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Comparing the Performance of National Curriculum Statements and Old Curriculum Students' in Electric Circuits

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ABSTRACT This paper compared the performance of National Curriculum Statements (NCS) and Old Curriculum Students' (OSC that is, Nated 550) in electric circuits. The research population consisted of hundred (100) first year science education students enrolled at a South African university, both from South Africa's OBE-based curriculum (the NCS) and the Old school curriculum (OSC, the Nated 550). A single pre-test/post-test comparison group design was followed. Data analysis was carried out by the use of the "t" test statistic. The findings showed that there was no significant difference from students who studied under NCS and OSC.

INTRODUCTION

Since the introduction of Curriculum 2005 (C2005) in a phased-in process in South African school in 1998, the country's education system has seen fundamental reform. This entailed movement from a curriculum founded on a highly specified content base towards an outcomes-based education (OBE) curriculum in which the development of skills and attitudes were given equal prominence to discipline content (Hobden 2005). At the school level, electricity is one of the major themes of the National Curriculum Statement (NCS). The importance of this topic does not end with the high school curriculum but also finds itself as part of the first year university physics curriculum. In terms of the merits of learning about electricity, learners need to understand it because it constitutes an aspect of energy – energy being a unifying concept in the overall science curriculum. However, as a unifying concept, learners often come across concepts of electricity from different angles – and this is what makes it fertile ground for alternative conceptions, in which students develop views and imagery that are conceptually different from scientific ones (Nada et al. 2009).

This paper focuses on outcome–based education (OBE), given that it was the official pedagogic orientation of the country's education system before CAPS can be introduced in 2012. Some of the current first year university students have been exposed to this way of teaching during their school years. These students would have brought with them a number of challenges to universities, particularly with regard to the instructional approaches in universities which still remain largely frontal, content-based and lecturer-centered– and taking place in large lecture halls.

The NCS science students come out of an OBE learning paradigm and four cohorts have already written examinations based on the NCS. University lecturers will need to make a paradigm shift from traditional lecturer–centered instructional practices towards approaches akin to OBE in order to accommodate the learning experiences of these students. An understanding of the alternative conceptions that students bring to the tertiary education sector will serve as a very important input into the recurriculation of university programmes. These alternative conceptions in teaching strategies, which may lead to the required conceptual changes, must be studied in the science education modules by prospective science educators. Additionally, science education lecturers must, themselves, use these approaches so that the student teachers learn from experience regarding the constructivist ways of learning and teaching. Students come to university with various ideas about science. This is shaped by a number of factors, one being school instruction, and university lecturers are usually unaware of the alternative conceptions held by students.

According to Edwards (2010: 3), changes in the educational system in South Africa have been driven by constitutional imperatives and were characterized by policy changes influenced by international perspectives and global economic trends (Organization for Economic Co-Operation and Development 2008: 75). Curriculum policy changes were followed by an implementation phase and subsequently revisions were undertaken to address problems that arose. Curriculum 2005 (C2005) was launched in 1997 and was informed by principles of OBE as the foundation of the post-apartheid schools' curriculum (Chisholm 2005: 193). C2005 was revised and in 2002 the Revised National Curriculum Statement (RNCS) became policy to be implemented in 2004, and culminated in the first Grade 12 cohort to graduate out of the NCS in 2008 (Organization for Economic Co-Operation and Development 2008: 81). The DoE also published content frameworks for each subject as well as work schedules and subject assessment guidelines in response to Grades 10 to 12 teachers' concerns about the content to be taught (Edwards 2010). Rogan (2007: 457) argues, however, that it is not enough to merely publish a new curriculum and assessment standards, particularly in a developing country. Detailed attention must be given to how things will unfold in practice.

The introduction of OBE in South Africa purportedly brought about a move away from norm-referenced testing to criterion-referenced testing. Less emphasis on summative assessment practices (assessment of learning) and more formative assessment (assessment for learning) was envisaged. In reality, however, the final examination in Grade 12 constitutes 75 percent of the pass requirement in most subjects and thus represents a summative assessment. Edwards (2010) contend that the underlying assumptions regarding the assessments, such as norm-referenced tests and normally distributed achievement can result in misalignment with standards that are targeted for all students.

The lack of emphasis on higher-order cognitive skills could possibly lead to teachers not preparing Grade 12 learners adequately for examinations. It has emerged from the findings above that in instances where educators appear to be familiar with the work from the old curriculum, the learners are doing well. However, it would seem that a lack of development of teachers in the new materials hampered the progress of learners. The students also performed worse in the chemistry paper overall and a lower alignment index was one possible explanation for this. Within the knowledge area Matter and Materials in Chemistry, there is a 5 percent over-representation in the final examination (DOE 2003). This contains a great deal of new material based on Organic Chemistry that learners struggle to understand. Perhaps there is also a need to develop teachers in this area, given that many of them do not have an adequate background in Organic Chemistry (Edwards 2010). Similar problems arose in physics, where learners struggle to understand electric circuits within the knowledge area Electricity and Magnetism (Edwards 2010).

In 2008 Umalusi, which is the quality assurance body for schools, needed to review its systems, the main reason being that the first cohort of learners following the NSC for the National Senior Certificate (NSC) qualification had reached Grade 12 level. The first national examinations for this new system took place by the end of 2008. What had to be addressed immediately was the fact that there were no historical norms for the associated examination results. Thus, in order to ensure the integrity of these results, Umalusi sought to achieve a valid understanding of the quality and levels of cognitive demand of the new curricula relative to those just superseded. The research was specifically designed to provide Umalusi's Assessment and Statistics Committee with succinct information on the comparability of the NATED 550 (old school curriculum) and the NCS curriculum, and on the comparative difficulty of the examinations associated with each. The intention was that the findings of the research involving in-depth curriculum evaluation and exam papers analysis had to be used to support the new norms in 2008. The aim was that all of this information would be used to adjudicate the standard of the NSC exam in 2008, in relation to the standard of the previous Senior Certificate exam. The subjects included in the research were English FAL, Geography, Life Sciences, (previously Biology), Mathematics, Mathematical Literacy, and Physical Science. Teams of four researchers evaluated the NATED 550 Higher and Standard Grade, and NCS curricula for each subject. They also analyzed all Higher and SG examination papers from 2005 to 2007, as well as the August 2008 exemplar and final papers for their subjects. The physical sciences, mathematics, and geography teams found that information on amounts and levels of difficulty of content and skill topics yielded solid evidence of the respective overall levels of difficulty of the curricula, meaning that the three exams were not the same in terms of assessment. In all, three teams (physical science, life Sciences, and mathematics) found their NCS curricula to be midway between the NATED 550 Higher and Standard Grade equivalents, in 50:50 proportions (Umalusi 2009).

Regarding the overall findings of the current paper, a comment can be made. First, in terms of the levels of difficulty of the six NCS curricula evaluated: three of these curricula (those for life sciences; mathematics; and physical science) are judged to be midway between the NATED 550 Higher and Standard Grade curricula overall, but at the same time had pockets of difficulty that way far exceed the difficulty levels in the previous Higher Grade curricula (Umalusi 2009). This means that NCS students' curriculum was quite challenging as compared to the NATED 550 which was content based.

Objective

The objective of the study is to compare the performance of National curriculum statements and Old curriculum students' in electric circuits

Research Questions

Will NCS curriculum students perform better than students who have studied under OSC curriculum in electric circuits?

METHODOLOGY

Research Design

A single one-group pre-test-post-test research design was followed with a view to determining the effectiveness of the activity-based intervention.

Participants and Setting

The paper involved hundred (100) first-year university science education students enrolled at a South African University, both from the NCS and the OSC registered for the Electricity and Magnetism Module. From hundred (100) first-year university science education, there were fifty (50) NCS students and fifty (50) OSC students.

Data Collection

The Electric Circuits Concept Evaluation (ECCE) test, developed by Prof David Sokoloff to assess students' understanding of simple circuit concepts (Sokoloff 1992), was used in this paper as both a pre- and post-test.

Procedure

First, a pre-test was administered to students for diagnostic purposes, that is, to determine their prior knowledge concerning electric circuits. The identified prior knowledge was then used as a basis for developing the instructional materials in the field of electric circuits. These were based on succession of activities and discussions, and were aimed to enhance progression from contextual to conceptual, through to formal understanding of the concepts.

Secondly the intervention strategies based on activity-based learning were developed. On the basis of the identified alternative conceptions, interventions consisting of activity-based lessons were implemented for a period of two weeks comprising 1.5 hour sessions. A total of 9 hours of contact intervention time was used. The identified alternative conceptions were incorporated into the development of the intervention using them as the basic building blocks for understanding. In order to ameliorate alternative conceptions held by the students, the intervention followed the order proposed by Lemmer and Lemmer (2005) that is, progression from contextual to conceptual activities and, final to formal problems. The intervention was developed by the researcher. The researcher's own ideas and activities were integrated with examples given in the paper guide by Watson (2003) and Wesi (2001). The activities were also performed in groups so that co-operative learning could take place.

For the activities a problem was posed that the learners had to solve in groups. The contextual and conceptual activities utilized the strategies of verbalization and analogical explanations.

In the contextual problem, students were given a bicycle analogy. They had to answer questions related to the bicycle analogy. During the post-activity discussion, the researcher introduced the concepts; electrical resistance, battery, current intensity, electric charges, electric field, electromotive force (elf) and the Law of Energy Conservation. With the acceptance of the analogy, students would have been able to understand and accept the interpretation of electric circuit experiments. After the students had understood the contextualized concepts and principles from the bicycle analogy, they were able to explain elf, the function of the battery and the law of energy conservation.

To ensure conceptual understanding of electric resistance, battery, current intensity, electric charges, electric field, an elf, a conceptual problem (experiments) was used to conceptualize these concepts. This analogy is related to a move from contextual to conceptual development.

As a way of preparing students for the second phase which focuses on conceptual development. The researcher linked use of analogies (bicycle analogy) and modeling to foster a move towards the contextual problem.

In the first contextual problem, the students were given a bicycle analogy and the researcher together with the students discussed how energy is transferred when a bicycle is pedaled. When the bicycle is pedaled or when the pedal is pushed pushing the pedal with a constant force and with constant obstacles (electrical resistance), the flow rate of the wheels (current intensity) will be the same at each point (no losses). The pedals (battery) maintain the movement by tiring the muscles (energy exhaustion of the battery). The chain which serves as a link (it is like electric charges) moves slowly but the energy (the pushing on the pedal) is instantly available. The energy is only transferred from the source (pedal) to the user (wheels) when the links move. The links never get lost or are used up and this is how Law of Energy Conservation was introduced, and the concept of electric field was also brought in. it was explained that a cell is a devise which separates + and – charges and charge the separation in the cell sets up and electric field between the charges. Further discussion made it clear that when a disaster happens like the chain breaking, the students foresaw that the wheel of the bicycle would still rotate for a while. In applying this example to the notion of electrical circuit they could understand that the bulb may continue shines for a little while after its source of electricity has been cut off. This contradicted their normal experience with electrical switches.

Correspondence between the Bicycle Analogy and a Simple Electric Circuit

Bicycle analogy	*Electric circuit*
Pedals	Source of energy (battery)
Wheels	Bulbs
Muscular fatigue of person	Wearing out of the battery
Chain	Electric charges

It was explained that a battery is a device which converts chemical energy into electrical energy on a continuous basis, and which tries to maintain a constant potential difference across its terminals.

In very broad terms, a battery comprises of a chemical reaction that is in some way constrained to create an electrical current. Any chemical reaction is caused by electrons moving between atoms. Clearly, when all the chemical reagents that in the battery have been used up (that is, they have all completed the chemical reaction, so there are no more unreacted chemicals left waiting to form the reaction), then there will have no more electrons to move from one reagent to another, and thus the battery is dead (worn out).Once an explanation for the battery’s wearing out was understood, the crucial point of acceptance was students’ recognizing that the bicycle speed was the same everywhere.

With the acceptance of the above analogy, students were able to understand and accept the interpretation of the electric circuit experiment (the current is the same everywhere, although the battery wears out).

The following activity is one of the examples of activities done by students to accomplish change in electric circuits.

Conceptual Problem

Experiment

Apparatus: 3 bulbs, 2 cells, connecting wires, ammeter and a battery.

Instructions:

Step 1: Connect a battery of two cells to three bulbs in series, and observe the brightness of the bulbs.

Step 2: Use an ammeter to measure the current in the circuit.

Step 3: Disconnect the circuit and connect the three bulbs in parallel to a battery of two cells Observe the brightness of the bulbs.

Step 4: Use an ammeter to measure the current in the circuit.

Data Analysis

The t-test results were analysed to assess whether the means of the two groups are statistically different from each other (Table 1).

Table 1: Comparing the brightness between series and parallel connection by measuring current

How does the current strength in a series connection (bulbs) compare to that in parallel connection?
Give reason for your answer.
When light bulbs are connected in parallel such that the current branches will equal current flow through the bulb?
What can you say about the potential difference of the resistors in parallel?
What can you conclude about the resistance of resistors connected in parallel?
What can you say about the potential difference of the resistors in series?
What can you conclude about the resistance of resistors connected in series?

Formal Problem

1) Bulb A glows brighter than B when both are connected to a 12v source as indicated in the Figure 1.

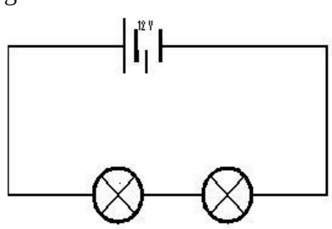

Fig. 1. The same bulbs now are connected to the same 12 V source as indicated in diagram Y. By referring to potential difference, currents, explain how the brightness of the two bulbs now compare.

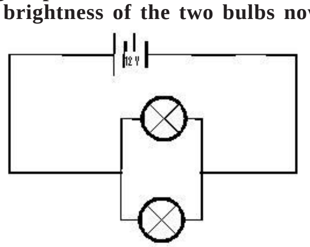

Fig. 2. Finally during the post-activity discussion, the researcher introduced the concepts; electrical resistance, battery, current intensity, electric charges, electric field, electromotive force (emf) and the Law of Energy Conservation.
A post-test, the same as the pre-test, was administered at the end of the intervention in order to ascertain the effect of the intervention.

RESULTS

Performance of NCS and OSC Groups on the Pre-test

In order to establish the equivalence of the two sub-groups (that is, the NCS versus OSC) before the instructional intervention, the t-test statistic was applied to their performance on the pre-test. The result of this comparison is presented in Table 2.

The t-test did not yield a statistically significant difference between the pre-test scores of the two groups. The mean for the NCS pre-test was 31.7 (sd= 24.5) while the mean for the OSC pre-test was 33.1(sd= 23.8), $p > 0.05$.This result is important in that any difference between the two groups that may be observed after the intervention may only be attributed to the effects of the intervention and not to any pre-existing conditions.

The Performance of NCS and OSC Students

The t-test yielded a statistically significant difference between the pre and post-test scores. The mean for the pre-test was 31.7 (sd = 24. 5) and the mean for the post-test was 60.6 (sd = 16.2); p < 0, 05. Therefore, there was a statistically significant difference between the pre-test and the post-test for the NCS group. There is no significant difference in the performance of NCS and OSC students (Table 3).

Comparison of Post Test Results of NCS and OSC Students

The statistical comparison yielded a non – statistically significant difference between the post-test results of NCS and OSC students. The test did not yield a statistically significant difference between the post-test scores of the two groups. The mean for the post-test for the NCS group was 60.6 as against 62.6 for the OSC students.Therefore, the hypothesis null hypothesis will be rejected (Fig. 2).

DISCUSSION

In explaining these results, it may be reasonable to posit that the NCS may not have been implemented fully on the principles of OBE. Indeed, a number of reports indicated implementation problems related to the new curriculum (Jansen 1999; Vinjevold and Taylor 1999; Umalusi 2009; Edwards 2010). So, one may argue that if the NCS was not implemented satisfactorily, this may suggest that the teachers continued to teach as before – and the learners continued to learn as before. In this regard, it may be safe to say that the NCS, and its OBE orientation, never really became infused into the teaching and learning cultures of the NCS students. This, then, explains the lack of a statistically significant difference in the learning experiences and achievements of the two groups of students, following the instructional intervention at first year university level. By and large, they both came from the same learning and teaching experience

The results of this paper indicated the effectiveness of the intervention in ameliorating students' alternative conceptions about electric circuits, regardless of which high school curriculum the participants came from. After students' alternative conceptions have been confronted through activity-based instructional approaches they were guided to construct scientifically acceptable knowledge. The knowledge was consistent with their experimental observations. However, contrary to the researcher's expectation that students who came from the OBE-based curriculum (the NCS group) would perform better than the group from OSC, the results of this paper showed that the gains of the two groups were identical. This is contrary to the findings of Umalusi (2009) which found that the NCS students' curriculum was quite challenging as compared to the NATED 550 which was content based.

CONCLUSION

This paper investigated whether or not first year physics students from the old school curriculum would perform at the same level, compared with those from the new OBE-based curriculum – the NCS, if both were subjected to an OBE-based intervention. The findings showed that no statistically significant difference between the two groups of students existed in-sofar as their performance on the post-test was concerned. However, the fact that both groups benefited greatly from the intervention, through substantial gains in scores between the pre- and post-tests, had great educational significance. To this end, this paper has succeeded in achieving its objectives, thereby making a significant contribution to both theory and practice

RECOMMENDATIONS

The department of education needs to train teachers and subject advisors about the curriculum before they can implement it. Teachers need to research and teach students using contemporary teaching strategies that are learner centered.

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APPENDIX

Appendix 1: Comparing the brightness between series and parallel connection by measuring current

	Brightness	*Current*
Series circuit		
Parallel Circuit		

Appendix 2: Comparison of pre-test scores for NCS and OSC students

Group	*Means*	*Sd*	*df*	t_c	t_0	*Results*
NCS	31.7	24.5	26	2.04	0.01	$P > 0.05$
OSC	33.1	23.8				

Appendix 3: Comparison of pre and post test scores for NCS students

Group	*Pretest mean*	*Posttest mean*	*sd*	*df*	t_c	t_0	*Result*	*Inference*
NCS	31.7	60.6	24.5	13	1.76	-4.3	$p < 0.05$	Significant
OSC	33.1	62.6	23.8	13	1.76	-4.3	$p < 0.05$	Significant