Problem Solving Strategy in Balanced Forces

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Abstract

Force and motion consists of abstract concepts which often reported difficult to be learned by students. The aim for this study is to identify student's ability level in problem solving skill which involved balanced force of surface plane system, inclined plane system, pulley system, lift system and combination system. Data collection was through physics problem solving test questionnaire carried out to 189 science stream Form four students from three secondary schools in Kuala Kangsar district, Perak. All the data obtained were processed by using SPSS 21 version and presented in form of frequencies and percentages. The result showed problem solving ability level among students was poor. Suggestions have been proposed to help teachers and students for teaching and learning (P&P) improvement and on the other hand to solve problem in Physics subject in future.

Keywords: Problem solving strategy, Force and Motion, Balanced Forces, Physics, Form Four

1. Introduction

Physics problems can be solved through teaching and learning (P&P) method in order to gain knowledge on Physics principle by conceptual and procedural (Leonard, Dufresne & Mestre, 1996). Apart from that, problem solving can also be described as Physics principles from problems given (William Gerace & Beatty, 2005). Physics principle consists of two type of knowledge, namely conceptual and procedural. Traditional learning involves the use of textbooks and chalk & talk method (Neo & Rafi, 2007; Havice, 1999). It is a one way method where teacher delivers the subject's content and students only listen on what has been taught. Thus, this situation make the students become passive. Besides, student also fail to form conceptual physics's concept (Mazur, 1996) because they just memorize without understand the concept of primary knowledge. In traditional education, teacher will provide problem solving method and student only need to follow the procedure to solve the frequently asked questions. Each problem faced by the students has their own specific method and they will only receive it. Therefore, students only need to focus on certain procedure. As stated by Ben-Zhi (2006) students currently tend to memorize certain facts and procedure where they no longer emphasize in problem solving method. Thus, this condition makes weak students will not able to master the Physics concept. Other than that, students need to do revisions and only depend on the model answer in textbooks and thereafter solve problems in the end of chapter. Students will only copy and do the solution without solution scheme. Students also are not trained based on scheme by the experts during problem solving activity. Moreover, the use of model answer also discounted the gap of students learning to identify the structure of particular problem in order to be matched with the new encounter problem.

2. Problems Statement

Physics traditional learning method is one of the factors that causes Physics often assumed as difficult subject to be understood either during school or university level (Angell, *et al*., 2008; Osborne & Collins, 2001; Mazur, 1996; McDermott, 1993). Same scenario also occur in Malaysia where weak Physics students consider Physics as an abstract subject (Aziz, Nordin & Lin Hui Ling, 2011; Abdullah Nor, 1998; Shahanom Nordin, 1994). Physics requires strong basic cognitive knowledge in order to comprehend it. In order to gain the structure of content during learning process, they must understand the primary concept (Hoover, 1997).

Without strong concept comprehension, learning process will be meaningless and they will only choose to memorize it (Hanafi, 2004; Duit & Treagust, 1995). Students must have some essential knowledge before they able to master in Physics. Otherwise, they will having difficulties to learn new topic since Physics concept are related to each other. The achievement of students depend on the basic concept. If they not manage to master the fundamental of particular topic, they will not able to understand what has been taught. Consequently, students will not able to solve problem with high difficulty level as they fail to hold the concept (Kamarudin & Naim, 2010; Aziz Nordin, 2006; Abd. Karim Yahya, 1999; Baker, 1991).

At the beginning, learning Physics is to apply the knowledge learnt to solve related Physics problems (Dan Styer, 2002; Khalijah Mohd. Salleh, 1987; Reif, Larkin & Brackett, 1976). Thus, problem solving skill is an important component in thingking strategy which cannot be exempted by students. Students not only have to think in fact they have to decide and use particular strategy to solve problem. There are various problems faced by the students in learning Physics and this study focused on learning Balanced Force topics. Student's achievement in Force and Motion topic is poor(Phang & Noor Izyan, 2012; Thornton, 1998) due to misconception and lack of understanding in force's concept (Chambers & Andre, 1997; Hammer, 1996; Lawson, 1995). Force's concept is important and can be found in all Physics fields (Prideaux, 1995). Force misconception always experieced by secondary school students and high level students (Norita, 2011; Abd Hadi, 2005; Lilia *et al.*, 2002; Beynon, 1994; Huis & Berg, 1993). One of the factor for this kind of misconception is because they use their own opinions to understand and explain concepts and phenomenas of force based on their daily experiences (Thornton, 1998; Anderson, 1986; Fisher, 1985; Gilbert & Watts, 1983; Gilbert et al., 1982; Helm, 1980). There are various methods done by teachers and students in comprehending and mastering Force and Motion topic. Most of students spend time in solving the routine problem that usually acquire from textbooks or reference books. Memorizing on how to solve problem which already done by others is the way how they master the frequently asked questions. Therefore, they merely to memorize rules and solutions but unable to apply the same rules and solutions in different situations.

3. Objectives and Methodology

The aim for this research is to identify the ability level of students in problem solving skill which consists of 5 different contexts; balance force of surface plane system, inclined plane system, pulley system, lift system and combination system. A research sample of 189 form four Physics students from secondary school in Kuala Kangsar district was chosen. This group was selected because they have the same prior knowledge. Questions given consist of problem solving of 5 different contexts; balance force of surface plane system, inclined plane system, pulley system, lift system and combination system. Collected questions then were analysed according to correct and wrong answer. Besides, problem solving strategies used by students were grouped into 3 categories; understanding, planning and implementation.

4. Results

Researcher analyzed student's answer to every context in balanced force. Table 1 shows the analysis of student's answer accuracy in each context. Apart from that, Table 2 was used to analysed Physics problem solving strategies choosed by students in each context.

Table 1: Analysis of Student's Answer Accuracy in Each Context

	Balanced Force in									
	Surface plane system		Inclined plane system		Pulley system		Lift system		Combination system	
	Correct	Wrong	Correct	Wrong	Correct	Wrong	Correct	Wrong	Correct	Wrong
No. of students	26	163	21	168	36	153	6	183	20	169

Table 2: Physics Problem Solving Strategies Used by Student in each Context

Context	Problem solving strategies in Balanced Force topic			
	Understanding		Planning	Implementing
	Drawing	Resolution of Forces		
Surface plane	32	107	90	26
Inclined plane	82	35	33	21
Pulley	49	48	47	36
Lift	16	9	15	6
Combination	48	46	43	20

Based on Selcuk (2008), the force problem solving strategies were classified into three categories namely understanding, planning and implementation. There are several methods used in understanding problem solving strategies which are reading problem repeatedly, visualizing problem, use appropriate Physics term, resolve components and variables identification (Selcuk, 2008). In this study, only two method has been used in comprehension strategy which are drawing and resolution of forces. This is because only these two methods are relevant in solving problem related to Forces in Equilibrium topics. From Table 1, 26 students have answered questions correctly for surface plane system questions. For inclined plane system questions, 21 students managed to get the right answer. Meanwhile, 36 students able to answer pully system questions. Only six students could answer in lift system questions and 20 students got right for combination system questions. For comprehension strategy, 82 students drew the correct pictures when answering inclined plane system questions while only 16 students were abled to draw correct pictures when answering lift system questions. A total of 107 students break force properly when answering surface plane question and only nine students resolve of forces properly when answering questions in lift system. A total of 90 students used appropriate planning strategy when answering questions in surface plane system and 36 students used implementation strategy properly when answering questions in pulley system.

5. Discussion

Comprehension Strategy

Comprehension strategy can be divided into two methods, namely draw pictures and resolution of forces. Number of students who drew pictures properly in question which related inclined plane. Questions which related inclined plane is frequently asked questions that often given by teacher. This show that students were followed step by step in problem solving which related inclined plane system exactly what have been taught by teacher. So, students focused on a few common procedures which often have been carried out. For questions which related lift system, the number of students who drew pictures is the least. This is because lift system questions are not frequently asked questions. So, only some students can visualize what has been asked by the questions.

Apart from that, students also often do mistakes in drawing pictures when solving balanced force problems (Heller et al., 1992). Student failed to determine the direction of force which acted on object, force relative magnitude and direction object acceleration. This problem due to student just remembers but not able to understand (Halim et al., 2014). Students also fail to see force that act on counter direction together with force which acted on balanced body. This condition makes students fail to complete the force which acted on object completely. Without complete figure, students only accept the new knowledge without the existence of continuity with their existing knowledge (Norliana & Shaharom, 2004).

Most students able to understand the triangle of forces method. For questions which related surface plane, majority of students able to see properly and clearly force component involved. However, only some students could solve questions which related to lift system. For method of breaking force, not all students which use this method gave the correct answer. This is due to the usage of certain terms in Physics which are not according to term in Malay Language subject. Apart of that, language usage in Physics become relatively complex and students find it hard to understand and identify the sentences or terms in questions.

Strategy Planning

Majority of students use strategy plans that had given the right answer in each item, namely by choosing Newton's Second Law equation and consequently solve the problem. There are only some students that could not choose the correct equation when solving physics problem.

Implementation Strategy

Not all students which used the strategy plans successfully used the last strategy which is implementation strategy. Most students that were failed in implementation strategy were caused by carelessness during calculation, inserted the wrong value in Newton's Second Law and no unit included in final answer. Thus, students got inaccurate answer although they used correct comprehension and planning strategies. If they used the wrong comprehension and planning strategies, the implementation strategy must be also wrong.

6. Conclusion

The results show that capacity level of form four students in selected secondary schools in Kuala Kangsar district, Perak solving Physics problem related to Balanced Force is very low. Student difficulty in solving Balanced Force problem was due to the lack of practice on unfrequently asked questions because of time constraint. In conclusion, the difficulty in mastering this topic should be given serious attention so that this weakness could be overcome immediately to ensure the quality of student's achievements always at high-level.

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