IMPROVING THE PERFORMANCE OF PHYSICAL SCIENCE LEARNERS: A CASE STUDY AT MANDLETHU SCHOOL, MPUMALANGA PROVINCE, SOUTH AFRICA

P. J. H. Heeralal

Department of Science and Technology Education, University of South Africa (South Africa)

heerapj@unisa.ac.za

Learner performance in science subjects, especially Physical Science, is cause for concern in South Africa, since learners perform poorly in both internal and external examinations and assessment tests. Various research projects have identified the reasons for poor performance. This paper, which is based on quantitative data collected from Physical Science learners and a Physical Science, reports on ways to improve the performance of learners in Physical Science at secondary schools in the Mpumalanga Province of South Africa. Grades ten, eleven and twelve learners, as well as the Physical Science teacher, were interviewed to ascertain the causes of poor performance. The main reasons cited by learners for poor performance was that they experienced difficulty in grasping basic science concepts that were taught in primary school and answering questions in the examination. Learners also experience difficulty in expressing themselves in English. Recommendations are made that will assist both teachers and learners to overcome these issues, in order to improve performance of learners in Physical Science.

Keywords: learner performance, basic concepts, language.

INTRODUCTION

Since the end of apartheid, South Africa has been working to improve the quality of its mathematics and science education. However, international comparisons show that South African students rank at the bottom of the countries included in the Trends in International Mathematics and Science Study (TIMSS). There is evidence of very low-performing ninth grade students in South Africa in Natural Sciences, with the percentage of students with achievement too low for estimation between 15 percent and 25 percent (TIMSS 2011 International Science Results). This is cause for concern; hence this study examines the causes of poor performance in Physical Science, in order to device ways of improving performance.

LITERATURE REVIEW

According to National Senior Certificate examination technical report (2012, 45-61), 511152 candidates wrote the National Senior Certificate examination in 2012, 377829 passed the examination with a National percentage of 73.9 %. The percentage of Grade 12 learners who qualified for Bachelor's studies nationally is 26.6% in 2012. The number of learners who wrote Physical Science in 2012 is 179194. 109918 passed with a National percentage of 61.3%. Despite a recent increase, there are schools that do not produce quality and high numbers of learners who pass Physical Science.

In South African schools the subject Physical Science at grades 10, 11 and 12 covers both Physics and Chemistry topics. Six study units or knowledge areas are covered by the curriculum. These study units/knowledge areas are: Matter and Materials, Chemical

Systems, Chemical Change, Mechanics, Waves, Sound and Light and Electricity and Magnetism.

Research indicates that there are factors that cause poor performance of learners at high school across all subjects (Lemmer, 2000, p. 81). The key causes of poor performance in any subject are: lack of facilities and material resources, high educator and administrator turnover, teacher's workload, shortage of qualified educators, poor teaching methods, inadequate communication ability of learners and educators in the language of instruction, unmotivated educators and a tendency to place the greatest demand on educator's time and energies in terms of discipline, lesson planning, unproductive paper work and time management. Researchers agree that the factors associated with poor performance of learners in science in South Africa are the following: inadequate communication ability of learners and educators in language of instruction, large classes, lack of qualified science educators, poor teaching methods, inadequate educator knowledge, poor time management, lack of material resources (e.g. textbooks, scientific calculators and laboratory equipment), disruption in class, content coverage and lack of professional leadership. Mji and Makgato (2006, pp. 253-264) and Howe (2003, pp. 1-13) discuss the issue of knowledge and skills particularly in science and emphasizes the fact that many South African science educators have little content knowledge of how to teach science. In many schools worldwide science education is practiced in a traditional age-old manner, that is, dictative, and authoritarian which has eliminated all forms of imagination. According to Christensen et al., (1995), when this form of teaching approach was used in American schools, critical analysis of the results of learners indicated clearly that this system had failed. Thus, for the transformation of science learning, Christensen et al., (1995) points out there must be change in the strategies and methods used in the classroom.

In their criticism on how science is taught in the classroom, Driel, Beijaard and Verloop (2000) argue that teachers usually present science as a rigid body of facts, rules to be memorized and practiced by students and theories which they regard as absolute. Constructivists believe that emphasis should be on designing activities which provide active knowledge, instead of traditional knowledge transmission. Teachers are encouraged to investigate students' knowledge. In order to assign appropriate methods for teaching science, learners' misconceptions need to be identified (Kennedy, 1998). Constructivist theorists hold the view that teachers should deal not only with learners having high abilities or high motivation for science, but they should also look at the learners' cognitive and affective dimensions. By giving attention also to these dimensions, teachers will be shifting towards inquiry skills (Driel, Beijaard & Verloop, 2001).

In general, constructivism puts emphasis on the ways that people create meaning of the world through a series of individual constructs (de Jong, 2005). The constructivist teaching and learning models require learning that is hands-on, whereby students are actively involved in the learning process allowing them to build a better understanding; minds-on, allowing for learners to develop their cognitive processes, and encourage them to question validity of the situation; and authentic, presenting learners with real-life problems that they may be faced with, in order to develop them to take a critical look in order to obtain the best possible solution (Christensen et al., 1995).

Concerning the language of science, South Africa is a multilingual country with 11 official languages. In her study to determine the factors that influence poor performance in mathematics and science, Howe (2003, p. 8) discovered that native English speakers

performed best in mathematics and science of all language groups while the Afrikaans speaking attained the next highest score. Science educators must consider number of issues including their teaching approaches, and techniques, interpersonal interactions to ensure the effectiveness of science teaching, so that they motivate their learners towards acquiring necessary scientific skills, scientific knowledge, values and attitudes and provide high quality of science education for all learners (Lemmer et al., 2006, p. 11).

Problem Statement

The overall performance of the Mandlethu FET School has been poor for a long time, and the performance of science subjects is below expectations. The average pass rate for science subjects has been below 35% for the past three years. Lack of adequate resources for teaching and learning of science subjects has been reported to contribute to low pass rate in rural schools of South Africa by other scholars. However, the ability of SGB and school management has an impact on the school performance as well. It is unknown whether the SGB and school management at Mandlethu FET School are capable of supporting the teaching and learning of science subjects at the school.

The Aim of the Study

The aim of the study was to build the capacity of science teaching and learning at the Mandlethu FET School in order to improve pass rates of science subjects, so that learners ca n qualify for admission to tertiary institutions which may address science skills shortage in South Africa.

The Objective of the Study

The objective of the study was to ascertain what the causes of poor performance in Physical Science are, in order to design an intervention programme so that performance of learners can be improved.

RESEARCH METHODOLOGY

Research Design

The study was conducted in the form of a case study at Mandlethu FET School. A mixed method research design was employed whereby, qualitative and quantitative data wa s collected. The case study was selected in order to create a baseline for schools in Nkangala District Municipality of Mpumalanga Province.

The Study Area

The study was conducted at Mandlethu FET School in Vlaglaagte Location 1 in Empumalanga, Mpumalanga province in South Africa. The school has about 253 learners; 9 educators; 1 admin clerk, 2 general assistants and 2 kitchen helpers as of 2012. It is located in a township about ± 76 km northeast of Pretoria. The township has about 300 000 inhabitants, the majority of whom are the Ndebele people.

Sampling

A survey was conducted at Mandlethu FET School, in Mpulanga Province in South Africa Nine (out of 48) Physical Science learners (3 from each of grades 10, 11 and 12) were purposive sampled and face-to-face interviews were conducted using a structured questionnaire. From each grade a poor performing student, an average performing student and a student who performed well were chosen to be interviewed. Appointments were made with the participants prior to the interviews. The interviews were conducted at the school

boardroom. Two people were involved in interviewing each respondent where, one person was the interviewer and the other person was the scribe. In order to gain further insight into poor learner performance in Physical Science at the school, the teacher was also interviewed. (there is only 1 Physical Science teacher at the school)

DATA ANALYSIS

Audio recorders were also used to assist scribes to capture the proceedings. The recordings were transcribed and analyzed by coding and memoing (Babbie, 2010). The analytical procedures for qualitative data included seven (7) phases: (a) data organization; (b) data immersion; (c) generating categories and themes; (d) data coding; (e) offering interpretations through analytic memos; (f) searching for alternative understanding; and (g) writing of the report (Marshall & Rossman, 2011).

FINDINGS AND DISCUSSION

Learner Perspectives

Data indicated that the learners in the sample had chosen Physical Science as a subject because it is a requirement for the choice of career that they want to pursue. They experience difficulty in the following areas of the chemistry curriculum:

1. Defining terms
2. Chemical reactions
3. Electron configuration
4. Organic chemistry
5. Writing formulae
6. Experiments in Physical Science

Most of the areas of difficulty relate to the chemistry topics of the curriculum. With the exception of organic chemistry the areas of difficulty are elementary chemical concepts which form part of the Intermediate and Senior phase Natural Science Curriculum. Learner s need to have a clear grasp of these basic concepts before they can learn and understand the more complicated aspects of the secondary school Physical Science curriculum. Since learners have difficulty in grasping elementary concepts, it seems that the problem emanates from inadequate teaching and learning of Natural Science in the above mentioned phases. In order to overcome these difficulties the teaching and learning of science in the primary school needs to be investigated and researched, however, in order to assist learners in the present focus group, the above mentioned topics need to be reviewed and revised. The areas of the physics curriculum that they experience difficulty are:

1. Difficult terminologies
2. Mechanics
3. Momentum
4. Electricity
5. Force
6. Calculations

In most of the above areas the basics are covered in the Natural Science curriculum in the primary school and the comments made for how to address the problem for the chemistry aspects of the curriculum apply. An in-depth review of basic concepts in science needs to be undertaken in order to assist the learners come to grips with secondary school science curriculum.

The type of questions that pose problems for learners are explaining terms, one word answers, multiple choice questions, matching and calculations. A possible way of overcoming these issues would be for the teacher to use previous exam questions as guided class-work exercises. Learners need ample exposure to answering these types of questions in order to master the technique of answering them. Students need to be exposed to and guided in answering multiple choice questions, in particular, as early and as frequently as possible as the grade 12 examination in Physical Science always has multiple choice questions.

Since most of these learners are Ndebele speaking, language issues are also cited as a problem that they experience in their learning and understanding of Physical Science. In order to address the language issue in science the teacher should use the following strategies:

1. Develop a science terminology dictionary
2. Write all new terms encountered in a lesson together with their meanings on the board and ask learners to copy them into the terminology dictionary. Students must learn these terms and their meanings. Set aside time to test them orally or in writing as often as necessary.
3. Start the dictionary in grade 10 and continue with the same dictionary until grade 12.
4. Code switching should be avoided so that learners become familiar with the use of English as the medium of instruction in the physical science class.

This will develop not only their science language ability but also their conceptual understanding of science.

In order to improve their performance in physical science learners engage in self/ individual study, summarizing the text book on their own, practicing calculations and trying to answer previous examination question papers. There is a suggestion that group studies should be introduced with mentors to assist in their studies. This avenue should be explored by the researchers in conjunction with the subject teacher and school management.

Much can be achieved in improving performance if this suggestion is put into practice. Mentors need to be identified and trained. Group study activities can be extended to include other schools in the area.

Although learners should be encouraged to read and summarized their textbooks, this can often be time consuming and exhausting for grade 12 students. Summaries of lessons taught should ideally be provided by the teacher so that learners can spend time on more meaningful study activities such as answering application exercises and previous examination papers. External examinations (conducted in grade 12) and internal assessment tasks (for all grades) include questions on different ability levels according to the requirements of the South African curriculum for Physical Science. Learners make no mention of the use of a personal home study time table or roster to study. The school

needs to encourage learners to develop a study time table and use it to guide them in their studies at home, over the weekends and during the school holidays. This will help learners in becoming organized regarding their studies and will teach them time management skills. Time management skills are not only need for study purposes but will also assist learners in the examinations as well as in their personal lives.

Educator Perspectives

Educator's perspectives of issues needing attention in the teaching and learning of Physical Science

1. Challenges in teaching of Physical Science
    - Lack of methodology of teaching Physical Science subject.
    - Scientific language barrier: Physical Science language cannot be translated into IsiNdebele for learners.
    - Lack of assessment tools (there is no bank of questions).
2. Support required improving teaching
    - Help with teaching of learners
    - Assistance with practical investigations.
    - Interpretation of practical concepts. d. Motivation of learners
3. General comments by the teachers that need to be attended to
    - Learners cannot cope with English language.
    - Learners cannot define fractions, electricity etc.
    - Majority of learners come from very poor family background. They are not exposed to so many things such as new technology.
    - Majority of learners did not have proper career guidance to choose the right subjects.

RECOMMENDATIONS

Students and the teacher need to be provided with assistance on the topics that are mentioned in this article. The teacher needs guidance and support in improving his pedagogic content knowledge. Guidance needs to be provided to both teacher and learners in the area of assessment. For the learners, they need to be exposed to a variety of types of questions and how to answer them. The teacher needs guidance on setting of balanced assessment tasks. Basic science concepts and terminology needs to be reviewed.

CONCLUSION

Improving learner performance in Physical Science requires that attention be given to basic science concepts that are taught in the primary school and that learners are exposed to being taught Science in the medium of English.

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