Practical Strategies to Improve Leaner performance in Chemistry Topics Perceived as Difficult to Learn in Secondary Schools of Northern Province of Zambia

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Abstract

Senior secondary school pupils have, for some time now, exhibited unsatisfactory performance in some chemistry topics that are perceived as difficult to learn in their school certificate and General Certificate of Education (GCE) Examinations.

This study aimed, firstly, at establishing the effect of gender on the perception of learning difficulties in secondary school chemistry, and, secondly, identifying possible practical teaching and learning strategies that would address pupils' learning difficulties in secondary school chemistry with a view to improving their performance.

The study was conducted in 8 secondary schools in Kasama, Luwingu, Mbala and Mungwi districts. Eight heads of departments, 16 chemistry teachers and 221 secondary school pupils constituted the sample. Data were collected through questionnaires and semi-structured interviews. Heads of departments, chemistry teachers and pupils completed questionnaires. Sixteen (16) chemistry teachers and 68 pupils attended follow-up oral interviews. Results of the study revealed that gender difference had an impact on the pupils' perception of learning difficulties. Teachers of chemistry acknowledged this fact but they ***were not agreed*** *on which gender, per se, had a better or a more positive perception of learning difficulties. It further established that pupils' learning difficulties could greatly lessen by conducting practical work, revising difficult topics and providing remedial lessons, strengthening formative assessment through additional assignments or research work or homework, integrating Information ,Communication and Technology* ***(ICT)****, Virtual Instrumentations (****VIs)*** *, motivating pupils , using a variety of active teaching techniques, allocating enough time to difficult topics and providing learners with study resources such as tailor-made handouts so that they have the information they need for their study, conducting school-based Continuing Professional Development (****CPD)*** *when used for the first time it is important to write it in full and put the acronyms in brackets) and attending subject associations such as Zambia Association for Science Educators (* ***ZASE)*** *meetings ,upgrading teachers, procuring necessary equipment, apparatus and chemicals and setting up a chemistry- specific laboratory.*

Keywords: Gender, impact, perception, strategies.

1.0 Introduction

Various studies have investigated difficulties pupils face in learning chemistry in countries such as, Uganda, Ethiopia, Scotland, Nigeria, Turkey and Israel

(Johnstone and Mahmoud, 1980). In their findings, Johnstone (1991) suggested that chemistry was among the most challenging subjects for secondary school pupils.

While adequate research has been conducted in other countries of the world as named above in relation to strategies critical to improving learners' performance in chemistry topics perceived as difficult, very little research of this nature has been carried out in Zambia. Despite the teachers' full knowledge of the difficulties that pupils face in learning some of these topics in chemistry which actually lower their overall performance in chemistry, teachers have taken no steps to redress the situation. This study will therefore establish the effect of gender on the perception of learning difficulties and identify possible practical teaching and learning strategies that would address pupils' learning difficulties in secondary school chemistry.

1.1 Statement of the problem

Results of past Examination Council of Zambia (ECZ) school certificate and General Certificate of Education (GCE) Examinations have indicated poor performance in science subjects especially in chemistry. The senior secondary school pupils have exhibited unsatisfactory performance in some chemistry topics that are perceived as difficult to learn, and strategies to mitigate the situation are not known.

1.2 Objectives

This study sought to address the following objectives:

1.2.1 Primary objective:

The primary objective of this study is to establish suitable strategies which could significantly improve the education of chemistry at secondary school level ,and raise the pass rate of this subject.

1.2.2 Secondary objectives:

(i) To establish the effect of gender on the perception of learning difficulties in secondary school chemistry.

(ii) To suggest possible practical teaching and learning strategies that would address pupils' learning difficulties in secondary school chemistry.

1.3 Significance of the study

This study may help policy makers and curriculum designers to make changes to teaching methods. It may also be useful to institutions, teachers, pupils, parents and other stakeholders who may desire to improve classroom practice. The study may also motivate teachers to attend conferences, seminars or refresher courses focusing on practical strategies to handle difficult chemistry topics. It may equally motivate other scholars to scale up this study.

1.1 Theoretic framework.

This study is premised on the theory of constructivism. The formation of this theory is generally attributed to Jean Piaget who explained the mechanism by which knowledge is internalised. The theory holds that:

(i) Learning depends on learning environment and knowledge of the learner;
(ii) Learning involves constructing meaning;
(iii) Construction of meaning is influenced by existing knowledge;
(iv) The meanings constructed are evaluated and can be accepted or rejected;
(v) There are patterns in types of meaning pupils construct due to shared experiences with physical world and through language (Bennett, 2002; Vygotsky, 1978).

The theory implies that as long as teachers do not employ appropriate teaching strategies as a way of providing an enabling learning environment to teach some topics that are new , complex in terms of terminologies, and the pupils lack pre-requisite knowledge, the pupils will certainly fail to construct meaning and make sense out of their learning experiences.

2.0 Review of Literature

2.1 General Learning Problems

The study referred to general problems such as impact of language, effect of gender, lack of practical work , qualification and teaching strategy.

2.1.1 Impact of Language

Language plays a role in understanding of scientific concepts. Language is the medium of instruction and a vehicle that conveys meaning and thoughts to learners. If the language used is complex, high-flown, there will be communication break down and learning will not take place. Learners will not get explanations; they will fail to read test items and they will not understand the questions. In the same vein, if the learners' language is poor, they will fail to communicate their thoughts, hence they will perform poorly. (Lemke, 1990 in Bennett, 2003; Knippels ,2002; Young, 1999).

2.1.2 Effect of Gender

Some studies have indicated that girls tend to have a more positive attitude compared to their male counterparts (Ajayi and Ogbeba, 2017). On a contrary, study conducted by Tinklin, Croxford, Ducklin &Frame (2001) showed that there were more girls than boys who perceived more scientific concepts as difficult to learn. There is no clear-cut position as to the effect of gender on perception of learning difficulties by learners. . (Shamai, 1996; Tinklin, Croxford, Ducklin & Frame, 2001).

2.1.3 Lack of Practical Work

Absence of practical activities and over reliance on theoretical work will lead to poor pupils' performance in chemistry. By its very nature, chemistry is a practical subject and should be taught practically. Practical work brings reality into the classroom, links theory to reality, clarifies unclear theoretical concepts, it is motivational , and teaching is efficiently done (Czerniak & Lumpe, 1996; Riggs & Enochs, 1990; Tschannen-Moran et al., 1998).

2.1.4 Teacher Qualification

Teachers are deemed to be critical assets with regard to quality of learning. Well qualified teachers are vital tools in determining not only the quality of knowledge that pupils will acquire but the character of development of a Nation in the final analysis. There is need to realise that poorly qualified teachers are very likely to transmit wrong descriptions of observations, misconceptions, misinformation and misapplication of content taught and scientific terminologies (Harris and Sass, 2008).

2.1.5 Teaching strategy

There are some features about science that have implications on how it should be taught. Science is about constructing meaning out of knowledge. (Corno & Snow, 1986). Musonda (2017) augments the foregoing and states that use of effective, active methods, promotes deep understanding as an individual is rigorously engaged in constructing meaning and sharing knowledge. This way, the pupils become *their own teachers*, *and teachers begin to see learning through the pupils' eye* (Hattie 2009, p.22) .

2.2 Specific learning problems

Specific learning problems include: specialist vocabulary, pupils' motivation, mathematical background, pre- instruction conceptions and ineffective assessment**.**

2.2.1 Specialist vocabulary of Chemistry

Learning chemistry can be daunting as it is characterised by a vocabulary which is not only vast but also technical. Bennett (2003) observes that technical vocabulary associated with scientific concepts has proved to be responsible for reducing the readability and understandability of the scientific text which very often results in poor conceptualisation. It uses strange symbols. For example, Sodium, is Na (from natrium), Potassium is K (from Kalium). Looking at the names (sodium and potassium) and the symbols (Na and K), one would see that the symbols have no relation with names.

2.2.2 Pupils' Motivation

The scholars have also shown that there is a significant relationship between study habits and pupils' interest in chemistry. The pupils that perceived some topics as difficult had very little or no interest in studying such topics, and if they ever studied them, they normally employed poor study habits. Consequently, pupils failed to comprehend the concepts involved and their performance remained poor (Ogunkola & Samuel, 2011; Ejidike and Oyelana ;2015).

2.2.3 Mathematical background

It is observed that topics in chemistry such as stoichiometry, mole concept, kinetics, energetics, and many others that pupils find difficult to learn have mathematical aspects. (Knippels, 2002; Osborne *et al.*, 2003). Marie (2018) explains that pupils with poor mathematical skills will fail to grasp chemistry topics that are mathematical in nature, not that the concepts are complex but that their mathematical skills are poor.

2.2.4 Effect of pupils' pre-instructional conceptions

Scholars have asserted that pupils will always come to chemistry lessons with already existing "chemistry knowledge" which may or may not be correct. If the existing knowledge is correct, it then forms a positive and helpful basis for understanding new information as the links will be meaningful. Conversely, misconceptions already existing in the pupils' minds prior to instruction will be a barrier and will impede further learning (Clement et al., 1989).

2.2.5 Ineffective formative assessment in chemistry

Scholars have argued that if the desire is to increase and raise pupils' achievement then the key is formative assessment (Black & William, 1998; in Brookhart, 2009). *"There is a body of evidence that formative assessment is an essential component of classroom work and that its development can raise standards of achievement. We know of no other way of raising standards for which such a strong prima facie case can be made."* (Black and William 1998 ; Brookhart, 2009)

3.0 Methodology

3.1 Research Design

The study was a survey. It sought to interpret the information gathered to capture the respondents' views in order to explain pupils' learning difficulties in chemistry.

3.2 Target Population

All chemistry teachers, all pupils taking chemistry, all heads of department (HoDs) of Natural sciences Department in Mbala, Mungwi, Kasama and Luwingu districts constituted the population.

3.3 Sample Size

The sample for the study was drawn from 8 secondary schools. The sample included 16 chemistry teachers 8 (HoDs) of Natural Sciences Department and 221 chemistry learners. A total of 221 pupils answered the questionnaire and 68 pupils were orally interviewed.

3.4 Sampling Techniques

The purposive sampling technique was used to hand pick a class of grade 12 pupils at each school to answer the questionnaires as these secondary schools only had one grade12 chemistry class each. The pupils were drawn only from grade 12 as these were assumed or deemed to have long and adequate experience of, and interaction with, the chemistry curriculum.

Ten (10) grade 12 pupils (5 females and 5 males in case of co-education schools where total enrolment was between 30 and 40) were picked using systematic random sampling from among the pupils who answered the questionnaires. This was done by picking every 4th leaner from each of the girls' - boys' class list. But as few as 4 pupils were randomly picked for interviews where the total enrolment of pupils was as low as 13 by picking every 3rd student from class list.

3.5 Data Collection Instruments

The following instruments were employed to collect data:

3.5.1 Questionnaires

These were of three types, one for teachers, another for (HoDs) of Natural Sciences and the other for pupils.

3.5.2 Interview Schedules

Interviews were conducted with teachers and with pupils respectively as follow-ups to help fill in gaps or clarify any unclear matters from questionnaires.

3..6 Data Collection Procedures

The actual procedure began with questionnaires being distributed by the researcher to teachers, pupils and HoDs. Interviews were conducted soon after the respondents had filled in their respective questionnaires.

3.7 Data analysis

Data captured in this study were analysed by making use of software, Excel. This analysis made use of descriptive statistics which involved: frequency tables, charts and percentages.

4.0 RESULTS

4.1 Introduction.

The researcher presents findings on the research conducted to establish the impact of gender on performance and the suitable strategies critical to improving learners' performance in chemistry.

4.2. Teachers' Experience

The study sought information on the teachers' experience as this was deemed to have a bearing on the pupils' performance in chemistry. The data obtained on this were presented in figure 4.1

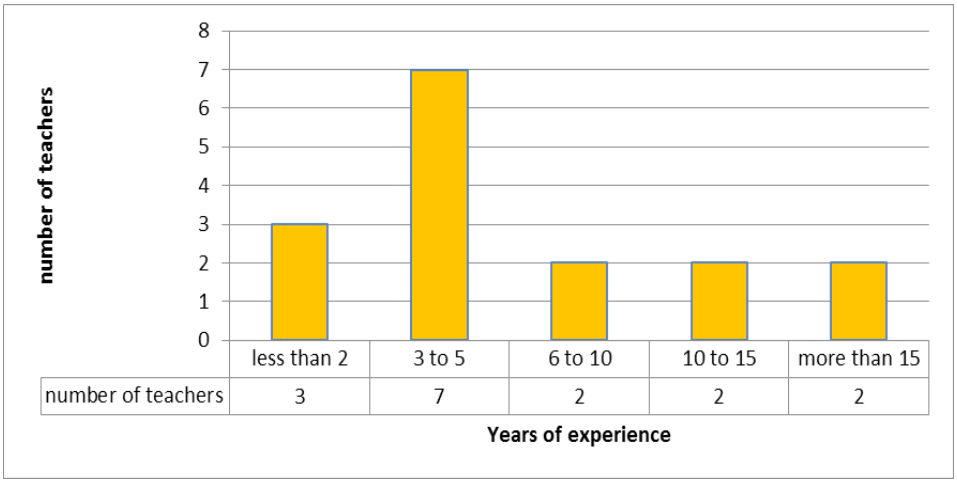

Figure 4.1 Teachers' experience

Figure 4.1 indicates that, of the 16 chemistry teachers involved in this study, three (18.75%) had only taught chemistry for less than 2 years, nine (56.75%) had taught for 3 to 10 years. It also shows that only four (25%) of the teachers had taught for at least ten years. It was generally discovered that among teachers of the same qualification, those who had longer experience taught better and produced better pass rates as they, over the years, had improved their pedagogical skills including improvisational skills, and demonstrated a better psychological understanding of learners than their counterparts.

4.3 Teachers' Qualifications

Data were collected on teachers' qualifications so as to see a nexus between performance and teacher quality. Data presented in figure 4.2

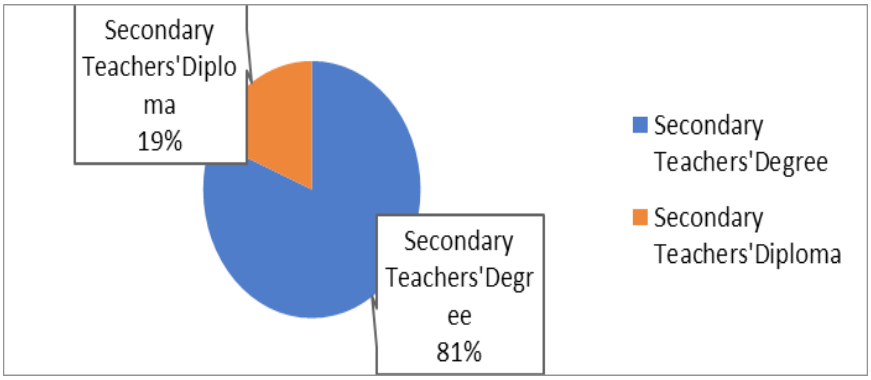

Figure 4.2 Summary of Teachers' qualification

Figure 4.2 shows that the majority (81.5%) of the chemistry teachers were degree holders, and a smaller proportion (18.75%) of them had a secondary teachers' diploma. It is clear from the findings that although 18.75% of the respondents taught chemistry to senior pupils, they did not qualify to do so. Only teachers with a secondary teachers' degree officially qualify to handle senior pupils (grades 10-12) in secondary schools. The implication is that intellectual competence of the teacher is a primary asset in the quality of learning the students acquire in schools. There is also need to realise that poorly qualified teachers are very likely to transmit wrong descriptions of observations, misconceptions, misinformation and misapplication of content taught and scientific terminologies.

4.4 Chemistry Teachers' Teaching Load

The information about the teaching loads of the chemistry teachers was sought as it was assumed that this could have had a relationship with the pupils' performance in chemistry. Data were shown in figure 4.3

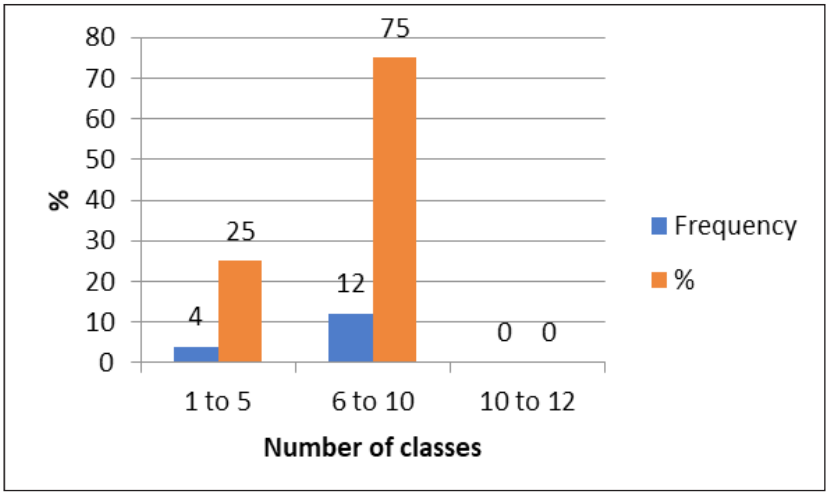

Figure 4.3 Chemistry teachers' teaching load

According to figure 4.3, a total of 16 chemistry teachers gave responses about their teaching load. The results indicated that 12 (42.1%) of the chemistry teachers taught between 6 to 10 classes while four (25%) had between 1 and 5 chemistry classes. The high teaching loads as indicated for some teachers could be attributed to the fact that the same teachers taught other sciences in addition to chemistry.

4.5 Pupils' profile

4.5.1 Pupils Performance in Chemistry

The information on the pupils' performance in chemistry was sought from the chemistry teachers and the pupils themselves in order to establish whether or not there was a relationship between the perception of difficult topics in chemistry and the pupils' actual performance.

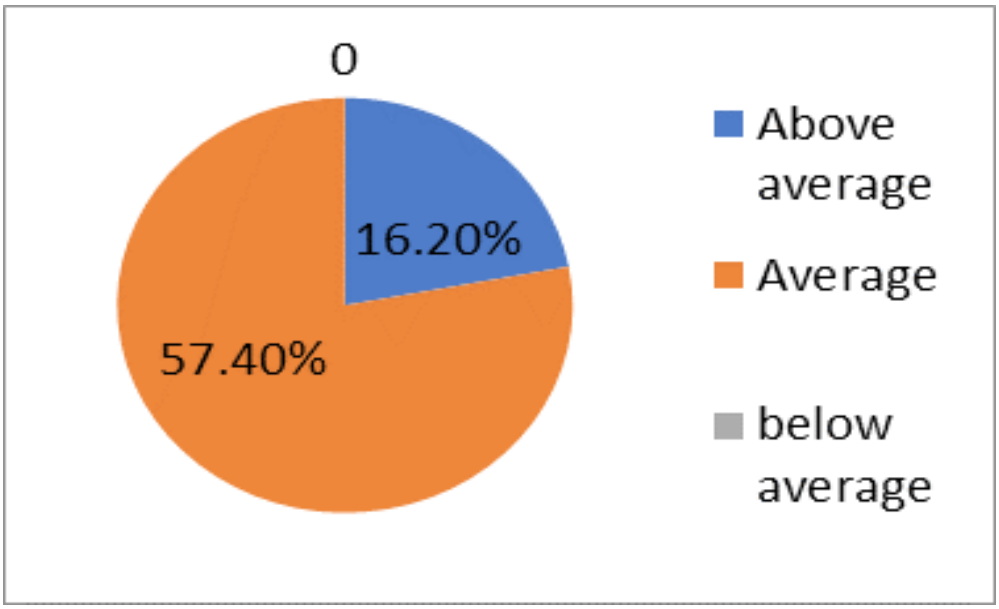

Figure 4.4 Pupils' responses about their performance in chemistry

Figure 4.4 shows what the pupils said about their performance in chemistry. It indicates that more than half (57.4%) of the respondents said their performance was average A small proportion (16.2%) of the pupils said their performance was above average.

4.5.2 Pupils' Favourite Science Subject

Information was obtained on the favourite science subject of the research population to try and establish their perception of chemistry. The data obtained were analysed and presented in Figure 4.5

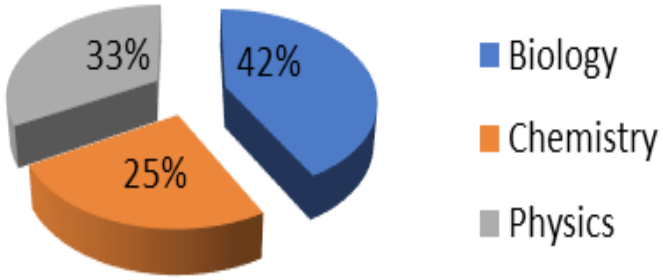

Figure 4.5 Pupils' responses about their favourite science subject

Figure 4.5 indicates that the majority (42%) of the pupils said their favourite science subject was biology, 33% mentioned physics and a relatively small proportion (25%) of the respondents said chemistry. The figure suggests that chemistry is the least popular science subject among pupils and this is an indication that there is a negative perception of chemistry subject.

4.6 Possible Practical Teaching Strategies to lessen Pupils' Learning difficulties

The findings on this theme were obtained from questionnaires and interviews. The study sought information on the strategies that could be used to lessen the pupils' learning difficulties. As many as 221 pupils completed the questionnaire while 68 pupils were orally interviewed to give responses as to how the pupils' learning challenges would be lessened. The data obtained were analysed and presented in Table 4.1.

Pupils' responses	N	%
Give assignments/ homework to pupils	57	19.00
Teacher should not be too fast	22	7.00
Conduct practicals / experiments	47	15.50
Revisional /Remedial work	74	24.00
Use practical/ real examples	37	12.00
Provide handouts e.g. pamphlets	47	15.50
Regular assessment	20	7.00
TOTAL	**304**	**100**

Table 4.1 Pupils' ideas about how best teachers could help them learn the difficult topics

Table 4.1 shows the findings from the questionnaires about the pupils' responses as to how best they would want to be helped to learn difficult topics with ease. A number of ideas were advanced. The majority (24%) of respondents said there was need for the teachers to conduct a lot of revisional wok and provide enough remedial work. A proportion of 19% mentioned giving a lot of assignments, exercises, and homework so that pupils are exposed to constant practice. The Table further shows that 15.5% of respondents suggested that teachers needed to conduct practical work or experiments to help clarify theoretical concepts. Another 15% suggested handouts which includes pamphlets in order to provide pupils with simplified and suitable notes on difficult topics. A relatively small proportion (12%) of respondents said teachers would be very helpful if they cited real or practical examples in the course of teaching.

Information on the strategies that could be used to lessen the pupils' learning difficulties was sought from the pupils through the oral follow-up interviews, 68 pupils were interviewed and the data obtained were presented in Table 4.2.

Pupils' responses	F	%
Motivate and encourage	5	10.6
Conduct practicals / Experiments	6	12.8
Allocate enough time to difficult topics	3	6.4
Provide handouts / books	7	14.9
Give practical / real examples	4	8.5
Give more assignments/ home work	3	6.4
Conduct revisions / remedial work	9	19.1
Teacher to simplify language	3	6.4
Teacher to use T/L resources plus ICT	4	8.5
Give guidance on study skills	3	6.4
Total	**47**	**100**

Table 4.2: Pupils' ideas about how best teachers could help them learn the difficult topics

The findings in Table 4.2 which were obtained from the follow-up interviews show pupils' thoughts about how best the teachers could help them learn better the topics they perceived as difficult. The table indicates that the majority (19.1%) of the respondents mentioned conducting revisions and providing remedial work often. A significant proportion (14.9%) of respondents said that teachers should provide well prepared handouts and some suitable books tailored to cover the topics perceived to be difficult. About 13 percent (12.8%) said that conducting practical activities and relevant experiments by the teacher would lessen their challenges in learning difficult topics. The findings also show that 10.6% of the pupils said

that teachers needed to encourage and motivate pupils to enhance learning. Less than ten percent (8.5%) said giving meaning and practical or real examples in the course of teaching would be helpful. Another 8.5%cited employing concrete teaching and learning resources to link theory to reality.

During the follow-up oral interviews, some pupils emotionally expressed the following sentiments.

i. "Teachers should be researching before coming to teach. He should also be motivating, he says you guys will not pass" (student 3 [F, 8])
ii. "Some teachers just rush to finish the syllabus, they should be interested in teaching to make pupils understand the concepts" (student 5 [F, 8])
iii. "In this modern world, technology can be of help in simplifying difficult topics. Things we cannot see should be presented on LCDs and by screens" (student 8[M, 04])
iv. "Teachers do not attend to us who are slow learners and he says even if you also write a test, you will still fail. He should learn to encourage and motivate us. We need write tests as well." (Student 4 [F,03]).

The statements the pupils made during the oral interviews were explaining and highlighting the major challenges they faced in the classroom and they equally explained why pupils' performance was not pleasing or satisfactory.

4.7 Teachers' Responses

4.7.1 Teachers' Responses about the Pupils' Performance in Chemistry

The findings on this theme were based on 16 teachers who attended follow up interviews. The data obtained were presented in the figure 4.9

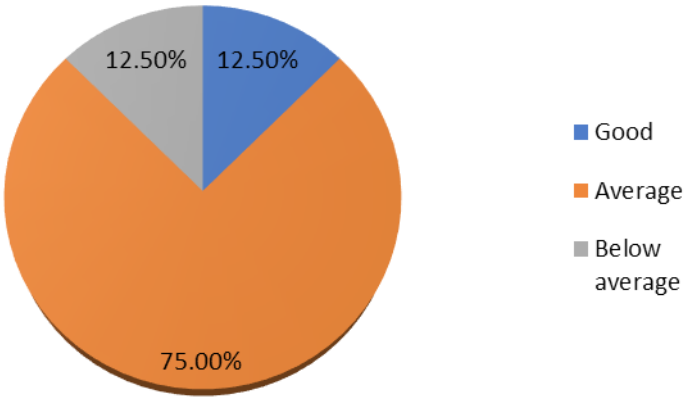

Figure 4.6 Teachers' responses about the performance of pupils in chemistry

Figure 4.6 shows that the majority (75.00%) of chemistry teachers described the pupils' performance in chemistry as average. It also indicates that 12.50 % of the teachers considered their pupils' performance as being below average. Another 12.50% of teachers described the pupils' performance in chemistry as being good.

4.7.2 Possible practical teaching strategies to lessen pupils' learning difficulties

The findings on this theme were obtained from questionnaires and interviews. The study sought information on the strategies that could be used to lessen the pupils' learning difficulties. Sixteen teachers completed the questionnaire and were then orally interviewed to give responses as to how the pupils' learning challenges would be lessened. The data obtained were analysed and presented in figure 4.20 and 4.21.

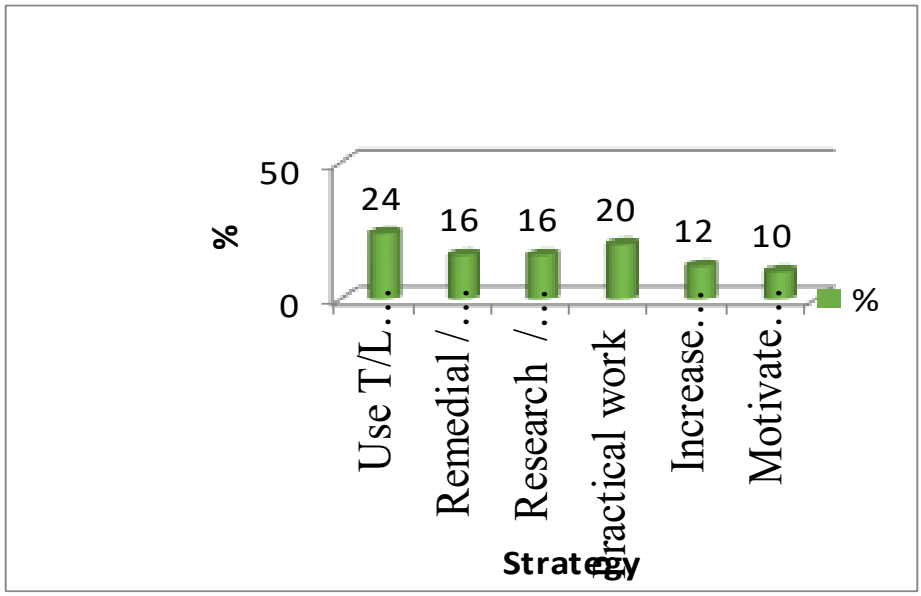

Figure 4.7 Teachers' suggested strategies to lessen pupils' learning difficulties

The data presented in figure 4.7 which were obtained from the questionnaire show that the majority (24%) of the respondents said that providing teachers with learning resources alongside an integration of ICT in teaching chemistry would help lessen the challenges the chemistry teachers face when teaching difficult topics in chemistry. Another good proportion (20%) of respondents said, employing practical activities or work would be helpful to learners. Some respondents cited giving remedial or revisional work often to pupils as a strategy that would greatly help the learners get the concepts. This is represented by an equal proportion of 16%. A small proportion (12%) of teachers said difficult topics in chemistry

needed enough time, meaning that the difficult topics should be allocated enough time so that they were adequately handled rather than just rushing through as was the case sometimes. Another small proportion (10%) of teachers indicated that motivation of learners was vital in so far as making learners understand the topics that are challenging is concerned.

The study sought information on the strategies that could be used to lessen the pupils' learning difficulties from chemistry teachers through follow-up interviews. Sixteen teachers were orally interviewed to give responses as to how the pupils' learning challenges would be lessened. The data obtained were analysed and presented in figure 4.8.

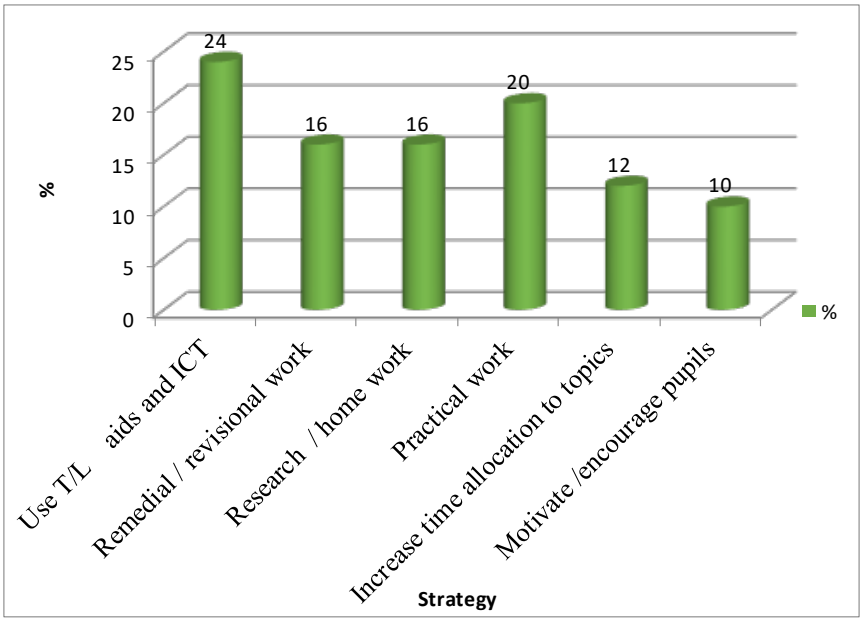

Figure 4.8: Teachers' suggested strategies to lessen pupils' difficulties

Figure 4.8 which shows the data collected from the oral interviews show that the majority (28%) of the respondents said challenges would be minimised when teaching difficult topics if teachers constantly give remedial and revisional work. A proportion (17%) of respondents indicated that giving extra work and assignments including home work would be an effective strategy to make pupils understand the topics that are perceived as difficult. Some teachers said provision of suitable notes through handouts and pamphlets, and effective use of learning and teaching resources would help pupils grasp difficult concepts. This is represented by an equal proportion of 13.8%. A small proportion (10.3%) of teachers said that teaching pupils in a way that would lead to their being motivated would be helpful. Teachers emphasised the fact that there is need to motivate pupils in various practical ways including teaching with interest. Some respondents cited the use of practical activities as an effective way of clarifying theoretical and abstract

concepts, others said there was need to allocate enough time to topics that pupils perceived as difficult as this will give an opportunity to pupils to conceptualise at their own pace to ensure deep understanding. This was represented by 10.3%.

4.8. Heads of Departments' responses

The researcher obtained data based on teaching strategies from 8 HoDs

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4.8.1 Practical Teaching Strategies to lessen Pupils' Learning Difficulties

The findings on this theme were obtained from a questionnaire. The study sought information on the strategies that could be used to lessen the pupils' learning difficulties. Eight HoDs completed the questionnaire to give responses as to how the pupils' learning challenges would be lessened. The data obtained were analysed and presented in figure 4.9 below.

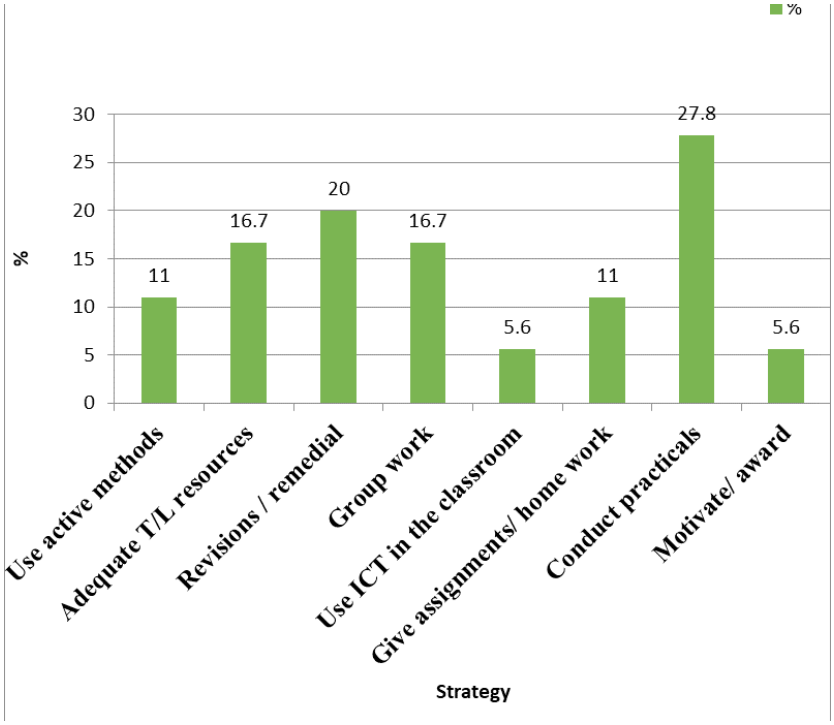

Figure 4.9 HoDs'suggested strategies to lessen pupils' learning difficulties

Figure 4.9 shows significant interventions that teachers would embark upon to lessen pupils' challenges as suggested by HoDs. Most respondents (27.8%) cited conducting practical work to clarify theory. A proportion of 20% indicated revisional and remedial work as an effective way of making learners get the concepts well. Effective use of teaching and learning resources was cited by 16.7% of respondents who said this would most effectively help the pupils learn the most

difficult topics in chemistry. An equal proportion (16.7%) of HoDs stated that use of group work proved to be useful in helping pupils who were lagging behind with respect to topics perceived to be difficult as they effectively learn from peers. The figure also indicates that 11% mentioned use of active methods that engage pupils effectively in the course of learning process as opposed to teacher-centred methods. Other respondents (11%) mentioned the act of constantly giving learners homework or assignments so that they become active researchers a situation that will enable them understand difficult topics.

5.0 Discussion

5.1. Effect of gender on pupils' perception of learning difficulties

After analysing the results presented in chapter four in reference to the effect of gender on learning chemistry, it was concluded that gender difference had an impact on the pupils' perception of learning difficulties. Teachers of chemistry acknowledged this fact but they were not agreed on which gender, per se, had a better or a more positive perception of learning difficulties. Teachers who taught chemistry in co-education schools indicated that the boys understood the topics faster and were more likely to endure and work on the difficult topics until they grasped the concept than the girls would. This thought is supported by Tekkya *et al.* (2001) whose findings showed that there were more girls than boys who perceived scientific concepts as difficult to learn. The findings were further reinforced by Tinkling, Croxford, Ducklin & Frame (2001) who, in their study, also indicated that there were more girls than boys who perceived scientific concepts as difficult to learn. This is because, unlike girls, b**oys** were seen as more competitive, more confident, and more willing to accomplish a task as opposed to low esteem and passive dependant behaviour of girls.

In single sex schools, however, teachers were either ambivalent or indicated that gender did not play any role in determining the perception of difficult topics in chemistry. They further suggested that the topics that boys found difficult to learn, girls found them easy to learn and *vice versa*. This goes without saying that teachers were not agreed on which gender has a better or a more positive perception of learning difficulties. This is in agreement with Mavrikaki *et al.* (2012) who revealed in their study they conducted that teachers did not seem to ascertain whether it is the male pupils or their female counter parts who perceive more learning difficulties than the other.

As can be seen, the study concluded that gender difference had an effect on how pupils perceived the difficult topics in chemistry. It would therefore be important for other scholars to take it up and conduct a research to establish why gender is a factor in the perception of difficult topics.

5.2 Possible Practical Teaching Strategies to Lessen Pupils' Learning Difficulties

The possible solutions which would lessen learning difficulties have been discussed in relation to the following categories:

5.2.1 General Learners' Difficulties

The study concluded that the following solutions would help lessen general learners' difficulties.

i. Conducting practical work.
ii. Revising difficult topics and providing remedial lessons.
iii. Strengthening formative assessment through additional assignments or research work or homework.
iv. Motivating pupils.
v. Providing pupils with study resources, for example, tailor-made handouts / pamphlets and others.
vi. Strengthening teaching of mathematics in schools.

The study established that conducting practical work would be one of effective strategies to ease pupils' learning difficulties. If schools have to effectively go around the pupils' learning challenges posed by the difficult topics, teachers of chemistry need to conduct practical activities. Practical work is not only engaging, but it also brings reality into the classroom and serves as a bridge between real life and theory, a situation that immensely enhances pupils' understanding of abstract terms. Failure to use laboratory activities on the part of the teacher as Onyegegbu (2001) explains, makes it rather difficult for pupils to grasp difficult and abstract concepts. The findings are further supported by Akeem and Ikechukwu (2015) who strongly argue that lack of adequate practical periods, and laboratory facilities causes the teaching of chemistry to be ineffective in most secondary schools. The theoretical concepts which are not necessarily complex, would prove to be so in the absence of suitable practical work.

In some schools, teachers confessed outright that they rarely conducted practical work and attributed this to lack of necessary equipment and apparatus. The teachers also cited the absence of a laboratory technician as a factor that equally caused them not perform practical work often. In fact, of the eight schools under study, only one school had employed a laboratory technician. A technician , as teachers suggested, is indispensable in schools as she or he helps teachers prepare practical activities in good time. School administration should ensure that essential personnel are available to support academic work in schools as this is the core business of learning institutions. This way, a teacher would find it easy to conduct practical work as it would save time that is wasted on running around to prepare and set the experiments or practical work prior to execution.

Another helpful strategy that the study confirmed, was the need for teachers to embark on strengthening formative assessment through administering quizzes, assignments research work or home work very often in the course of teaching so as to easily diagnose the pupils' weaknesses in good time with a view to redressing the situation. When learners are given a task, they are naturally compelled to research and study in order to work at a task. This way, they appreciate and deeply understand concepts they are dealing with. Teachers need to make corrections or additions with the class together and discuss how best it could have been alternatively done. Formative assessment which occurs as an integral part of teaching and learning process provides a wide spectrum of opportunities to assess how pupils are learning so that the information thus collected could then be used to make necessary adaptations and adjustments to learning with a view to improving pupils' achievement. The findings are supported by Black & William (1998), Boston (2002) and Baroud (2007) who strongly advise that there is no better alternative to formative assessment if the intention is to improve the pupils' performance especially with regard to difficult topics.

It was also concluded that motivating pupils was a vital ingredient to boost their confidence and interest. However difficult a topic may be to learners motivation will always be a major factor in their ability and willingness to learn it (Johnstone & Kellett, 1980 in Sirhan, 2007). In support of this, Resnick (1987) emphasises that learners will engage more easily and eagerly in activities that are interesting, meaningful, and engaging as they tend to be intrinsically motivating to learners. It follows closely, therefore, that if the teachers of chemistry do not devise motivational activities or motivational teaching and learning strategies, the pupils will always *tune out* and fail to understand even topics that they could otherwise excel in when given a motivating learning environment. Schools should publicly award hard working pupils (through praising, tokens including cash, allowing high achievers to learn without paying school fees, conducting career talks by guest speakers, allowing pupils to present work to peers, among others).

It was further established though that the teachers may employ motivational devises in a bid to improve the pupils' performance, but pupils would still not significantly excel if they do not strive to be responsible for their own learning ,and that self-driven learning (intrinsic motivation) is the best *panacea* to pupils' learning difficulties. Therefore, to strike a balance, teachers' motivational techniques should involve cultivating in the pupils a deep sense of responsibility that puts pupils in the drivers' seat to promote deep learning.

This study also concluded that providing pupils with study resources, for example, tailor-made handouts / pamphlets is an effective strategy to improve pupils understanding of material being learned. School administrators and teachers should therefore rise to the challenge and take initiative of providing well summarised and user-friendly handouts or pamphlets especially on the topics that pupils perceive as difficult. This will help alleviate the problem of lack of suitable textbooks, poorly stocked libraries and lack of internet connectivity which was the case in almost all schools under study. Young (1994) and Woodley (2009)

back this and argue that the poor pupils' performance in chemistry with respect to difficult topics is as a result of some schools not having relevant textbooks and other chemistry learning resources that pupils need to effectively learn and study the challenging topics.

The study concluded that strengthening teaching of mathematics in schools which is a factor vis-à-vis learning chemistry would greatly help. Therefore, the School Administration, Natural sciences and Mathematics Departments should collaborate and devise mechanisms of teaching mathematics effectively. For instance, schools should ensure that pupils taking chemistry subject also take and pass mathematics. The critical role that mathematics plays in learning chemistry should be well communicated to pupils including their parents or guardians so that they attach value to, and appreciate, learning mathematics. Schools should make *mathematics club* compulsory to all pupils in a chemistry class. This way, they will learn and acquire mathematical skills in a fun and interesting manner.

5.2.2 Teacher's incompetence

The study concluded that the following solutions would help lessen pupils' learning difficulties relating to teacher's incompetence.

i. Conducting school-based CPD and attending Subject Associations meeting (ZASE)
ii. Upgrading teachers
iii. Enhancing monitoring of teachers

The study established that conducting school - based CPD and attending Subject Associations meeting (ZASE) further improves and sharpens a teacher's pedagogical skills and approaches, deepens his or her professional knowledge, content knowledge and improves pastoral care for the learners. As for 'novice teachers', CPD is a *vehicle* that delivers to them the practical knowledge of pupils' psychological learning needs, the insight into how pupils learn chemistry, and it is a platform that enriches teachers with relevant experience in their profession. Hence, school administration should strengthen the implementation of CPD policy through SPRINT frame-work existing in schools today, and make CPD meetings mandatory to all teachers. Specifically, encouraging subject teachers' meetings would be *a silver bullet* in this case as the teachers share pedagogical knowledge regarding how to teach challenging topics in chemistry. These meetings would equally provide deep collaboration among teachers teaching the same subject, a situation that gives more confidence to a teacher to teach learners better than ever before. (Adalikwu & Lorkpilgh,2013)

The study concluded that upgrading teachers who did not possess the required qualification (a bachelor's degree in chemistry) but taught chemistry to senior classes (grades 10 to 12) would really boost the teacher's content knowledge and confidence to teach chemistry competently and effectively. The school head teachers should facilitate this upgrading of teachers through their respective School

Management Boards as this comes with a cost so that the university fees are not necessarily a burden on that teacher.

It was further established that enhancing monitoring of teachers of chemistry would be an important strategy to improve pupils' performance. The school administration in close collaboration with Heads of Natural sciences Departments should draw up a monitoring schedule. The Head of Department or the Deputy head of the school should every so often monitor the teachers' performance using a monitoring instrument the school has devised in order to make certain that teaching is actually going on. This would provide the school and the department with vital information relating to quality of teaching, and how the teaching is being executed.

5.2.3 Inadequate Infrastructure

The study established that the following solutions would help lessen pupils' learning difficulties relating to infrastructure.

- Procuring equipment, apparatus, chemicals and other relevant practical materials.
- Setting up chemistry - specific laboratories in schools

The Study concluded that procuring the needed equipment, apparatus, chemicals and other relevant practical materials would improve teaching of chemistry as a subject. It is the responsibility of head teachers to improve the teaching of chemistry in their respective schools by providing what is required for the teachers to perform experiments or practical activities to enhance learning. Pupils' performance can be dramatically changed and improved if head teachers prioritise procurement of what is needed to teach chemistry.

5.2.4 Unsuitable teaching methods used

The study concluded that the following solutions would help lessen pupils' learning difficulties in relation to unsuitable methods employed by teachers.

i. Using a variety of suitable and active teaching methods.
ii. Allocating enough time to difficult topics.
iii. Integrating ICT / Virtual Instrumentations (VIs) in teaching.

The study established that using a variety of teaching and learning techniques or methods could help chemistry teachers to lessen the pupils' learning difficulties in relation to difficult topics. The use of effective, active instructional strategies promotes deep understanding as an individual is rigorously engaged in constructing meaning and sharing knowledge. For example, *speed dating, swap meet, Rally robin, Jigsaw, text- rendering, market place, think-pair-share, whip around, conveyor belt, think with feet, Socratic method and individual presentation* among

many other active instructional techniques.

The study established that allocating enough time to difficult topics would not only greatly provide learners with enough space to concretise their understanding but they will also have an opportunity to grasp the difficult topics way before writing their examinations. Generally, the topics that pupils perceive as difficult were taught few weeks before the final examinations, and pupils hardly understood these topics. For instance, the findings confirmed that organic chemistry is notably among the difficult topics that were either taught few weeks before the final examination or not taught at all. The topics pupils find problematic should be covered in very good time way before the examination time. This, naturally, eliminates the act of rushing and teaching at a pace not in agreement with the learners' rate of understanding.

The study further established that there was need to integrate Information and Communication Technology (ICT) in teaching chemistry to aid learners' understanding of difficult topics. Teachers should seriously get committed to integrating ICT in their chemistry lessons. For example, the *chemistry crocodile software,* available online, at www.crocodile-chemistry.software.informer.com is one such effective example that integrates ICT into the classroom teaching to yield positive results. The software could be downloaded free, but gives a teacher an opportunity to easily use *Virtual Instrumentations* which uses a software with a specific user interface. With this software the users have the latitude to create own applications by designing what a particular whole process requires. One might ask, how helpful and effective are *Virtual Instrumentations (VIs)?* A teacher will create practical activities or experiments that she or he intends to use in the course of classroom teaching. For example, demonstrations on titration involving a base and an acid which will not only involve indicator colour change but will also provide pH values for various reactions between a base and an acid. Displacement reactions including single or double decomposition of reactants could be part of the simulations prepared. Additionally, difficult reactions in chemistry such as substitution, addition, condensation reactions, among others could easily be demonstrated to help the learners get the concept in a concrete manner. The *VIs* platform provides a platform that teachers could explore and exploit to make teaching and learning not only real but also very interesting. The *VIs* concept if popularised and embraced by teachers would be an effective teaching strategy that would greatly simplify theoretical concepts and guarantee learner engagement (Gorghiu et al.,2006).

There are a number of suitable websites that teachers of chemistry need to visit and download free videos or simulations to help them teach chemistry realistically. Teachers can visit the following websites to access free teaching materials as well as animations or simulations needed to not only to simplify their teaching and make it a lot more interesting but also to make learners grasp chemistry concepts well with ease. The websites will provide easy-to-use but state-of-the-art videos designed to meet learning needs of a typical Zambian learner. For example, teachers

can explore the following websites: www.youtube.com/watch ; www.learner.org; www.teachertube.com; www.youtube.com/user. www.youtube.com/user/virtual; www.open.edu/openlearning. https//phet.colorado.eduen, www.periodicvideos.com/index. www.olabs.org.

Teachers of chemistry should easily down load on 'You-tube' interesting chemistry lessons which involve simulations and animations especially with regard to practical work. They should be able to demonstrate any practical activities including those that, under normal laboratory circumstances, would not be carried out. For example: if a teacher needs to download an experiment *on the rate of chemical reactions on* a smart phone or computer, this simple procedure could be followed: touch or click on icon *U-tube,* touch or click on *search icon,* search by indicating *experiment on rates of chemical reaction play list.* This way specific videos will be displayed and a teacher only makes a choice of which video suits the outcomes best. By indicating *playlist* in your search area, a full video on rates of reaction will play. This video can be shared and saved so that learners watch it at the right time. Learning in this case is effective because *seeing* and *hearing* enhance understanding.

There is this misnomer that teachers would only use ICT in the classroom if they had computers and had access to internet. Teachers have to realise that even use of phones, DVD/CD players, radios, video cassette recorder, TV sets and decoders is a very effective and efficient way of integrating ICT in the classroom. For instance, a chemistry teacher would play a DVD/CD to show the rate of reaction and demonstrate collisions between reacting molecules. Life-like situations as this, would help pupils understand concepts more effectively.

6.0 Conclusion

The study has established that gender difference had an impact on the pupils' perception of learning difficulties . Pupils' learning difficulties could greatly lessen by conducting practical work, revising difficult topics and providing remedial lessons, strengthening formative assessment through additional assignments or research work or homework, integrating ICT / Virtual Instrumentations (VIs) , motivating pupils , using a variety of active teaching techniques, allocating enough time to difficult topics and providing learners with study resources . This includes : tailor-made handouts or pamphlets so that they have the information they need for their study, conducting school-based CPD and attending subject associations (ZASE) , upgrading teachers, procuring necessary equipment, apparatus and chemicals and setting up a chemistry- specific laboratory.

6.1 Recommendations

In view of the findings presented and conclusions drawn in this study, it is recommended that:

i. There should be a rigorous regular monitoring of the teaching of chemistry in both public and private secondary schools by the local school authorities as well as by external authorities who may include the Senior Education Standards Officers (SESO), District Education Standards Officers (DESO), and Education Standards Officers (ESO) so that the teachers of chemistry intensify their lesson preparation and formative assessment including the aspect of improvisation.

ii. School boards or District Education Boards or Provincial Education Boards through fundraising ventures or Government grants should renovate and restock chemistry laboratories in terms of necessary equipment or apparatus, chemicals, models and other required teaching and learning materials to ensure effective teaching of chemistry in schools.

iii. School Boards should impress upon the Government to establish modern computer laboratories and effective internet connectivity at all public secondary schools in order to promote integration of ICT in the classroom teaching.

iv. Secondary schools should support and strengthen school- based CPD, which would provide teachers of chemistry with an opportunity to interact and exchange ideas based on the best pedagogical practices with respect to teaching chemistry.

v. The head teachers, through School Boards, should facilitate the upgrading of chemistry teachers with low professional qualifications by sponsoring them for further studies (degree programme) so that they have the required minimum qualification to teach chemistry with confidence, and effectively.

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