

A Preliminary Study of Students' Problems on Newton's Law

Siti Nursaila Alias

Faridah Ibrahim

Department of Physics
School of Distance Education
Universiti Sains Malaysia
11800 Minden, Pulau Pinang
Malaysia

Abstract

Preliminary studies have been carried out to identify learning problem of form four students in Newton's Law topic. The research sample involved 189 of form four students from secondary school in Kuala Kangsar, Perak. In this study, the data gathered through diagnostic tests. The findings of this study showed that students experience some problems in terminology approach and solving problem of Newton's Law. This research is expected to benefit all parties especially to Physics teachers to make the teaching and learning processes (T & L) Newton's Law more effective and efficient.

Keywords: Physics, learning problems, Newton's Law, form Four.

1. Introduction

The aim of teaching and learning (T & L) Physics is to acquire knowledge about the principles of Physics conceptual and procedural knowledge in order to solve problems in Physics (Leonard, Dufresne & Mestre, 1996). Problem solving in turn reflect the principles of Physics from given problems (Gerace & Beatty, 2005).

Principles of Physics consist of two types of knowledge are conceptual and procedural knowledge. Most of students master in procedural part, which is the knowledge that involves problem-solving measures rather than conceptual knowledge. This situation prompted the students to solve problems in two forms, namely in working backward and analogy. Both strategies of problem solving make students more likely to use the strategy of surface and contrary to the purpose of solving a problem which is to stimulate the understanding and internalization the principles of Physics. Thus, this situation causes unachievable of T & L purpose in Physics when students merely emphasized the aspects of procedural only.

Traditional learning which involves the use of text books and methods of chalk and talk are not effective on all T & L process (Neo Rafi, 2007; Yusoff & Tanlol, 2005; Havice, 1999). It is one-way in nature where teachers deliver the content of the lesson and students just listen up which just make them passive. This situation caused the students failed to form the conceptual basis of the Physics principle (Mazur, 1996) because they simply memorize without understanding the underlying concept of the knowledge.

In traditional teaching, instructors will give step by step for troubleshooting and students only need to follow the procedures to complete frequently asked questions. Each problem category has been designed for students with specific methods. They will not be involved in the settlement activity and will only accept. Therefore, students will not require another procedure in troubleshooting and only focused on some procedures only. Coincide with Ben-Zvi (2006) stating that the student is now more specific to the method of recitation the facts as well as the procedure where they no longer emphasis on problem solving. This situation led to a weak students and will not able to master the concepts of Physics. In addition, students also make references and rely on examples of answers in text books and thus analogically solve the problem in questions at the end of the chapter. Students do and make solutions without the solution's schema. Students are also not been trained by schema-based experts during problem solving. The use of answer's schemas also discounted student learning problem to identify the structure of certain example of problem to be matched with new problems that wish to be solved.

2. Problem Statements

Learning Physics traditionally is one of the contributing factors of Physics often considered difficult to understand because students failed to understand the structure of the concept contained in Physics no matter at both school and university level (Angell, *et al.*, 2008; Osborne & Collins, 2001; Mazur, 1996; McDermott, 1993; Cockroff, 1989). A similar scenario also occurred in Malaysia where students weak in mastering physics and they consider that Physics is something abstract (Aziz, Nordin & Lin Hui Ling, 2011; Abdullah Nor, 1998; Shahanom Nordin, 1994). In addition, the problem of education examination-oriented also affects and cause Physics is unable to be seen and be applied in everyday life.

In form Four Physics syllabus, Newton's Law lesson contained in Force and Motion topic. This study focuses on the learning problems in Newton's Second Law and Newton's Third Law. Newton's Second Law states that the the acceleration of an object as produced by a net force is directly proportional to the magnitude of the net force, in the same direction as the net force and inversely proportional to the mass of the object. Newton's Third Law states that for every action, there is an equal and opposite reaction.

The concept of force is important in learning of Newton law and in all branches of Physics (Prideaux, 1995). Although the students realize the concept of vital force in Physics is important but their achievement in the concept is still low (Phang & Noor Izyan, 2012; Thornton, 1998). This was due to misconception that is often experienced by secondary school students or high level students (Norita, 2011; Abdul Hadi, 2005; Lilia *et al.*, 2002; Chambers & Andre, 1997; Hammer, 1996; Lawson, 1995; Beynon, 1994; Huis & Berg, 1993). One of the causes of the occurrence of the misconception is because students use their own point of view to understand and explain the phenomenon on the basis of their daily experience (Thornton, 1998; Anderson, 1986; Fisher, 1985; Gilbert & Watts, 1983; Gilbert *et al.*, 1982; Helm, 1980).

Student's misconception will be difficult to change by teachers if teachers do not know their problem. According to Halim *et al.* (2002), teachers needed to carry out pioneering study first before conducting study. Therefore, this pioneering study aim to identify learning problem in Newton's Law and altogether find solutions to make Newton's Law learning is more effective and more efficient. Student problem towards Newton's Law learning identified through answer given by the students.

3. Literature Review

This study will discuss Newton's law learning problem based on two approaches, namely terminology approach and problem solving approach.

3.1 Terminology Approach

Terminology lesson could help the students to explain the process and it must be taken seriously by teachers and students (Nurasyikin Abd Rahman, 2008). However, most teachers and students think that terminology lesson is less important as it may be obtained with itself through textbook or reference book. Student just memorizes the term and do not understand what does it mean (Muhammad Nazim Seman, 2002).

Study carried out by Nurasyikin Abd. Rahman (2008) showed some of the problems faced by students in giving explanation of certain term, namely sentence stated by student is incomplete because the needs of key word to explain term meanings were not attached. At the same time, fallacy in terms of language usage especially term that usually give certain meaning in daily life but has different meaning in scientific term. Failure in term mastery of the schema will cause the mind becomes blurred and fragmented which lead to difficulties in memory development (Khalid Mohamed, 1993).

3.2 Problem Solving Approach

Problem solving is a T & L process that can actively describe Physics principle (Gerace & Beatty, 2005). Process of problem solving carried out according to systematic and organized steps. Problem solving will not only till seek the final answer but it also involve comprehension and strategy mastery that are more complex like understand meaning of question, link information with operation, carry out operations that were identified and get the wanted satisfaction. This point of view in accordance with Mayer (1985, 1987) explanation that claim four strategy of problem solving that should be passed through by person, namely translate problem, integrate problem, plan and seeking for a strategy and implement solutions.

Most of the students spend time to solve routine problem achieved from textbook and reference book. Method used by students to control routine question is by memorizing way work something out problem that had been made by others. So, they merely memorize formulas and method of solution yet unable apply the formulas and method of solution in different situation if problems are not routine are given.

4. Objective Of The Study

The objective of this study is to identify Newton's Law learning problem through terminology approach and problem solving approach.

5. Study Methodology

Research sample is 189 form Four Physics students from secondary school in Kuala Kangsar, Perak. This group of students was selected because they have similar basic knowledge. Researcher build questions based on SPM Physics reference book and with the help from form Four Physics teacher. Question built consist of 13 questions related to Newton's Law. Collected questions have been analyzed based on student's answer diversity that is correct and wrong.

6. Study Findings And Discussion

Table 1 shows Newton's law learning problem could be categorized into two aspects, namely terminology education approach and problem solving approach. Diagnostic test retrieval carried out shows that student facing problem in interpreting angle force definition, force arrow usage, force and motion term, resultant force usage and force resolution.

Table 1: Newton's Law learning problem

Learning Problems	Problem's causes
Terminology Approach	a) Definition of force i) Fragmentted critical element usage ii) Definition usage from textbook / reference books iii) Formula usage iv) Misconception b) Force arrow size c) Force and Motion term i) Synonymous terminological usage ii) Self interpretation
Problem Solving Approach	d) Resultant force e) Force resolution i) Draw diagram ii) Memorizethe force resolution rule

6.1 Terminology Approach

Terminology approach is a conceptual knowledge. It is a basic concept that first needs to be controlled by students. Force definition, force arrow size, force and motion term are problems that always face by students.

a) Force definition

Students face problems to state the force definition. This problem happened due to wrong interpretation of force definition by students:

- i) Fragmentted critical element usage. Example
 - Force is something that can change stationary state
 - Force is movement of certain object

ii) Definition usage from textbook/reference book. Example

- Force is vector quantity (feature of force)
- Force is push and pull (type of force)
- Force is something invisible (nature of force)

iii) Formula usage. Example

- $F = ma$

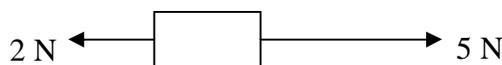
iv) Misconception. Example

- Force is pressure imposed on object
- Force is capacity do work

Student failed to interpret the meaning of through word because they are too depending on textbook/reference book without comprehending what it means. From the wrong principle led to misinterpretation. Force term interpretation was the first step in the process of problem solving.

b) Size of force arrow

Student does not distinguish the size of force arrow as follows:



Students think that arrow size does not bring any meaning in this topic even though they know that force is a vector quantity, namely have magnitude and direction. Drawing diagram completed with force arrow will facilitate student to identify resultant force and force resolution. If students do not distinguish the arrow size, they will face problem when solving the force problem.

c) Force and motion term

Problem in understanding and using term in force and motion (stationary, uniform velocity and acceleration) as follows:

i) Synonymous terminological usage of force and motion. Example

- At rest = Zero velocity
- Uniform velocity = Constant velocity = Zero acceleration
- Acceleration = Velocity increased

Students were disclosed with stationary, uniform velocity and acceleration terms. Every term have synonymous term that need to be known by students. This is because every term will be used until they learn Physics to the higher level. The poor mastery of synonymous term among student discommode student to solve Newton's law problem.

ii) Self interpretation. Example

- At rest : student consider that no force acted on it
- Constant velocity : student consider that moving object move is unbalanced

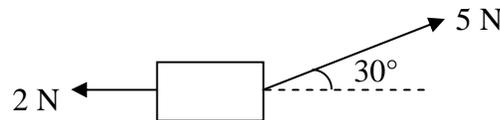
Students also use their own point of view to explain term based on their everyday experience. This condition will cause occurrence of misconception in force concept.

6.2 Problem Solving Approach

Problem solving approach is procedural knowledge. It is platform for student to apply basic concept. Problems that always faced by students are to get resultant force and resolve force. Memorizing rule and procedure techniques in solving problem of Newton's Law does not ensuring the accuracy of answer because it first requires resultant force mastery and force resolution before finalizing Newton's Law problem. This condition cause student sometimes gets right answer and sometimes they get bad answer when they unable to master the resultant force and force resolution concepts.

d) Resultant force

Student does not take into account the addition and subtraction force as follows:

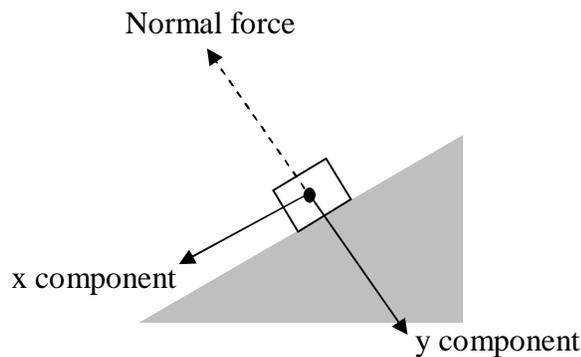


Student can resolve force to x component but they neglect other energy involved. This show that student do not master resultant force concept where all forces involved must be added or rejected before use in Newton’s second law.

e) Force resolution

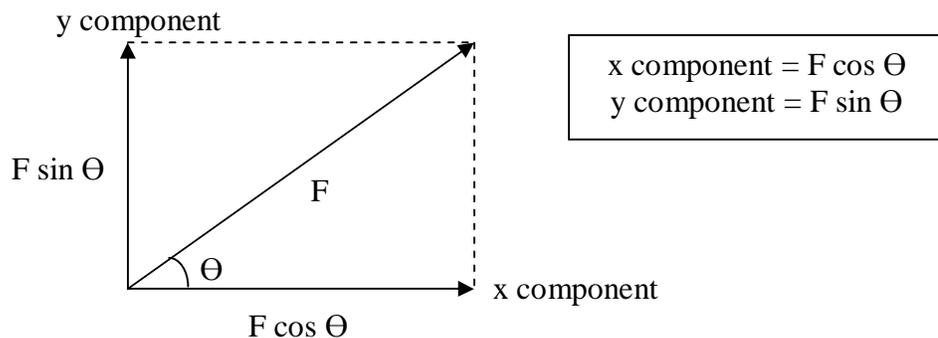
Student face problem in drawing diagram and resolving force as follows:

- i) Draw diagram with wrong y component as follows:



Students face problem in drawing diagram, which they resolve the wrong y component. Some students also do not know how to resolve the x component and y component. This condition make student difficult to solve Newton's Law problem especially in inclined plane and pulley.

- ii) Memorize the force resolution rule. Example



There are students that can resolve force to x component and y component but still having problem when they memorize force resolution as in textbook. This force resolution has relation with form two mathematics subjects, namely Pythagoras Theorem. Student can get either correct or wrong answer when solving problems by using rule in textbooks. This is because every problem solving requires students to resolve force by using Pythagoras Theorem by them and not just memorize the rule given in textbooks. This situation shows that students are not applying mathematics they study during form two into Newton's Law.

7. Conclusion

In conclusion, this study find that form Four students in Kuala Kangsar, Perak face problems in terminology lesson and solving problem in Newton’s Law. Therefore, this problem will be overcome by development of education game software which stresses knowledge in both conceptual and procedural. Educational games software usage with multimedia elements expected can meet requirements in T & L of Newton’s Law. Educational games software also believed able to improve motivation and student learning.

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