The analysis of tenth grade LMM on work and energy

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Abstract. The purpose of this research was to intimidated LMM (Learners’ Mental Model) of work and energy. The mental model can be used to considered more extremely apparatus of misconceptions. The research method is a case study with descriptive quantitative analysis. The samples are 30 tenth grade students (14 boys and 16 girls, their ages were middling 16 years-old) at one of senior high school in Bandung. The research sample used cluster random sampling technique or random class. LMM was analysis through two-tier test in the form of open-ended questions as many as 5 questions. The data investigation was approved purchasable in two stages. In the first stage the analysis learners level of understanding and in the second stage the analysis learners model of understanding. The result illustrations that mental models have been identified in the three categories, that are, 1) Scientific 26.7%, 2) Synthetic 16%, 3) Initial 57.3%. In conclusion, mental model of the initial category is higher than other categories.

1. Introduction

Theories about mental models have been around since 1970. Johnson and Laird exposes [1] model mental have three fundamental principles. First, separately mental model characterises what is communal to a dissimilar established of opportunities. Second, mental models are iconic, namely, their assembly as remote as likely matches to the construction of what they characterize. Third, mental models constructed on descriptions embody what is correct at the expenditure of what is incorrect. Coll and Treagust explained [2] mental models are purposeful developing systems, often imperfect and moderately unbalanced that permit a separate to involve in description, explanation and prediction. According to Abdo and Taber [3] learners then method their particular mental model of the desired mark knowledge. Brewer said [4] the theory of the mental model is used here to designate the classes of mental illustrations we reason persons construct when the reason about the physical creation. In other words, the mental model is a form of individual representation used to describe or shows the concept and understanding of the individual from scientific phenomena, and mental model can be used to painstaking more enormously device of misconceptions.

Mental models are very important in education, especially in physics learning. Physics developments contain several abstract concepts, for example force and energy, and learners’ complications in completely acquisitive these concepts are recurrently conversed in correlated literature. This relates to Clement [5] opinion it is tough for learners who have inappropriate or missing information about physics to appropriately form new concepts. The unrelated tolls between the supposed that learners realize to lesson and the concept by the current scientific principle’s prominent misconceptions. Learners misconception have been inimitable of considerable purview investigation in science education, additional explicit at physics education. more concepts in physics education are informed that has misconceptions on learners [6] such as on work and energy. The concept of work and energy also the
stage a crucial part in physics [7]. Bezen said [8] from the lessons on the instruction of energy, we resolute that learners have misconceptions about energy as a concept and about conservation of energy, conversion of energy, transfer of energy, and energy bases.

For example, on the concept of work. To do work on an object, one must move the object by applying a force with at least a component in the direction of motion. It is very important to note that for work to be done there must be a component of the applied force in the direction of motion. Forces perpendicular to the direction of motion do no work.

\[ W = F \cdot s \]  \hspace{1cm} (1)

Where:

- \( W \) = work (Joule)
- \( F \) = force (N)
- \( s \) = space (m)

Figure 1. A beam is given a force of \( F \) to move as far as \( s \).

Arslan explained [9] it is acknowledged that influential learners’ likely weaknesses and faults about conceptual acuities in advance is helpful in terms of providing learners and teachers with essential information to explain and to develop solution strategies for scientific or daily life problems related to these concepts.

The aim of this research was to frightened LMM (Learners’ Mental Model) of work and energy. So, we know the category of mental models on the learners, as well we can also know the level of learners’ understanding of physics concepts on work and energy.

2. Methods

2.1. Research purpose
The aim of this research was to analysis LMM (Learners’ Mental Model) of work and energy.

2.2. Research method
This research method is a case study with descriptive quantitative analysis. In this research, the first is accumulating quantitative data shadowed by collecting qualitative data, the results of quantitative data are proposed to support the results of qualitative data.

2.3. Participant
The samples are 30 tenth grade students (14 boys and 16 girls, their ages were middling 16 years-old) at one of senior high school in Bandung. The research sample used cluster random sampling technique or random class.

2.4. Instrument
LMM was analysis through two-tier test in the form of open-ended questions as many as 5 questions about the concept work and energy. Question of number 1 and 3 about concept of kinetic energy, question number 2 about concept of law of conservation of mechanical energy, question number 4 about concept work by conservative force, and question number 5 concept about relation work and potential energy. We present the test matters below:
2.5. Data Analysis

From the answer of learners, the data investigation was approved purchasable in two stages. First, the researcher analyzed the data from learners’ level of understanding. The rubric use in this research is concise in Table 1. [10]

Table 1. Evaluation rubric for understanding levels

| Level of Understanding (LU) | Score | Criteria |
|-----------------------------|-------|----------|
| Sound Understanding (SU)    | 4     | Responses containing all components of the scientifically accepted response. |
| Partial Understanding (PU)  | 3     | Responses containing some components of the scientifically accepted response |
| Partial Understanding with Alternative Conception (PU-AC) | 2 | Responses showing that the concept is understood but also containing alternative conceptions |
| Alternative Conception (AC) | 1     | Scientifically incorrect responses containing illogical or incorrect information |
| No Understanding (NU)       | 0     | Blank, irrelevant, or unclear responses |

The second, the researcher identified the learner’s model of understanding with classifications as shown in the following Table 2 [10].
Table 2. Evaluation rubric for Mental Models

| Model of Understanding | Content                                                                 | Level of Understanding |
|------------------------|-------------------------------------------------------------------------|------------------------|
| Scientific             | Perceptions coincide with scientific knowledge: the answer at the level of 3 (PU) or level 4 (SU). | [3 3 3 3 3] 4 4 4 4 4 |
|                        | Perceptions which partially coincide or do not coincide with scientific knowledge. | Other possibilities |
| Synthetic              | Perceptions everything do not coincide with scientific knowledge: answers on level 0 (NU), 1 (AC) and 2 (PU-AC) | 1 0 0 0 0 1 1 1 1 |
| Initial                | Perceptions which do not coincide with scientific knowledge: | 2 2 2 2 2 |

3. Result and Discussion

3.1. Learners’ level of understanding

Table 3 shows data from the learners answer after analysing each item about work and energy. The results are presented below.

Table 3. Percentages of understanding level

| Level of Understanding | Q1    | Q2    | Q3    | Q4    | Q5    | Average |
|------------------------|-------|-------|-------|-------|-------|---------|
|                        | f     | %     | f     | %     | f     | %       |          |
| SU                     | 4     | 13.3  | 2     | 6.7   | 2     | 6.7     | 1 23.3   | 10.7     |
| PU                     | 8     | 26.7  | 13    | 43.3  | 1     | 3.3     | 0 2 6.7  | 16       |
| PU-AC                  | 8     | 26.7  | 3     | 10    | 7     | 23.3    | 2 6.7 4 13.3 | 16     |
| AC                     | 10    | 33.3  | 8     | 26.7  | 18    | 60      | 25 83.3 14 46.7 | 41.6    |
| NU                     | 0     | 0     | 4     | 13.3  | 2     | 6.7     | 2 6.7 3 10 | 7.3      |

As seen in Table 1, 10.7% of learners were classified at the SU understanding level by identifying the answer of all questions, about 16% of learners were classified at the PU understanding level, 16% of learners were classified at the PU-AC understanding level. It seen that learners in all question are dominant classified in AC 41.6%, and NU 7.3%.

Based on the above data, the highest average classification is in AC category. For example, in question number 4 has 83.3% in AC category. This indicates that the answers of many learners are still inconsistent with the concept of effort by the conservative force. Learners answer only on the basis of visible phenomena and contain alternative answers without being based on concepts in physics. However, there are some learners who provide answers that fit the concept of physics. Correlated to Goldring [11] study show that learners answer, learners have problems with the elementary concept of energy and its correlated concepts. However, there are some learners who provide answer that fit the concept in physics.
For example, learners answer that is:

“On track II there is a steep curve so that the value of the resulting work is greater” (learners 6)

Learners answer that a larger work value is found on a steeper track but learners do not state reasons. Learners are seen as learners not answering scientifically and only guessing from the shape of the track. So that these learners are categorized in the AC category. In this case the learners are expected to be able to explain how the work value of the trajectory is different from the scientific concept.

“The resulting work value is just as large as a different from of trajectory” (learners 15)

Learners answer that the resulting work value is the same even though the shape of the track is different. Learners answers are correct that the value of the work is the same but does not explain the reason based on scientific concepts. In this case learners are categorized as PU-AC because the answer still contains alternative answers.

“The value of effort generated on track I and II is the same because it is influenced by conservative force (not influenced by the form of trajectory)” (learners 30)

Learners answer that the work value produced in different trajectories is of the same value because it is influenced by the conservative force. Efforts by the conservative force do not depend on the trajectory being taken, only depending on the initial and final position. In this case learners answer correctly and are accompanied by reasons that are in accordance with scientific concepts. So that these learners are categorized as SU categories.

3.2. Learners’ Mental Models

Mental models of learners determined in accordance with understanding levels defined for each item of question. The resulting classification are shown in Table 4.

| Mental Model | Q1   | Q2   | Q3   | Q4   | Q5   | Average |
|--------------|------|------|------|------|------|---------|
|              | f    | %    | f    | %    | f    | %      | %       |
| Scientific   | 12   | 40   | 15   | 50   | 3    | 10     | 1       |
|              | 3,3  | 9    | 30   | 26,7 |
| Synthetic    | 8    | 26,7 | 3    | 10   | 7    | 23,3   | 2       |
|              | 6,7  | 4    | 13,3 | 16   |
| Initial      | 10   | 33,3 | 12   | 40   | 20   | 66,7   | 27      |
|              | 90   | 56,7 | 57,3 |

From Table 2, it was found that 26,7% learners were classified at is scientific, 16% learners were classified at synthetic and 57,3% students were classified at initial. Mental model of the initial category is higher than other categories.

Based on the above data, mental model of the initial category has the highest percentages. This means that many learners don’t fit the concept of physics or unclear responses. Vosniadou [12] Scientific models about replies comprehending all apparatuses of the scientifically accepted response or the answers that fit the concept of physics, synthetic models are possible to be designed when the knowledge achievement course involves a reconsideration of assumptions that are based on interpretations of everyday experience, and initial models are rely exclusively on interpretations of experience which can be derived from everyday observation.

4. Conclusion

Based on the results of the data, it can be concluded that mental models in the initial categorical have the highest percentage. This means that there are still many learners who answer questions that are not in accordance with the concept of physics or the level of students' understanding of the concept of physics is still low, so it can cause misconception in students. Therefore, it is expected that teachers can find a good method to change or improve learner’s conception.
5. References

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