

Secondary school teachers' perceptions of practical work in biology in the Oshana Education
Region, Namibia

Lahja L. Nghipandulwa¹, Hileni M. Kapenda² and Choshi D. Kasanda³

University of Namibia

Abstract

This study investigated Biology teachers' perceptions of the importance of practical work in selected secondary schools in the Oshana Education Region (OER) in Namibia. This study was situated in both the qualitative and quantitative research paradigms. The population of this study consisted of all Biology teachers of Grade 11 and 12 students. Eight secondary schools in the OER were purposely selected to take part in the study. A sample comprising of 23 Biology teachers was then chosen purposively from the eight secondary schools. A questionnaire and an observation schedule were used to collect the data. Descriptive statistics was used to analyse the quantitative data while the qualitative data were categorised into themes. The findings showed that the 69.9% of the Biology teachers did not have a laboratory specifically for conducting Biology practical work and they carried out their practical work in a common laboratory used for both Physical Science and Biology or in their classrooms. Two out of the nine observed teachers did not bother to carry out practical work at all and they taught Biology as a completely theoretical subject. The study recommends that Biology teachers should be encouraged to source materials necessary for conducting practical work from private schools in cases where their schools do not have the necessary resources for conducting practicals in Biology.

¹ Dr Leena L.T. Nghipandulwa is a Biology lecturer and coordinator of the SFP at UNAM Oshakati Campus. Her research interests are Mathematics & Science Education, Teacher education as well as on bridging programmes. Email: lnghipandulwa@unam.na

² Prof Hileni M. Kapenda is an Associate Professor of Pedagogy in the Department of Mathematics, Science, and Sport Education in the Faculty of Education at UNAM main campus. Her areas of interest include: Mathematics and Science Education, IKS, and Research Management. She is currently the Director, Centre for Research & Publications. Email: hkapenda@unam.na

³ Prof Choshi D. Kasanda is a Full Professor in the Department of Mathematics, Science and Sport Education in the Faculty of Education at UNAM main campus. Email: ckasanda@unam.na

Correspondence concerning this article should be addressed to Prof Hileni M. Kapenda Centre for Research & Publications, UNAM. Email: hkapenda@unam.na

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After independence, the Ministry of Education and Culture (MEC) in Namibia introduced a new educational system, aimed at “reviewing inequality and inequity within the education system” (MEC, 1993, p. 5). The main aim of the educational system was to equip students with the necessary knowledge, skills and attitudes that could enable them gain admission to institutions of higher learning in and outside Namibia and contribute to the country’s skill base. According to the Ministry of Education (2009a), the examiners’ reports on Biology Practical Examination Paper 3 indicated that Namibian learners performed poorly countrywide in comparison to Paper 1 (Multiple choice questions) and Paper 2 (Structured questions). The examiners’ reports pointed out that from the candidates’ answers, only a few schools followed a practical approach to the teaching of Biology.

It is against this background that this study was carried out in order to find out the attitude of Biology teachers to practical work in selected secondary schools in the Oshana Education Region (OER).

The study was guided by the following research questions:

1. How do Biology teachers in Oshana Education Region perceive conducting practical work during instruction?
2. Do secondary schools in Oshana Education Region have all the necessary resources for conducting practical lessons in Biology including the existence of dedicated laboratories?

Theoretical Framework and Literature Review

Theory of Constructivism

This study was based on the theory of constructivism. Constructivists view learning as an active process in which learners discover principles, concepts and facts for themselves while they and the instructor are equally involved in learning from each other (Woolfolk, 2004). Crawford (1996) indicated that social constructivists, such as Vygotsky, emphasize the importance of the learner being actively involved in the learning process so that he/she can construct his/her own understanding. It is believed that learners with different skills and backgrounds need to collaborate

on tasks, such as when they are doing practical work in order to arrive at a shared understanding of the truth in a specific field.

The teacher, according to the constructivist theory, is not seen as a person who is responsible for constructing knowledge for the learners but rather as a person whose role is to guide the students and provide them with opportunities to test the adequacy of their current understandings (Amineh & Asl, 2015). Thus, the teacher's role becomes that of a guide provocateur, creator of opportunity and co-developer of understanding with learners. The instructional practices of the Biology teachers should therefore assist learners to acquire the required skills (Ritchie & Rigano, 1996). However, due to changes in the society of the 21st century, Scheer, Noweski and Meinel (2012) argue that there is a need to equip students or learners with meta competencies that go beyond cognitive knowledge. That is "education needs a transition from transferring knowledge to developing individuals with the help of constructivist learning" (Scheer et al., 2012, p. 8).

Practical Work

Whilst the value of and purpose of practical work has been continuously debated, it has nevertheless remained a core component of science education. Indeed, the inclusion of practical work within an academic subject is a significant feature that distinguishes science from the majority of other subjects in secondary schools (Abrahams, 2011). Thus, in order to educate our future leaders in science, there is a widespread belief that students should learn science by doing what scientists do (Klainin, 1995). Learning of science, therefore, is seen by most science educators as likely to be more effective if the child is involved in practical activities and takes an active part in the learning process.

Practical work is used to refer to laboratory activities that include lectures, group experiments, and teacher demonstrations where learners are involved in handling and observing real objects and materials (Millar, Le Marechals, & Tiberghien, 1999). Teachers should therefore provide opportunities for learners to handle materials, observe events, handle observation results and be able to draw conclusions. In this paper, practical work is referred to by the researchers as an activity that promotes active learner participation in learning. This definition does not only mean hands-on activity involving equipment, but also encompasses a range of other ways of learning, including teacher demonstration, group discussion of problems and their solutions, interaction between

students, and between students and teachers. Most of these hands-on activities could assist learners in comprehending laboratory work that are usually tested in the Namibia Biology Paper 3 alternative to practical work examination. These activities may involve individual activity such as measurement, observation and investigation. Thus, practical work can take different forms from experiments to pencil and paper activity and may take place in the laboratory, classes or elsewhere.

Namibia has included a practical work component in the teaching and learning of science. Learners in grades 11 and 12 are expected to do practical work in Physical Science and Biology. In grade 12, learners are assessed on practical skills in Paper 3 which is an alternative to course work in Biology. The inclusion of practical work is clearly stipulated in the Biology syllabus (Ministry of Education, 2009a). The value of practical work has long been recognized at the secondary school level. Many teachers acknowledge the value of learning by doing rather than just being shown or told (Driver & Braund, 2002, p. 222). If students can be allowed to do practical work in Biology, then this could help them understand the content better, because students learn better by doing. This was further emphasized by Hodson (1990) who asserted that practical work is an essential component of science and vocational subjects' teaching. It is, therefore, advisable that students should be prepared for mastery of the skills required for practical work so that they will be ready for assessment activities.

Hodson (1990) notes that in practical work, the candidate performs certain activities in order to discover something, to test a hypothesis or to check an already known fact. In order to perform these activities, the candidate has to learn the skills required for practical work which includes preparing and performing experiments and processing the results obtained. Newman (n.d., p. 2) confirms students' interest in this mode of lesson delivery:

We observed classes who studied Chemistry and found that, with few exceptions, pupils enjoyed what they are doing in the laboratory even if difficulties arose in the procedures or even if students became aware that they didn't understand what was happening, it didn't seem to matter.

Woolnough and Allsop (1985, p. 201) note that, "many science teachers recognized the importance of practical work. They believed that pupils should have first-hand practical experience in laboratories in order to acquire skills in handling apparatus, to measure and to illustrate concepts

and principles”. Having first-hand information will thus allow students to apply the skills acquired during practical work when they become scientists in future.

Ramorogo (1998) explored teachers’ perceptions of practical work in Biology in Botswana secondary schools. Ramorogo found that in large classes, the shortage of laboratories and the lack of laboratory assistants were serious impediments to teachers in involving students in meaningful practical activities. Leach and Paulsen (1999) reviewed the use of practical work in science education in different countries. They found that teachers spent or claimed that they spent considerable amounts of time in supervising laboratory work. However, they found that the bulk of science assessments was traditionally non-practical. In other words, the assessment of students’ performance in the science laboratory was by and large neglected in most countries and by most teachers.

Philip and Taber (2016) conducted a study in the UK aimed at improving the quality of practical activities by developing a scaffold for Biology practical lesson and it involved 11 -19 year olds learners in the East Anglia region of England. The study indicated that using a simple structure (a novel scaffold) that could be readily adopted, Biology teachers could explicitly make “the difference between inquiry questions and techniques and force the learners to make a series of choices to be able to conduct the practical” (Philip & Taber, p. 224, 2016). Based on these findings, the authors concluded that with careful planning and sequencing of practical activities, “there is no reason why school practical activities should only engage learners ... [in the] domain of observables to the exclusion of the domain of ideas” (p. 224). In fact, Randler, Hummel and Prokop (2012) recommend the use of living animals in Biology lessons. This is because living animals and plants greatly assist students during Biology practical activities by engaging them within the observable domains. Osuafor and Amaefuna (2016) could not have put it better by stating that Biology, like other sciences, is a practical-oriented subject and therefore everything that needs to be done to encourage Biology teachers to teach theory with practical must be undertaken by all the concerned parties and stakeholders.

Methodology

This research was situated in both the qualitative and quantitative research paradigms. Qualitative inquiry aids the researchers to find out the views of individuals experiencing a

particular phenomenon from their standpoint. One of the strengths of the qualitative inquiry is the active engagement (interaction) of the researcher with the subjects of the study (Henning, Van Rensburg, & Smith, 2004). Part of the data in this study was gathered by means of observations. This, according to Strauss and Corbin (1998), is a technique normally associated with qualitative methods which involves close contact between the researcher and the research participants.

Quantitative inquiry, on the other hand, relies on the collection of numerical data. It relies on collecting data based on precise measurement using structured and validated data collection instruments (Johnson & Christensen, 2008). In this study, the frequency of the use of practical work and facilities in schools was quantified to find out to the extent of Biology practical work in Namibian secondary schools. The researchers combined the two research designs in this study because they were concerned with understanding the social phenomenon from the participants' perspectives. The researchers also sought to understand the problem from a quantitative view point by finding out about the practical resources such as apparatuses and laboratories available at the selected secondary schools.

The population of this study consisted of all 13 secondary schools in the Oshana Education Region which offer Biology as a subject at Grade 11 and 12 levels. Eight secondary schools in the Oshana Education Region and 23 Biology teachers from the eight secondary schools were purposely selected based on their willingness and availability to participate in the study. The participants were selected irrespective of their age and teaching experiences. Two research instruments were used to collect data for this study; namely a questionnaire and an observation schedule. The questionnaire had both closed and open-ended items that addressed teachers' perceptions on practical work in the teaching of Biology. The data collected using the study questionnaire were categorised into these themes: Perceptions of the Biology teachers on the importance of practical work and perceptions of Biology teachers regarding the use of practical work. The observation schedule was designed to capture information about classroom organization, resources to support the practical lessons, introduction of the practical lessons, teacher - learner interactions, role of the teacher during the practical lesson, and conclusion of the practical lessons by the teachers.

The quantitative data was analysed using descriptive statistics. Frequency tables and pie charts were used in analysing the close-ended questions on teachers' perceptions of practical work

in Biology. The data that were collected about the availability of practical resources such as, laboratories and apparatuses in secondary schools was also quantified and presented in tables and charts. Themes generated from open-ended questions from the questionnaires and classroom observations were coded accordingly. The data helped in answering questions about teachers' perceptions of the importance of practical work in Biology. The researchers also wrote reflective memos in order to record what they learned from the data collected.

Findings and discussions

The Biology teachers' perceptions of practical work and the conditions of the laboratories in which they carry out the practical work in Biology in the OER are presented below.

Teachers' perceptions of practical work

Teachers were asked whether practicals were necessary in the teaching of Biology. All 23 teachers agreed. Teachers were then asked to give reasons as to why practicals were important in the teaching of Biology. Six (26.1%) of the teachers mentioned that practicals were necessary in the teaching of Biology because practicals proved theory in Biology and made Biology an interesting subject. Five (21.7%) of the teachers stated that practicals promoted learners' understanding of the topics better and also stimulated students' interest in Biology. Three (13.1%) of the teachers asserted that practicals developed learners' skills in handling and organizing apparatus and materials and in following instructions, while four (17.4%) of the teachers were of the opinion that practicals allowed learners to learn better when they saw and touched objects as they do not forget what they have seen and this reinforces their content grasp.

The responses show that most Biology teachers in this study were aware of the importance of practical work and what its aims were and why it was necessary in the teaching and learning of Biology. This corroborates scholars' (Clackson & Wright, 1992; Gott & Duggan, 1995; Leach & Paulsen, 1999) position that a teacher's belief or conception of practical work can impact directly on the way she/he arranges for practical work. Teachers should, therefore, have a clear understanding of what practical work entails and the purposes it serves. Having a clear understanding about the nature of practical work might help the teachers to effectively plan for teachable practical activities.

Although the teachers viewed practicals as important in the teaching and learning of Biology, the class observations showed that, only nine (39.1%) of the teachers carried out practical work. The rest of the teachers did not do practical work. Some of the reasons given for not carrying out practicals by the teachers were: “It was time consuming to prepare practicals than [traditional] teaching”; “practicals prescribed in the syllabus were not familiar to the teacher” and; “practicals were frustrating especially if equipment were not enough.”

Teachers were also asked about what their learners did at the end of the practical lesson. Figure 1 presents their responses.

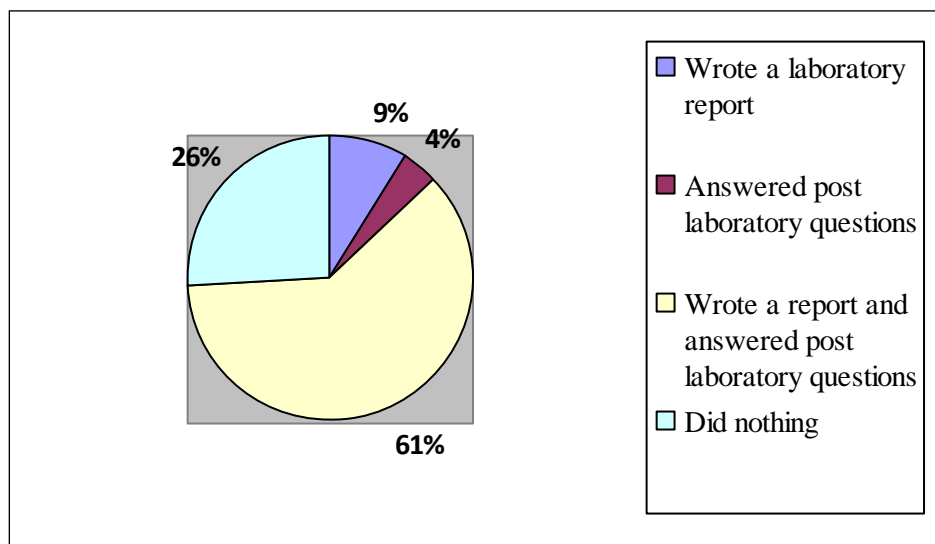


Figure 1: What learners did at the end of each practical lesson

From Figure 1, one (4%) of the Biology teachers responded that the learners answered post-laboratory questions at the end of the practical lesson. Two (9%) of the teachers said that the learners wrote a practical report, 14 (61%) of the teachers said learners answered post-laboratory questions and also wrote a practical report. Six (26%) of the teachers, however, said that the learners did not write anything at the end of the practical lesson.

Six teachers (26%) as shown in Figure 1 did not give their learners any type of work at the end of the practical lessons. Teachers are supposed to give learners some kind of work at the end of the practical lessons to find out if any learning had taken place. The Ministry of Education (2006; 2007), Examiners’ Reports showed that practical examinations remained the biggest challenge in comparison with multiple choice and structured examinations within the Namibian education system. Learners continued to have problems in performing well in practical

examinations due to lack of high-level procedural and conceptual skills. The lack of practical assessment of learners after practical lessons could be one of the reasons.

Teachers were further asked to indicate what should be the role of the learners during the practical lesson. Six (26.1%) of the teachers said that it was “to handle the materials, observe and record their findings.” Eleven (47.8%) of the teachers said the role of the learners was to carry out the practicals themselves following the right procedures and then answering post-laboratory questions. Two (8.7%) of the teachers, on the other hand, indicated that it was “to observe teachers demonstrating for them in order to answer the questions, and ask for clarity from the teacher.” The remaining 4 (17.4%) of the teachers said that “it was to follow the instructions carefully, write down the results and draw conclusions.” Students need to be involved in practical activities that will enhance their acquisition of higher-order processing skills rather than lower-order thinking skills (Lake, 2004; Savage, 1998). Sometimes, some form of data-handling that was never used in class is examined extensively in the end-of-year practical examinations (Keiler, & Woolnough, 2002). Therefore, learners should be active participants during practical lessons. They should do the practicals themselves under the teachers’ supervision and they should be the ones handling the apparatus during the practicals if they are to be successful in practical examinations.

It is interesting to note that, in the class of 25 learners, the teachers did not allow learners to do practicals on their own. In six practical lessons observed, the teachers were doing the practicals themselves. In three other cases, the teachers randomly selected two learners (one was male and another one was female) and used them to demonstrate the practical work, while other learners observed. Most of the learners were not actively involved during the observed practical lessons. Hofstein, Novon, Kipmis, and Mamlok-Naaman. (2005) noted that students involved in carrying out a task may perform better than those that were not involved in carrying out the task. Therefore, it is important that all learners take an active role during the practical lessons so that they can acquire practical skills. This, however, can only become a reality if all schools are provided with enough laboratory equipment and the secondary school teachers are given the necessary training on how to conduct practicals. In a country where many learners may not have a scientific background that will help them develop the skill and knowledge to excel in science, it must be seen as a serious opportunity lost if this experience is not provided in the school environment (Ministry of Education, 2009b).

Availability of resources to carry out practical work in Biology

Existence of laboratory manual and/or materials for carrying out practical work is necessary for successful practical work that will yield the desired results. Both teachers and learners need these materials to ensure learning takes place. Accordingly, the Biology teachers were asked to indicate whether these materials existed in their schools for effective carrying out of Biology practicals.

All 23 (100%) of the teachers indicated that their learners did not have a practical manual that serves as a guide to practical work. This was also confirmed during the observations of practical lessons where none of the learners had a laboratory manual. When asked to indicate how they got around the lack of a laboratory manual, the majority of the teachers said that they often prepared handouts for their learners to use during practicals and also that they used textbooks as a guide for the practicals. In fact, it was found out during practical lesson observations that some teachers were using the syllabus as a guide for practicals.

If learners are not given a practical manual, they might not consider practicals to be important. Preparing practical manuals might save teachers a lot of time and effort, instead of preparing a separate handout for each practical lesson. It might take time for the teacher to write the procedures on the chalkboard because this is the time that they are to use to do the practicals with their learners. For those that were using the textbook as a guide for the practical lesson, textbooks might not have clear instructions and some of the prescribed practicals in the syllabus might not be in those text books. The other problem with using the textbooks might be that the text books might not be enough for all learners as is the case with most secondary schools. This would imply that lack of textbooks might have contributed to the poor performance in paper 3, relative to lack of laboratories, lack of manuals and lack of apparatuses.

In order to find out the conditions under which the Biology teachers carried out practical work in OER, the Biology teachers were asked whether laboratories existed in their schools. Sixteen (69.6%) of the respondents indicated that a laboratory dedicated for the teaching of Biology practicals existed in their schools while seven (30.4%) said they used classrooms. With respect to the conditions of the laboratories, the respondents' answers are given in Table 2

Table 2

Conditions of the Laboratory for Practical Work

Condition of laboratory	Frequency
Laboratory was a bit too old without posters to support the practical	2
Big but empty; it does not have stools for learners to sit on; tables not enough; learners standing and; benches not enough	2
Laboratory was in a good condition, with enough benches and chairs for learners	1
Laboratory was very small and not neat; it is old.	1

The nine observed practical lessons took place in laboratories which were old, dilapidated and, as such, not conducive for practicals. Of the five laboratories, only one was conducive for practical work. It is important that the practical learning environment is conducive for learning if teachers and learners are to become interested in practicals. An ideal high school laboratory must be clean, not dilapidated, and well equipped with practical equipment to allow meaningful practicals to take place.

Teachers were further asked to state whether their schools had sufficient materials for conducting practicals in Biology. All the 23 Biology teachers indicated that their schools did not have sufficient materials for conducting practicals in Biology. According to Crawford (2000, p. 916), “increasing costs of equipment and consumables for laboratories have put science laboratories in universities and schools in a pathetic condition.” The high cost of scientific equipment and infrastructural facilities required for science laboratories have resulted in several educational institutions being hesitant to put basic science subjects on their priority list (Crawford, 2000).

It was also observed that in all the nine practical lessons, there were not enough apparatus and equipment for all the learners to use. Learners shared the apparatus and equipment in three practical lessons observed even though those practicals were meant to be done individually by each learner with his or her own laboratory apparatus and equipment. In the other two, the

laboratory apparatus was for the teachers' use only, while in the remaining four practical lessons, there were no apparatus at all. For those schools that had apparatuses, the researcher observed that most of the apparatus were in good working condition, a few were old and dusty indicating that they have not been used for a long time and some chemicals had long expired (a year ago) and thus could not be used during practicals.

The lack of essential laboratory resources tended to limit how much practical work could be done in secondary schools (Kandjeo- Marenga, 2008). Lack of resources can limit the number of practicals that can be carried out in Biology in secondary schools. The researchers were of the view that the Ministry of Education and the Biology teachers should work together in order to ensure that there are enough practical resources at all secondary schools offering Biology. Improvisation should be encouraged among Head of departments, Principals, and Regional Directors in this regard.

Insufficient of materials for conducting practicals might prevent teachers from allowing all their learners participate in practicals, especially hands-on practicals. In other words, teachers might be forced to do demonstrations only, instead of allowing their learners to do practicals on their own. Furthermore, this might also prevent teachers from carrying out all the practicals that were stipulated in the syllabus which, in turn, will disadvantage the learners in the Alternative to Practical Work examination paper.

To the question of whether the equipment was for teachers use only or were to be used by the learners as well, ten (43%) of the teachers indicated that the equipment was for both teachers and learners while the remaining 13 teachers (57%) responded that there was only enough equipment for teachers. If the schools do not have equipment for conducting practical work, for both the teachers and the learners, teachers might be forced to do demonstrations only and might not allow learners to handle the equipment themselves. This will prevent learners from performing well in paper 3 which is alternative to practical work. These findings are similar to those by Maboyi and Dekkers (2003) who found that almost all the Natural Science teachers in their study in South Africa preferred teacher demonstrations because of the lack of laboratories and laboratory equipment amongst other reasons.

On the question as to whether there was enough equipment for all learners to carry out practical work in Biology, all 23 teachers responded that the equipment was not enough for all the learners to use during the practical lessons. All learners were supposed to be active participants during the practical lesson; they were supposed to be handling the apparatus themselves, during the practical lessons. If equipment's are not enough for all learners, this will prevent some learners from participating during the practical lesson. This, in the long run, might contribute to learners not being able to answer the practical examination questions in paper 3.

The Namibian Senior Secondary Certificate for Ordinary Level Biology Syllabus (Ministry of Education, 2009c, p. 27), states that, "learners should get practical (experimental and investigative) skills and abilities that will allow them to be able to follow a sequence of instructions; use appropriate techniques; handle apparatus/materials competently and; have due regard for safety." Learners can only learn how to handle the apparatus or the materials if they are available at their schools. If the apparatus is not enough, teachers might be forced to do demonstrations and learners will be forced to observe only. As such, learners might not be able to learn how to handle the apparatus when doing practicals. This would mean even if they make it to university where students are required to handle the apparatus themselves, they will not be able to do so, and this might negatively impact their success at the tertiary level.

The results in this section show that most secondary schools in the Oshana Education Region did not have laboratories, and for those that had the laboratories, they were not well stocked. Furthermore, the laboratories did not have enough resources for conducting practicals.

Conclusions

From the observations of lessons in the selected secondary school, it can be concluded that not all the Biology teachers were doing practicals in Biology even though they claimed that they do. The teachers did not allow their learners to do the practicals themselves even though they were expected to do practicals under the teachers' supervision. This might be one of the reasons why learners performed poorly in Biology Paper 3.

It can also be concluded that the schools studied did not possess Biology practical manuals. Neither teachers nor learners used Biology practical manuals to guide them in carrying out of practicals. Without practical guides, both teachers and learners might not take practicals seriously

and this might affect the learners' performance in Paper 3. Furthermore, it can be concluded that the lack of assessment of the learners' practical work in some schools studied could have been sending the wrong signal to learners that practical work was not important and, as a result, learners expended little effort in undertaking practical tasks in these schools. Consequently, learners in these schools were not familiar with the questions format in Paper 3 resulting in poor performance. It should be pointed out that the lack of Biology laboratories in some of the schools, the necessary resources, apparatus and equipment for both the teachers and the learners to use during the Biology practical lessons could be said to have contributed to poor performance in Paper 3 in the Oshana Education Region.

Recommendations

In light of the findings of this study, the following recommendations are made:

The Ministry of Education, Arts and Culture should provide funds for purchasing the apparatus and the equipment that will be used by both teachers and learners during practical lessons.

Laboratories which are empty and do not have the necessary chemicals, apparatus and materials for conducting Biology practicals serve no purpose in the conduct of practical work in Biology. The Ministry of Education, Arts and Culture should come up with a plan to renovate laboratories that are old so that they can become conducive for conducting practical work.

The Ministry of Education should, through curriculum development initiatives, make practical tests compulsory for Grades 11 and 12 so that learners are prepared to answer questions in Paper 3.

The Biology Advisory teachers should visit secondary schools regularly in order to identify the problems that teachers are facing in conducting practical work. In this way, they will be able to assist Biology teachers in conducting practicals and in ordering required consumables and equipment.

The Advisory Teachers should, together with the Ministry of Education, organise workshops and in-service training for Biology teachers in order to train them on how to conduct practicals in Biology. In addition, teacher training institutions should train teachers on how to conduct practical work in Biology.

Biology teachers should liaise with and source materials from private schools for conducting practicals in Biology if they lack these at their schools.

Biology Teachers through the School Management should inform the Biology Advisory Teachers where their schools do not have the necessary resources for conducting the practicals in Biology. In this way the Advisory Teachers might organise the needed resources for conducting practicals.

Biology teachers should be afforded the chance to attend workshops organized by the Ministry of Education and the Advisory Teachers dealing with conducting practicals so that they could get the skills on how to implement practical work in Biology.

Biology teachers should organise bazaars and other fundraising activities in order to generate funds for buying equipment and chemicals that will help them to carry out practicals in Biology.

Like any other study, this in spite of its contribution, has some limitation that other scholars may wish to investigate. A longitudinal study should be carried out that would shed more light on the nature of Biology practical work in Namibian secondary school classes. There is need to conduct a countrywide study to find out why Biology teachers are not conducting practical work at the secondary school level.

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