. The data retrieval stage includes: [1] recording of experimental class student activities in the learning of collision concept mechanics according to the HOT paradigm (include: a) student activity in group discussion to obtain clarity about the vectors occurring at the collision event; students in trying to describe the vectors that occur in partial collision events, and (c)
student activity in trying to make a complete problem related to the collision); and (2) collecting post-test data on collision concept conception multi-representation from control class and experiment class. The data analysis stage includes: [1] data analysis descriptively recording of experiment student activity in impact learning with PP media; and [2] impact analysis of PP media implementation in mechanical learning of impact concept, using parametric statistic independent sample t-test. Independent sample t-test is used because the analyzed data consists of two groups that are both independent (unrelated).

3. Scarf Trigonometry plus Non-Central Rosen-Morse Potentials

3.1 Student Learning Activity

To answer the formulation of problem 1, description of student learning activities includes (a) average student activity during the discussion process including: mentioning topics discussed, debating issues discussed, finding solutions, showing evidence of each argument, drawing conclusions; (b) average activity of drawing process, including position, size, and direction; and (c) the activity of making a problem related to the topic of conformity to the topic (collision). Activity description data include frequency distribution, mean, and standard deviation (s) in each group. The frequency distribution data of student learning activities can be shown in Figure 2.

![Figure 2. Frequency distribution of student learning activity 3 senior high school.](image)

Figure 1 shows that of three high schools there is a tendency to (a) average learning activity during the discussion process, (b) drawing activity, and (c) the activity of formulating the problem shows similar results, respectively between 3 – 3.4; 3.1 – 3.2 and between 2.8 – 2.9 with standard deviation between 0.5 – 0.7.

3.2 Student learning of multirepresentation abilities

As has been described previously that the impact of learning with PP seen from the ability of students in representing the concept. To know the effect of PP on student ability, hence need data of student ability in experiment class and control class. The results of mean rank and sum ranks analysis for four indicators of image representation (I), verbal (V), mathematics (M), and graph (Gr) in the experimental and control class can be seen in Table 1 and the significance test results are shown in Table 1.

| Table 1. Mean and standard deviations of representational ability experimental and control classes. |
### Groups and Ability of Representation

| Groups               | I   | V   | M   | Gr  |
|----------------------|-----|-----|-----|-----|
|                      | E   | E   | E   | E   |
|                      | M   | M   | M   | M   |
|                      | Sd  | Sd  | Sd  | Sd  |
| Senior High School A | 72  | 77  | 76  | 72  |
|                      | 5   | 3   | 4   | 6   |
|                      | 40  | 40  | 4  | 48  |
|                      | 7   | 77  | 3  | 77  |
|                      | 3   | 79  | 3  | 77  |
|                      | 76  | 3   | 3  | 72  |
|                      | 6   | 47  | 9  |     |
| Senior High School B | 72  | 77  | 76  | 72  |
|                      | 5   | 3   | 4   | 6   |
|                      | 40  | 40  | 4  | 48  |
|                      | 7   | 77  | 3  | 77  |
|                      | 3   | 79  | 3  | 77  |
|                      | 76  | 3   | 3  | 72  |
|                      | 6   | 48  | 10 |     |
| Senior High School C | 75  | 78  | 74  | 77  |
|                      | 5   | 3   | 13  | 3    |
|                      | 43  | 47  | 9  | 6    |
|                      | 10  | 48  | 10 |     |
|                      | 78  | 3   | 4  | 77  |
|                      | 72  | 6   | 4  | 79  |
|                      | 6   | 47  | 9  |     |

**Table 2.** Results of significance test of senior high school.

| Groups               | I   | V   | M   | Gr  |
|----------------------|-----|-----|-----|-----|
| Senior High School A | .500| .519| .515| 41.000|
| Mann-Whitney U       |     |     |     |     |
| Wilcoxon W           | 630.500| 1149.000| 1145.500| 671.000|
| Z                    | -7.277| -1.216| -1.283| -6.842|
| Asymp. Sig. (2-tailed) | .000| .224| .199| .000|
| Senior High School B | .500| .519| .478| 43.000|
| Mann-Whitney U       |     |     |     |     |
| Wilcoxon W           | 630.500| 1149.000| 1108.000| 673.000|
| Z                    | -7.282| -1.216| -1.762| -6.811|
| Asymp. Sig. (2-tailed) | .000| .224| .078| .000|
| Senior High School C | 33.500| 405.500| 507.500| 28.500|
| Mann-Whitney U       |     |     |     |     |
| Wilcoxon W           | 663.500| 1035.500| 1137.500| 658.500|
| Z                    | -6.895| -2.678| -1.367| -6.958|
| Asymp. Sig. (2-tailed) | .000| .007| .172| .000|

Based on Table 1, there is an average difference in multirepresentation capabilities (I, V, M, and Gr) between the experimental class and the control class in Senior High School A. Table 2b for difference of representation of I and Gr of sig < 0.05, it can be said that there is significant influence of learning with print media of process image to the two capabilities. However, the difference does not occur in the ability of verbal and mathematical representation. In these two capacities there is an average difference, but the difference is not significant because the sig value> 0.05 (Table 2).

### 4. Conclusion

Based on the data analysis and discussion of research results, it can be concluded:

- The use of PP make students active (a) during the discussion process, (b) during the drawing process, and (c) the activity at the time of formulating the problem.
- The use of PP has a significant effect on the ability of image and graph representation, but for verbal and mathematical representation is different but not significant.

From these conclusions there are several suggestions that need to be considered when using PP, namely:

- For physics teachers, PP may be used for other physics topics.
- For media developers, need to pay attention to the characteristics of the material when it will develop the PP.

For teachers and media developers, when implementing PPs it is necessary to prepare students to think at HOT level.
Acknowledgement

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