**Simple Pendulum: A first year students’ dilemma**

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1. **Abstract**

Many first year university students in the Science related fields have a problem in identifying and applying the fundamental mathematical concepts that they have learnt from as far back as Grade 10 in solving some of the physics related problems. The majority students, mostly from public schools, cannot seem to relate the two fields of study. Previous studies have shown that majority of first year students lack the integrated approach to different scientific disciplines in solving some specific problems and in experimental analysis.

This paper presents the findings of an investigation on the ability of the first year students to use the mathematical concept of the straight line equation and graph in analysing physics properties, with particular reference to a Simple Pendulum motion experiment. The method employed was experimental. Students were given a simple pendulum experiment to determine the gravitational acceleration of the pendulum by graphical analysis. Two graphical approaches were employed, with both expected to yield the same results. Participants were required to analyse the motion of the pendulum, specifically the variation of the length of the pendulum with the period of oscillation.

The feedback showed a far reaching implications relating to first years’ abilities to mathematically analyse a physics concept. These findings serve as a basis for a need to improve the teaching of science and mathematics in the schools, especially the practical approach to teaching and learning science.

1. **Introduction**

Most first year university students are faced with a dilemma of adjusting from the traditional separation of teaching and learning of mathematics and physical science in schools to the integrated approach to teaching and learning in both disciplines. Graph-related activities take an important place in recent reform efforts in mathematics and science education (Wolff-Michael and Bowen, 2001). This is particularly prevalent in students who come from mostly public and disadvantaged schools, with no practical laboratory experience whatsoever. According to Hung and Jonassen, 2006, students are not able to connect corresponding qualitative and quantitative knowledge of physics to each other as experts do.

This paper seek to investigate the extent to which first year students are able to manipulate mathematical principles and approach in the analysis and solving physics problems. This is done with particular reference to a Simple Pendulum motion experiment. Unfortunately even students who are good in physics have a difficult time obtaining useful information from graphs that consist of more than a single straight line (McDermott, Rosenquist and Van Zee, 1987). This survey aims to identify whether the students can relate and use the straight line equation and properties to find the values of gravitational acceleration from the Simple Pendulum experiment.

The results of this research survey is particularly important in helping to structure the instructional methods of teaching practical physics experiments to first year university students.

1. **Method**

*3.1 Participants*

A sample of 61 first year physics student in the Department of Teacher Education, Central University of Technology, Bloemfontein Campus participated. Of the 61, 20% are from private schools and 80% from mainly rural public schools.

*3.2 Instruments*

A simple pendulum set with varying length.

*3.3 Procedure*

The participants were required to set the pendulum swinging and measure the total time (t) that it

takes to make 50 complete oscillations. They recorded the results in a table form. The procedure was repeated 10 times while uniformly increasing the length of the pendulum.

*3.3.1 First approach:*

The students were required to plot two sets of graphs using the data collected, i.e. Period (*T*) vs length (*l*) and period squared (*T2*) vs length(*l*). From each graph they must identify the linear relationship between the period and the length of the pendulum given the relation *T2=4π2 l./g*, and hence find the value of *g*.

From the graphs and relation *T2=4π2 l./g*, the students were required to find and identify the slope of the graph as well as the y-intercept and hence find the value of the gravitational acceleration *g*.

*3.3.2 Second approach*

Using the same set of data, students were asked to plot the graph of *logT* against *logl*. Given the relation *logT = nlogl + logk*, where *k = 2π/√g*, students were asked to find the slope *n, logk* and *k* from the graph. From the information obtained above, the value of *g* had to be calculated.

1. **Results**

*4.1 First approach:*

In figure 1, of the 61 students, 8 (13%) managed to give a linear relation between period squared (*T2*) and length(*l*) and hence the straight line graph (bar 1). 53 (87%) said there exist a linear relation between period (*T*) and length (*l*) (bar 2). 54 (89%) could not find and relate the slope to *4π2./g* (bar 3). 54 (89%) could not relate that y-intercept = 0, and hence the graph must start at the origin (bar 4). 56 (92%) could not find the value of gravitational acceleration as required (bar 5).

*Figure 1: Number of students vs students’ performance.*

*4.2 Second approach*

15% of the students managed to find and calculate the value of *n*, the slope. 8% were able to extrapolate the value of *logk* directly from the graph and hence calculate *k* and *g*. Because of the concepts of logs, students could not relate the logs to the straight line. On the other hand, only 12%of the participants managed to obtain a straight line graph.

*Figure 2: Sample percentage versus students’ performance*

1. **Conclusion**

90% of the participants could not graphically analyse the pendulum motion. There is no cohesion between the mathematical concept of a straight line and data analysis of the motion of the pendulum. The study shows that there is a need to redefine the curriculum to accommodate first year students as far as graphical analysis and mathematical manipulation of data is concerned in the first part of the term. Emphasis should be placed on the need for competency in graphical analysis. Therefore for as long as laboratory experiments are not conducted in schools, the problem will always persists.

Practical work was generally effective in getting students to do what is intended with physical objects, but much less effective in getting them to use the intended scientific ideas to guide their actions and reflect upon the data they collect. (Abrahams and Millar, 2008)

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