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AN EXPLORATION OF TEACHER AND SCHOOL CAPACITY TO DELIVER PRACTICALS AT O-LEVEL UNDER THE NEW CURRICULUM FOR SCIENCE SUBJECTS

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APPROVAL FORM

The undersigned certify that they have read and recommended to Midlands State University For acceptance a research project entitled:

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DEDICATION

This paper is dedicated to nobody.

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I would like to acknowledge the Lord Jesus Christ for sending all the help he sent my way to see this project through. From giving me this topic, strengthening my supervisor to guide me, allowing the school the research was done to willingly assist me, giving me the research respondents who gave me the results I analysed, letting people lend me their vehicles during data collection, paying my school fees and all other expenses as well as keeping me in good health among others.

ABSTRACT

The purpose of this study was to explore teacher and school capacity to deliver practicals under the new curriculum for science subjects in Zimbabwe. The study was carried out on a single school in the Midlands Province capital of Gweru in the Lower Gweru area. The main areas under study where teacher and school ability to effectively deliver practical lessons in O-level science under the new curriculum. The other area of study was on the challenges being faced by teachers to effectively incorporate O-level science practicals into the time table in harmony with other subjects. Results were obtained through the use of the questionnaire, interview and observation check list. The principal findings of the research showed that teacher qualification and the type of institute that trained the teacher had a significant impact on teacher ability to deliver practicals. Further findings also revealed that the type of subjects a teacher sat for at O-level had a significant impact on the subjects they would be willing to teach comfortably under the new science curriculum. From the study it was found that though some teachers were doing practicals, this practical work was only done by way of teacher demonstrations with reasons being lack of adequate time on the timetable as well as lack of lab apparatus for the large O-level classes averaging fifty five pupils to use. Looking at the status of the school it was seen that lack of lab apparatus, water sources and stools in relation to class size would significantly affect practical lessons with increased risks of accidents and poor completion rates if learners were grouped. From the findings above it was concluded that the school should have adequately trained teachers for each level, lab apparatus should be sourced while new labs are built, repaired or upgraded where necessary. Failure to do so would see the average public examination science pass rates of the school likely to fall.

Table of Contents

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER ONE: THE RESEARCH PROBLEM

1.0 Introduction

In order for schools to produce results of high quality, there is need to consider a schools capacity to deliver the intended results as well as the teacher's ability in regards to meeting the goals of the school and the syllabus. Such considerations will assist in avoiding negative feedback/strife between the school and grievances from its teachers or the school and its teachers both (non-verbally) resisting to implement the proposed changes by curriculum planners. This study aims to explore the feasibility of introducing practical subjects at ordinary level instead of continuing with the alternative to practical paper which has been written in the past for intergrated science, O-level biology and physical science while practicals were reserved for pure chemistry and physics at O-level. The study will address issues associated with such changes to Zimbabwe's science curricula. This chapter will focus on the background to the study, statement of the problem, delimitations and limitations of the study among others.

1.1 Background to the study

As a student teacher at Lower Gweru Adventist High School (LOGAHS), the researcher was alarmed by the dismal performance of A-level students in Biology. This poor performance amidst the widely speculated high pass rates of missionary schools drove the teacher to consider the impact that the new curriculum had on the students (Mugove, 2015; Mswazie, 2018). The class of 2017 was the first class to be exposed to the new curriculum content which was totally different from what previous classes were exposed to. The introduction of tasks to science learners amidst other factors that could have led to the poor performance of learners led the teacher to do an investigation on the ability of teachers and schools to take on the task of administering practical subjects at O-level given that the A-level learners have practical slots slated into their time table but still performed poorly (Mandina, 2012; Bennet, 2007; Dekeza, 2017).

The dawn of the new science curriculum came about after the realisation that under the old curriculum, learners were not taught to be entrepreneurs but to be skilled labourers in an economy that was failing to accommodate all the graduates the tertiary institutions were producing (Dekeza, 2017). The result of this was that it created competition for the few available jobs that were available on the market and at the same time creating an exodus of trained personnel out of the country heading to develop other nations that could offer job security (Anganoo, 2014; Sinyolo, 2012). This led to the country's former minister of education Dr Lazarus Dokora to propose a change to the old curriculum through the idea of STEM in 2016.

STEM is an acronym which stands for Science Technology Engineering and Mathematics (Dekeza, 2017). On these four words lay down the foundation blocks of the new science curriculum which is now in operation since 2017 where the first group of students have already written their public examinations. The STEM campaign since it was mostly a science oriented campaign began to provide scholarships for learners to pursue science subjects at A-level and this sponsorship is supposed to have lured/forced non-science students into science areas which they could not tread on. Such an occurrence has led some scholars to speculate that poor results are due to poorly implemented interventions in education and not on the teachers (Alvarez, 2008; Zhang, 2008).

The second thing that the STEM campaign brought about was an emphasis on increased science teacher training to fill in the void in schools that could be a hindrance to the STEM campaign as it was noted that there was a shortage of science teachers in Zimbabwe. Again, in emphasising teacher recruitment without much emphasis on STEM training for in-service teachers again meant that the nation acknowledged that in-service teachers were already competent enough to teach the STEM curriculum (Zhang, 2008). Again, with such assertions other scholars have been led to look at the problems of a lack of technological support in implementing the STEM curriculum (Zindi and Ruparanganda, 2012).

Therefore, it is in-light of the above speculations and others that have led to the exploration on the effect the changes in the curriculum have on the learners and teachers. The gaps have been in the following areas in that very little is being said about teacher capacity to deliver content under the new curriculum. Though studies have been done that mention the weaknesses of schools in dealing with science practicals, very few of them have been done after the implementation of the new curriculum to highlight any gaps in school ability to meet the requirements of the new curriculum among which include practical delivery (Mandina, 2012; Bhukuvhani *et al*, 2012; Ewing, 2017).

1.2 Statement of the problem

As seen from the background to the problem, it is unclear for the most part as to the exact cause of low pass rates in science. Under the old curriculum where the practical paper was not compulsory for O-level, pass rates were still low in intergrated and physical science and it is unclear how the new curriculum with its compulsory practical paper will be taught to learners by the old curriculum oriented teachers. Due to this lack of clarity on the future of learners it is a danger to adopt the new science curriculum without taking note of and addressing the mistakes of the old curriculum in the new curriculum among which include inadequate infrastructure, unqualified teachers and under staffing. Therefore it is in the interests of the researcher to identify how teacher quality and school ability have an influence on the overall performance of learners in the new science curriculum.

1.3 Research objectives

1.3.1 Major research objective

i) What impact does teacher training have on effective administration of science practicals?

1.3.2 Sub research objectives

ii) What impact does availability of school resources have on science practicals?

iii) What challenges are schools facing incorporating science practicals in harmony with other subjects in the school timetable?

iv) What strategies can be used to deal with the above mentioned problems?

1.4 Significance of the study

The study seeks to help the curriculum implementers from the curriculum development unit (CDU) to have an up to date understanding of how the teachers in the schools have managed to adopt the new science curriculum by highlighting the on the ground facts in the schools under study. The aim of this is that if there are any interventions deemed necessary by the CDU such as a delay in administration of the practical paper for a year or so as the teachers acclimatise to the new curriculum these can be done with an informed decision stemming from this research and others to follow.

Secondly, this publication seeks to be a source of reference for any school heads who might be having troubles in properly adjusting school resources to meet the goal of the school. For example if the head is coming from or has a non science teaching background they will be able to understand the limitations each teacher has in teaching certain classes/science subjects which might be the cause for low pass rates at the school in science. Such limitations being largely dependant on the subjects the teacher sat for at O-level and the kind of intake or training they received at tertiary level. Though such a problem might not exist for headmasters of adequately staffed schools who will receive such information on teacher quality from the Heads Of Department (HOD), it is mostly the smaller understaffed school heads that might find use for the information especially where the science department is run by a single teacher.

Thirdly, this study seeks to be used as a template for convincing rural folk on the need for the community to build school labs for their children after explaining to them what the new curriculum is, the gaps the curriculum seeks to cover and what it means for their children given the current state of rural school labs with regards to science education. In doing so, this study would have undone/minimised the likely arguments School Development Associations (SDA) would go through when suggesting fundraising activities to build, repair or upgrade school laboratories especially if parents were suspecting the association of abusing school funds.

Finally, this publication is of significance to the researcher as it is a means for the researcher to successfully complete his studies. So the material included in this study is of great importance to the researcher who was compelled to do a research in the area of his choice which was to be submitted in partial fulfilment of the post graduate diploma in education.

1.5 Delimitations of the study

The study is going to be carried out at LOGAHS in Gweru where the researcher has taught before and has friends who are science teachers in the school. The school is located 40km from the main central business district in Gweru and therefore the researcher will borrow a vehicle to travel with to the school and back in one day. Though the items the researcher will be focusing on are numerous and might take up some of the respondent’s time, the researcher is confident that the teacher’s attitudes can be contained especially with teachers who socialise with the researcher. Since the researcher did his student teaching at the school, confidence is therefore given that the researcher will have no problems getting approval from the school authorities to do the study. Finally, since the researcher is familiar with the people he is studying, the lab technician will have no reservations giving me the keys to the lab to successfully conduct observations and her absence will not hinder observations as keys can be secured from the senior teachers whom the researcher knows well. Though the researcher is familiar with the people at the site of study, there is a possibility of some teachers being available at the site for several reasons among which being they would be on leave the researcher will interview the teachers available on their behalf. The issue of biased responses in regards to teacher qualifications the researcher is at liberty to have assistance from his former/fellow workmates to remove such fears out of the minds of some of the respondents the researcher is not well versed with on a social level.

1.6 Limitations of the study

Teachers in schools are a mixture of trained and untrained science teachers, therefore there is a likelihood of untrained teachers forging their academic qualifications in fear of being plucked out of the service by the Public Service Commision as was done in 2015. So there is a likelihood of false responses in the questionnaire. Secondly some of the stuff might not be available in the day of the data collection because they are still yet to come from holiday or they have gone on leave as the research data will be collected in the second week of opening. Thirdly, absence of the lab technician who normally keeps keys for the labs might hinder observations as planned by the researcher. Fourthly some respondents might feel the process is too time consuming and might be in a hurry to finish interviews or questionnaires. Finally school authorities may be reluctant in giving out details on the inventory of available lab apparatus left at the school in fear of uncertainty associated with either theft of lab apparatus or breakage of equipment donated by UNICEF (United Nations International Children's Education Fund) prior to the implementation of the new curriculum.

1.7 Definition of key terms

The following are definitions of terms used in the chapter and may be found occurring again in the following chapters.

Practical

A hands on manipulation of lab apparatus or other physical things in learning that is used as a high level instructional tool to help learners deal with abstract concepts (MerriamWebster, 2018).

STEM

An acronym standing for Science Technology Education Mathematics (Dekeza, 2017).

School lab technician

An assistant who has technical skill or know how in dealing with a certain area of expertise (MerriamWebster, 2018). The technician is mostly confined but not entirely restricted to laboratory preparation of reagents and preparation of work areas for practicals.

O-level

These are ordinary level public examinations set for in Zimbabwe by form 4 (grade 11) students.

1.8 Summary

The main purpose of this chapter was to answer the questions associated with the purpose for doing this research using the support of the available literature gaps. This chapter was also to assist in explaining the key terms that shall be used in the study to assist other scholars to interpret the language being used by the researcher if they are not familiar with it. Using the background to the study and significance of the study among others this chapter has also served to highlight the boundaries that this research is limited to in an effort to offer readers an idea of what to expect in the following chapters. In chapter two literature review that will be guided by the research questions contained in this study shall be availed to further on highlight the significance of the study.

CHAPTER TWO: REVIEW OF RELATED LITERATURE

2.0 Introduction

This chapter will be looking on related literature that is associated with research work that has been done so far regarding the new science curriculum in Zimbabwe and other countries. Using this scholarly work this chapter seeks to bring about an understanding of the current brand of science teacher out there and the differences between these teachers which will result in them being ranked differently with regards to content mastery and delivery. The ability of teachers to deal with the proposed instructional technologies suggested by the science curriculum and ways on how to improve content delivery by subject specialists shall be explained using related literature from other scholarly studies.

2.1 What impact does teacher training have on effective administration of science practicals?

2.1.1 Qualified and unqualified teachers in Zimbabwe

With regards to teachers researchers have focused on several points of reference among which include teacher personality traits, attitudes or values in relation to student achievement (Alvarez, 2008). Others focus on the previous academic performance of the students (Grade seven in this case) in their defence for poor pass rates further up while others have argued that teacher quality is a powerful predictor of student performance (Alvarez, 2008). According to ZIMSTAT (2013), Zimbabwe currently has nineteen percent untrained teachers and eighty one percent trained teachers. The number of untrained teachers makes up about a fifth of the teaching population as a result of the mass exodus by teachers from the teaching profession in the 2007 – 2008 economic decline and also due to a decrease in the number of teachers who are training to teach science (Anganoo, 2014; Sinyolo, 2012). The problem of untrained teachers at secondary level in the area of science presents the problem of reduced explanations or skipping of topics which the teacher is not well versed in (Cinkir & Kurum, 2013). Secondly, because most science teachers did biology, Intergrated science and physical science at O-level, therefore it becomes difficult for a teacher who is science competent to teach agriculture when staffed there due to shortages of agriculture teachers or the current freezing of posts by the public service commission (PSC) (Zhang, 2008).

Looking at qualified teachers in science, their level of academic achievement is dependant on two factors which are, the year they trained and whether or not they went back to school after graduating. Therefore this means that the qualified teaching staff is made up of science teachers who have certificates in teaching, diplomas, degrees and masters degrees (UNESCO, 2001). According to Zhang (2008), science teachers with advanced degrees moulded their students more positively irrespective of their years in the teaching practice. Unlike in times past where there were very few schools offering the practical paper at O-level science, times have changed leading to ZIMSEC under the new curriculum to implement a practical paper at O-level science. Therefore this means that teachers with a certificate and in most cases a diploma for science teaching now become disadvantaged when it comes to practical competency (Zhang, 2008).

This information will help in establishing whether the current science pass rates are due to teacher competency (in the event of many unqualified teachers) or due to infrastructure availability.

2.1.2 Science teacher training in Zimbabwe

According to UNESCO (2001), in Zimbabwe teacher training is now being offered by several tertiary institutes such as teachers colleges among them Hillside in Bulawayo, Belvedere in Harare, University of Zimbabwe and Midlands State University (Mhishi *et al*, 2012). The entry requirements for entry into the program of choice vary depending on which tertiary institute is conducting the training. For teacher colleges with regards to science two kinds of intakes are on offer, which are post O-level and post A-level. For post O-level only O-level results are required with a good pass in the subject of interest while for post A-level it is the same save for the fact that they will be considering passes at A-level in the preferred subject of choice (UNESCO, 2001). For University training intake is mostly by way of A-level results or diplomas for mature students who are already in service (Mhishi *et al*, 2012). The third access point into teaching at universities is by way of an undergraduate degree into the post graduate diploma in education course.

Using all these entry points into teaching, the resultant graduates of these programs are the ones that are making the bulk of the qualified teachers available in Zimbabwean schools at the moment (ZIMSTAT, 2013). Comparing the two kinds of graduates from teacher colleges and universities, Zhang (2008) states that the university graduate has a more in depth understanding of theory and practice in comparison to the college student because of the extra years in academics done by the former before deployment. Considering the total number of years for each program, college students do three years training for the post O-level course and two years training for the post A-level course before being deployed (UNESCO, 2001). The university students do four years for the undergraduate degree program if they are coming straight from A-level and three years if they are coming by means of the mature intake. For students under the postgraduate diploma in education, the total number of years they take in training can be considered as five years in total, though the first four years may not be related to education as most of them pursue education as an after-thought.

Given these circumstances, the teaching profession has a lot of teachers from colleges than from universities as colleges are more numerous than universities and thus give a high output trained in one area while universities tend to give outputs in several disciplines (Costley, 2015). Therefore from the above mentioned trend of teacher training in Zimbabwe it puts other teachers at a disadvantage in science teaching in comparison to others (Zhang, 2008). Taking the example of a teacher who graduated in the 1980's and has a certificate that they obtained using O-level and you compare them to a teacher who graduated in the 2000's and has a degree and an extra four years of training over the former, the latter is more versatile in executing practical work than the former due to a rich theory base to rely on (Mhishi *et al*, 2012). Therefore this is a factor that can lead to a reduced or delayed interpretation and implementation of the new science curriculum by the two kinds of teachers mentioned above (Zhang, 2008).

This information will help in forming up a category as to the kind of training (degree/diploma) that the teachers had to establish how many years of practical experience are they likely to have had.

2.1.3 Teacher qualification and science subject competency

According to Zhang (2008), depending on the qualification the above trained teacher has, it is the one that will determine which subject the teacher can teach. For example, a teacher who entered into a college using post O-level qualifications cannot teach A-level subjects under normal circumstances. Similarly, a post A-level teacher trained to teach chemistry at O and A level cannot teach any other subjects than the ones he/she learnt at A-level. Therefore, according to (Cinkir & Kurum, 2013), this means that a post A-level teacher with maths, biology and chemistry as their A-level subjects cannot jump over and teach agriculture at A-level though it is a science subject. However, unlike the post A-level teacher, a post graduate diploma in education holder who has maths, biology and chemistry at A- level and was trained to teach chemistry up to A-level (as was the case with the post A-level teacher) can teach agriculture at A-level provided that he/she did an agriculture first degree or its equivalent (Mukweredzi, 2016).

Given the above scenario, this means that in an education setup, the post O-level teacher is less versatile in comparison to a post A-level teacher who is also less versatile to a postgraduate diploma in education holder. Therefore this means that delegating an A-level load to a post O-level teacher may have disastrous consequences on the part of the learner with more regards to practicals that the learners cannot educate themselves in for the most part.

Also looking at subject competency with regards to untrained teachers in Zimbabwe, puts untrained teachers at a somehow disadvantage in comparison to even the lowest trained teacher mentioned above (post O-level) (Mukweredzi, 2016). According to (Mhishi *et al*, 2012) this is due to the fact that this teacher does not have a teaching background/theory on how to deal with learners. This absence of teaching theory makes them fail to appreciate the various teaching methods to use on learners and how to plan practical sessions with the learners as well as drafting realistic/achievable schemes for learners (Zhang, 2008). This is so because this teacher has never gone on teaching practice and therefore has not been fully exposed to the variables associated with teaching such as interference by sports, meetings or other and how to cover up for the lost lessons under a mentor (UNESCO, 2001). Lack of familiarity to these problems that can arise causes a larger back log of work on the part of the untrained teacher without a mentor.

Secondly, though at this point in time most untrained teachers are degree holders, with regards to science teaching they don't have much science practical foundation that is offered in the applied subjects learnt by all trained teachers before deployment (Mhishi *et al*, 2012). Therefore, classroom control and later on demonstrating of a practical session even planning one from the level of designing it, carrying it out and recording the results might be difficult. For example, a teacher who did computer science during his/her first non teaching degree being asked to teach A-level/O-level chemistry is impossible given the fact that prior to the new curriculum, science practicals at O-level were not a must therefore this teacher may have no mastery of practicals at O-level save for theory only (Zhang, 2008; Mukweredzi, 2016).

This information will help to craft out adequate questions in the research instruments to establish how the respondents feel about taking on particular subjects under the new curriculum, for example asking a former intergrated science teacher how they feel towards combined science.

2.1.4 Understaffed schools and science teaching

Most Zimbabwean schools are understaffed with teachers having to deal with many students in one go. The current teacher to pupil ratio in Zimbabwe according to ZIMSTAT (2013) was 1:24 in 2005 further lowering down to 1.22 in 2012. Though it can be seen according to Madanire (2016) that this is an incorrect reading in most rural setups where this ratio even reaches a 1:40 and from my own experience in the schools I have taught an average of a 1:50. All these are factors that affect the teaching of science in the sense that, a high school that has one science teacher to take form 1 – 4 in combined science may have a large load such that the time he/she has left for marking becomes too little let alone not mentioning practical sessions and their write ups (Dlakama, 2015). The problem now becomes amplified when the very same teacher is expected to teach biology and chemistry at the same school to cater for the more intellectual students. Such a scenario on its own can cause the science teacher to be occupied with the O-level classes alone while the form 2 and 1 classes have no teacher or have been given over to a non-science teacher for the time being (Chiparange, 2016; Dlakama, 2015). It is the allocation of these classes to a non-science teacher that causes problems. A teacher who was trained in languages who is given the science class cannot teach the class to perfection considering that he/she is not well versed in science let alone the practical load that the new curriculum demands on a weekly basis (Ngwenya, 2015).

According to Zhang (2008), a second case to the understaffing of science teachers at a school is when a situation arises whereby the above mentioned school has two post O-level teachers trained to teach combined science and biology. If a vacancy arises in O-level physics or chemistry which are both science subjects which the available teachers are assumed to be able to teach while in reality they know nothing about these subjects let alone their practical content, puts the learners at a disadvantage already in comparison to adequately staffed schools (Zhang, 2008). Such cases that are already happening in schools are the very reason as to why the new curriculum science subjects might take the teachers a long time to adjust to with a need for redeployment in certain cases due to teacher qualifications and contentment (Ngwenya, 2015).

This information will help to look at whether or not the number of teachers at the school is adequate for the students in order to ascertain whether the probem is solely on human resources, infrastructure or both.

2.1.5 The new science curriculum and science teaching

According to Dekeza (2017), the new science curriculum was brought about in response to the economic decline of Zimbabwe. Therefore this is the reason why there has been much emphasis placed on practical subjects in the new curriculum Dekeza (2017). However under the old curriculum, though the practicals were instructed to be taught, Banu (2011) notes that the teachers would not teach them anyway or gave them low priority as they could be taught in theory and written in the alternative to practical. The alternative to practical was solely based on theory thus allowing science teachers of the old curriculum to hide behind that fact and not conduct practicals at O-level physical science, biology and intergrated science.

However, under the new curriculum the alternative to practical paper has been removed, intergrated science is now taught as combined science while the content for physical science has been moved to pure sciences like chemistry and physics. It is in light of these changes that the same things teachers used to ignore (science practicals) due to understaffing have come back re-packaged under the new curriculum and can no longer be ignored (Dlakama, 2015). The problem associated with this gap is that in most cases when teachers are grieved and do not have somewhere where the problem can be addressed is that, the learners take the fall and society will not remember nor consider that fall in the learners academic pursuits (Cinkir & Kurum, 2013).

Secondly, apart from the introduction of the practical paper, the new curriculum has added new content to the combined science paper (formally known as intergrated science). Most of this content is of chemistry origins and was not found in the intergrated science syllabus such as chemical bonding and electronic configuration. The challenge this presents in science teaching is that combined science is the merging together of three science subjects namely biology, chemistry and physics. In the old curriculum for intergrated science it was still the same three subjects intergrated together to give one. However the difference between these is that under intergrated science, the teachers (both new and old) were teaching content they had covered in their academic years at school as the syllabi never changed for the most part. The problem that the new curriculum has caused by adding concepts such as chemical bonding disadvantages the post O-level teacher who did intergrated science alone and was teaching intergrated science (Zhang, 2008). This is so because the teacher is not well versed with this content as it was taught in physical science which he/she did not do. Again this disadvantages the learners especially if such a teacher is asked to work on an O-level class where these concepts where introduced (Jokiranta, 2014; Bhukuvhani *et al*, 2012).

Thirdly, the new curriculum has also introduced practicals for subjects such as geography, these practicals now put added pressure for laboratory occupation as well as slotting in the times for practicals. In a school which has fewer science labs this creates problems in successfully executing all the practicals for geography and other science subjects and not to mention the extra pressure put on the lab technicians as well if schools don't adjust accordingly by hiring extra technicians where necessary (Mandina, 2012).

Lastly, the new curriculum has introduced more emphasis in subjects such as physical education (PE) which also fall under science where learners are supposed to do mass displays and other forms of physical activity. Though this does not impact most teachers as PE has its own subject specialists who are available in some cases, the problem is in the first term and other terms to come, PE takes up space for practical lessons in the afternoon hours even after inter house sports as learners still have to attend PE to prepare for other sporting activities scheduled for that term.

This information will help the researcher to look into how the school is coping with slots (if any) for O-level practical requirements in as far as the timetable is concerned.

2.1.6 Instructional media for science in the new curriculum

Traditionally the chalk board has been used as the instructional media of choice over the years. It is the most widely available method of instruction for learners in most schools. The chalk board has its own advantages such as it is a low cost piece of tool for a school to own and it is familiar for most teachers to use. However, in the new curriculum there is a lot of emphasis on the use of computers and computer based methods of instruction (Dekeza, 2017). According to the ZIMSEC Combined Science syllabus (2017), simulations of practical experiments and videos are needed to relay abstract concepts on how things are made as well as the use of Jaws (software for the visually impaired). The strong emphasis on the use of computer based software is what is responsible for the increased interest of introducing e-learning facilities in schools (Dekeza, 2017; Bennet, 2007). However, though all these are useful tools for use in schools, they somehow disadvantage the learners not only with regards to their expensive nature but also regarding teacher competence with regards to using such types of computer based software (Lizer, 2013).

2.2 What impact does availability of school resources have on science practicals

2.2.1 School and teacher ability to use the proposed instructional media.

Most teachers who never went back to school for further studies in the years after 2004 may not be well versed with using computers and computer based software as they are not computer literate due to in-exposure of doing assignments by computer (Bennet, 2007; Mhishi *et al*, 2012). The most recent teacher graduates from tertiary institutions are more at a competitive advantage in using computer based instructional packages/tools in the form of overhead projectors and blue tooth speakers to deliver science lessons (Zhang, 2008). However, though the old and new teachers can be tutored in a very short space of time to use this kind of teaching material, the same cannot be said about a schools capacity to aquire these computer based instructional tools (Zindi & Ruparanganda, 2012).

A new acer projector is costing on average $750 while laptops are costing $400 on average. For urban schools this bill can be footed, however for rural schools such an investment may be difficult to embark on without external funding outside of the school (Kelvin, 2015). The emphasis on projectors or computer based software is that in the case where apparatus are insufficient, virtual experiments can be shown to learners while the school sorts out the apparatus shortage at the school. Secondly the acquisition of these computer based tools brings an issue of further expenses in securing the labs for these tools as well as the need for internet services where the teachers can access the proposed teaching materials (Lizer, 2013). All these sound like a far cry for the new curriculum that is already in place but the above said resources being absent from most rural schools will put the rural student at a competitive disadvantage come examination time (Mandina, 2012; Kelvin, 2015).

Since each school will have to use at various points in their lessons these tools, it is necessary for schools to have a fixed supply of electricity and a school computer(s) which will be used for this very purpose (Zindi & Ruparanganda, 2012). According to Dekeza (2017) the new curriculum is seeking to bring exposure to learners of all walks of life to the kind of practical work done in schools of developed countries, the schools however may fail to meet the desired outcome in the early years of curriculum implementation due to lack of resources.

2.2.2 Apparatus, reagents and science practicals

Under normal circumstances, each student should have their own apparatus during practical experiments in preparation for the exam (Jokiranta, 2014; Banu, 2011; Bhukuvhani *et al*, 2012). It is necessary to give the learner a space of about two square meters work area in order that should any mishaps happen the chances of it hurting another student are minimal. Therefore this calls for a school laboratory that is spacious. According to ZIMSTAT (2013) the acceptable teacher to student ratio for a successful practical should be 1:25 in which the teacher has free mobility to interact with each student and making note of progress and any areas of weakness. The concept of grouping learners together in groups results in one learner being dominated by others such that during the experiment the other learner is not participating. So grouping of learners has to be avoided when conducting science practicals, though for most rural schools this is far from being practical due to lack of adequate and sufficient laboratories (Mandina, 2012).

Depending on the setup in which the practicals are being done, sometimes the laboratory technician may take over the class through the whole practical during practical sessions and then hand them over to the teacher during theory sessions. However the most common practice in most Zimbabwean schools is for the lab technician to make reagents, prepare a batch of clean apparatus for the learners to use as the practical commences and then later on clean the equipment after the practical. So in the last scenario the bulk of the teaching work is done by the teacher while the cleaning and preparation of reagents is done by the lab technician.

2.3 What challenges are schools facing in incorporating science practicals in harmony with other subjects in the school timetable?

2.3.1 The school timetable and practical slots for O-level science

The A-level science classes have their own timetable that has four period lessons weekly whereby practicals can be effectively administered each week if needs be, however it is not the same case with the O-level classes. O-level science classes have only six periods per week with each lesson being two periods long. For a successful planning and execution of practical work, there is need for more than an hour with each class of students and before that hour commences all apparatus and reagents should be in place (Ewing, 2017). Also while the practical commences, time should be put in place for the cleaning and storing away of lab apparatus afterwards. Several factors come into play when considering practical slots for O-level science, firstly whether the school has a laboratory technician to prepare the reagents and apparatus needed for the practical (Dekeza, 2017; Bennet, 2007). Secondly, if it is a practical that needs the use of burners, the type that is available also is considered as spirit burners are slower than gas burners in heating or boiling stuff. Finally, the last factor is availability of resource personnel (teachers) to supervise and conduct the practical session (Mandina, 2012; Dekeza, 2017).

If there are no laboratory technicians then this puts the burden on the teachers to prepare the reagents and also if these very same teachers are fewer in number such that they cannot share the load amongst themselves then this can lead to no practical work being done (Ngwenya, 2015). The end result of such an occurrence is that the students will be the ones at a disadvantage as certain practicals will be skipped and taught in a manner that is similar to the alternative to practical test (Bhukuvhani *et al*, 2012).

As is the case in most cases where the class size is too big for the teacher to handle a practical with, the class is split leaving others in class while others are doing the practical. However the major setback with doing this is that there is a need to keep the learners occupied while at the classroom which means more work for the teacher to plan for. Though this could be an alternative route in addressing the two period lesson slots for science, it may not be favoured by teachers as it gives them more work to deal with on top of the practical write up that is expected from every student (Ngwenya, 2015).

This literature will help in obtaining answers from teachers who would be doing practicals to ascertain whether they are doing them under individual, group or teacher demonstration in order to ascertain the exposure to the concepts each student will get.

2.4 What strategies can be used to deal with the above mentioned problems

2.4.1 Staff training

According to Zhang (2008) and Kelvin (2015) the training of school teachers by the Ministry Of Primary and Secondary Education (MOPSE) will help teachers to improve on their knowledge base and increase their versatility in so much that on average a secondary school teacher should be able to teach up to A-level in the subject area of their choice. Computer literacy tutorials can be done at the school by the school computer teacher so that the teachers who began teaching before the computer era also have a chance to use computers in typing lesson plans or other (Zindi & Ruparanganda, 2012). This in the long run will help the teachers to be able to use other computer peripherals such as projectors and bluetooth speakers as the teachers are now familiar with using these gadgets.

School laboratory technicians need to be trained adequately to be able to support teachers in teaching of practicals instead of having their participation being mostly limited to preparation of reagents and setting up of apparatus (Alvarez, 2008). The curriculum development unit from Harare can arrange continued awareness programs through workshops in which they assist school administrators on how to plan practical sessions for large classes in order to cut out the time taken by school authorities in considering how to fit in the practical lessons (Ewing, 2017).

2.4.2 Supplying resources

According to Mandina (2012), teachers need adequate resources from the MOPSE or from the school to be able to access content from the textbooks and the internet to deliver to the learners in order to maximise content delivery to the learners. Secondly, since the new curriculum also emphasises the use of computer based tools, the teachers/science department needs to be supplied with a computer(s) as well as projectors in order to conduct simulations of practicals in virtual laboratories or to deliver content of abstract topics by way of audio visual teaching media (Zindi & Ruparanganda, 2012).

Thirdly, since the largest disadvantaged population are rural schools which in some cases may not have electricity reaching the schools, there is need to improvise using solar panels, batteries and invertors to tap into the solar energy in order to power the projectors, run the internet as well as charge the laptops or power the computers (Mukweredzi, 2016; Kelvin, 2015; Mandina, 2012; Lizer, 2013). This literature will help question or advocate for the use of audiovisual equipment under the recommendations for the school.

2.4.3 Staffing of teachers

Though the Public Service Commission (PSC) is trying to minimise the government wage bill but with regards to the new curriculum there is need to deploy qualified science teachers to help share the load with the already existing teachers (Cinkir & Kurum, 2013; Zhang, 2008). The problem of not doing so will cause a burn out among the already existing teachers leading to poor content delivery in the long run as teachers struggle to handle the load of theory and practice without much assistance in sharing the classes in some cases (Ngwenya, 2015; Dlakama, 2015).

This information will help to recommend if needs be (based on the findings of the study) if the school should hire teachers on its own via School Development Asssociations (SDA) or to wait for the PSC deployments.

2.4.4 Construction of or repairing damaged school laboratories

According to Mandina (2012) lack of adequate labs especially in rural schools brings about weaknesses in the competent delivery of science lessons. Lack of laboratories among rural schools has also been noted by Dekeza (2017) as a leading cause of poor practical activities in science lessons. It is in light of all this that Ngwenya (2015) and Dlakama (2015) note that if teachers are provided with modern work spaces to carry out their duties, this in a way motivates them to deliver to the learners the content they ought to deliver. Therefore there is need to build school laboratories in rural areas and to repair damaged gas pipes, stools and laboratory equipment.

2.5 Summary

This chapter gave literature supporting the research questions from chapter 1 and showing all the possible variables involved in administering practical work under the new curriculum for science. The following chapter will give details on the proposed plan of action to collect data, analysis, all the factors which will be considered in taking this data to answer the research questions that had associated literature availed in this chapter.

CHAPTER THREE: METHODOLOGY

3.0 Introduction

The chapter focuses on the research instruments, methodology, population size, data collection procedures as well as the target population used. It will give the plan for organising, analysing and presenting the gathered data as well as explaining the logic for the chosen research design.

3.1 Research design

According to De Vaus (2001) research design is an overall strategy considered when intergrating components of a study into a coherent logical way that ensures that the research problem is effectively addressed. The research design is a template that is dependant on the research problem that assists for the collecting, measuring and analysing of data. According to (Gorard, 2013; De Vaus, 2001) a research design ensures that evidence obtained allows you to appropriately address the research problem as unambiguously as possible. In social sciences, obtaining information regarding a problem involves among other things describing and assessing meaning related to an observable problem (Leedy & Ormrod, 2013). It is in this regard that several scholars among whom include Gorard (2013) and De Vaus (2001) suggest that the description on research design in a publication varies depending on the type of design being used and suggest reviewing literature on studies that have used a similar research design.

Among three kinds of research design that the researcher considered for use, the researcher chose the descriptive survey design after considering that it was the best design to address the problems of this study. The descriptive research design gives answers to the questions of who, what, when, where, and how associated with a particular research problem (Lisa, 2007). Since all of the study’s research questions asked the “what” question, this gave the descriptive design the first point for consideration. Secondly, a descriptive design cannot answer the "why" question on its own without relying on other research designs done by other scholars using among others an exploratory design to give reasons for observed problems. Also, some of the reviewed literature supporting content in this paper used this kind of design among which is the work of Ngwenya (2015) and Kelvin (2015). Then finally according to (Lisa, 2007) the descriptive design was chosen as it allows the observance of a subject in their natural/unchanged environment at their schools of practice in this case and likely to give more valid results unlike true experiments that tend to force subjects to change their behaviour.

The descriptive survey is going to be used, which refers to the type of research questions and design that will be applied to a given topic, in this case teacher and school ability to deliver O-level science practicals (Burke & Christensen, 2012). The descriptive survey involves research that concerns itself with present or current phenomenon such as conditions, practices, beliefs, relationships or trends. The descriptive survey design describes and interprets what is there allowing the use of a small group of people that will allow conclusions to be drawn to cover the generality of the whole group as will be the case in this study (Burke & Christensen, 2012).

This study is going to be a quantitative study as it seeks to present questions that ask about the relationship between two or more variables which are teacher and school ability to deliver practicals (just to mention a few) in this research. Secondly the research questions have been formulated in very specific terms to ensure that an understanding of the variables involved in the area of study is obtained from questions such as "What impact does availability of school resources have on science practicals" which make part of the research questions in this study (Burke & Christensen, 2012). Finally the research is going to be quantitative in the sense that it is going to measure parameters to gain an understanding of the variables associated with the research questions.

3.2 Population and Sample

According to Merriam Webster (2018) a population is the whole number of people or inhabitants in a country or region or the total of individuals occupying an area or making up a whole. A population can also be defined as the total number of persons inhabiting a country, city, or any district or area or the body of inhabitants of a place (dictionary.com, 2018). Using these definitions, Kazerooni (2001) further goes on to divide populations into two categories namely target population and study population.

According to Kazerooni (2001), target population refers to the whole group of individuals on which the interests of the study will draw up conclusions for while a study population is the group of individuals to which the conclusions of a study can be legitimately applied.

With these definitions in mind the researcher targets (target population) science teachers of rural Gweru for the study as they will most likely be at a disadvantage in as far as the teaching of practicals is concerned (Dekeza, 2017; Mukweredzi, 2016). The intention is to have a population (study population) of about thirteen science teachers including trained, untrained and student teachers from one school (LOGAHS) and one school head from the same school to provide details on, school science pass rates which will be used to relate the schools performance to available infrasture in the coming chapter.

According to Merriam Webster (2018) a sample is a representative part or a single item from a larger whole or a finite part of a statistical population whose properties are studied to gain information about the whole. A sample is also defined as a small part of anything or one of a number, intended to show the quality, style or nature of the whole specimen (Dictionary.com, 2018). Using the above definitions Kazerooni (2001) goes on to explain the reason for selecting a sample from a population as being that it reduces time and financial constraints while the study is being conducted.

The researcher used purposive sampling to select the site and the people that are supposed to be involved in the study (Lizer, 2013). This is so because given the several schools in the area under study, there was a need to narrow down the schools to one to allow the study to be completed in the designated time. The thirteen science teachers and the one head of the selected school (LOGAHS) will be considered all for the survey, as it is supposed that the population of the teachers will be small due to the workforce reduction done by the government in the past years and as a result of the 2007-2008 exodus of teachers to neighbouring countries (Anganoo, 2014; Sinyolo, 2012). The teachers will be grouped into the categories, the first being status (trained and untrained) while the second being number of years in service and the third being qualification (degree, diploma or certificate e.t.c). The other parameters to be appended to the teachers will be class/load size, available apparatus and reagents for practicals as well as lab capacity for practical work.

3.3 Research instruments

The research instruments that will be used include the questionnaires, interviews and observation check lists.

3.3.1 Questionnaires

To increase the accuracy of responses from the thirteen science teachers and one school head, the questionnaire is going to be used for all the teachers at the school involved in the study. The purpose of the questionnaire is to remove the need for the researcher to have to see the respondents face to face and talk to them as is the case with the interview. The researcher went to the school intending to give questionnaires to the fourteen respondents so that they could give their own perspectives and perceptions on the impact of curriculum changes in teaching and learning of science (Lizer, 2013). The questionnaires were aimed at probing the teacher’s attitudes and feelings towards the curriculum changes. With the questionnaire the researcher could not just leave them at the schools involved and come and take them at a later date because of time left to complete the study. This gives the respondents the chance to respond to the questions in a specific time to avoid biased responses emanating from delayed collection of the questionnaires.

The questionnaire was intended to answer to answer the major research question and the first sub research question. The advantages of questionnaires according to (Ngwenya, 2015; Kelvin, 2015) are, there is no face to face dialogue between the researcher and respondent therefore no feelings of intimidation can unsettle the respondent. They give respondents the chance to answer them in their own time without affecting the respondents work schedule. Once presented to the subjects the researcher can live them and then come and collect them at a convenient time. Since questionnaires need not the researchers presence, they can be mailed to remote schools via social media platforms such as whatsapp and teachers give their feedback on the same platform.

The disadvantages of questionnaires according to Ngwenya (2015) and Kelvin (2015) are, firstly there is a risk of respondents discussing with each other to try and give uniform, favourable answers so as to avoid giving the school a bad name. There is also a risk of loss/damage to the questionnaires if they are not collected as quickly as possible, Finally, interpretation to responses depends on the participants understanding with no room for explanations by the researcher who may not be around at the time of filling in the questionnaire (Lizer, 2013). In order to deal with these the researcher self administered the questionnaire to offer interpretations to the respondents where necessary.

3.3.2 Observations

The researcher also sought to use observations (where possible) of school infrastructure while out distributing the questionnaires and interacting with the respondents. The observation of infrastructure is convenient as this can be done with the assistance of the respondents especially when considering availability of science labs and electricity among others. The observations were guided by an observation check list which had a list of areas of interest. The checklist was used on the school laboratories as well as the school inventory of apparatus.

The observations sought to answer the first sub research question and according to Kawulich (2005), observations describe items, events and behaviours in the social setting chosen for study. Observations allow the use of the five senses to draw information needed for a study but at the same time calling upon the researcher's patience to wait for an observable item on the check list, and this is a major disadvantage during informal observations. The advantages of observations are they permit the checking of non-verbal feeling among subjects, gain an understanding on who interacts with who as well as noticing the availability or competition for resources among which include school furniture (Kawulich, 2005). The observation check list will look at areas such as number of labs available for use, number of taps per lab, number of work areas among others. The disadvantage of the list is that certain items of interest might become apparent while on the ground, so to combat this the researcher kept the check list open for such items that might be of interest but not listed on the list.

3.3.3 Interviews

According to Kawulich (2005), interviews are also a part of data collection. These interviews will be used to collect the attitudes of the school heads and head of department and other teachers regarding the new science curriculum (Kawulich, 2005). Of the teachers the researcher interviewed those who still had time after filling in the questionnaire to entertain more questions. However the HOD would be asked to participate fully as some of the responses given by him would be used to check against the responses given by the teachers in the questionnaires.

The teachers available for interview would be asked the interview questions during random chit chat as they mark their books or do other random chores pertaining to their work while the interviewer is guided by the interview guide. The interview seeks to address mainly the last two sub research questions to a greater extent and also partially sub research question one and the major research question. The problem with interviews is that they need the target respondents to be on site, however, if the respondents are not on site their deputies will be interviewed instead. If the deputies are not on site their nearest subordinates shall be interviewed. The advantage of self administered interviews is that all these changes can be factored in accordingly in the event of an abscence.

3.4 Data collection procedure

The following were considered as part of the process of collecting data in schools.

3.4.1 Research protocol

Currently the law states that no research can be done in schools without proper documentation or a letter of consent from the relevant authorities (Gall *et al*, 2003). A letter of approval or its equivalent from the Midlands State University introducing me and my research topic into the schools under study for data collection will be used (Burke & Christensen, 2012).

Secondly the researcher is aware that forgery of the findings of a research amounts to an academic offence, it is in the researcher's best interests to have all the questionnaires completed by the study sample and not anyone else outside of the study sample.

3.4.2 Ethical considerations

It is understood that ethical viewpoints differ from region to region, therefore for the purposes of this study and its boundaries as explained in chapter 1 will not be transgressed by overlapping into areas that have nothing to do with the research. An example of such a transgression would involve asking about the replacement theory that is being taught at A-level biology under sexual reproduction. Since this topic forwards a homosexual agenda and would undoubtedly cause arguments with the community, such questions have been omitted from the questionnaire (Burke & Christensen, 2012).

Secondly, since the school under study was taken from Lower Gweru which is mostly a Seventh Day Adventist doctrine centered area, the researcher will try to make sure that all of his questionnaires are collected before 1pm when most of the respondents are likely to have gone to Sabbath preparation on Friday.

3.4.3 Logistical considerations

Since the school the researcher is travelling to is 40km from the central business district and though the road network is fair enough to get the researcher to the school under study, the researcher will (by means of a borrowed motor vehicle) travel to the school and will self administer the questionnaires, interviews and do the observations in one day. The reason for all this being put in one day is so that the researcher is able to analyse the data and complete the project within the time frame left (Burke & Christensen, 2012).

3.4.4 Itinerary

The researcher has no plans of having to spend a night at the school under study if he is able to avoid doing so due to reasons beyond the researchers control among which include, borrowed transportation and the need to attend lectures and prepare for exams.

3.4.5 Others

Deception which involves the use of lies or establishing false intimacy will not be used in this research. The research questions shall be confined to areas with which the researcher is well versed with or qualified enough to handle. Privacy and confidentiality of information obtained from the data collection instruments shall not be shared with anyone in a manner that reveals the identity of the respondent (Gall *et al*, 2003)

3.4.6 Actual data collection

The actual data for the research shall be gathered using questionnaires, observations and interviews with the questionnaire being the most valued instrument among these in this study as it contains the bulk of the answers to the major and first sub research question. Two questionnaires shall be prepared, and the teachers will answer one that has the parameters explained in the data analysis plan. The school head on the other hand will have a questionnaire that has mostly items related to the school's average science pass rates and average teacher to pupil ratio across all forms.

Interviews will be used on some teachers as well as the head of department if the researcher is allowed to have an audience with him. Some of the questions of the interview are similar to the check list of observations among which will include questions on apparatus availability. Observations that don't involve sitting in a classroom will be done by just looking at the science labs when no lessons are being done to avoid interrupting the lessons of the teachers under study.

3.5 Data analysis plan

Once the data has been collected it shall be arranged in the following categories namely category 1: teacher status (trained/untrained), category 2: number of years in service, category 3: teacher qualification. The other parameters that will be appended to each of those categories in relation to the teachers will be class/load size, availability of apparatus, school lab capacity (max number of students under exam conditions).

The other data that is going to be looked at and categorised will be category 1: ZIMSEC science results/school for the past 10 years, category 2: Availability of lab technicians at the school.

The purpose for this categorical classification of data is to import it from the returned questionnaires and place it on an excel spread sheet under the following categories. Once these details have been entered the researcher then goes on to produce tables and graphs to be used during data presentation. The purpose of this is to make data interpretation easy on the part of the researcher as it is difficult to interpret several questionnaires without the above data presentation formats (Burke & Christensen, 2012).

Once the tables and graphs have been compiled, then the researcher will link the observed phenomenon with scholarly work that explains what it means for example if a school has unqualified teachers only, or what it means if a teacher's average load size/class exceeds the 1:25 teacher pupil ratio reported by the ministry of education (ZIMSTAT, 2013). Then from these relations between research findings and those of other publications the researcher can then accurately conclude on the likely impact that the new curriculum will have on learners if the proposed intervention strategies are ignored.

3.6 Summary

This chapter discussed the research methodology of the project used in data collection and explained the strength and weaknesses of the methods. The chapter also explained in detail the logic behind the choice of design used and the proposed plan for data analysis after collecting data with the proposed instruments. The data collection procedure was also explained in brief. The next chapter will present the research findings in the formats mentioned in data analysis, and interpret the results, relate them to other scholarly findings and later on discussing the findings.

CHAPTER FOUR: DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.0 Introduction

This chapter is a follow up of the data collection procedures discussed in chapter three. It contains a presentation of the data gathered from questionnaires, observations and interviews carried out on the target population. The data is presented in the form of bar graphs and tables under the categories of teacher competency in science teaching, availability of resources for science lessons, science pass rates from 2007-2018 and finally the challenges faced by teachers in science teaching as well as a discussion on the research findings.

4.1 Presentation and analysis of findings

4.1.0 Response rate and distribution of participants

Of the thirteen science teachers and one school head chosen, eight teachers and the head responded giving a response rate of sixty four percent. Of the five teachers who did not respond, three (twenty one percent) were off site on the day the data was collected, one totally refused to take part in the research and the other one couldn't participate in the study because he had a busy day as he was filling in for another off duty teacher. The interview was administered to the available teachers while that for the Head of Department (HOD) was used on a sample of three teachers. These teachers were used to represent their HOD who was among the three teachers not on site on the day of the interview.

4.1.1 Teacher competency to teach science.

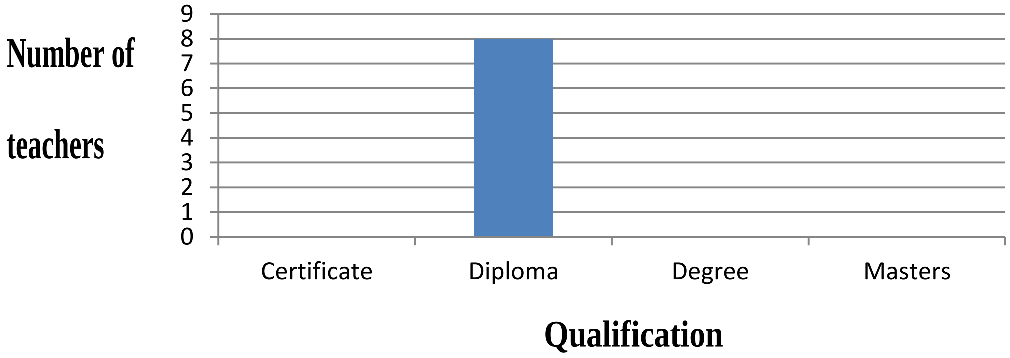

Figure 4.1 showing teacher academic qualification

Of the teachers under study, all teachers were holders of diplomas. Of this number seven are trained teachers while one is an untrained teacher. All the teachers graduated during 2010-2018 therefore this is their first time exposure to new curriculum concepts as it was first implemented in 2017 on a large scale. This on its own shows that most teachers are less likely to have done A-level and therefore their success in teaching O-level which now has practicals which may need an A-level background will be likely to be low

The next set of results shows the respondents by the institute that trained them.

4.1.2 Respondents by institute offering qualification

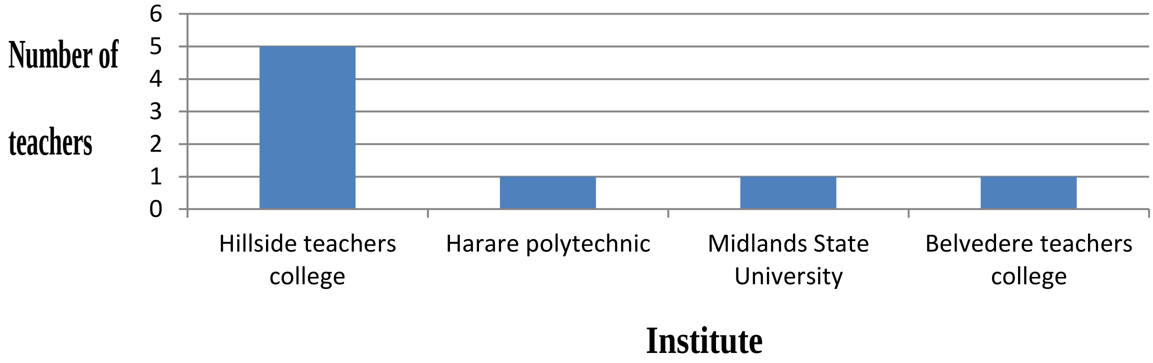

Figure 4.2 showing respondents by institute offering qualification

From the above figures five teachers were from Hillside teacher's college (HTC), one from Harare polytechnic (the untrained teacher), one from Midlands State University (MSU) and one from Belvedere Teacher's college (BTC). An interview was done to gain an understanding of whether all teachers had gone through A-level. It was established that though three of the seven trained teachers had gone to A-level, only one of them had used their A-level qualifications to train as a teacher and this was the teacher from MSU who had done a postgraduate diploma in education. The rest of the teachers had entered teaching through the post O-level enrolment programme offered by the above mentioned teacher's colleges in response to science teacher demand to implement the STEM initiative. The post O-level enrolment is the lowest entry level for someone aspiring to enter into teaching which led to the inquiry on why teachers enrolled using the post O-level intake. Upon enquiry using the interview, one of the teachers said the reason why they entered through the post O-level enrolment programme was that their A-level qualifications were so poor that they wouldn't have been able to keep up with the fast paced teaching administered to teachers under the post A-level enrolment. The other teacher said that they had done commercials at A-level and came out with poor results and had to fall back on their O-level science qualifications to earn a living by taking advantage of the STEM initiative which relaxed entry requirements to train as science teachers by most institutes.

The following set of results shows science subjects sat for by respondents at O-level.

4.1.3 Science subjects sat for by respondents at O-level

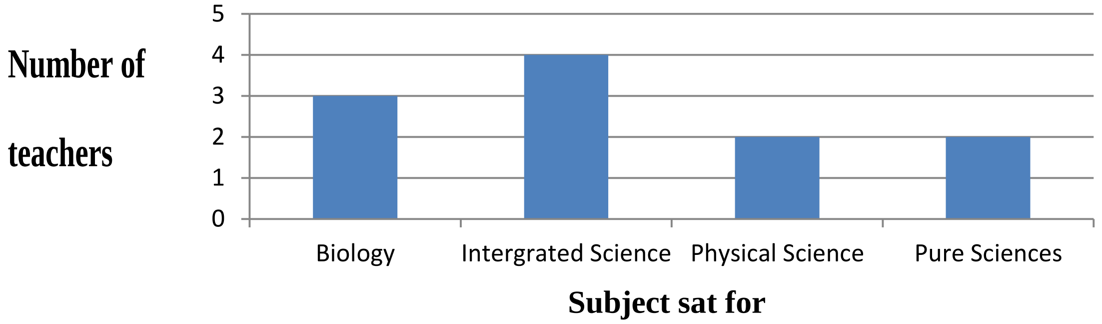

Figure 4.3 Science subjects sat for by respondents at O-level

From the above results, it should be noted that though the study has 8 teachers, not all the teachers sat down for one science subject at O-level. Some of the teachers actually sat down for more than three science subjects, thereby increasing their exposure to science concepts and improving on the quality of their theory and practical know how. Pure sciences in the figure relate to science subjects such as chemistry and physics at O-level which offer practical papers instead of alternative to practicals offered by the other three. From the above findings it means that only two teachers of the eight had an early exposure to practicals at O-level while the rest have never had much exposure with the exception of the MSU graduate who went through A-level and did four years in science practical work doing their first degree.

The next set of results shows subjects taught comfortably at O-level by respondents.

4.1.4 Subjects taught comfortably at O-level by respondents.

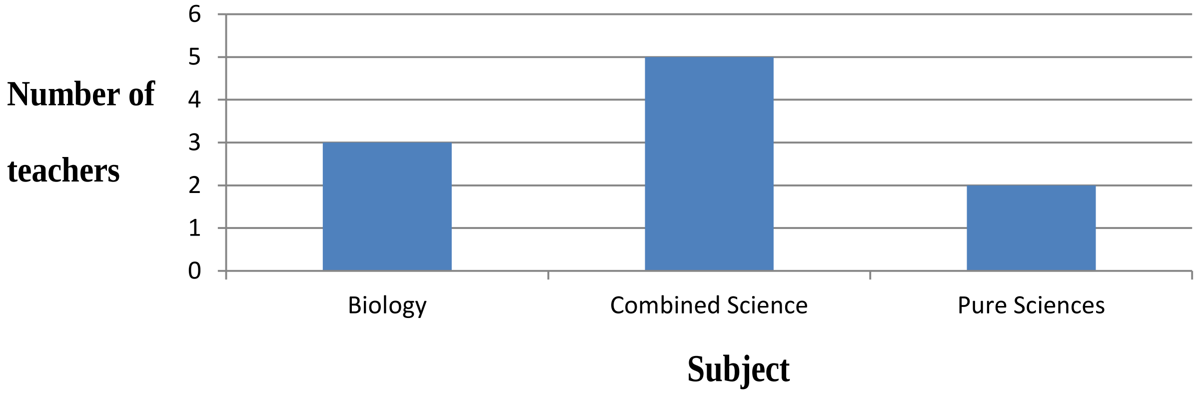

Figure 4.4 Subjects taught most comfortably at O-level

The results above should not be interpreted as though each teacher was stating one subject at a time, some teachers gave two subject areas they were comfortable with in responding to the questions on the questionnaire. From the above findings it can be deduced that two of the teachers only are able to teach pure chemistry and physics at O-level which are new subjects that the new curriculum has made compulsory to replace physical science and intergrated science with. Upon interviewing the respondents to get a better understanding of how the load is split it was established that all these teachers save for one (the MSU graduate) teach O-level, while the A-level classes are taken mostly by the teachers who were off site the day data collection was done. Further inquiry was made and established that the Form three and four classes have one class for each level doing pure chemistry and physics at O-level. Only one of these classes is being taught by one of the two teachers who are comfortable teaching the subject area of chemistry and physics at O-level as they have had exposure to it for a long time.

Of the teachers who are teaching combined science, upon interviewing one of them (the one who did commercials at A-level) showed strong reservations of teaching it to Form three and four. The other teachers were rather neutral having no reservations of teaching the subject to Form threes and fours. The following set of results shows the number of practical lessons done so far by the respondents in the first half of the year.

4.1.5 Number of practical work done by respondents in the year.

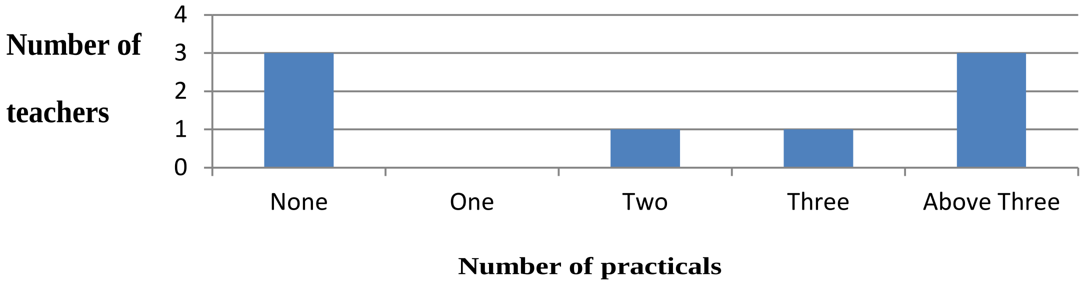

Figure 4.5 showing number of practical work done in the year

The results of practical work done so far by the teachers is shown in the graph above. Since data collection was done in the second week of the start to the second term it should be noted that chances are high these were counts of practical work done the previous term. Interest was kindled on the part of the researcher to know how those who did practical work were managing since from the above figures (4.1 and 4.3) it can be deduced that on average the teachers got practical training only at their colleges and very few got the exposure during their O-level. Using the interview, the researcher understood that these teachers were doing demonstrations which basically involve the teacher manipulating lab apparatus while the class looks on. The results were due to the teachers trying to work with the available time of two periods of thirty five minutes each availed to each per lesson.

The next set of results shows the level of classes taught by the respondents.

4.1.6 Classes taught by the respondents.

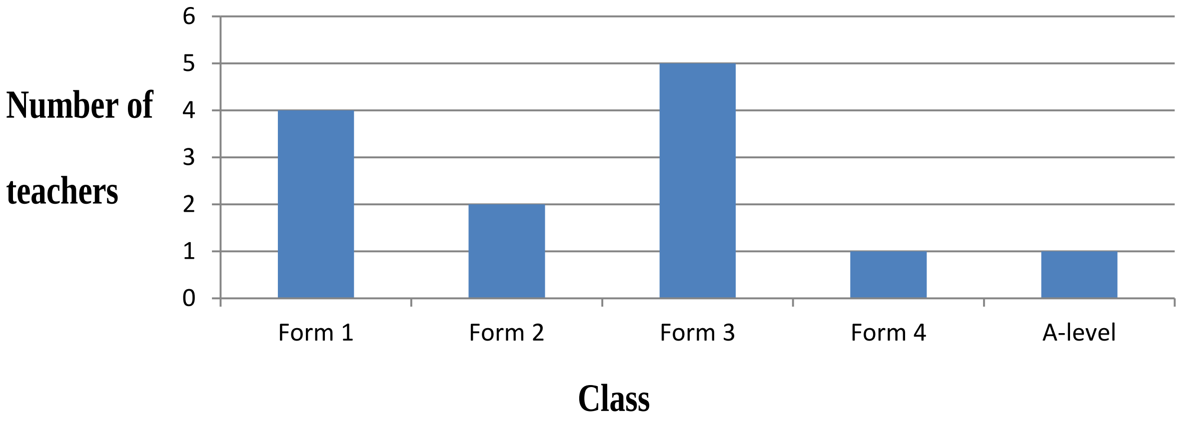

Figure 4.6 showing classes taught by teachers under study

The above figures show the number of teachers studied teaching the classes above. It should be noted that only one of the teachers is taking an examination class at O-level through the pure sciences while the marjority are dealing with non-examination classes mostly in the area of combined science as seen in Figure 4.4. Upon review of information gathered from the questionnaire, it was established that seven of the eight teachers had been teaching for less than five years while only one had been teaching for nine years.

The following results show the sites where science lessons are taught at the school under study.

4.1.7 Sites where science lessons are taught

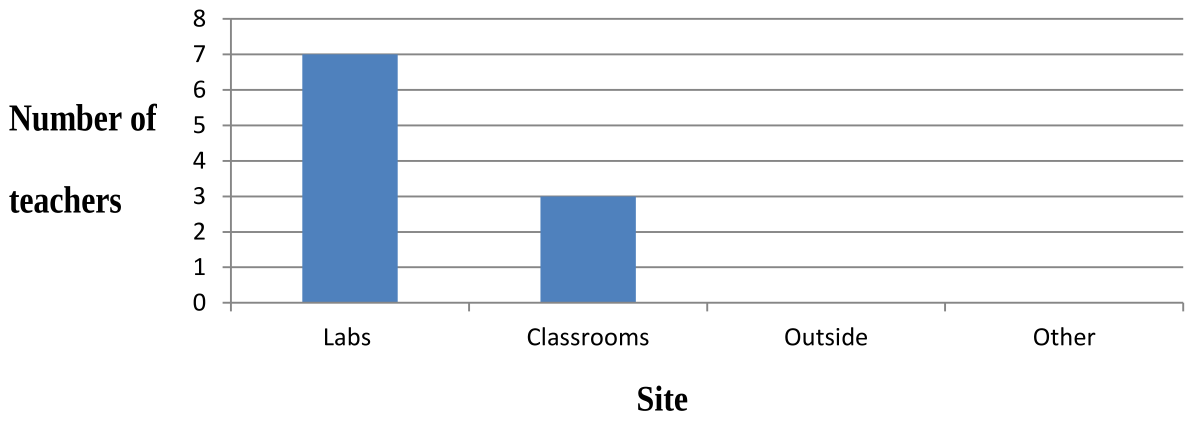

Figure 4.7 showing sites where science lessons are taught

The above results show the venues were science lessons are taught at the school. Since the school has four available labs for science, one junior lab, one chemistry lab, one physics lab and one biology lab, the teacher was interested in knowing how all the eight teachers under study manage to have the majority of their lessons (seventy percent) in a lab. It was later on revealed from an interview that there was a lecture theatre which was opposite the science labs which the science department had somehow monopolised and was being considered as a lab where some of the lessons were conducted. The lecture theatre for the purposes of this study after making observations in it cannot be considered as a lab as it has no gas pipes, taps, sinks, work areas (benches) and an even terrain as it has steps arranged in an ascending manner where the students are to sit and listen to their teacher.

The following set of results shows the availability of school labs at the school.

4.1.8 Availability of stools in labs.

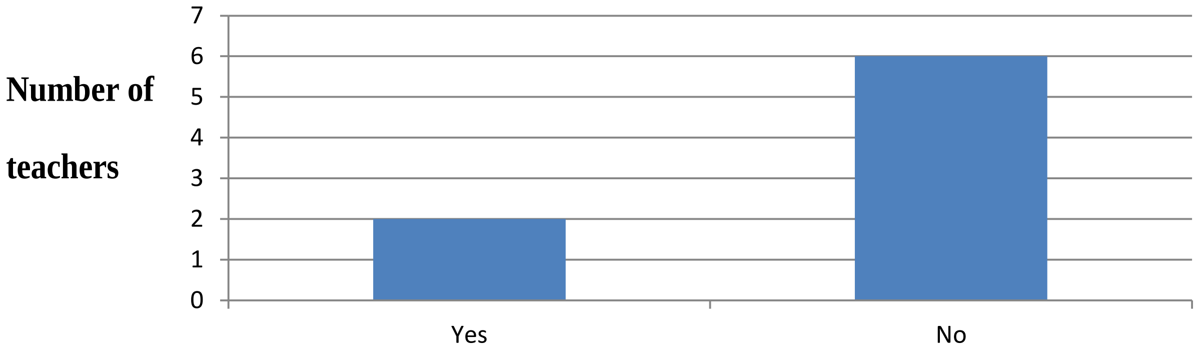

Figure 4.8 Availability of stools in labs

Six of the teachers agreed that there are limited lab stools in the labs, which is why the researcher was probed to ask the question of how the teachers managed to do this (Having seventy percent of lessons in labs). This was after making observations of the available lab stools in relation to the average class size of fifty five from form one to four, it was difficult to comprehend how seventy percent of the lessons under Figure 4.7 were done in labs.

The next set of results shows the availability of apparatus in relation to class size.

4.1.9 Availability of apparatus in relation to class size.

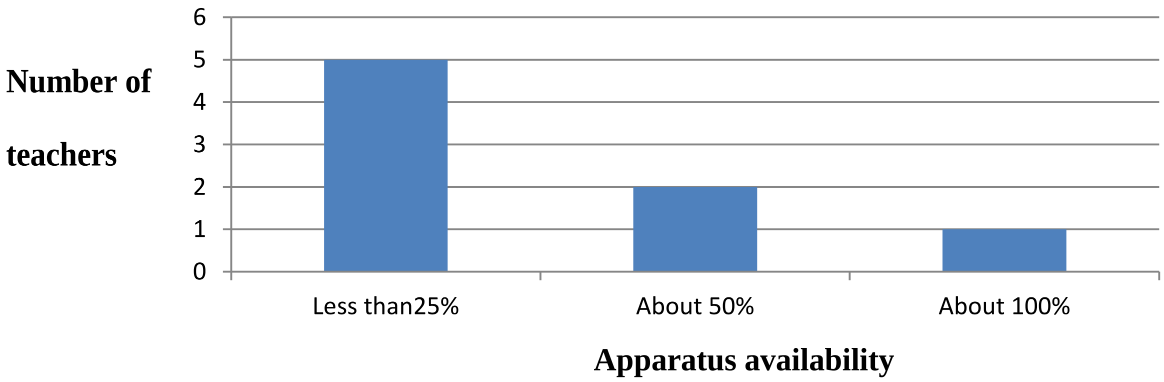

Figure 4.9 Availability of apparatus in relation to class size

More than fifty percent of the teachers under study agreed that the available apparatus was enough for less than twenty five percent of the learners. Apparatus being referred to here are beakers, spatulas, test tubes, flasks e.t.c which are not normally fixed in the labs in comparison to Bunsen burners. The discrepancy arising with the other teacher acknowledging that it was enough for all learners is possible that it was the A-level teacher from Figure 4.6 who probably had forgot that the study was focusing on O-level science practical lessons. Also using the average numbers of fifty five per class obtained from the questionnaire, there is no way that the apparatus observed in the inventory could be enough for each learner in such large classes. This consistency in findings also explains why the teachers in Figure 4.5 were using demonstrations more without actually allowing the learners to have a hands on practical manipulation of apparatus.

The next set of results shows the availability of burners for practical work in relation to class size.

4.1.10 Availability of burners in relation to class size

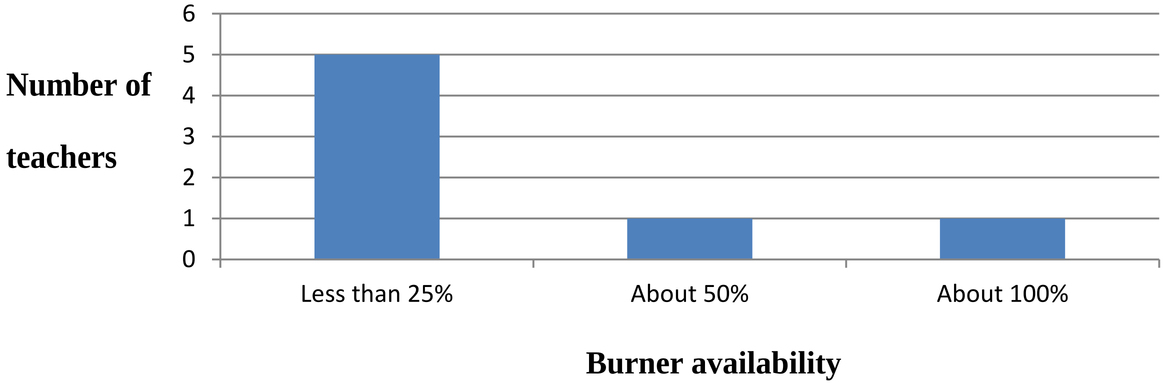

Figure 4.10 showing availability of burners in relation to class size

The results above show that the availability of burners within the labs also tallies with the above findings of apparatus availability in relation to class size. These findings are showing seven teachers instead of eight because one of the respondents under study left this area unanswered. Of these burners seven of the teachers agreed that they are spirit burners while one said that they are using Bunsen burners. The reason for such a discrepancy could probably have been that this one teacher could have been among the three from Figure 4.5 who are not doing practicals because after making lab observations it was observed that some of the gas taps were damaged and could no longer open or close. Upon inquiring from the teachers on the status of their gas taps it was revealed that they don't use gas in their labs as the pipes and taps are yet to be serviced as they leak gas once opened. So the likelihood of using Bunsen burners which are fuelled by gas is less likely.

The following set of results shows the type of water source used for practicals at the school.

4.1.11 Type of water source used in practicals

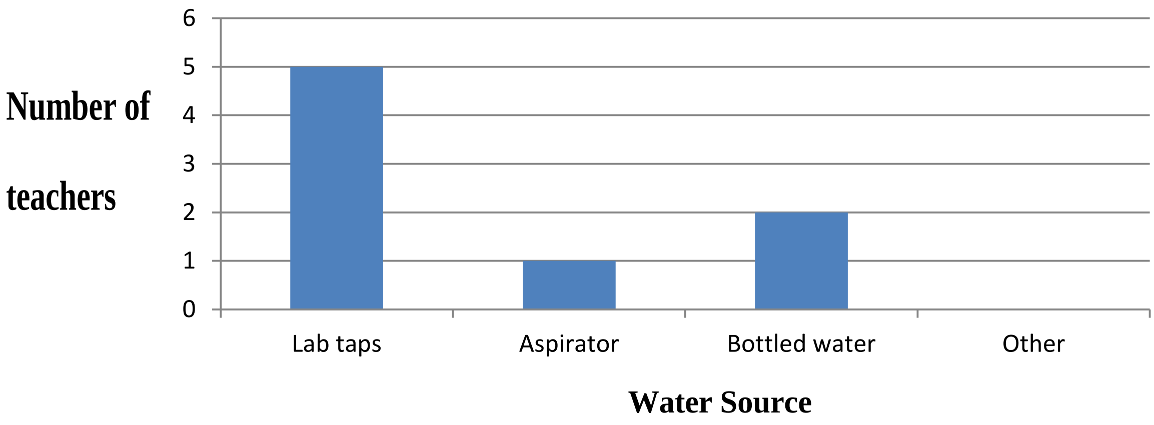

Figure 4.11 showing the type of water source used in practicals

The above results show the type of water sources used during practical work at the school. These findings also tally with the explanations in Figure 4.5 and 4.7 where by the teachers who had done practical work also spoke of doing demonstrations (demos). Upon further inquiry using an interview which later on exposed the monopoly of the lecture theatre explained in Figure 4.7 it was understood why demos were mostly done in the lecture theatre which was mostly favoured as it gave full view to all the learners as the demo proceeds. Therefore this accounts for the teachers using aspirators and bottled water in demos which are both containers for transporting water from point A to B hence their use in the lecture theatre where there are no taps. Five of the teachers said they used lab taps, it is possible that this number is mixed and also inclusive of the three teachers (who had done no practical work) from Figure 4.5 who could have used the labs with functional taps at the school during lessons. However, these would not be enough to cater for all learners had all the teachers chosen to do their practicals in labs as it was observed that the labs had four functional at taps which were observed working. So in other words this would force learners to queue waiting for water and which might cause them to run out of time to finish the practical.

The final set of results shows the average school pass rates in science in past years

4.1.12 Average school pass rate for science.

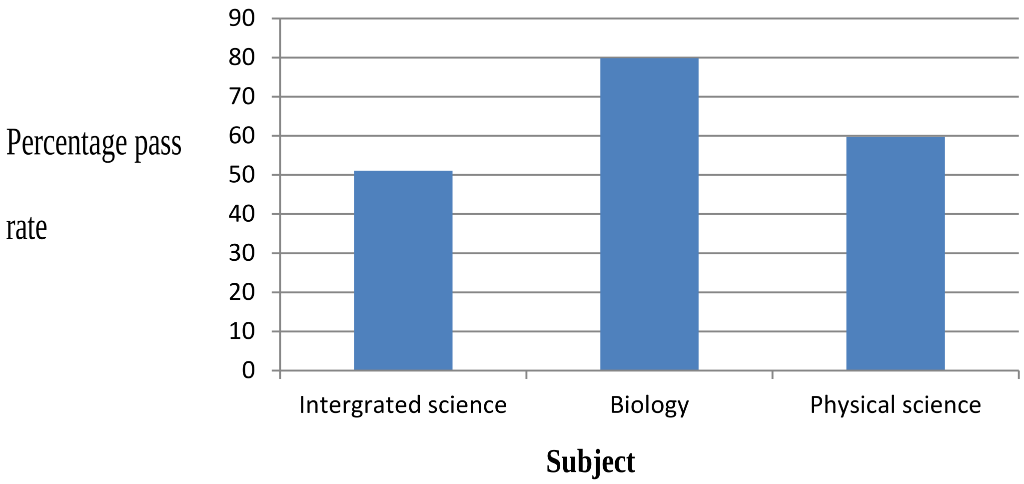

Figure 4.12 showing average school pass rates.

The above graph shows that the average for Intergrated science is fifty percent, while that for Biology is eighty percent and physical science being sixty percent when they are all rounded off to the nearest ten. Such results will be used below to look at what bearing might new curriculum interventions have on the above passes.

4.1.13 Challenges faced by teachers in science teaching

Using the interview guide it was noted that the teachers agreed that there were problems in changes done to the new curriculum. Giving examples of how they are failing to scheme properly and find answers in text books for new topics such as hormonal replacement therapy and facets of hydrogenation that have been added in the new curriculum biology and combined science. In some cases the teachers noted that even the new curriculum textbooks which they did not mention by name are lacking answers to some of the questions they are led to teach by the syllabi to examine the learners on.

Teachers also noted how they were aware that geography was to also have practical slots, thereby putting pressure on the labs which were already pressurised as it were, causing some of the teachers to use classrooms to teach science as seen in Figure 4.7. On the day of the interview the teachers noted that the geography HOD made mention of how ZIMSEC had sent in a paper explaining to the teachers for geography how they ought to administer the practicals. Such a move the teachers noted would increase pressure on the labs until a time when the labs would have fully been renovated adequately to deal with the large classes.

Finally the teachers admitted that if the two periods were increased to four for the practical work required by the new curriculum, it would be much more manageable. However they also noted that it is going to be difficult to include these extra two periods as science is now competing with geography for practical time at O-level, a problem which the teachers at the school are still yet to address.

4.2 Discussion

In this section the above findings are going to be discussed in order to give meaning to the obtained results as well as answering the research questions.

4.2.1 What impact does teacher training have on effective administration of science practicals?

From the above results, Figure 4.1 shows that all the teachers have diplomas while Figure 4.2 shows that only one respondent was from a University having done a Postgraduate Diploma in Education (PGDE). From the enquiry made during interviews it was established that six of the science teachers under study had enrolled to teach science using post O-level entry while one had used A-level and a first degree to train as a teacher. The untrained teacher who had no teaching background was much at a disadvantage in as far as teaching is concerned as the teacher has never been schooled on how to properly administer lessons (Cinkir & Kurum, 2013). Using these as an initial basis for comparison and the findings by Costley (2015), it can be concluded that of the eight teachers, the University teacher is more well versed with practicals, followed by the teacher's colleges and lastly the untrained teacher. This was also the conclusion that Zhang (2008) made highlighting that a teacher's level of education has a bearing on the quality of information they will give out to the learners.

The above is based on the findings by Zhang (2008) and the reason that the PGDE graduate had done two years in A-level doing Food Science, Biology and Chemistry which are all practical based, had attained a first degree in Science which was interspersed with practicals for four years, and had completed a PGDE programme that taught him theory on how to properly administer practicals. So in as far as exposure to practical work the PGDE graduate had six years exposure to practicals (excluding O-level). On the other hand, the teachers who enrolled for the post O-level intake at the teacher's colleges were a mixed group. The first group was that of the teacher under Figure 4.2 who had done non science subjects at A-level but was forced by circumstances to ride on the lowered entry requirements for science teacher training. This kind of teacher according to Ngwenya (2015) is likely to lack the proper motivation to carry out their duties as they ventured into an area they had no plans of participating in as seen by their choice to do commercials at A-level. Such a teacher will only have an average of one year of thorough practical work (according to them) which is almost similar to what they would have received had they gone to A-level. So in summary the total number of years the teacher would have had exposure to practical work is about one year only. Such an occurrence Banu (2011) notes might be a stumbling block to teachers effectively administering practicals. This assertion is also supported by (Bhukuvhani *et al*, 2012; Bennet, 2007) who also claim that such an occurrence may lead to the preference of teaching practical work in theory as opposed to hands on manipulation of apparatus. The second group is that of the ones who have had exposure to practicals at A-level but still used the post O-level entry requirements to enter into teaching. These teachers on average will have two years A-level practical exposure and then one year college exposure giving a total of three years practical exposure. For this group (Zhang, 2008; Alvarez, 2008) note that has a much higher quality and exposure to practical work, therefore chances of this group successfully implementing the practicals is high. The last group which has the untrained teacher cannot be accurately accounted for in as far as total practical exposure is concerned but basing on the reason that the teacher has had a diploma in some science pursuit can be said they have had at best two years exposure to practicals. It is rather difficult to accurately ascertain this teacher's total exposure to practical work since the diploma being held is unknown save for the fact that it is a non teaching diploma. The issue with such teachers according to (Cinkir & Kurum, 2013) is that they have the problem of compromising on the quality of content delivered based mostly on the fact that they have non-teaching qualification. This on its own according to Dekeza (2017) has a negative bearing on the implementation of STEM curriculum in rural secondary schools of Zimbabwe.

From the above categorisation of the teachers it can be concluded that teacher training has a significant impact on administration of science practicals in the sense that, from the several years of practical exposure a teacher has had, the more well versed they are likely to be at using apparatus confidently before learners. Also, the teacher will appreciate how important it is to have enough time, to have all reagents and apparatus available on work areas, as it can be deduced that through six years of practical exposure the teacher has seen the strengths and weaknesses of their tutors and lab technicians. Such exposure and correcting of errors seen from past tutors is said by Zhang (2008) and Alvarez (2008) to be of utmost importance in delivering practical skills to learners. It is from these strengths and weaknesses during their (teachers) early practical work that they can then incorporate improvements during practical administration with the children under their charge to improve on concept delivery and mastery, something that Banu (2011) notes as being important in the roles of practical work in teaching.

Secondly, teacher training has a bearing on proper practical administration especially in the new curriculum in the sense that, given the teacher from Figure 4.2 who said they had done commercials at A-level. Such a teacher will have difficulty in dealing with the concepts of double bonding and hydrogenation being introduced under chemistry in the new curriculum syllabus for combined science (Zhang, 2008). This theory aspect on which some of the practicals is based on needs an understanding on the part of the teacher of the theory as well behind the practical being done (Bhukuvhani *et al*, 2012). Therefore, according to Alvarez (2008) the quality of work the teacher is likely to deliver when asked something that is practical like “Why does cooking oil flow while butter and margarine don’t”, is most likely to be of a lower quality as these are A-level Food Science and Chemistry concepts falling under hydrogenation and saturated and unsaturated fats. Since the teacher would have had no such back ground of these A-level based theory concepts might prove a hindrance to them when asked to deal with variations in the melting and boiling points of fats and oils. This on its own according to Ngwenya (2015) will cause a lack of motivation on the part of the teacher being made worse once the students realise this weakness and lose confidence in the teacher. So again, from this point of view teacher training has a bearing on effective practical administration by teachers, something that (Zhang, 2008; Cinkir & Kurum, 2013) totally agree on.

Also, relating to Figure 4.3 and 4.4, it can be seen that the teachers are favouring combined science more than they are doing with the other heavier science subjects being administered under the new curriculum with Biology, Chemistry and Physics as examples. At the school where this study was conducted such a problem of having several teachers seeking to deal with light weight subjects only can be compounded as the school has a very abundant number of science teachers who can assist each other with concept mastery. However, the problem arises when the teachers with the results in Figure 4.3 and 4.4 are staffed in rural areas or smaller schools where there are three science teachers at most who have to cut across combined science, chemistry, physics and biology up to form four level (Dekeza, 2017). The problem evidently would be that, since most teachers enjoy the job security working for the government offers, they are likely not to hesitate taking up tasks they might have weaknesses in. For example, the teacher in Figure 4.2 (who did commercials at A-level) who enjoys taking combined science only for form one and two, might be forced to go up to form four at an understaffed school something that Bennet (2007) and Lizer (2013) found out to compromise negatively on teacher efficacy in new curriculum implementation. Such a teacher might end up rubbing off other practical work due to lack of familiarity with the theory concept on which the practical topic is based.

The result would be that looking at Zimbabwe as a whole, depending on the number of such teachers deployed, the resultant O-level science results will have a strong bearing on the level of teacher training since in the practical paper students are solely relying on the teacher for guidance (Alvarez, 2008). Gone are the days where learners could prepare for the alternative to practical paper alone, therefore teachers with reservations on taking higher forms in science will most likely hinder the overall performance of some learners.

4.2.2 What impact does availability of school resources have on practicals?

Availability of school resources has a strong impact on practical administration in the sense that, looking at Figure 4.7 and 4.8 which dealt with sites where science lessons are done and availability of stools respectively. It can be concluded that science lessons conducted outside of classrooms deny the teacher the ability to instil in the learners the curiosity or longing for manipulating lab apparatus (Banu, 2011). This is so in the sense that in the school lab learners are exposed to beakers, test tubes and their racks e.t.c stored on the shelves which are all things that can stir up a learners curiosity of longing to physically handle the apparatus. Therefore, if a class of form ones does science lessons in classrooms up to about form three, chances are high that by the time the teachers want to get serious with practicals to prepare learners for O-level public exams, most of the learners have already lost interest in science practicals. In this area lack of infrastructure being the chief cause of lack of practical work according to findings by Dekeza (2017), Mandina (2012) and Bennet (2007), has brought about a lack of repetitive conditioning to stir up interest in science done by a lab's atmosphere from form one. Therefore through this, availability of school resources has a significant impact on an interest from learners to do science practicals.

Secondly, in light of the new curriculum where by geography is supposed to also have practicals in school labs, the likely result according to findings by Dekeza (2017) and Jokiranta (2014) will be that practicals dictated by the syllabi to be done at form one and form two and repeated over the years will all likely be put on hold. This will likely be due to the schools trying to deal with the form three and four learners to prepare them for their public examinations by trying to fit their (form three and four) practical sessions in the available labs (Mandina, 2012). This is due to the reason that a school such as Lower Gweru Adventist High School (LOGAHS) which has three classes per stream will have a total of form three and four classes being six. This six considering geography practicals as well will become twelve as all the classes do geography and science (provided that each class does one science subject which is less likely). Given the average class size to be fifty five, with each class requiring four periods of practical work (similar to A-level) per week, this on its own according to findings by Lizer (2013) will create pressure every week in the labs as the A-levels will still have their practicals running along side with those of the O-levels. So looking at the O and A levels alone, it is very clear that unless new labs are built to deal with the surplus as advised by (Banu, 2011; Jokiranta, 2014; Bennet, 2007) among others, some classes will likely lag behind, especially the ones with teachers who already have reservations on doing practicals. Such a likelihood being supported by findings by Ngwenya (2015) on motivation as they will likely take any excuse that comes along (in this case, pressure on the labs) not to do practical topics they have weaknesses in. Therefore school resources have a significant impact on the administration of practicals.

Also, considering Figure 4.9 and 4.10 it cannot be argued that the school where the study was done has a significant shortage in availability of apparatus and burners in relation to class size. With more than half of the respondents acknowledging that the school has apparatus and burners available for less than twenty five percent of the class at a time is increasingly worrisome. Such findings are consistent with those of Mandina (2012) who noted a lack of resources as a hindrance to science practicals. Considering that the classes have on average fifty five learners, twenty five percent of fifty five therefore becomes fourteen learners. This means that, even if the labs could accommodate all learners for practicals, they would be doing at best fourteen learners per class per practical session. However, this number will not remain fixed since during practicals there are breakages of apparatus which means that if the school does not procure more lab equipment that number will keep on lowering save if the school decides to have two learners per work station something Bennet (2007) states needs addressing. However the problem associated with having more than one learner per work station is that accidents are increased and very few teachers would welcome such a move as they are held responsible should harm come to any learner during practical work. Therefore, using the above argument, availability of school resources has a significant impact on science practicals, findings which are consistent with work done by (Mandina, 2012; Dekeza, 2017; Bennet, 2007).

Fourthly, using Figure 4.11 involving the water source used in practicals. Given the situation of LOGAHS were by four taps were seen to be in the labs. This means that there would be need to increase aspirators put per work station in the lab especially if it is a practical that involves the use of plenty of water in washing apparatus after every use. In the case whereby there are few aspirators available, this will cause queuing at the water source causing some of the learners to fail to finish the practical work something that needs to be avoided as highlighted by Banu (2011). Also considering the water used in practicals, there is need to consider water to be used in cleaning apparatus after every practical session. Therefore given an average of fifty five learners per class for example, if each learner needs one litre of water during the practical, this means that they might need another one litre of water to clean apparatus and wash their hands after the practical (a safety precaution). Therefore, for every practical lesson with such a class there will be a need for an average of one hundred and ten litres of water, failure to get the water and containers to hold the water meaning that the practical may fail to take off or to be completed as found by (Zindi & Ruparanganda, 2012). Therefore in this regard availability of school resources (lab taps and aspirators in this case) have a significant impact on the administration of science practicals.

Lastly, using Figure 4.12 there is a clear need of availing the adequate time resource needed to conduct practical work as it can be seen that the fifty one percent pass rate for intergrated science which was a light weight subject in comparison to combined science is on the half mark. Introducing the combined science paper which has a practical paper instead of an alternative to practical paper cannot be done successfully as found by Lizer (2013) while still having the paper superimposed on the old time table for intergrated science as it has more concepts to master including the practical aspect. Therefore, in order to avoid the grades going below the half way point of fifty percent, time sufficient for the combined science practical paper needs to be availed. In this regard also, availability of the time resource in a school has a significant impact on the administration of science practicals. This comes in light of the extra hours needed by a class to do the actual practical as demanded by the combined science syllabi.

4.2.3 What challenges are schools facing in incorporating science practicals in harmony with other subjects in the school timetable?

Of the challenges schools are facing, the need to add an extra two periods on the science time table for O-level science means that each O-level class might have to drop a subject especially in classes doing more than one science subject if findings by Jokiranta (2014) on effective practical work are to be realised. Given the case of the first class doing combined science, chemistry, biology and physics, it means the class has to drop either combined science to cater for the increase of six periods across the other three. Failure to do so will mean that such a class will need eight extra periods per week for practicals, not to mention the two periods for geography as well. Therefore, failure to properly deal with the timetable to accommodate learners needs might put the learners at risk of burn out or fatigue as it means more subject matter to master and lack of free periods which might result in fatigue among learners over time causing poor concentration spans and sleeping during lessons.

On the other hand, with the changes that are being made to the new curriculum, school authorities, given the class above are pushing that combined science be also done so that if things change back to the old way of doing things for a season, the learners have a place to fall back on. This means that unlike having dropped combined science and then hearing that chemistry and physics papers for the new curriculum are not going to be run until a certain time, and that schools that formerly sat for the papers are the ones that will do them means that the class which was doing combined science can easily revert back to physical science. Therefore the blows of such a change of physical science coming back means that in doing combined science which is a replica of physical science under its chemistry and physics sections means learners are still at a competitive advantage come the public exams something highlighted by Zhang (2008) when he looked at experience and teaching behaviours. Therefore failure to decide which science subjects to let learners do in association with others is a bit of a challenge because previously physical science was two subjects in one which have now been expanded into two with each subject needing its own time on the timetable.

4.3 Summary

This chapter provided results obtained during the study and meaning given to the results as to why they are what they are and what it means to science practical teaching. This chapter's discussion will also form the basis on which the following chapter will ride on as a summarisation, conclusions and recommendations to the study are talked on.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter is a follow up of items touched on in the previous chapter. This chapter will summarise the research as a whole, give conclusions and recommendations based on the findings of this research.

5.1 Summary

The researcher was doing an exploration of teacher and school capacity to deliver science practicals at O-level under the new curriculum. The researcher managed to answer all the research questions laid down in chapter 1 using questionnaires, interviews and an observation checklist to collect data. The only major setback was that some of the respondents in the exploration refused to take part while some were unavailable on the day of data collection. However, these setbacks did not hinder the answers to the questions on the impact of teacher training on effective practical administration in science, the impact of availability of school resources on science practicals, challenges schools face in incorporating science in harmony with other subjects as well as being able to come up with possible strategies to deal with the problems. Summaries to these questions are presented below.

Since some of the teachers had entered in the post O-level intake in the colleges, it means that the teachers have very little exposure to practicals before and after course completion. This means that their skills or abilities to manipulate lab apparatus are not as refined as the teachers who go through universities who on the other hand have had a vast experience of practical work in A-level and also at the university compared to the approximately one year of exposure given by teachers colleges. This causes differences on the qualities of available trained teachers to effectively administer practicals at O-level.

Secondly, looking at the role of the subjects a teacher sat for at O-level and the subjects that the teacher is comfortable to teach, it was seen that these also have a bearing on effective practical administration. This came in light of the fact that certain O-level concepts that have been introduced by the new curriculum such as double bonding in combined science (formally called intergrated science) give former intergrated science teachers hassles mastering the topic enough to teach to the learners. The reason is this will be a totally new concept if the teacher sat for intergrated science only at O-level and never went to A-level. Such matter of content is dealt with more in depth at A-level, therefore such weaknesses on the theory part of the teacher were found to be a hindrance on the effective administration of science practicals.

Lack of teacher familiarity with apparatus may lead to mostly demonstrations even in well resourced schools as some teachers may likely prefer this method to escape the hassles associated with planning, preparing and teaching fifty five pupils how to handle apparatus. This may come in light of lack of know how as on the part of the untrained teacher under study, or due to lack of confidence by teachers as exemplified by the commercials student turned science teacher.

It was found that sites where science lessons are done, availability of stools and apparatus have an effect on the administration of science practicals. It was deduced that science lessons conducted out of labs are likely to cause a reduced interest by some learners in the subject area causing problems later on of failure to rekindle enthusiasm for practical work or science by teachers as learners were never conditioned to find interest in science through lessons in school labs. This will have an impact on science practical work if too much competition for labs results in learners going to the labs at a later level.

Availability of resources regarding burners and water used was found to be a determining factor on whether practicals are likely to be completed in time. For example, if learners have to queue in line for anything such as water during practicals, it is more likely that some may fail to finish the practical or get incorrect results as some of the results are time sensitive such as those on colour changes doing food tests. Therefore school resources were found to have a bearing also on effective administration of practicals at O-level, as lack of any resource has a bearing on the successful completion of tasks by learners during practicals.

Finally, looking at the average results of the school in days when the alternative to practical paper was running, it was seen that there is a high likelihood of the averages for intergrated science (fifty one percent) and physical science (sixty percent) to further plummet, as content for these two subjects has been merged together to give combined science. The reason being that combined science is done by all learners at most schools, therefore there is need to come up with school time tables adequate to cater for revision purposes, repetitions of practicals so that no learner is at a disadvantage. If a school fails to adjust the time resource accordingly, it was deduced that worse averages than the two mentioned above are likely to be recorded.

It was found that the pressures associated with adding two extra periods for every science subject to have an available time for practicals similar to what is done at A-level means that classes may have to drop other subjects. For example a class doing combined science, biology, chemistry and physics will have to drop one subject to accommodate geography which also may need an extra two periods per week as it is now going to have practicals under the new curriculum. Such problems of fixing time allocations for practicals on top of incorporating new subjects such as heritage studies and physical education are the initial challenge the school was having on top of a shortage of school resources to do practical work.

5.2 Conclusions

Basing on the findings of the research, the researcher concludes the following.

5.2.1 What impact does teacher training have on effective administration of science practicals?

Since differences in the qualities of teachers coming out of tertiary institutions were noted, it can be concluded that a school that has several teachers who are post O-level graduates is more likely than not to have a strong weakness among its learners regarding practical abilities especially if the teachers in question never did A-level science.

The subjects that a teacher did at O-level have a very high bearing on the kind of subjects the teacher is going to favour teaching and up to which level. Therefore it can be concluded that it is mostly the teachers who did intergrated science alone who are more likely to be in favour of teaching form one and two combined science while, those who did intergrated science and another are more likely to have no reservations of teaching combined science up to O-level.

From the findings it is also concluded that untrained teachers are more likely to be worse of in doing practical work as was the case of the untrained diploma holder. The reason being there is no background to teaching to help the teacher plan for lessons which makes the teacher struggle with small things like lesson planning which a trained teacher is less likely to have. Also on concept mastery the untrained teacher in the study may be at a disadvantage especially if they are a holder of a non-science diploma.

Finally it can be concluded that the method a teacher will use in practical work may have a bearing on their familiarity with practical concepts. Teachers who are not well versed with the concept being taught will more likely rely on demonstrations alone which are more teacher centered while those with familiarity of the concept will likely use problem solving approaches in practical work whereby learners are allowed to physically manipulate apparatus in practical work.

Therefore in light of the above, teacher training is concluded to have a significant impact on science practicals, being more detrimental in cases where teachers have little to no training.

5.2.2 What impact does availability of school resources have on science practicals?

The sites were science lessons are done and availability of stools in labs determine which classes will do science in labs especially in cases where there is a reduced availability of labs. This on its own can be concluded to have a major impact on the level to which learners will have enthusiasm for science as they were never conditioned to spend time in a science environment (lab). This on its own might cause problems of some learners liking science practicals later on and might have a bearing on the number that return back to do science at A-level.

Secondly, availability of apparatus and burners in relation to class size can be concluded to have a bearing on the total number of learners that can be allowed in the lab for a practical session. For example if available apparatus accommodates ten learners per go while the lab can hold twenty learners per practical session. Only ten will be accommodated in that lab based on apparatus availability, while increasing the number of learners to two per set of apparatus to maximise lab holding capacity will increase the likelihood of accidents.

Finally the water source used in practical work determines the time a practical will run for. For example a practical session being done with aspirators in a lab with no built in taps or functional tabs as was the case with at least two of the labs at the school under study will require more time to complete as the learners go out to refill the aspirators where there are few of them available. This will result in two periods per lesson being too little as the teacher has to remain at all times in the lab while the learners go out to fetch water. So doing practical work with two periods availed for the alternative to practical papers can be concluded as not feasible under the new curriculum.

Therefore with regards to the above arguments, availability of school resources is concluded to have a significant impact on science practicals. The fewer the available resources being related to an increase in challenges of successfully doing practical work.

5.2.3 What challenges are schools facing in incorporating science practicals in harmony with other subjects in the school time table?

It can be concluded that the challenges schools are facing currently in trying to make do with two periods per science practical are likely to spill over into the overall performance of learners in the new curriculum subjects. It can also be concluded that in the days where alternative to practical papers were written, if the average pass rate for intergrated science was fifty one percent, the passes are likely going to hit a further low now with a much harder subject (combined science) having replaced intergrated science if arrangements are not made to increase practical slots by two periods.

5.3 Recommendations

There is need for the school management to conduct training workshops to assist teachers through seeing and doing how they ought to conduct the practical work proposed by the new curriculum. Such workshops will focus on areas of practical planning, dealing with large classes, how to adjust school timetables to cater practical work. The purpose of these workshops will be to run away from the all too often idea that sending teachers back to school is the only way to improve on content delivery. This is seldom the case every time as the teachers simply need to be assisted to deal with the new topics, something that the tertiary institutions might fail to touch on as they deal with large numbers of teachers per given unit time. These work shops on the other hand will be dealing with several teachers but without set time limit that is normally placed by tertiary institutions as they seek to examine their learners. The school since it is a private school can achieve this by liasing with other schools in the area to have such workshops on its premises if needs be.

Secondly there might be a need to employ extra school laboratory technicians to deal with the increased work load likely to come about with the introduction of practical papers at O-level as well including geography. This is so because formally practical lessons were normally a preserve of the A-level science scholars, now having them at O-level with geography practicals as well may require an extra hand to take care of the work load. Schools without lab technicians need to receive government assistance to secure competent lab technicians in order to avoid increasing the work load of practical preparation on teachers who themselves are already over burdened by the new curriculum changes as it is.

Thirdly there is a need for schools to secure resources in the form of text books via the Ministry of Primary and Secondary Education (MOPSE), as well as purchasing audio visual equipment such as laptops and projectors to try and compound the effect of lack of apparatus for practical work by showing learners virtual experiments in preparation for the real practical session. This in a way buys time for school resources to be mobilised to secure the needed apparatus but at the same time not depriving the learners of access to the practical skills required of them by the syllabi. In the case of the school under study, using these would be easy as the school has access to electricity.

Fourthly the school (since it is a private school) has to ensure that it has an equal representation of teachers to cater for all levels during staffing. For example, it would be unprofessional to have the school fully staffed with untrained teachers only in science. The school has to mobilise its recruits via the School Development Association (SDA) to ensure that the staff members at the school complement each other, with a teacher for every level, unlike a case of having post O-level teachers being forced to teach up to A-level.

Fifthly, there will be need to construct and rebuild new labs while damaged ones are repaired as required to ensure that no learners are disadvantaged. For example, having learners with gas burners being examined under the same conditions with those using spirit burners and those using heater elements for their water baths (the last one being a substitute for what is required) puts one group at a disadvantage. This is because water heated by gas warms faster than that heated by a spirit burner with heaters varying in time as to the extent that they heat depending mostly on the water volume and the heater size used for heating.

Sixthly there is a need for the same study to be done again on a larger scale involving several schools and being done as a comparative study a few years after this one to check on how the schools have managed to adapt their timetables and distribute their resources to cater for the new curriculum changes among other things. The purpose being to see how each school has fared with the result trying to suggest the methods being used by the successful schools to the less successful ones.

Finally, the researcher recommends that the Ministry of Primary and Secondary Education has a representative either stationed at each teacher training institute or who is mobile and allocated a set number of teacher institutes in the area who is supposed to liase with the institute on behalf of the institute in approving research topics for researchers to collect results. The business of doing a research project shouldn’t be made harder than what it really is.

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APPENDIX 1: QUESTIONNAIRE FOR THE TEACHERS

Midlands State University
Established 2000
Our Hands, Our Minds, Our Destiny

Warm greetings to you, my name is Michael Kokera Butai from the Midlands State University doing my final term pursuing a Post Graduate Diploma in Education. I will be conducting a research to explore teacher and school ability in the effective administration of practicals under the new curriculum. The main areas of focus in this questionnaire will be on teacher training and science practicals as well as availability of school resources and practical work. Please fill in all sections of this questionnaire.

NB* PLEASE NOTE THAT IF YOU DO NOT KNOW ANYTHING ON THE ASKED QUESTIONS, PLEASE LEAVE THE QUESTION BLANK.

Section A: Teacher training and science practicals

(Please fill in or tick the appropriate box)

1) What qualification do you hold?

Certificate	Diploma	Degree	Masters	Doctrait

2) Are you a trained teacher?

Yes	No

3) If you answered **yes** above, what were your subject areas?

....

4) Which institute did you train with?

....

5) Which period did you graduate?

Before 1980	1980-1990	1990-2000	2000-2010	2010-2018

6) Which science subjects did you register for in ZIMSEC during your school years?

....

7) Which subject do you feel most comfortable teaching, give a reason for your answer?

....

....

8) How many years have you been teaching science since you began teaching?

Less than 5yrs	5-10 years	10-15 years	15-20 years	20+ years

9) How many science teachers are at your school? ....

10) What forms do you teach? ....

11) Which science subjects are you teaching?

....

12) What is the average size of the classes for each form?

....

13) Since the beginning of the year, how many practicals have you done so far for each subject?

None	One	Two	Three	Above three

14) In your own words, what can be done to improve the number of practical work administered by teachers?

....

....

Section B: Availability of school resources and practical work

(Please fill in or tick the appropriate box)

15) Where do you conduct your science lessons?

Labs	Classrooms	Outside	Other

16) Are there enough stools for all your learners?

Yes	No

17) Does the school have a lab technician(s)?

Yes	No

18) If you answered **no** above, who assists you in preparing practicals for the learners?

....

....

19) Given the size of your classes, is the apparatus adequate for learners?

Less than 25% of the class	50% of the class	All learners have apparatus

20) Which kind of burners do you use in your labs?

Spirit burners	Bunsen burners	Other	None

21) How many burners do you have in relation to class size?

Less than 25% of the class	50% of the class	Each learner has a burner

22) What do you use as a water source during practicals?

Lab tabs	Aspirator	Bottled water	Other

23) Using ZIMSEC standards, how many learners do your labs hold during practical exams?

....

24) What kind of improvements if any do you suppose need to be made to properly cater for practical experiments at your school under the new curriculum?

....

....

....

THANK YOU VERY MUCH FOR YOUR PARTICIPATION.

APPENDIX 2: QUESTIONNAIRE FOR THE SCHOOL HEAD

Midlands State University
Established 2000
Our Hands, Our Minds, Our Destiny

Warm greetings to you, my name is Michael Kokera Butai from the Midlands State University doing my final term pursuing a Post Graduate Diploma in Education. I will be conducting a research to explore teacher and school ability in the effective administration of practicals under the new curriculum. The main areas of focus in this questionnaire will be on teacher training and science practicals as well as availability of school resources and practical work. Please fill in all sections of this questionnaire.

NB* PLEASE NOTE THAT IF YOU DO NOT KNOW ANYTHING ON THE ASKED QUESTIONS, PLEASE LEAVE THE QUESTION BLANK.

1) How many science teachers are at the school (including science student teachers)?

   ....

2) Among the science teachers, how many are trained, untrained and student teachers?

Trained	Untrained	Student teachers

3) On average, how well does the school perform in science subjects at ZIMSEC?

   ....

   ....

4) What is the average size of the classes at your school among the form 1s, 2s, 3s, 4s, and A- levels (who do science only)?

Form	Average class size	Number of classes
1		
2		
3		
4		

5&6		

5) Please give a summary of percentage pass at O-level Intergrated science, Biology and Physical science (or their equivalents for the past 10 years)

Year	Intergrated science	Biology	Physical Science
2008			
2009			
2010			
2011			
2012			
2013			
2014			
2015			
2016			
2017			

6) What are the constraints faced by the school in teaching science?

....

....

7) Does the school have any lab technician(s)?

....

8) In your own words, what improvements can be done under the new curriculum for science subjects to help learners in their studies at your school?

....

....

....

THANK YOU VERY MUCH FOR YOUR PARTICIPATION.

APPENDIX 3: INTERVIEW GUIDE FOR TEACHERS AND HOD

INTERVIEW GUIDE

1) What challenges have new curriculum changes done to your time table and work load?

   ....

2) Are you aware that Geography now has practicals to be done in the lab at O-level

   ....

3) What challenges do geography practicals present to the planning of science practicals in the time table.

   ....

4) Given the number of classes you have, are two periods enough to effectively administer practical work at O-level?

   ....

5) What changes would you recommend with regards to practical work at O-level

   ....

6) In the science department, how do you share the classes (e.g based on level of qualification or other)

   ....

7) How do you manage to teach the classes given the number of labs/infrastructure in relation to class size?

   ....

8) What intake/mode of entry where you and other teachers enrolled in at the tertiary institute?

   ....

9) Would you consider taking an exam class in any subject? If no, please explain why.

   ....

10) Do you ever use projectors on a regular basis of at least once a week in your lessons?

    ....

11) Do you have any other comments regarding current work conditions/requirements under the new curriculum?

    ....

APPENDIX 4: OBSERVATIONS CHECK LIST FOR LABS AND APPARATUS

OBSERVATIONS CHECK LIST

1) Do the labs have functional water taps? ....
2) How many sinks are in each lab? ....
3) Do the labs have functional gas pipes? ....
4) Do the labs have power sockets and lighting? ....
5) Number of learners accommodated by labs using ZIMSEC standards ....
6) How many labs does the school have ....
7) How representative of the learners is the apparatus ....

APPENDIX 5: LETTER OF APPROVAL

APPENDIX 6: TURN IT IN REPORT

Turnitin *Originality Report*

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