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The Status and Quality of Science Education in Rural Day Secondary Schools in Chirumanzu District, Zimbabwe

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Abstract
The study investigated the current status and quality of science education in satellite schools in rural Zimbabwe. The study was conducted in five secondary schools in Lalapanzi cluster in Chirumanzu district, Zimbabwe. The study adopted the descriptive survey research design. It used semi structured questionnaires, observations and interviews as data collection tools. Results show that science teaching and learning is more didactic and theoretical in approach so that learners only develop factual knowledge of science principles and facts. Furthermore a number of factors such as insufficient teaching and learning resources, ill equipped laboratories, inadequate time for preparation and teaching due to a heavy workload and large class sizes limit the quality of science teaching and learning. The study also show that the provision of adequate funds to purchase equipment, build more laboratories, facilities and ensure a regular supply of consumables will improve the quality of science teaching and learning. The provision of laboratory assistants as well as payment of adequate salaries, allowances and incentives for science teachers could improve the quality of science education in Lalapanzi cluster secondary schools. It is recommended that more resources and funding be allocated to education and science education to enable schools to provide the required infrastructure and facilities as well as consumables. Science teachers should engage in ongoing professional development to be equiped with pedagogical skills as well as pedagogical content knowledge.
Keywords: science education, satellite school, quality science education

1. Introduction

Advances in science continue to have a significant impact on the way people live, consequently, many countries have acknowledged the vital importance of a well-educated and skilled workforce for them to remain internationally competitive in the 21st century (Bybee and Fuchs, 2006). It is therefore, imperative that people in contemporary society have a strong grounding in science so that they can understand such developments in science so as to make informed decisions on that basis. This suggests that science can play an influential role in the life of an individual as well as on the development of a nation. The foregoing brings into focus the importance of science education in schools and the fundamental role it potentially plays in developing scientifically literate citizens.

Thus the present global scientific and technological civilization calls for an imperative effort to equip every Zimbabwean youngster with appropriate scientific literacy on the basis of which they would interact intelligently with fellow global citizens. In light of the above, science is widely recognized as a very important school subject which has the potential to significantly contribute to the technological development of any nation. In Zimbabwe the importance of science is officially recognized in terms of the central place given to science in the Zimbabwean education secondary school curriculum (Ministry of Education Sports Arts and Culture Policy Circular P77 of 2006). However, for the science curriculum to be implemented effectively, it is imperatively that it be taught effectively.

Zimbabwe is not alone in emphasizing on science education as several countries during the last two decades, such as Australia, USA and UK have expressed widespread concerns about how science education is delivered. Worryingly, there has been a decline in student interest in science as evidenced by the decreasing numbers of students electing to pursue the sciences beyond the post-compulsory levels of education. Decreasing interest in school science shown by students across the world is an important challenge (Royal Society 2008a). There are well-documented studies of declining interest in science and science careers in both primary (Jarvis & Pell 2002) and secondary schools (Royal Society 2008b; Sturman & Rudduck 2009). It seems as if when students progress through school a large proportion of them is disappointed with the science they experience. This may stem from the lack of relevance of the science curriculum, consequently failing to stimulate interest in students. In addition, many non-science careers are more financially rewarding.

In Zimbabwe, in recent years a complicating factor was low teacher morale in the context of their declining earnings from their job following the downward spiral in the country`s economic fortunes (Mufanechiya & Mufanechiya, 2011). Some scholars such as Ainley (2004) have noted teacher efficacy as the biggest challenge to effective science teaching as teachers fail to put into place a stimulating and engaging pedagogical learning environments for students. Other studies (Bhukuvhani et al 2010, Holtman et al, 2008) mention that Zimbabwe like many others in developing countries face challenges of limited resources

particularly financial resources for acquiring apparatus and materials for imparting effective and efficient science education, low teacher morale, shortage of material resources to support teaching and learning. Such challenges are widely recognized by scholars as potentially limiting the provision of quality science education.

Nyagura (2011) paints a gloomy description of science education in Zimbabwean schools when he laments the severe shortage of science and mathematics teachers. He notes that the shortage has resulted in the low uptake of science and mathematics subjects at secondary school level as well as in our universities. Furthermore, the pass rates in these subjects across the education sector have been a serious cause for concern in universities. There is another aspect that needs pointing out, involving a feedback loop. With decreasing student interest leading to decreasing participation in university level science, we have decreasing numbers of teachers coming into the system and a looming shortfall in qualified science teachers, particularly in the physical sciences (Osborne & Dillon, 2008). This will arguably make it more difficult to provide innovative and interesting science experiences in schools. We thus find ourselves in the midst of a downward spiral of engagement with science which will almost certainly need to be addressed at a number of points if it is to be arrested.

The above bleak state of science education is particularly worrisome given the fact that Zimbabwe as an aspiring technologically advanced society undeniably requires a supply of well-qualified research scientists and scientifically literate citizens. In light of the above, there seems to be need for a fundamental review and reconsideration of the aims and content of the science curriculum. Without this fundamental review and reconsideration of the aims and content, what we offer our young people is in danger of becoming increasingly irrelevant both to their needs and those of society (Millar & Osborne, 1998).

As noted above, the current situation in regard to science education in Zimbabwe is a concern to all including government and the society as it is not fully achieving its goal of producing scientifically literate citizens (Nyagura, 2011). To solve the problems facing science education in secondary schools in Zimbabwe, there is arguably need for a holistic understanding of what is currently happening in the teaching and learning of science in the schools so that the limiting factors can be identified and their nature fully and empirically described . On the basis of this empirical evidence, then solutions could be proposed in a more informed and knowledgeable manner. This study therefore seeks to establish the real picture in as far as science teaching and learning is concerned in order to propose recommendations for closing the gaps between the actual and ideal that are necessary for improving the quality of science education for Zimbabwean secondary students.

2. Statement of the problem

Science education in Zimbabwe, as in other post-industrial countries, is in a state of crisis. Research indicates that there is generally a shortage of science and mathematics teachers which has resulted in the low uptake of science and mathematics subjects at Advanced level as well as in our universities (Nyagura, 2011). Limited material and physical resources, inadequate financial resources, low teacher morale, lack of support for teachers, large class sizes and inadequate teaching further limit the provision of quality science education in Zimbabwe (Bhukuvhani et al 2010, Holtman et al, 2008) . The solution to these problems lies in identifying the current practices by science teachers in the teaching and learning of science as well as the factors that are limiting the quality of science education.

3. Purpose and Research Questions

The purpose of this study is to propose solutions to problems facing science education in secondary schools in Chirumanzu district, Zimbabwe on the basis of an empirically grounded understanding of the workings of the factors that constrain the effective delivery of science education. The study was guided by the following questions:

1. How are science teachers currently implementing the Zimbabwe Junior secondary school science curriculum?
2. What difficulties do teachers and students face as they try to deliver and learn science in junior secondary schools in Zimbabwe at present?
3. How can the quality of science teaching in junior secondary schools be improved?

4. Methodology

4.1 Research design

The study adopted the descriptive survey design. Aggarwal (2008) notes that a descriptive research is devoted to the gathering of information about prevailing conditions or situations for the purpose of description and interpretation. Descriptive research is thus a type of research that is primarily concerned with describing the nature or conditions and degree in detail of the present situation (Landman, 1988). As further implored by Best & Khan,(2007) the descriptive survey design describes and interprets what is. It is concerned with the conditions or relationships that exist, opinions that are held, processes that are going on, effects that are evident, or trends that are developing. The design was found appropriate as the study sought to find out how science teachers are currently implementing the curriculum and the challenges they face as they try to deliver science to learners at

ordinary level.

4.2 Population and sample

The population of the study comprised of 480 form 4 learners and 12 teachers from five secondary schools in Lalapanzi cluster in Chirumanzu district, Zimbabwe. The sample was made up of 120 learners and 10 teachers. Twenty four learners (12 boys and 12 girls) were selected from each school using stratified random sampling technique. The technique ensured that both boys and girls are equally represented in the sample. A simple random sampling technique was used to select two science teachers from each school to participate in the study.

4.3 Instruments

The researchers collected data on the status and quality of science teaching and in all the secondary schools in Lalapanzi cluster. Data was collected using a semi structured questionnaires, semi structured interviews and observations. The semi structured questionnaires elicited information from teachers and learners on what is actually happening in the teaching and learning of science, the constraints to quality teaching and learning of science in schools and the constraints could be remedied. The semi structured interviews were used to gather relevant data on the nature of quality teaching and learning/ best practice in science education, and describe the current status and quality of science teaching and learning in Lalapanzi cluster. Classroom observations conducted to investigate processes and behaviours that actually occured in the science classrooms. The observations were conducted in all the four schools.

5. Results and discussion

5.1 How are science teachers currently implementing the integrated science curriculum?

The findings of the study reveal that there is a gap between the intended curriculum and what is actually happening in the classroom (the implemented curriculum). The teachers are mainly using the traditional lecture method in teaching and learning science as shown in table 5.1.1.

Table 5.1.1: Methods of instruction used in science classrooms

Method	Percentage of teachers using the method
Lecture (Chalk and talk method)	90
Inquiry method	20
Discovery method	10
Demonstration	80
Project method	10
Discussion	60
Field trips	10
Technology/ Computers	10

The findings of the study further indicate that science students spend most of the time during lessons lesson copying notes from the teacher while practical work is rarely conducted by the science students and is limited to teacher demonstrations. (see Table 5.1.2 below).

Table 5.1.2: Frequency of learning activities identified by students

Item	never	Once a term	Once a month	Once a week	Nearly every lesson
Note copying					√
Teacher demonstration				√	
Practical activity in groups		√			
Whole class discussions					√

The findings are consistent with those of Sun et al (2014) who found that Chinese science classroom environments were characterized by students having limited opportunities for participating and engaging in learning as science teachers were dominant in classroom talk. As noted by Omorogbe & Ewansiha (2013), the teaching of science has been reduced to a descriptive exercises through the use of lecture method and very little inquiry. They further note that instead of being activity based and child centered, most science lessons are of the traditional lecture. The classrooms are characterised by few hands-on practical activities, few demonstrations, and when in use it is often teacher demonstration which makes students passive. Omoifo (2012) is also found that science lessons are yet to be structured, guided and students directed. Goodrum, Druhan & Abbs (2011) have also found similar results in Australian schools.

When teachers were asked about the strategies/methods they commonly used for assessment, all of the respondents mentioned written examinations, tests and exercises (100%). Research assignments and quizzes were mentioned by 30% of the respondents while investigations and practical exams are rarely used at all (See Table 5.1.3).

Table 5.1.3: Common assessment methods

Method of Assessment	Teacher response (%)
Written exams	100
Written tests and Quizzes	100
Written exercises	100
Research assignments	30
Practical exams	0
investigations	0

The findings corroborate with those of Ogunmande (2006) who noted that written exams, tests and quizzes are the most commonly employed assessment strategies used by science teachers and that practical exams and investigations are the least commonly used assessment strategies. Abrahams & Millar (2008) have noted the importance of practical work in promoting engagement and interest of students as well as testing important skills of inquiry and conceptual understanding. If practical work is not used for assessment purposes then it will be difficult to determine whether science process skills of observing, classifying, inferring, predicting, measuring, and communicating have been developed in learners. Since science is a practical subject, the above assessment modes being used by teachers imply that the skills which are assessed are minimal than those skills which practical work aims to develop. The finding are also consistent with Goodrum, Hackling & Rennie (2001) who noted that traditional assessment practices still remain common in Australian secondary schools where teachers are required to cover too much content to prepare students for examinations.

5.2 What difficulties do teachers and students face as they try to deliver and learn the intergrated science in secondary schools in Zimbabwe at present?

The science teachers were asked to give any factors that limit the effective teaching and learning of science in their schools. The following were the common responses given by the teachers.

♦ Inadequate teaching and learning resources
♦ Ill equipped laboratories (inadequate equipment, apparatus and reagents)
♦ Inadequate time for preparation and teaching due to a heavy workload and large class sizes.
♦ Poor student attitudes towards science as a result of poor teaching skills and approaches.
♦ Inadequate motivation as a result of poor remuneration.
♦ teachers lack of pedagogical content knowledge.

The students also noted that the large classes makes it difficult for them to engage in practical work and that the poor foundation of students in primary school science poses problem in learning basic science at secondary level. It was further noted that lack of qualified and dedicated science teachers also hinders the implementation of quality science education.

The findings of the study concur with Ogunmande (2006) & Chiromo (2010) who found that many secondary schools have inadequate science teaching and learning resources with their laboratories ill-equipped lacking appropriate apparatus, equipment and reagents. Hamilton et al (2010) have noted the importance of learning facilities (such as science labs) in the provision of quality science education. As noted by Mahlaba (2006) lack of adequate science teaching and learning resources not only denies students' the opportunity to develop scientific skills, but lead to loss of interest in science based disciplines hence students will develop negative attitudes towards the subject. The findings agree with Windschitl, (2009) who highlighted the availability of committed, qualified and experienced science teachers as among the significant factors influencing the quality of science teaching and learning.

Studies by Goodrum et al (2001), Ogunmande (2006) have demonstrated that The quality and adequacy of pedagogical approaches (i.e. the way science is taught and learnt) used by teachers has a direct impact on quality science learning in schools which are in turn dependent upon class size and subject content knowledge. Because of large sizes and lack of laboratory assistants' science teaching becomes tedious and demanding for teachers consequently students are less involved in hands-on practical activities (Ogunmande, 2006). Thus resources limitations impact on the implemented curriculum in ways that limit opportunities for learning.

The study has reported that lack of motivation and poor remuneration for Science students and teachers affects quality science teaching. The findings are consistent with Omorogbe & Ewansiha (2013) who note that poor remuneration affects the morale of teachers, distracts and hinders their commitment and effectiveness hence quality science teaching and learning.

5.3 How can the quality of science teaching in junior secondary schools be improved?

The questionnaire asked the science teachers to suggest various ways for improving the teaching and learning of science in schools. There were varied responses when teachers were asked about how they might improve science teaching in their school. The following were suggested by the teachers:

♦ Provision of funds to purchase equipment, build more laboratories, facilities and ensure a regular supply of

consumables.

♦ Reducing the class size and work load so that teachers can have adequate time for preparation and teaching
♦ Employing qualified laboratory assistants in schools.
♦ Professional development for teachers to improve pedagogical content knowledge as well as pedagogical skills
♦ Motivating science teachers through better remuneration and incentives.

The students shared similar views with their teachers but further noted that science teaching can be improved through the following ways:

♦ make science learning more interactive by engaging in hands-on activities.
♦ Teachers should use good teaching approaches
♦Teachers should be friendly and respond to students' problems.

The findings of the study are consistent with those of Ainley et al (2008) who highlights the need to train and retrain science teachers so as to develop teachers' capabilities knowledge, pedagogy, and dispositions for science teaching. Science teachers require new pedagogies, knowledge and commitments in order to undertake innovative science teaching hence teacher training would be vital in creating engaging and dynamic science teachers. Teaching quality is one of the most important factors for effective learning in science. Improvement in teaching effectiveness would lead to an improvement in quality science teaching and learning. Therefore professional development of science teachers is highly essential in this regard. As noted by Bellibas & Gumus (2016) providing effective professional development to teachers plays a key role in improving teacher quality, which eventually results in greater student achievement. Thus professional development is critical for maintaining continuous improvement in science teacher quality.

The findings of the study are also in agreement with Schanzenbach (2014) who noted that reducing class sizes enable teachers to be more effective. Effective science teaching is characterized by student-centered activities associated with students engaging in regular hands-on practical inquiry-based activity and carrying out their own observations among others. Hence reducing class sizes would make the management of practical work easier. Furthermore as noted by Pia (2015), large classes are characterized by teacher- centred teaching with low student participation. Frequent practical work becomes difficult to arrange with too many students in a class. Quiet students often get neglected. Teachers find it difficult to give follow up assignment due to workload in marking. Therefore the reduction in class sizes would help improve teacher effectiveness and quality science teaching and learning.

The teaching and learning of science requires the provision of equipment, laboratories, facilities and a regular supply of consumables. As opined by Hamidu, Ibrahim & Mohammed (2014 good laboratory and preparation room facilities are essential in science teaching and learning because they enable high quality practical work to be carried out in a pleasant environment, motivating and inspiring teachers and students alike. The findings further corroborate with those of Hackling (2009) who says that laboratory technicians have a vital role to play in the provision of high quality science education, primarily to support practical work in the classroom including preparing equipment and solutions for use in lessons, stock control, maintenance of equipment and health and safety. For this to be a success schools and the government should ensure that science education in schools is heavily funded so that the necessary equipment, facilities, consumables are purchased as well as employing laboratory technicians to assist science teachers. The findings of the study are in line with Nyamubi (2017) who notes the importance of good remuneration in the recruitment and retention of qualified science teachers.

6. Conclusions

Evidence from the study reveals that there is a gap between the intended science curriculum and what is actually happening in the classroom (the implemented curriculum), with science teaching and learning being more didactic and theoretical in approach so that learners only develop factual knowledge of science principles and facts. There is a difference between the intended curriculum and what is being implemented in the schools. The science lessons are more theoretical than inquiry based.

Furthermore the findings revealed that quality of science teaching and learning is limited by insufficient teaching and learning resources, ill equipped laboratories (inadequate equipment, apparatus and reagents), lack of laboratories and inadequate time for preparation and teaching due to a heavy workload and large class sizes. More so negative student attitudes towards science as a result of poor teaching skills and approaches, lack of teacher motivation as a result of poor remuneration and teachers lack of pedagogical content knowledge further limit the quality of teaching and learning of science.

The teachers and students suggested various ways for improving the quality of teaching and learning of science in Lalapanzi cluster schools. These include the provision of adequate funds to purchase equipment, build more laboratories, facilities and ensure a regular supply of consumables. Further more there should be provision for laboratory assistants, good maintenance of laboratory facilities and equipment and well managed class sizes so that teachers can be able to provide more inquiry-based hands-on practical and activity work for students on a

weekly basis. In addition the welfare of teachers should be improved through payment of adequate salaries, allowances and incentives. More so there should be professional development for teachers to improve pedagogical content knowledge as well as pedagogical skills.

7. Recommendations

From the research findings of this study conducted in secondary schools in Lalapanzi cluster there is enough evidence suggesting the parlous state of the quality of teaching and learning of science. If Zimbabwe is to achieve scientific literacy for her citizens then realistic recommendations to address the constraining factors that limit the quality of science education have to be made. The study therefore makes the following recommendations:

(i) The government should allocate more resources and funding for education and science education to enable schools to provide the required infrastructure and facilities as well as consumables.

(ii) There should be ongoing professional development for all science teachers to equip them with pedagogical skills as well as content knowledge.

(iii) science teachers should be motivated through payment of enhanced salaries, allowances and incentives similar to those of their colleagues in other professions.

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