Investigating the presence of resources for conducting practical work in Biology in secondary schools in Oshana education region

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Abstract
This study aimed to investigate whether secondary schools in the Oshana education region had all the necessary resources for conducting practical lessons in Biology. This study was situated in both the qualitative and quantitative research paradigms. The population in 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 were randomly selected to take part in this study. A sample comprising 23 Biology teachers was then chosen purposively from the 8 secondary schools. A questionnaire and an observation schedule were used to collect the data for this study. Descriptive statistics were used to analyse quantitative data and included frequency tables, graphs and pie charts. Qualitative data were categorised into themes that emerged from the data.

This study found that most secondary Schools in Oshana Education Region did not have a laboratory specifically for conducting Biology practicals and that most of the laboratories used did not have enough apparatus and equipment. The study also found that some of the laboratories had expired chemicals and thus could not be used for practicals as indicated by 28.6% of the teachers. Furthermore, the study found that there was only enough equipment for teachers to do practical work and that the equipment was not enough for all the learners to use during the practical lessons. The findings also showed that both teachers and learners did not have Biology practical manuals to guide the conduct of practicals. It is apparent from these findings that the lack of laboratories, equipment, apparatus and chemicals made it difficult for Biology teachers to conduct practicals. This might be the reason why learners performed poorly on Paper 3 which is an alternative to practical work paper.

The study recommends that the Ministry of Education should budget money for building Biology laboratories at all secondary schools. The Ministry should also budget money for buying the apparatus and the equipment that will be used by both teachers and learners during practical lessons. The study further recommends that Biology teachers should be encouraged to borrow materials necessary for conducting practical work from private schools in cases where their schools did not have the necessary resources for conducting practicals in Biology.

Keywords: *practical work, laboratories, Biology, resources, constructivism*

Introduction and background

At independence in 1990 Namibia inherited an Apartheid Education System which did not meet the aspirations of the newly independent nation nor the objectives of the Ministry of Education and Culture (Angula, 2010) to make Namibia a truly politically and economically independent nation. The new Curriculum Statement of 1991 stressed student-centred activities at all levels of education, not the transmission of a host of disjointed scientific facts to be committed to memory

(Angula, 2010). The curriculum reform of 1991 was enacted in order to educate and equip students with necessary knowledge, skills and attitudes that would enable them to meet the social demands in their respective communities (Kandjeo-Marenga, 2008). The reformed curriculum brought some major changes to the Namibian education system and these included: (i) a student-centred approach to teaching and learning science rather than the transmission approach; and (ii) the writing of practical examinations (Paper 3) at the end of the senior secondary level which constituted 19% of the total score of the final examination (NIED, 2010). Before the science curriculum was reformed, practical work was not assessed or examined.

In Namibian Secondary schools, Grade 12 Biology has three examination papers which are written by learners at the end of the year. Paper 1 is multiple choice, Paper 2 is structured questions and Paper 3 is the Alternative to Practical Work. Namibia has included a practical work component in the teaching and learning of science. Learners in Grades 11 and 12 in Namibia are expected to do practical work in all the two Science subjects (Biology and Physical Science) (Sneyder, 2015). In Grade 12, learners are assessed on practical skills in Paper 3 which is an Alternative to practical work. The inclusion of practical work is clearly stipulated in the Namibian Biology syllabus (Ministry of Education, 2009a).

According to Sneyder (2015), the assessment objectives of Biology in Namibia are summarised in the syllabi (Ministry of Education, 2009a, p. 26) under the following three domains:

Domain A : Cognitive domain (knowledge with understanding).
Domain B : Handling information and solving problems, and
Domain C : Practical skills and investigations.

The cognitive **domain (A)** focuses on subject matter content while **domain (B)** stresses the importance of handling information and solving problems and **domain (C)** focuses on the importance of practical work for the development of skills and investigations. For this study, Domain B and C were very important. It is through practical work that students might be involved in different activities that might enhance their abilities to handle information and solve problems and/or develop experimental skills and learn how to plan investigations.

Statement of the problem

According to the Ministry of Education (2010, 2011), the Examiners' Reports on Biology Paper 3 shows that the learners have continued performing poorly in Paper 3 countrywide in comparison to Paper 1 and 2. The Examiners' Reports further point out that it is clear from candidates' answers that only a few schools follow a practical approach to the teaching of Biology. Lubben (2012) notes that eight years after Namibia's independence, practical work in Science education, in most Namibian schools, is still a pipeline dream as few teachers are capable of teaching Science by practical work and many Science teachers still need assistance on how to involve students in meaningful practical activities. It is against this background that a qualitative and quantitative study was carried out in order to investigate whether secondary schools in the Oshana education region had all the necessary resources for conducting practical lessons in Biology. This study sought to answer the following research question: do secondary schools in Oshana education region have all the necessary resources for conducting practical lessons in Biology?

Theoretical framework and literature review

This study is based on the theory of constructivism. Constructivists view learning as an active process whereby learners learn to discover principles, concepts and facts for themselves. The instructor and the learners are equally involved in learning from each other (Woolfolk, 2013).

Crawford (2014) 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 together 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 is denoted by the many responsibilities given to him\her during instruction in mediating meaning at the inter-mental plane in the classrooms. Thus, the teacher's role becomes that of a guide provocateur, creator of opportunity and co-developer of understanding with learners (Woolfolk, 2013). The instructional practices of the Biology teachers should therefore assist learners to acquire the process skills (Ritchie & Rigano, 2016).

Ever since experimental Science was advocated in the sixteenth century (Klainin, 1995), it has been well accepted that practical or empirical work is the major task of scientists. 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, 2014). 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 has been a prominent feature of school Science teaching from the late nineteenth century when Science was established as part of the curriculum of schooling in a number of countries (Klainin, 2014). 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, & Tibergnien, 2011). 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 researcher 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 working, including teacher demonstration, group discussion of problems and their solutions, interaction between students, and between students and teachers. It also involves individual activity such as measurement, observation and investigation. Learners in Grade 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, 2010). 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, 2014, p. 222). If students are allowed to do practical work in Biology, this might help them understand the content better, because students learn better by doing. They will remember better something that they have

done with their own hands. This was also emphasized by Hodson (2015) who said that practical work is an essential component of science and vocational subjects teaching. It is therefore advisable that students should be prepared with mastery of the skills required for practical work so that they will be ready for assessment.

Newman (undated, p .2) write: "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". On the other hand, Woolnough and Allsop (2016, 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 allow students to apply the skills acquired during practical work when they become scientists in future. Ramorogo (2000) explored teachers' perceptions of practical work in Biology in Botswana secondary schools. He 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.

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 point of view. One of the strengths of the qualitative inquiry is the active engagement (interaction) of the researcher with the subjects of the study (Henning & Van Kensburg, 2016). Some of the data in this study were gathered by means of observations, these according to Strauss and Corbin (2017) are a technique normally associated with qualitative methods which involves close contact between the researcher and the research participants. The 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 for practical facilities in schools were quantified to find out the extent these hindered the use of practical work in Biology in secondary schools in Oshana education region.

The researcher combined the two research designs in this study in order to understand the social phenomenon from the participants' perspectives, by being a participant observer during practical lessons. The researcher also tried to understand the problem from a quantitative view point, by finding out the presence of the practical work resources such as apparatus and laboratories available at the selected secondary schools. The population in 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 were randomly selected to take part in this study. A sample comprising 23 Biology teachers was then chosen purposively from the 8 secondary schools.

Two research instruments were used to collect data for this study. These were a questionnaire and an observation schedule. Descriptive statistics were used to analyse quantitative data and included frequency tables, graphs and pie charts while qualitative data were categorised into themes that emerged from the data.

Results and discussion of the results

This section is divided into 2 sub-headings. First, resources for conducting practical lessons and second the availability of resources for conducting practical lessons in Biology.

1. Resources for conducting practical lessons in Biology

Teachers were asked whether their schools had a laboratory dedicated for conducting practical work in Biology. Their responses are presented in Table 1.

Table 1: Availability of a dedicated laboratory for carrying out practical work in Biology (N=23)

Availability of a laboratory for Biology practicals	Frequency	Percentage
Yes	7	30.4
No	16	69.6
Total	**23**	**100**

From Table 1, 69.6% of the teachers responded that their schools did not have a laboratory specifically for conducting Biology practicals. From the responses in Table 1, it is clear that most secondary Schools in Oshana Education Region did not have a laboratory specifically for conducting Biology practicals. Lack of a dedicated laboratory, might be used as an excuse for not carrying out practicals in Biology by teachers who might not find it comfortable to carry out practicals in ordinary classrooms or in the open. All secondary schools offering Biology should therefore have a laboratory, because Biology is an experimental subject as stated in the Namibian Senior Secondary Certificate for Ordinary Level Biology syllabus (Ministry of Education, 2006) that scientific subjects are by their nature experimental. The teaching of Biology cannot be done theoretically only; there should be a practical component. Teachers were also asked to state the place where they usually conducted practical lessons in Biology if they did not have a dedicated Biology laboratory. Their responses are presented in Table 2.

Table 2: Places where practical work was conducted in Secondary schools (N=7)

Place	Frequency
Classes	2
Common laboratory	3
Rossing Foundation laboratory	2
Total	**7**

In Table 2, three of the seven teachers who responded that there was no laboratory for conducting Biology practicals at their schools indicated that they conducted practicals in a common laboratory where all science subjects had their practicals; two teachers responded that they used the normal classes; while the remaining two said they used the Rossing Foundation laboratory, which was about ten kilometres from the school. The use of the Rossing Foundation laboratory required teachers and their learners to leave the school premises because Rossing Foundation was not in the vicinity of the school. However, going to the Rossing Foundation premises every week was not possible according to these teachers because there was lack of transport and the distance that they had to travel to the Rossing premises was too

long. Teachers were also asked to state how well stocked their laboratories were. Table 3 shows their responses.

Table 3: How well stocked were the Biology laboratories (N=21)

How stocked is your Biology Laboratory?	Frequency	Percentage
It does not have enough equipment and apparatus.	13	61.9
No laboratory at school.	2	9.5
It has expired chemicals.	6	28.6
Total	**21**	**100**

It can be seen from Table 3 that most of the laboratories used by the Biology teachers did not have enough apparatus and equipment as indicated by 61.9% of the respondents. Some of the laboratories had expired chemicals and thus could not be used for practicals as indicated by 28.6% of the teachers. It was also apparent from these results that the lack of laboratories, equipment, apparatus and chemicals made it difficult for Biology teachers to conduct practicals. 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 Mortimer and Scott (2018, p. 916), "increasing costs of equipments and consumables for laboratories have put science laboratories in universities and schools in a pathetic condition". The high cost of scientific equipment and infrastructure facilities required for science laboratories have resulted in several educational institutions being hesitant to put basic science subjects on their priority list (Mortimer & Scott, 2018). This might also be the case in most of the Namibian schools from the teachers' responses.

Insufficiency of materials for conducting practicals prevented teachers from allowing all their learners from doing the practicals themselves. 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 are stipulated in the syllabus which in turn might disadvantage the learners on Paper 3, the Alternative to Practical Work examination paper. To the question of whether the equipment was for teachers use only or enough to be used by the learners as well, 10(43%) of the teachers indicated that the equipment was both for teachers and learners while the remaining 13(57%) teachers responded that there was only enough equipment for teachers to do practical work. If the schools do not have equipment for conducting practical work, for both teachers and the learners, teachers might be forced to do demonstrations only and might not allow learners to handle the equipment. If teachers do demonstrations only, this will prevent learners from being actively involved during the practical lessons and as such will not benefit from the teacher's demonstration (Crawford, 2010).

On the question of whether there was enough equipment for all learners to carry out practical work in Biology, all 23 teachers responded in the negative. All learners were supposed to be active participants during the practical lesson and were supposed to be handling the apparatus themselves, lack of adequate number of equipment might prevent some learners from actively participating during the practical lessons.

The Namibian Senior Secondary Certificate for Ordinary Level Biology Syllabus (Ministry of Education, 2011, 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 there are materials to be handled 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 they might not be able to learn how to handle the apparatus when doing practicals. There is also a need for a different approach to timetabling in Secondary Schools so that not all teachers and learners are in the laboratory at the same time. Such a situation makes it impossible to carry out effective practical work.

The results in this section show that most secondary schools in the Oshana Education Region did not have well stocked laboratories. Furthermore, the laboratories did not have enough resources for conducting practicals. These findings are similar to those by Maboyi and Dekkers (2017) who found that almost all the Natural Science and Health Education teachers in their study in South Africa preferred teacher demonstrations because of lack of laboratories, materials and laboratory equipment.

2. Availability of teacher resources for conducting practicals in Biology

When asked whether learners had a practical manual, all 23 Biology teachers responded "no". From the teachers' responses, it was clear that learners did not use a practical manual when conducting practicals in Biology. The practical manual was supposed to be compiled by the teachers themselves for the learners to use as a guide during practical lessons. Teachers were then asked to state what they used as a practical guide when carrying out practicals in Biology. Their responses are presented in Table 4.

Table 4: What teachers use as a practical guide for conducting practical work in Biology (N=23)

Guide for conducting practicals	Frequency	Percentage
Teacher prepared handouts for a specific experiment	9	39.13
Procedures are written on the chalkboard	5	21.74
The teacher explains and demonstrates to the learners how to do the experiment	2	8.7
Used the textbook	7	30.43
Total	**23**	**100**

From Table 4, 39.13% of the teachers responded that they prepared handouts for the specific experiments as a guide during the practicals, while 30.43% of the teachers said that they used a textbook as a guide when conducting practical work. About 22% of the teachers on the other hand responded that they wrote procedures on the chalkboard for their learners to copy and follow them. The remaining 8.7% said that they just explained verbally and demonstrated to their learners in order to show them how to do the experiments. If learners are not given a practical manual, they might not consider practicals to be important in the learning of Science. 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, hence waste the time that they are supposed to use in order 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 textbooks. The other problem with using the textbooks might be that the textbooks might not be enough for all learners, as most secondary schools do not usually have enough textbooks for all the learners to use as a guide during the practical lesson.

On the question of what effect, class size had on doing practicals, seven (30.4%) of the teachers said that their classes were too large to out practicals. The common response was usually. "Since the classes had too many learners, a teacher was not able to control all of them and one could not allow all of them to use the apparatus". Ten (43.5%) of the teachers said that, "materials were in a short supply and therefore was not enough for every learner, forcing the teacher to demonstrate only". Three (13.1%) of the teachers on the other hand said that, "teachers were not able to reach to all the learners which made some learners not to participate". The remaining three (13.1%) of the teachers said that, "some learners were not able to observe when the teacher was demonstrating because they were sitting far". If classes are overcrowded, this might prevent teachers from carrying out practicals with their learners.

Teachers might be forced to demonstrate only instead of allowing all learners to use the apparatus during the practical lesson. If classes are overcrowded, materials for conducting practicals might not be enough and this might have a negative effect on the performance of learners in Paper 3. Learners were supposed to be assessed at the end of the practical lessons in order to determine whether they had understood the practicals. The Biology teachers were asked how they assessed their learners at the end of the practical lesson. Their responses are shown in Table 5.

Table 5: How learners are assessed at the end of the practical lesson (N=23)

Type of assessment	**Frequency**	**Percentage**
Handed in post laboratory answers and these are marked	10	43.47
Gives them a quiz based on the practical done	4	17.39
No assessment done on practicals	6	26.09
Marked their laboratory reports and post laboratory Answers	3	13.04
Total	**23**	**99.99***

*Does not equal to 100 due to rounding off

Table 5 shows that 10 (43.47%) of the teachers allowed their learners to hand in post laboratory answers for assessment at the end of the practical, while six (26.09%) of the teachers responded that they did not do any assessment of their learners when it came to practicals. Four (17.39%) of the teachers said that they just gave quizzes to their learners which were based on the practicals done at the end of the practical, while the remaining three (13.04%) indicated that they allowed their learners to hand in a laboratory report and post laboratory answers and then marked those at the end of the practicals. These learners are required to write Paper 3 at the end of

the year. The question is, how do teachers prepare their learners to answer questions in Paper 3 if they do not assess them during or at the end of the practical lessons? Assessing practical work ensures that it remains an important part of the science curriculum, and it also ensures that practical work remained at the heart of the science curriculum (Millar, Le Marechals, & Tiberghien, 2011).

Learners should be assessed during the practical lessons. This is the only way that teachers could find out whether their learners have understood what was being done during the practical lessons. Assessing learners during the practical lesson will also make learners put in more effort in doing the practicals because they know that they are going to hand in something for marking. Practical assessment gives learners an opportunity to show case acquired knowledge and skills during practical work (Millar et al., 2011). If learners know that they are not going to hand in anything for marking at the end of the practical lesson, they might not put in any effort in doing the practical work, which will in turn prevent them from participating fully in the practical lesson.

Conclusion

This study found that most secondary schools in Oshana education region did not have a laboratory specifically for conducting Biology practicals and that most of the laboratories used by the Biology teachers did not have enough apparatus and equipment as indicated by 61.9% of the respondents. Some of the laboratories had expired chemicals and thus could not be used for practicals as indicated by 28.6% of the teachers. It is apparent from these results that the lack of laboratories, equipment, apparatus and chemicals made it difficult for Biology teachers to conduct practicals. This might be one of the reasons why learners performed poorly on Paper 3.

The study further found that most secondary schools in Oshana education region did not have sufficient materials for conducting practicals in Biology. This might prevent teachers from carrying out all the practicals that were stipulated in the syllabus which in turn might disadvantage learners on the Alternative to Practical Work examination paper. Further, the study found that there was only enough equipment for teachers to do practical work and that the equipment was not enough for all the learners to use during the practical lessons. It can also be concluded from the findings of this study that both teachers and learners did not have Biology practical manuals to guide the conduct of practicals. Without a practical guide for both the teachers and the learners, learners might not take practicals seriously and this might affect their performance on Paper 3. Furthermore, the study found that learners were not assessed at the end of the practical lessons, to determine whether they had understood the practical and to familiarise the learners with the question format in Paper 3. This might have adverse impact on learners' performance on Paper 3. In conclusion not all schools in the Oshana education region had laboratories for conducting practical work in Biology.

Recommendations

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

1. Ministry of Education

There is need for the Ministry of Education to budget money for building Biology laboratories at secondary schools. The Ministry of Education should also budget money for buying the apparatus and the equipment that will be used by both teachers and learners during practical lessons.

2. Biology teachers

The Biology teachers should borrow materials from neighbouring schools for conducting practicals in Biology if they lack these at their schools. Biology teachers 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.

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