Difficulties in Learning for Solving Problem of Space-Time Special Relativity

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Abstract

This study has been done to study the difficulties of learning of first-year University's student in space-time special relativity topic. A total of 206 first-year students from three universities in Malaysia were chosen as research respondent. Research tools used involved questionnaire of 26 questions from the topic time dilation and length contraction. Computer program software SPSS was used to analyse the data. The study showed that there were learning difficulties among the students in solving the time dilation and length contraction problems. The results showed that the student failed in visualized question, identified proper and improper and using the correct formula.

Keywords: Difficulties in learning, first-year University's student, dilation time, length contraction, space-time special relativity

1. Introduction

Modern Physic Course in one of the core courses that offered to first-year students for most of universities in Malaysia. Among the topics that is often an issue in Modern Physics course is special relativity as most students have difficulty to understand the concept of simultaneity, time dilation and length contraction abstract (Scherr 2001). To understand this course, students should have at least a minimum in mathematics and physics.

Most of the instructors are using deductive approach in teaching process. They start the learning by giving the whole concepts which are theory or formula (McDermott & Lillian, 1993). This approach requires the student to understand deeply and will able to choose the right formula or theory to be applied to a given problem. However, the approach of teaching by explaining the concept of time dilation and length contraction in the form of a complex mathematical formula is not suitable for the study because it is the only concept of modern cosmology which is difficult to explain with words or mathematical formulas. In fact, this concept is a concept that challenged the views and thoughts of the human environment (YT Chen and Mustamam Abdul Karim, 1997).

Physics curriculum designed to produce students with the knowledge and skills in the fields of physics and be able to apply the knowledge and skills based on scientific attitudes and values to make decisions and solve problems in everyday life (Curriculum Development Centre, 2001). In 2002, Mohamed Zulkiffly found that the lack of emphasis on teaching thinking skills in the process of teaching and learning in Malaysia is one of the factors that caused them to fail in the learning of critical thinking (Phillip, 1992). Based on the findings, the process of teaching and learning in Malaysia is still centered teaching (Tang, 2004; Rajendran, 2001).

Students in Malaysia are usually complying with the instructions given by the instructors. For example, in solving physics problems, students should not be shackled by a common solution technique presented by the instructors.

This is because the instruction received by students is done without going through the process of thinking and assessment in advance. So, the students are found to be able to solve a problem or explain how they obtain an answer to a problem (Sternberg, 1982). Therefore, other suitable techniques should be encouraged, especially to the stage of cognitive development, the experience and the learning environment experienced by the students. Thus, this study is important to look at learning difficulties faced by first-year student at the university in solving problems of time dilation and length contraction.

2. Problems Statement

Problem solving is the main goal in the process helped. However, towards the goal of problem solving is not an easily accessible because it involves the stages and the use of certain skills. Among the members theorist who introduced the problem-solving approach are John Dewey (1910) and Helen Harris Perlman (1957, 1970, 1986) (Skidmore, 2000). The two famous theorists see as a form of problem solving methods help involving certain processes (Hepworth & Larsen, 2002).

The process of problem solving involves certain levels. An easy problem requires a solution that contains measures that are not complex. A person will receive all the information required to solve the problem either in oral or written form in the instructions given to him. Easy problems have solutions specific and easy student to know whether the solution is right or wrong. But for a complex problem, it requires a logical reasoning and analysis.

Solving problems in sentences is an important component in physics. However, most of the students have not mastered this skill when they are able to perform the basic operations involving physics formulas. One of the strategies needs to be identified to assist students in dealing with the difficulty in solving physics problems in the form of a sentence. Solving physics problems in the form of verse is not just to find the final answer but it also involves understanding and mastery of more complex strategies. Problem solving is a process where a student successfully mastered the concepts and uses this knowledge to solve new problems (Gagne, 1977). Problem solving is also a process used to get the answer to a question. Physics education which is focused more on knowledge of physics concepts and emphasizes high level reasoning skills. Therefore, the solution can also be expressed as the highest levels of learning in which students are able to master the concepts and be able to solve a given problem.

Problem-solving skills assume that the learning of physics is basically to acquire knowledge about the concepts and principles of physics. In addition, the learning of physics is basically to apply the knowledge gained to solve problems related to Physics (Reif, Larkin and Brackett, 1976, Khalijah Mohd. Salleh, 1987 and Dan Styer, 2002). Thus, problem-solving skills are one of the key components of thought that cannot be waived by the student. Students must not only think, but they need to make decisions and use specific strategies to solve problems. Solving problems is not only to find the final answer but it also involves understanding and mastery of more complex strategies such as understanding the meaning of the question, linking information operations, operations that have been identified and the required solution. This view is consistent with the explanation Mayer (1985, 1987) who proposed four stages to be followed by an individual during the solution of the problem (1) interpret the problem, (2) integration problems, (3) planning and search strategies, and (4) implement solution.

Gagne, R.M. (1977) has discussed the role of teachers in educating students to solve problems. He also stated that the problem must be identified and in certain circumstances must have a reason to fix it. Psychologists say that men are learning something when attempting to resolve the problem. This is because in the process of problem solving, students will find solutions about a thing, applying problem in the most simple, studied law and create problem-solving steps to problem solving.

Recently, the study about physics problem solving focuses more on problem solving (Chi, Feltovich & Glaser, 1981; de Jong & Ferguson-Hessler, 1986; Larkin, 1979; Larkin et al., 1980 and Reif, Larkin & Brackett, 1976). Commonly, students in Malaysia over compliance with the instructions given by the authority as instructors. The instructions received by the students were done without going through the process of thinking and assessment in advance. So, these students are found to be able to solve a problem or explain how they obtain an answer to a problem (Sternberg, 1982). This will make learning something that is not meaningful. Therefore, this study is important to look at learning difficulties faced by first-year student at the university in solving the problem of space-time special relativity.

3. Objectives and Methodology

The objective of this study was to investigate the difficulty of learning of first-year student at the university on the topic of space-time special relativity. The study was conducted through a survey method. Sample consisted of a first-year student from three universities in Malaysia that offers Modern Physics course as a core course. A total of 206 students were chosen to conduct the study. Student groups are selected because they have the basic knowledge (prior knowledge) and the same background. The main instrument used in this study was a questionnaire containing six questions. Interviews were conducted to learn the difficulties faced by students when attempting difficulty in physics.

After the instruments are collected, the data were analyzed descriptively. At the first stage, the test was analyzed based on right or wrong answers. In the second stage, the answers of the interview for each question are analyzed to identify learning difficulties, whether due to proper and improper identification, failure to visualize the question and failed to use the correct formula.

4. Results and Discussion

Based on the study, three difficulty learning was done by first year students were as follows:

4.1 Failure to visualize question

Majority of the students (99.0%) failed to visualize their questions in the form of diagrams while solving problems in the topic time dilation and length contraction. As a result, they are unable to reflect on what they read because they are not taught by live instructors during lecture. Therefore, most of the students will create knowledge and metacognitive skills slowly and it can only be achieved after they went through various learning experiences and challenging.

Through the strategy of physics problem-solving skills, students should be able to draw a diagram and label clearly. Therefore, they can describe what is in question as well as to facilitate more students to solve the problem (David Morin, 2007). According to Moses (1982), at the level of understanding of the problems, students can understand the problem better when they are able to produce a diagram that represents the situation in physics problem solving. Visualization can also help students in the state, represent and build the concrete model of the situation described in solving physics problems.

However, when students are not able to make a comprehensive overview of the questions asked, and then they will have problems in identifying and selecting the proper and improper. Thus, they are unable to solve a given problem. Cognitive load theory states that to increase the capacity of short-term memory, visual and verbal elements should be used together (Shaffer, Doube and Tuovinen, 2003). Therefore, if the understanding was visualized, then, students can improve their short-term memory as well as long-term memory.

4.2 Failure to identify proper and improper

The use of a term in physics is more complex and different from the Malay Language as it is in accordance with the terminology of physics. This resulted student to have problems especially in terms of current understanding of physics learning and problem solving. One of the main reasons why the students fail to solve physics words problems is because students do not understand the question in words and terms of physics. This is clearly shown in this study that showed 61.6% of the students failed in identifying and selecting the proper and improper neither in time dilation topic nor length contraction topic. Students are able to identify proper and improper when the questions given clearly state which of the proper and improper.

In addition, questions which were frequently asked during exercise are also among the questions to be answered correctly by students. So, the existing knowledge of the students on this topic is very important to help facilitate understanding and development of the idea (Kamarudin Hj. Husin and Siti Hajar Hj. Abdul Aziz, 2003). However, if students are given a question in different situations, they are not able to identify proper and improper. This shows that the students have difficulty in identifying a term because they simply memorize definitions and important words alone until it becomes incomplete and meaningless. This causes them to not be able to integrate the definition in the larger context (Mayer, 2002).

4.3 Failure Using the Right Formulas

Based on problem solving techniques, it shows that students are more likely to solve physics problems by memorize the formulas and procedures and using the keywords (Federal Schools Inspectorate [JNSP], 1993). This makes a lot of students who learnt from memorize the formulas and the solution are not able to apply the formula and the solution in different situations.

Besides students, instructors also tend to memorize and ask the students to remember the routine skills to solve a problem without providing an opportunity for students to think and understand perfectly the whole purpose of a problem while solving the problem (Bransford et al., 1996, and Hegarty, 1995). This is clearly shown in this study that 29.4% of the students failed to use the correct formula when solving problems in the topic of time dilation and length contraction. This shows that students are too dependent on mere formulas without understanding the underlying concepts of the topics due to lack of collection of concept-based questions (& Lillian McDermott, 1993). Normally, students will solve the problem starts with a specific formula for the question. If they do not remember the formula, then they will fail to solve the problem.

5. Implication for First-Year Physics Learning

In general, the difficulty of solving the problem of time dilation and length contraction in first- year students had given some implications for teaching and learning in physics.

Most of the students will face difficulties in solving problems of time dilation and length contraction when they lacked of practice on the topic given by the instructors as well as reference books. This situation will have an impact on students mastering this topic well. According to Robertson (2001), students will have difficulty applying the concept or method of settlement if they only use a few examples of questions. So, the role of instructors is needed in helping students to improve their understanding. The instructors should provide various examples of questions that students can see different situations to solve problems.

Although time dilation and length contraction is an abstracts topic but the selection of methods and correct techniques of teaching should be provided so that this topic does not cause any negative effects the students. Therefore, instructors should be more careful in selecting an appropriate problem-solving method to make the process of concept formation easily and effectively. However, if the strategy used by the student is not in line with the difficulties to be solved, then, the student will lose interest and become less confident with topics studied. Instructors should also plan the exercise problems that will be given to students and help the students to find a solution without giving any real answers (Carpenter, 2006).

Physics problem-solving ability showed that students exposed to a learning environment system in which it combines objective and subjective questions. Problem solving of wider question can test the metacognition of students to answer a question that is not in the textbooks. The ability of students to use problem-solving strategies have proved that students can work harder to understand the lesson, learn how to think and not what should be thought, when they use better methods of learning, practical and easy to practice.

In conclusion, may these findings provide insight into the problems of students in solving problems of space-time special relativity, particularly on the topic of time dilation and length contraction, and thus open up more research toward mastery of the concept of special relativity.

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