The impact of computer simulations on the performance of grade 11 learners in electromagnetism

Jonas Kwadzo Kotoka[1] and Jeanne Kriek [2]
[1]*Student at the Institute for Science and Technology Education, University of South Africa,*
[2]*Institute for Science and Technology Education, University of South Africa*
[1]**kotokajk@gmail.com**, [2]**kriekj@unisa.ac.za**

This study examines the impact of computer simulations on the performance of 65 grade 11 learners in electromagnetism in a South African high school in the Mgwenya circuit in the Mpumalanga province. The study followed a non-equivalent control group design. The performances of participants in the control group (N = 35) and experimental group (N = 30) were used to determine the impact of computer simulations on the performance of grade 11 learners in electromagnetism. The t-test for independent samples showed that the experimental group achieved significantly higher scores on the post – test than the control group. In the analysis of the short-answered written questions, the experimental group outperformed the control group. Average normalized gain, (*<g>)*, introduced by Hake on conceptual learning was calculated as 0.18 for the control group which is consistent with Hake's low <g> course and 0.32 for the experimental group which is consistent with Hake's medium <g> course. It was concluded that computer simulations influenced the higher performance of the learners in the experimental group.

Background

Science teachers nowadays have access to choose a range of computer simulations and some of these simulations are available at free-access internet sites, commercial internet sites, and resident commercial software producers (Trundle & Bell, 2010). According to Wieman, Adams, and Perkins, (2008) research shows that, learners learn better, when they construct their own understanding of scientific ideas within the framework of their existing knowledge. To accomplish this process, learners must be motivated to actively engage with the content and must be able to learn from that engagement. Interactive computer simulations can meet both of these needs. It is hoped therefore that interactive computer simulation usage may hold the key to learner's visualization of the abstract concepts in electromagnetism.

Aim of research

This research therefore seeks to answer the question, what is the impact of computer simulations on the performance of Grade 11 learners in electromagnetism?

Theoretical framework

The major theoretical perspectives which support Computer-Based Instruction (CBI) as a means of enhancing student learning are constructivism, and situated learning or situated cognition (Thomas & Emereole, 2002). A critical component of theories of constructivism is the concept of the zone of proximal development (ZPD), based on the work of Vygotsky (1978), which posits that learning takes place by the learner completing tasks for which support (scaffolding) is initially required.

Research design

The study followed a non-equivalent control group design. The performances of participants in the control group(x_2) and an experimental group (x_1) were used as basis to establish and explain the impact of computer simulations on the performance of grade 11 learners in electromagnetism.

Participants

The 65 participants of the study came from two intact grade 11 physical science classes that were randomly constituted at the beginning of the year in a high school in Mgwenya Circuit of Mpumalanga Province of South Africa. There were 35 learners in the control group and 30 learners in the experimental group To verify the equivalence of the two classes, the achievement of the June Exams was compared using a t-test. The results indicated that there was no statistically significance difference ($t = 0.906$, $df = 101$, $p = 0.3672$) between the classes. This implied that the learners were of the same academic ability before the treatment.

Methodology

The same test was written by both groups as a pre and post test. The control group was taught electromagnetism using traditional teaching methods, demonstrations and real laboratory experiments. Simultaneously the experimental group was also taught electromagnetism using traditional teaching methods**,** demonstrations and computer simulations using PhET simulations and simulations from the Plato learning centre. Both the real laboratory experiments and computer simulations were offered during a special arranged class with duration of approximately 2, 5 hours during the period of intervention.

Instrument

The test consisted of twenty multiple choice questions and five short-answered written questions. The questions in the test were adapted and slightly modified from three sources namely South Africans matriculation past physical science (physics) examination papers; commonly used South Africans physical science textbooks and Modelling teachers question banks CD2 Part 1. Reliability and validity of the instrument was ensured.

Findings

There was no statistically significant difference in the achievement of the two classes in the pre-test: t statistics = 0.390, df = 63, P = 0.05, t-critical two tail = 1.998 which is approximately 2.00, since the t-critical (2.00) is greater than the t-statistics (0.906) at $P > 0.05$. However, a statistically significant difference between the post test scores was found: t statistic = 3.582, df = 56, $p<0.05$ and t critical two tail = 2.00; since the t critical two tail = 2.00, is less than t statistics (3.582). In the analysis of the short-answered written questions, the experimental group outperformed the control group except on questions on transformers in which calculations had to be used. Furthermore, the average normalized gain gives an index that helps to compare the extent to which the treatment is effective (Hake, 2007). The average normalized gain, $\langle g \rangle$ was calculated as 0.18 for the control group which is consistent with Hake's low $\langle g \rangle$ course and 0.32 for the experimental group which is consistent with Hake's medium $\langle g \rangle$ course.

Conclusion

This study investigated the impact of computer simulations on the performance of grade 11

learners in electromagnetism and found that the simulations significantly influenced the performance of learners in the experimental group when compared to the control group.

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