CHEMISTRY TEACHERS' USE OF LEARNER-CENTERED STRATEGIES IN LARGE CLASSES: THE CASE OF SELECTED SCHOOLS IN KITWE DISTRICT.

By

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DECLARATION

I, Shadreck Nicoya., do hereby declare that this dissertation represents my own work and that it has not previously been submitted for a degree at the University of Zambia or any other University.

Signed 06/11/08

APPROVAL

This dissertation by Shadreck Nkoya is approved as a fulfilment of the award of the degree of Master of Education in Science Education by the University of Zambia.

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ABSTRACT

The purpose of the study was to find out if teachers of Chemistry were using learner-centered teaching strategies to large classes in order to enhance individual learning in selected Government High schools of Kitwe district on the Copperbelt Province in Zambia. The objectives of the study were to: determine the learner-centered strategies teachers of Chemistry were using in large classes, how they were using the strategies, the extent to which they were using the strategies and determine constraints if any they were experiencing when using the learner-centered strategies.

The research design was a descriptive survey. It employed three instruments of data collection, namely, self-administered questionnaire for the teachers of Chemistry, the teaching strategies observation schedule and video recording of Chemistry lessons. The questionnaire's aim was to identify the teachers who were teaching Chemistry using learner-centered strategies to a large extent. The teaching strategy observation schedule and the video recording of the lessons were to find out what the teacher's practice in the classroom really was. From the twenty-three (23) teachers who responded to the questionnaire, a sample of nine (9) teachers comprising of six (6) females and five (5) males were purposively sampled as subjects of study. Data collection involved observation of lessons of the nine teachers by means of observation schedules and video recording of the lessons. Qualitative data was analysed using narrative accounts while quantitative data was analysed by means of frequencies, percentages using Excel a computer statistical tool.

The study found that teachers were teaching large classes of an average size of 55. The science laboratories where the teachers taught from were also very under resourced. The learner-centered strategies group work, demonstrations, discussions, project, problem-solving and question and answer techniques were used despite the conditions of large classes and under resourced science laboratories. The teachers also varied their teaching strategies in the individual lessons with an average of three learner-centered strategies per lesson. The constraints identified to have affected the teacher's use of learner-centered strategies included the level of professional qualification of the teacher, years of teaching experience, and lack of teaching and learning materials.

The following recommendations are being made:

- The Ministry of Education should prepare, produce and distribute teacher's guides on the use of learner-centered strategies to schools.
- Colleges of Education and Universities should train student teachers as well as in-service teachers in the use of learner-centered strategies in large and under resourced classrooms.
- The identified learner-centered strategies, which worked well in the study, should be disseminated to practicing teachers by means of in-service programmes.
- Parallel research should be done to establish if learners construct they own knowledge when teachers employ the identified strategies in large classes.

DEDICATION

This work is dedicated to my children Pilati, Mulapwa and Shadreck and wife Charity who have supported me in all my endeavors.

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LIST OF ABBREVIATIONS

AIEMS	Action to Improve English, Mathematics and Science
AFCLIST	African Forum for Children Literacy in Science and Technology
AFT	American Federation of Teachers
BeSST	Better Secondary School Trained Teachers
COSETCO	Copperbelt Secondary Teachers' College
DFID	Department For International Development
JICA	Japanese International Cooperation Agency
LCT	Learner-Centered Teaching
MASTEP	Mathematics, Science and Technology Extension Programme
MEC	Ministry of Education and Culture
MOE	Ministry of Education
MOET	Ministry of Education and Training
SMASTE	Strengthening Mathematics, Science and Technology Education
SAARMSTE	Southern African Association for Research in Mathematics, Science and Technology Education
UNZA	University of Zambia
VVOB	Flemish International Cooperation and Technical Assistance (Belgium)
ZATERP	Zambia Teacher Education Reform Programme
ZASE	Zambia Association for Science Educators

CHAPTER ONE: INTRODUCTION

1.1 Introduction

Chemistry is one of the subjects offered at High school level in Zambia from grade ten to twelve. Chemistry classes in Zambia are usually large, that is well over forty learners in a class. Chemistry lessons can be taught using two main strategies. Those centered on the teachers, which are referred to as teacher-centered and those that center on the learner. The teacher-centered strategies are regarded not to be the best way of teaching and learning (Clegg, 1989; Kasanda, 2003 and Khoboli and Malcolm, 2004) because it makes use of a lot of lecturing. Teacher-centered teaching is characterized by the teacher giving information to the learners and the learners listening passively without taking an active role in their own learning. The teacher-centered strategy also makes learners to memorise facts instead of understanding and applying the information to other situations in everyday life (Cohen et al., 2002; Tobin, 1993). It has also been observed that, although lectures are an economical way to spread lots of information to a large group, they are not an ideal way to learn how to think about a subject and stimulate high order thinking (Mehta; 1995, Mehta et al., 1998). Teacher-centered teaching is also considered not to be the most appropriate method of teaching Science (Tobin, 1993). Studies done in Zambia show that the teacher-centered strategies are the most popular strategies used by most teachers in high schools including teachers of science subjects (Chiyeke, 1987; Lifalalo, 1995; Koshimura, 1997; Shanyinde, 2001; Haambokoma et al., 2002; and Haambokoma, 2004).

The current trends world over is to teach using strategies that provide opportunities for learners to participate in the learning process (Bracey, 1995; Stork, 2001). In

developed nations such as Belgium, Sweden and the United States of America (Bracey, 1995; McCombs, 1997; American Federation of Teachers, 2001) there has been a move for teachers to implement the learner-centered approaches. The results show that teachers were using more interactive methods of teaching and less teacher-centered ones (Bracey, 1999). In many countries of Africa, learner-centered teaching has been embraced and is being used as the strategy of teaching and learning in schools (Baie, 2003). The countries in Southern Africa, which have incorporated the learner-centered strategies in the teaching and learning in schools, include Namibia, Lesotho, Swaziland, Botswana and South Africa. According to Kasanda (2003) and Clegg (1989) learner-centered teaching is being used in almost all schools in Namibia. Lesotho and Swaziland have also made policies on education to shift the teaching to learner-centered teaching instead of the lecture strategy as reported by the Lesotho Ministry of Education and Training (MOET, 2000), Khoboli and Malcolm (2004) respectively. Yandila et al. (2002) reported the case of Botswana where learner-centered teaching was introduced following the adaptation of the General Certificate Secondary Education Science Syllabus in 1997. In South Africa also, Brodie et al. (1994) and Brodie et al. (2003) also report of the reforms where the Ministry of Education is shifting the teaching and learning in schools from teacher-centered or traditional ways of teaching to interactive ways of teaching and learning termed learner-centered.

In Zambia, as is the case in most developing countries, classes are large and under resourced especially in urban areas where there are 40 or more learners in a class. The Ministry of Education's statistics gives average class teacher: pupil ratio in urban provinces of up to 1:60. The book: pupil ratio is 1:10, while pupil: desk ratio

is 1:4 (MOE, 2005). Despite the above stated conditions, the Zambian government has been encouraging teachers to use learner-centered teaching strategies (MOE, 1996). The teachers in Zambia therefore teach large classes, which are under resourced, and the morale of these teachers is low due to poor conditions of service (Kelly, 1991). This was the case with the schools in this study.

The Zambian government's policies on education which are contained in *Educating Our Future* (MOE, 1996), emphasizes that teaching must be learner-centered. It says:

> "*... the Ministry will promote a variety of teaching strategies with a focus on stimulating learning through inquiry, guided-discovery, problem solving, application, and similar activity-based teaching and learning methods*" (p. 32).

Other documents encouraging teaching in a learner-centered way in schools and colleges include the Ministry of Education Strategic Plan on Education (2003), and Zambia Teacher Education Reform Program (ZATERP) (2000).

In line with the policy, the Zambian Ministry of Education and a Belgium organization, the Flemish Office for International Co-operation and Technical Assistance (VVOB), in 2003 came up with a project aimed at training Mathematics and Science teacher trainers in the use of learner-centered strategies. To accomplish this, a project called Better Secondary School Trained Teachers (BeSSTT) started at the two Secondary Teachers' Colleges, Nkrumah Teachers' College in Kabwe and Copperbelt Secondary Teacher's College (COSETCO) in Kitwe. Each college had identified six high schools at which teachers were trained on how to use learner-centered strategies through workshops, meetings and school based demonstrations

of sample learner-centered lessons. With the support of the BeSSTT project, the teacher trainers developed materials and sample lessons in learner-centered teaching. The learner-centered lessons developed were then tried out in the pilot study at the schools identified by the two colleges. This study sought to investigate the use of learner-centered strategies by the teachers trained by the BeSSTT project in Kitwe District of Zambia. These schools had the teachers of Mathematics and Science trained in the use of learner-centered strategies. The schools were Mukuba, Mindolo and Kitwe Boys High Schools.

1.2 Statement of the Problem

Since teachers in selected High Schools in Kitwe District of Zambia were trained in using learner-centered teaching strategies, in large and under resourced chemistry classes, it was not clear how the teachers were using learner-centered teaching strategies. This study sought to bridge this information gap.

1.3 Purpose of the Study

The purpose of this study was to investigate how teachers of chemistry were using learner-centered strategies in teaching chemistry in large and under resource classes in three selected High Schools in Kitwe District.

1.4 Objectives of the Study

The specific objectives of this study were:

1.4.1 to determine which learner-centered strategies chemistry teachers of large classes were using during lessons.

1.4.2 to establish how chemistry teachers were using learner-centered strategies in large chemistry classes.

1.4.3 to determine the extent or frequency of use of learner-centered strategies in large chemistry classes.

1.4.4 to establish difficulties (if any) teachers of chemistry were experiencing when using learner-centered strategies in large classes.

1.5 Research Questions

The research questions for this study were;

1.5.1 What type of learner-centered teaching strategies do chemistry teachers use in large classes?

1.5.2. How do teachers use these strategies when teaching chemistry to large classes?

1.5.3 How frequently do teachers use these strategies in large chemistry classes?

1.5.4 What difficulties do teachers of chemistry experience when teaching large classes using learner-centered strategies?

1.6 Significance of the Study

It was hoped that the study would generate information on teaching strategies that teachers of Chemistry would use in teaching Chemistry to large classes in a more effective manner. Further, it was anticipated that the findings of this study would provide insight to chemistry teacher educators on how best they could train student teachers to use learner-centered strategies when teaching Chemistry to large and under resourced classes.

1.7 Limitations of the Study

This study was limited by the several factors. First, we managed to record on tape only twenty-seven lessons. Second, the size of the sample, namely nine teachers who took part in the study were drawn from a group of many teachers in the Kitwe District. Only this number of teachers could take part in the study due to the scope of the study and the limited resources that were available. This small number is not a good representation of the teachers in the Kitwe District. The findings of the study therefore could not completely be generalized to all the teachers of Chemistry in the Kitwe District. However, the study managed to establish the strategies some of the teachers were using in teaching large classes in the Kitwe District.

1.8 Operational Definition of Terms

The following are the definitions used in this study.

Cooperative Learning: Refers to a learning technique in which the learners are members of an interdependent problem-solving group in which they collaborate, share and delegate responsibilities, practice with others of varying abilities, and also practice to communicate with others.

Constructivism: Refers to the theory of learning, which states that learners construct their own knowledge of the world around them, through experiencing things.

Didactic teaching: Is used to mean the way of teaching, where the teacher does most of the talking while the learner passively receives the information.

Epistemology: Refers to the philosophical study of how scientific knowledge is constructed and acquired.

Large Classes: Is used here to mean classes of forty-one (41) learners or more.

Learner-Centered Lessons: This refers to the type of lesson where the teacher does not do most of the talking and activities in the lesson. Instead the learners take responsibility of their own learning by being actively involved in the knowledge acquisition.

Practical Work: Refers to a learning situation that involves practicing science skills and using scientific equipment.

Pragmatic: Being pragmatic, refers to a situation where the teacher allows learners to solve problems or do activities in a lesson in a way that will work well with the conditions in the classroom rather than trying to do exactly according to a theory of learning.

Pupil/Class Ratio: This refers to the number of learners divided by the total number of classes available.

Problem Solving: This refers to the events when learners work to find the solution to a question or problem raised by the teacher or learner.

Project Work: Refers to a task given to the learner or group of learners by the teacher to supplement and apply a classroom topic.

Strategy: This refers to a teaching or learning way the teacher uses to make aware of the learners' knowledge and skills stated in the curriculum.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter presents the theoretical framework of the study, and review of literature related to this study.

2.2 Theoretical Framework

This study was influenced by the constructivists, who hold the idea that, learners construct and build their own knowledge of the world around them through experience (Piaget, 1970; Vygotsky, 1978; Driver, 1988; Tobin, 1993; Gespass and Paris, 2001; Wofoel, 2002). In this regard the learners are encouraged to actively participate in the learning process as opposed to listening to lectures by the teacher. To teach using learner-centered strategies the teacher will use strategies such as group work, project work, field trips, asking open–ended questions and generally giving the learner freedom during the learning process.

The study worked on the learner-centered notions, which are based on the constructivist theory. There are many forms of constructivism. This study's epistemology was pragmatic constructivism. Pragmatic constructivism is not to take constructivism to extremes such as radical constructivism (Tobin, 1993). Therefore to be pragmatic, is to be concerned with causes and effects or needs and results rather than ideas or theories. According to Brodie et al. (2003), learner-centered teaching has a long history, as far back as the Plato - Socratic dialogue, where through some strategic questioning, the teacher draws out the ideas of the learner.

A comprehensive presentation of learner-centered idea was in the 18th century. Friedrich Froebel (a German) is known to have used the term explicitly in 1889 (Brodie et al., 1994). On the use of the term learner-centered teaching an American named Dewey did experiments at a school in the United States of America where the curriculum was centered on children's interests (Cuban, 1993). In the same school young learners were encouraged to make decisions as to what they would learn. According to Cuban (1993) the learners in that school worked together independently with minimum teacher supervision.

The first attempt in science education to teach in a learner-centered way was made by Armstrong (Pragg, 1973; Jenkins, 1979). Armstrong was concerned with applying the history and philosophy of Science and psychology of learning to Science teaching. He believed that children could be trained to discover things, and that the process involved observing, and reasoning (Levinson, 1995).

In Britain, the Nuffield project that started in 1964 was aimed at improving the teaching of science (Levinson, 1995). Among its aims was to have learners with a good understanding of Science. The project also encouraged learners to think freely and courageously about Science on their own. The role of the teacher was to give enthusiasm and encouragement to the learners so that they could learn. This type of teaching was learner-centered, since they attempted to a large extent to consider the learner in the teaching and learning process. The learner-centered ideas and constructivism are built on Piaget's theory of how children learn (Piaget, 1970). This study was conducted within this framework to look at the extent to which the

teachers' strategies were adapted to large classes and under resourced classes in the teaching of Chemistry in Zambia.

2.3 Review of Related Studies on Use of Learner-Centered Strategies

2.3.1 Learner- Centered Strategies

The term, "learner-centered" can be described as a concept and a practice in which pupils and teachers interact and the teachers do not dominate as the only sources of information in the classrooms. It proposes a worldwide change from learning that is teacher-centered and puts emphasis on learning outcomes. It is not aimed at minimising the importance of the teacher in the classroom arrangement. Instead, instruction is broadened to include other activities that produce desirable learning outcomes (such as critical thinking and problem solving). Learner-centered teachers organize their lessons so that learners take responsibility for their own learning. The teachers design the lessons in a way such that the learners get the educational experiences to advance their learning (World Bank, 1995; Thekwane, 2001; Wofoel, 2002).

A learner-centered lesson relies on strategies that encourage students' interaction with the content, with one another and the teacher, and with the learning process. It encourages students' reflection, dialogue, and engagement in activities. McCombs (1997), Weimer (2002) and Bain (2004) outlined the characteristics of lessons that could be termed learner-centered similar to what this study has taken learner-centered teaching to be.

Bain (2004) gave several characteristics of teachers who embrace learner-centered teaching. According to him such teachers touched the lives of their learners; they placed a strong emphasis on student learning and outcomes through varied forms of assessment.

The study by Bain established that teachers who embraced learner-centered teaching, regardless of the school being resourced or under-resourced had the following characteristics: they knew their subject material well, were active and had valued critical thinking, problem-solving, and creativity on the part of the learners. He further argued that the teachers value teaching and have trust in the learner. The teachers also created a learning atmosphere not one of intimidation but that which allows learners to try, and continue trying even after they failed at first or second attempts. Bain (2004) continued to state that learner-centered teachers viewed teaching to begin with the learner and they had valued the individual learner in the class. According to Bain, "learner-centered teachers, did not teach the class as a whole, but that they taught an individual learner" (p. 43).

With regards to changing to learner-centered teaching, Weimer (2002) established that the change is not always initially welcomed by learners who often prefer passive learning. However later on the learners find the experience of learning in a learner-centered way better than the teacher-centered. She also found that in a learner-centered lesson there is power sharing between the teacher and the learners, and that the final control still remains with the teacher. The study concluded that student learning becomes even more effective when learners are teaching fellow learners and are involved in the marking of work given by the teacher.

McCombs (1997) emphasized the role of interactions between the teacher and the learners. McCombs said that learner-centered lessons have a good learning environment, be it in the classroom or outside. The study also emphasized the importance of having different strategies in teaching. In this case the teacher must be able to vary the teaching strategies in order to accommodate what fits each learner.

2.3.2 Arguments Against Use of Learner-Centered Strategies

There have been debates on use of learner-centered strategies in most developing countries of Africa. Brodie et al. (2003) reported on problems teachers encountered of having to deal with challenges of teaching according to the curriculum given by their Ministry of Education and in a given time in terms of periods per week and at the same time trying to be learner-centered. According to Brodie (2000) teaching in a large and under resourced classroom is a challenge to most teachers, but using learner-centered approaches under these conditions presents an even bigger challenge to the teachers.

Clark (1984) and Tatto (1999) argued that the ideas of learner-centered teaching and its theoretical basis may need to be changed with local realities to suit in the local situations. This is true with respect to Zambia (Walubita, 1993) and the rest of the developing world, because the conditions are quite different from those in the developed world, where teachers competently employ these strategies.

Darden (2003) pointed out that when the learners are put in groups doing experimental work or other activities in Science, it couldn't be assumed that they are constructing knowledge on their own. He argued that, the learners might be seen to be engaging in learner-centered activities but they could be thinking of other things. This may be true in the case of group work, where not every learner in that group is engaged in the work assigned to them by the teacher to the same commitment. Hence activities like group work require good planning and monitoring on the part of the teachers who teach in a learner-centered way.

Phungphol (2005) established that some teachers were of the view that learner-centered strategies cannot work for inexperienced learners and teachers. The teachers argued that the strategies require use of prior knowledge on the part of the learners which most learners lack. Further, they said that transferring the role, the power, and the control of teachers to learners, particularly to very young children can not work. The learners might be too young to know what they want to learn and how to learn. It is also argued by Clark (1984) and Tatto (1999) that learners could not construct their own knowledge in science laboratories, which they said encourage prearranged activities and teacher dominance. Clark and Tatto also argued that the learners in the laboratory were generally offered little opportunity to construct their own knowledge. This view is quite debatable. The science rooms could be used to teach in a learner-centered way and would encourage the learners to construct knowledge. This can be achieved by the teacher letting the learners discover things on their own by the activities given or solve problems using the practical activities in the laboratory. In this way the learners could construct their own knowledge in the science laboratories.

2.3.3 Arguments for Use of Learner-Centered Strategies

On the other hand there are many researchers that advocate for learner-centered teaching even in under resourced and crowded classrooms. For example, Edwards and Mercer (1987) said that, in a poorly resourced and large class, one could still use learner-centered approaches if she or he consistently tried to probe for pupils' meanings and tried to create an atmosphere where learners felt safe to participate.

Naidoo (2004) reported a teacher teaching a large class (44 pupils seated and 99 standing). The report however said that the teacher used learner-centered strategies too in such a class and that learning took place.

Liman et al. (2001) in the Mathematics and Science Teachers Extension Programme (MASTEP), module for science teachers who take up learner-centered teaching in Namibian High schools outlines strategies which could work in science teaching even in unfavourable situations. Strategies such as group work, discussion, project, field trips and others that teachers of science can use have been recommended in the manual. According to Liman et al. (2001), the strategies when used make teaching to be more learner-centred. The module also explains that teaching in such a way would encourage learners to construct their own knowledge in science lessons.

In education the world over, learner-centered or interactive way of teaching is considered as the best practice (World Bank, 1995). Researchers in education also point to the type of teaching that involves strategies like group work, discussion, project work and field trips (Cohen et al., 2002; Tobin, 1993). That these strategies could let learners take responsibility for their own learning and result in meaningful learning to take place.

Comparing the two views in literature and basing on the constructivist view of learning and taking into account large classes and under resourcefulness, the learner-centered strategies could be used in large and under resourced science classrooms. This could be possible if the teachers are well qualified for the

particular level of education, experienced and know their subject areas very well (Bain, 2004; McCombs, 2000 and Weimer, 2002).

2.3.4 Use of Learner-Centered Strategies in Africa

The World Bank (1995) encourages the implementation of teaching and learning strategies that maximize learning on the part of the learners. The report further states that learners who take responsibility for their own learning tend to understand the respective subject areas as well as apply the same knowledge in their day-to-day living in a community. Such a community with well-informed citizens will develop socially and economically (Kelly, 1991). As a result of this view governments in the Southern African sub-region have advocated for the implementation of learner-centered teaching in their schools.

For instance in Namibia, learner-centered teaching has been in place for more than ten years (Kasanda, 2003; Kasanda et al., 2003; Kasanda et al., 2005; Ministry of Education and Culture, 1993). When the new education policy for Independent Namibia was formulated, learner-centered education was chosen as a basis for reform in Namibia (Ministry of Education and Culture, 1993). Appropriate learner-centered courses for each grade level were developed, produced and supplied to schools. Also in-service and pre-service training in learner-centered teaching strategies were provided to support the teachers (Kasanda, 2003).

According to Clegg (1989) and Hoey (1989) most teachers in Namibia were using learner-centered strategies in all subjects including science through out the country. Kasanda (2003) however reported of some problems with regard to learner-centered

teaching implementation, such as teachers with pre-independence training and experience having difficulties to change from teacher-centered to learner-centered strategies. Other problems cited were that, not all teachers were effectively using the learner-centered strategies due to shortage of instructional materials, inadequate training, the curriculum being examination driven, and lack of practical activities in science.

Lesotho also implemented learner-centered education (MOET, 2000). Khoboli and Malcolm (2004) looked at the views and understanding of learner-centered education by Science teachers in Lesotho after the new curriculum was implemented. The results showed that teachers were aware of learner-centered strategies and its implications, but had a weak understanding of it and did not use it widely in their teaching. Studies with respect to learner-centered strategies in South Africa by Brodie et al. (2003) and Howie et al. (2002) are about teachers taking up learner-centered strategies after the implementation of the new curriculum, dubbed, Curriculum 2005. The results were not different from those in Namibia and Lesotho presented above (Brodie et al., 2003). In South Africa also it was found that teachers who were used to teach using lecture method were slow to change to learner-centered teaching strategies introduced by the authorities (Brodie et al., 2003). The study (Brodie et al.) concluded that teacher characteristics, such as prior qualifications, reflective competence, subject knowledge, access to resources and support structures in their schools, were factors which affected the teachers to take up learner-centered strategies.

The Zambian Ministry of Education's documents on Policy on Education namely *Educating Our Future* (MOE, 1996), *Strategic Plan on Education* (MOE, 2003) and *Zambia Teacher Education Reform Programme* (MOE, 2000) emphasized on learner-centered teaching, that is the use of teaching strategies that provided opportunities to learners to participate in the learning process. In Zambia the situation is not different from that in other countries cited above. Lifalalo (1995), Koshimura (1997) and Haambokoma et al. (2002) found that lecture method was dominantly used in teaching of Science in Zambian schools and most of these schools were under resourced and classes were large.

It was certain that teaching methodologies needed to place greater emphasis on self-initiated and self-sustained learning (Kelly, 1991). Co-operating partners in education such as Japanese International Cooperation Agency (JICA) and VVOB through subject associations such as Zambia Association for Science Educators (ZASE) and Department For International Development (DFID) through projects such as AIEMS (Action to Improve English, Mathematics and Science) have promoted learner-centered strategies in the teaching of Mathematics and Science (Koshimura, 1997). Resources such as Resource Centres and transport had to be put in the system so that the interventions could work. The Zambian government has also been eager to implement learner-centered strategies in the schools as seen in the *Educating Our Future* (MOE, 1996). It identifies learner participation in the classroom saying; "... *the learner is at the focus of the entire education process, and that the education system existed solely for the learner* ..." (p. 28).

The Ministry of Education (1996) however identifies lack of research in these issues and says that there was inadequate information on the teaching and learning processes within the schools and colleges. It further states that there was need for systematic programmes of research to investigate these issues at National and local levels (MOE, 1996).

One of the variables, which affect use of learner-centered teaching strategies, is the class size that is the number of learners in the class. In the next section, the use of learner-centered strategies and the issue of class size will be considered.

2.3.5 Class Size Controversy

Information exist (UNICEF, 1994; World Bank, 1995) that the size of classes in developing world are larger than in developed world. A report by United Nations International Children Education Fund (UNICEF, 1994) compared the class sizes in European countries and African countries and pointed out the differences in these two regions of the world. For example countries like Sweden and Norway have an average of 12 learners in a class while African countries like Central African Republic have 90 learners in a class. The reasons given for larger classes in developing countries is the large expansion of student enrolments after the declaration of universal primary education (Onwu, 1985). The World Bank (1995) reported of African countries whose school enrolments grew rapidly both in the primary and secondary levels of education after the declaration of universal education, *"...some Sub-Saharan countries figures showed that by the late 1980s the number of primary pupils increased by a factor of four and the number of high school pupils by a factor of 14 due to the declaration...."* (p. 23). The existence of

large classes is a reality in developing countries and Africa especially the Sub-Sahara region.

The Zambian picture of classes being large is not different from the rest of most Sub-Saharan African countries reported by the World Bank (1995). Kelly (1991) reports that the population of school-going children in Zambia increased enormously from 1.5 million at the primary level in 1985, to an estimated 2.5 million by the year 2000. The Ministry of Education (2005) Annual School Census showed that the average pupil class ratio stood at 45. The Nation Policy document, *Educating Our Future* (MOE, 1996), reports the following on the reality of large classes in Zambian High Schools: *"The average class-size is over 45, which is too high for this level. Very large classes are particularly characterised of Grade 12 where, in 1994, average class sizes of 47 or more was recorded for five of the large provinces..."* (MOE, 1996: 51). Problems of large classes and the classes being under resourced are a norm in developing countries and the situation presents a challenge to the teachers on the choice of teaching strategies to use in such classes.

On the choice of teaching strategies to use in large classes and the way to teach in these classes is a controversy the world over. The rest of this section highlights the findings of studies done on the best teaching strategies recommended for the teachers to use in large classes in order to have meaningful learning.

One such a study conducted to establish the relationship between class size, performance and the teachers' use of interactive teaching methods was done in Tennessee State in the United States of America (Bracey, 1999) called Project

STAR (Student/Teacher Achievement Ratio). For five years the study examined various class sizes and the teachers' use of interactive methods of teaching. The findings were that there was no significant correlation between the teachers' choice of teaching strategy and the size of the class.

Another study according to Bracey (1995) was between the classes in Japan and those in the United States of America. The class sizes in Japan were found to be large compared to those in the United States of America. When comparing the teachers' use of the teaching strategies and learner performance, it was found that the teachers in Japan with large classes used more interactive teaching methods and learners achieved more than their United States counterparts. However this was not attributed to the size of the classes and teaching strategies, but to the fact that Japanese students spent lots of time out of school studying while American students did not.

McLean (2001) prefers small classes in order to achieve better pupil performance and teachers' use of what he called authentic instruction. According to him, in small classes the learner is placed in an environment of doing things rather than a listener only, and while in that environment the learner assimilates the practices and beliefs associated with the discipline. In other words McLean was suggesting that learner-centered teaching strategies could not be used in large classes as compared to smaller ones.

Carolyn and Randolph (1989) on the other hand argued that teachers in small classes used similar strategies to those used by teachers who taught large classes.

They pointed to study findings on different class sizes, that the size of the class did not affect teaching practices. Further the findings showed that, in some cases teachers did not change their teaching practices if the class size became smaller. Another study by Sharpson (1980) showed that teachers did not modify their teaching strategies when placed in smaller classes. The study found that class size made little or no difference to instructional methods used. It suggested that teachers needed to be trained in the use of teaching strategies for different sized classes.

Glass and Smith (1979; 1980) conducted an exhaustive study on the effect of class size and teaching strategies. They found that teachers used more learner-centered strategies in class sizes with very few learners of less than 15 learners. Glass and Smith concluded that the size of the class does not to a large extent affect the teachers' choice of a teaching strategy. Hanushek (1998) and Ellis (2004) also found that there is no relationship whatsoever between teaching methods and class size. They however recommended having highly qualified and experienced teachers. According to them, these are the factors which affect the teacher's choice of teaching strategies.

Effect of large classes in relationship to the use teaching strategies in Africa by teachers have also been studied extensively. In South Africa, studies by Naidoo and Reddy (1994), Papo (1999) and Frazee and Radnitski (1995) compared the teachers' use of teaching strategies in different class sizes. They concluded that size of class taught does not have an impact on teaching effectiveness and selection of teaching strategies by teachers. Frazee and Rudnitski (1995) also observed that large class teaching did not negatively affect student's learning and that student's

reactions to large classes depended more upon the quality of instruction than the actual class size. Melton (1996) who did a similar study also came to the conclusion that teachers could be effective in their teaching despite the size of the class.

In Nigeria, Alonge (1985) investigated the effect of class size and strategies used in teaching of Chemistry. According to him, there were no significant differences in the choice of strategies by teachers between classes of 40, 60 or 120 pupils. Another study was by Ndakwe (1995) in which teachers used the same learner-centered strategies in small and large classes. It was found that there were only minimum differences in learner performance, pupils in the smaller classes performed slightly better. He also concluded that class size does not affect teachers' choice of the teaching strategy or learners' performance.

A study conducted in Southern province of Zambia by Lifalalo (1995) compared the relationship between the size of the class and the pupils' interactions amongst themselves and the teacher. The study was conducted at Linda High School in Livingstone and Chikankata High School in Mazabuka. The study showed that the teachers did not change their learner-centered strategies whether the class was small or large. These findings were in line with the Ministry of Education's National Assessment survey of learning achievement at the Middle Basic School level in Zambia (Ministry of Education, 2003). The survey showed that the teachers used learner-centered strategies such as group work, oral question and answer and researching new topics while teaching various class sizes.

2.3.6 Teaching Large Classes

Teaching of large classes seems to be a challenge for schoolteachers, school managers and communities at large. Some studies have supported this common notion, and especially if interactive strategies like the learner-centered ones are to be used. According to Johnson et al. (1991), Felder and Brent (1983) and Wankat and Brent (1994), the teaching of large classes using learner-centered strategies may not be effective or practical because of the large number of learners. Mehta and Schlecht (1998), also argued that teaching a large class itself is challenging and introducing learner-centered strategies in large classes is even more challenging.

The American Federation of Teachers (AFT) (2001) is one of the organizations which proposed splitting large classes into smaller ones. According to them, if large classes are split into smaller ones meaningful learning would take place. But studies by Hanushek (1998) and Sharpson (1980) found that splitting large classes into smaller ones brings about other hidden problems. They argued that small classes have shortcomings. They contended that for teaching to be effective, it's not only the size of the class that matters but that there must be an adequate supply of qualified teachers. Hanushek (1998) and Sharpson (1980) were also of the view that the cost associated with the implementation of small classes were also too high compared to the impact of small classes on learning. Their concerns were not completely groundless: reducing class size does not mean that the teachers would automatically use learner-centered strategies.

Some researchers (Ajewole, 1995; Mehta, 1995; Mehta et al., 1998; Noble, 2000; Stork, 2001; Montagna and Toth, 2002) suggest strategies that could effectively be

used in large classes. Oral questioning, project work, discussions, demonstrations, pairing of learners to do tasks and small group work have been suggested as some learner-centred strategies in large classes. The studies (Stork, Mehta and Mehta et al.) concluded that these learner-centered strategies had been proven to be effective in large classes. They further stated that these strategies were very useful in increasing class participation, acquisition of problem solving skills, critical thinking, improvement of communication, collaborative learning, attention, and attendance.

Stork (2001) pointed out that to teach effectively in large classes one had to add active learning i.e. involving the learners in the learning process. In active learning the teacher ensures that at every opportunity the learners are involved by either asking questions or letting learners pair up and discuss a problem given by the teacher. McKeachie (1994) supports the view that large classes could be taught using learner-centered strategies. According to him, if learners in a large class are in groups doing practical work, it would encourage skills like problem solving, and critical thinking and make large class teaching more effective. Other methods described by McKeachie included the use of learners researching certain topics on their own, peer-to-peer assessment and collaborative quizzes, which do not take a lot of time and resources. According to Stork (2001) one simple way learners could be engaged during a lesson in a large class was to ask questions, and instead of calling on individual learners for the answer, one had to let the learners discuss the answer with partners. The questions asked also should be at a higher cognitive level that is application, analysis, synthesis or evaluation according to the Bloom's taxonomy (1959).

2.4 Summary of the Literature Review

From the literature review in this chapter, it became clear that there was need for change world over in teaching strategies from teacher-centered or traditional to learner-centered. It was brought out that when learner-centered teaching strategies are used, the learners are able to construct and build their own knowledge of the world around them. The next chapter deals with the methodology used in collecting data for the study.

CHAPTER THREE: METHODOLOGY

3.1 Overview

This chapter on methodology presents the methods employed in this study to collect and analyse data. It gives descriptions of design, research site, population, sample description, the sampling procedures, research instruments, data collection procedures and data analysis. Before undertaking the study, a pilot study was undertaken on student teachers from COSETCO who were doing teaching practice in the Kitwe District.

3.2 Research Design

The study used a descriptive survey design. A survey was chosen as a method of collecting data due to the nature of the data and purpose of the study. A descriptive survey has several characteristics which are most appropriate in order to address the research questions. The survey design is the most suitable way of addressing the research questions as suggested by Cohen et al. (2002) and Gay (1996). A descriptive survey has a number of characteristics and those reflected in this study include:

- Using the same instruments for all the participants in order to gather standard information.
- Capturing data from questionnaires and observation schedules. The data obtained can be generalized within given parameters.
- Using of sampling techniques in order to present a target population.

In order to obtain comprehensive results, qualitative research methodology was mostly used. Qualitative and quantitative techniques compliment each other in that each of the techniques dwells on the other. Therefore, the qualitative research

method was employed due to the fact that the research questions were open-ended. Hence the study's main objective was to find new ways of how chemistry teachers could use learner-centered strategies in large classes. The fact that the research had a qualitative aspect, demanded that the field of study was to be in a natural setting of teachers of chemistry engaged in their normal everyday activities and as such there was no need of an experimental group. The study used questionnaires, lesson observation schedule and video recording of the lessons which were the most appropriate ways of collecting qualitative data. These methods provide many angles of understanding the problem and as an internal way of triangulation (Harris, 2003).

3.3 Research Site

The study was undertaken in Kitwe District on the Copperbelt Province of Zambia at three High Schools, namely Kitwe Boys, Mukuba and Mindolo. These schools were chosen for the study because Science teachers at schools were trained by the BeSSTT project based at COSETCO in the use of learner-centered strategies. In these same schools classes were large.

3.4 Target Population

The targeted population was all Chemistry teachers and large classes at the High schools in Kitwe District who had been inducted in the use of learner-centered strategies by the BeSST project. The Science teachers in these schools were chosen because they were easier to be accessed and ready to be observed while teaching as compared to the many that were not trained and would not easily cooperate (Cohen et al., 2000). Kitwe District was specifically chosen because it had a number of high schools with large and under resourced classes. In order to get more comprehensive

data, the study included twenty-three teachers of Chemistry who had indicated in the self-administered questionnaire that they were using learner-centered strategies to large classes to a great extent.

3.5 Sample Size

A sample of nine (9) teachers of Chemistry in the target schools who had indicated in the self-administered questionnaire that they were using learner-centered strategies in large classes to a great extent were picked for the study. This sample was representative enough because of the nature and purpose of this study. The study required a relatively small sample size because it required the application of triangulation in data collection instruments, i.e. lesson observation schedule and video recording of the lessons (Cohen et al., 2000). If a larger sample were picked, it would have been very difficult to triangulate the data collecting ways especially lesson observation which would have required a lot of time.

3.6 Sampling Procedures

Three high schools were picked due to the size of their chemistry classes and having teachers who had been trained on how to use learner centered strategies. Using purposive sampling, nine teachers were selected for study, that is, three from each school. These nine teachers showed from the questionnaire that they were teaching Chemistry to large classes using learner-centered strategies. The nine (9) teachers who participated in the study were given the codes A, B, C, D, E, F, G, H and I for ethical reasons.

3.7 Instruments

The research instruments used were a self-administered questionnaire, a lesson observation schedule sheet, and video recording of the lessons.

(i) Questionnaire

The questionnaire was adapted from Lifalalo (1995) but modified to fit this study. It mostly contained closed ended questions in order to have focused responses. The first part of the questionnaire had questions, which solicited for the demographic characteristics of the teachers. The answers to this part of the questionnaire were one-word answers or selecting the items that were appropriate. The second part of the questionnaire solicited from the teachers' information about the teaching strategies they used in their teaching. The last part of the questionnaire had questions on the large classes and the type of teaching strategies the teachers were using. For these two parts, options were given and the teachers selected the ones appropriate to them. The questionnaire helped the researcher to identify the teachers who to a large extent were using learner-centered strategies in teaching Chemistry to large classes.

(ii) Classroom Observation Schedule and Video Recording

The observation schedule (Appendix II) had rows and columns. The rows had teaching strategies being used and what the class was doing. The columns had teaching time from one minute up to sixty minutes of the lesson. The schedule was used to monitor the type of activities the teacher and learners were engaged in for each minute of the lesson. The video recordings of lessons were used to further

probe on the teachers' use of teaching strategies and the time they spent on each strategy.

The use of the observation schedule and video recording of the lessons was a way of triangulating (Harris, 2003). Howie and Crayson (2002) pointed out that questionnaires must not be used alone when finding out what teacher practice was. They argued that teachers do not practice what they say and therefore the best way to find out about the strategies teachers use is to see what they actually do in class. Hence, field notes, questionnaires, recordings and interviews were recommended.

3.8 Piloting Instruments

In order to test the suitability of the research instruments, a pilot study was conducted on a different group of teachers. The pilot study was conducted in the second term of 2005 academic year on the COSETCO student teachers that were doing their teaching practice in Kitwe District. The questionnaires were distributed to the twenty-six student teachers in three schools, namely Chibote Girls, Malela and Hellen Kaunda High Schools. From the feedback, the questionnaire was amended for clarity of questions, and logical ordering of questions.

The video recording of lessons and the use of observation schedules were also done during the pilot study. This helped to come up with the best positions of the camera in the classrooms and where to focus the camera when various strategies were being used in the classroom. The pilot study also helped to avoid other technical problems that could have been experienced like the camera batteries becoming discharged in the process of filming a lesson.

3.9 Data Collection Procedures

The data collection took place in the third term of the 2005 High School and College academic year during the months of September and October. Permission to carry out the study at the three High schools was sought from the Head Teachers by means of letters from the Principal of COSETCO who introduced the researcher as a member of staff at the college and stated the purpose of the study. The first activity was the distribution of a self-administered questionnaire to all the teachers of chemistry in the three schools. The teachers were given a week to respond to the questionnaire. All the teachers of Chemistry in the three High schools answered and there was a hundred percent return of the questionnaires. Nine teachers were identified, three from each school. These nine teachers had shown from the questionnaire that they were teaching Chemistry to large classes using learner-centered strategies. The major data collection involved the use of a teaching observation schedule sheet (Appendix II) and a video camera.

For each lesson the researcher sat at the back of the classroom and a well-trained cameraman recorded the proceedings. The researcher had a stopwatch, a ball pen and a blank sheet of the observation schedule. Immediately a lesson started the watch was started and the camera was switched on. On the observation schedule, a tick was made each minute for the activity happening. The ticks were also made to indicate if the teacher was talking to the whole class, small group or individual learners. The other information gathered was the type of activities the learners were engaged in such as doing a practical, writing an exercise, reading, discussing among peers, asking questions, giving explanations, observing and demonstrations,

listening to the teacher or copying from the board or paper and the time it took for each activity.

The observation schedule also provided for the ticks to be made to show each activity if it was being controlled by the teacher (educator) or the learners. Brief notes were also taken on the observation schedule to record any activity or happening that was not included on the observation schedule. The name of the school, teacher's code, class, name of observer, topic of the lesson and the number of learners present were also recorded on the observation schedule.

3.10 Data Analysis

The analysis of qualitative data combined the data sets from the video recordings of the lessons and from the observation schedule sheets. For each of the lesson observed the videotape was played back, transcribed and the strategies the teacher used were identified and the time the teacher spent on each strategy. From the observation schedule sheets, the ticks were also counted under each strategy to show the time spent on each strategy by the teacher. The data from the video tape recording was then compared with what was recorded on the observation schedule. The data was put according to the teaching strategies. Some data was categorized and re-categorised until the major themes emerged. The quantitative data was presented in form of tables and figures in chapter four. The qualitative aspects of the data were presented in narrative form to explain each lesson and the strategies that came out as recommended by Chenail (1995) and Malcolm and Kowlas (2002).

For quantitative data, the data was presented in form of percentages, and rankings. Also a computer-based software Programme, Microsoft Excel was employed to generate graphs, as recommended by Vithal and Jansen (2002).

3.11 Ethical Considerations

All the teachers who took part in the study were assured of confidentiality and no names of teachers and schools were used in the data presented as recommended by Cohen et al. (2002).

CHAPTER FOUR: FINDINGS

4.1 Preview

This chapter contains results of the study. The findings have been presented according to the research questions and have been presented in form of narratives, tables and figures.

4.2 Teachers' Perceptions of Learner-Centered Strategies and Large Classes

A self-administered questionnaire (Appendix I) was administered to all the twenty-three (23) Chemistry teachers who participated in pilot study and were teaching in the three schools selected for the study to find out their perceptions on teaching large classes using learner-centered strategies. The self-administered questionnaire was also aimed at finding teachers who were using learner-centered strategies while teaching large classes. The following presentations are giving the information that came up.

4.2.1 Teachers' Induction in the Use of Learner-Centered Strategies

Item number 7 on the questionnaire asked the teachers to indicate whether they had been inducted or made aware of the learner-centered strategies. All the 23(100%) respondents said that they had been inducted in the use of learner-centered strategies. The induction was done by means of workshops and in-house training programmes. The lecturers from the Copperbelt Secondary Teachers' College had inducted them during the workshops and the training, which had involved presentations and sample lesson demonstrations.

4.2.3 Regular Use of Learner-Centered Strategies

Item 8 on the questionnaire solicited for evidence of whether the teachers of Chemistry in Kitwe District who had been inducted in learner-centered strategies were using the strategies in their teaching. All the respondents 23(100%) indicated that they regularly used learner-centered strategies in their teaching of Chemistry.

4.2.4 The Extent to Which the Teachers Used Learner-Centered Strategies

Item 9 on the questionnaire asked the respondents to indicate the extent to which the workshops and in-house training they had attended had equipped them with understanding and knowledge about the use of learner-centered strategies. Item 9 provided the respondents with a variety of situations and asked them to identify the views they had on learner-centered strategies. The results are given in table 1:

Table 1: Teachers' Perceptions on Teaching Strategies (N=23)

	Statements on Teaching Strategies	Overall Percentages			
		Not at all	Not sure	Fairly well	To a great extent
A	I have knowledge and understanding of learner-centered Strategies	0	3.5	48.0	47.5
B	I know the connection between learner-centered teaching and reflective practice	25	52	4	21
C	I use a variety of teaching strategies	0	0	52	48
D	I always lecture	98	2	0	0
E	I use a lot of questions	0	43	18	39
F	I know how to demonstrate and use a variety of demonstrations	0	24	18	39
G	I use whole class discussion	0	12	26	62
H	I regularly give projects	0	2	53	45
I	I engage learners in problem solving	0	0	76	24
J	I give learners practical work	0	0	87	13
K	I use role plays in teaching	10	50	21	19
L	I use inquiry method	0	62	12	26
M	I use simulations, and games	42	18.2	24	27.4

4.2.5 Constraints in the Use of Learner-Centered Strategies

The respondents were to list three constraints encountered in the use of learner-centered strategies. Six (6) concerns came up in the order of importance as shown in table 2:

Table 2: Perceptions of Constraints in Use of Learner-Centered Strategies (N=23)

Constraint	Frequency	Percentage	Rank
Under resourced Science laboratory	23	100	1
Lack of a university degree	19	82.6	2
Large classes	17	73.9	3
Inadequate training in learner-centered strategies	12	52.2	4
Poor conditions of service	11	47.8	5

The study revealed that the under resourced Science laboratories was ranked first as a constraint in the use of learner-centered strategies. The findings in Table 2 also showed that lack of a university degree was ranked second as a limitation in the use of learner-centered strategies when teaching Chemistry. Lack of a university degree was ranked second because the majority of the respondents, 21(91.3%) held either a Secondary Teachers' Diploma or an Advanced Teachers' Diploma. Hence they thought that they would do better at using learner-centered strategies if they possessed university degrees. Thirdly, 17 (73.9%) of the respondents cited large classes as a constraint in using learner-centered strategies. Almost an equal number of respondents, 52.2% and 47.8% respectively indicated that inadequate training in the use of learner-centered strategies, and poor conditions of service hindered them from the use of learner-centered strategies.

A. Under Resourced Science Laboratories

The study wanted to establish the effect of under resourced Science laboratories on the use of learner-centered strategies for high school teachers of Chemistry. Chemistry being a practical subject, the availability of chemicals and apparatus is vital for the teachers in using learner-centered strategies. Learner-centered strategies are also material intensive, i.e. they require a lot of materials so that each learner is taken care of. The teachers stated that the under resourced laboratories was a constraint to the use of the learner-centered strategies. However it is necessary for every teacher of Chemistry to be very resourceful and be able to improvise in situations where the Science laboratories are under resourced.

B. Lack of a University Degree

The majority of the respondents, 18 (78.2%) held a Secondary Teacher's Diploma. The Ministry of Education's mandate is that the University graduates or Teacher training Colleges graduates with Advanced Diplomas were to teach in high schools from grade 10 to 12. Hence the concern for teachers of not being adequately qualified was appropriate because the majority were only qualified to teach Environmental Science for grades 8 and 9. The concern was justified because the teachers with only a Secondary Teachers' Diploma had to teach the content and the methodologies at high school level for which they had not been prepared. A total of 19 (82.6%) teachers cited this as a constraint in the use of learner-centered strategies. The level of professional qualification of the teachers appeared to have a bearing on the use of learner-centered strategies. From the observation of lessons, it was established that the teachers with higher qualifications, university degree and

Advanced Teachers' Diploma used more learner-centered strategies than those who held the Secondary Teachers' Diploma.

C. Large Classes

Large classes were listed third as one of the constraints in the use of learner-centered strategies. Of the respondents 17 (73.9%) said that large classes were a hindrance to using learner-centered strategies. The questionnaire solicited for the feelings of the teachers in handling classes of Chemistry of learners less than 40 and those which had more than 40 learners. In large classes of over 40 learners, the teachers had more work to do in terms of preparation of lessons and practical work (in cases where the laboratory assistant was unable to help the teachers because of many classes to attend to or was not well qualified to do the specific duties), the number of teacher-learner interactions and also in terms of volume of learners' work to be assessed. From the above it could be said that large classes could be a constraint in the use of learner-centered strategies by the teachers. Table 3 shows the perceptions of the teachers on large classes.

Table 3: Teachers Perceptions' on Class Size (N= 23)

	Statement	Frequency (Percentages)				
		Strongly disagree	Disagree	Not sure	Agree	Strongly agree
A	Teaching classes with less than 40 learners means higher learner achievement	2(8.7)	3(13.0)	8(34.8)	7(30.4)	3(13.0)
B	In classes less than 40 learners, the teacher easily assists learners with Chemistry problems solving	4(17.4)	2(8.7)	5(21.7)	6(23.0)	7(30.4)
C	Classes having less than 40 learners are well behaved	7(30.4)	11(47.8)	4(17.4)	1(4.3)	0
D	A teacher can use a variety of teaching methods in classes with less than 40 learners	6(23.0)	5(21.7)	3(13.0)	4(17.4)	5(21.7)
E	With learners less than 40, it is easier to give feedback	2(8.7)	3(13.0)	1(4.3)	8(34.8)	9(39.1)
F	With learners less than 40, there are good teacher-learner interactions	2(8.7)	4(17.4)	2(8.7)	7(30.4)	8(34.8)
G	Classes with more than 40 learners result in higher failure rate	4(17.4)	5(21.7)	1(4.3)	8(34.8)	5(21.7)
H	Classes with learners more than 40 make teaching exhaustive	6(23.0)	7(30.4)	0	4(17.4)	5(21.7)
I	If learners are more than 40 in a class, it hinders active pupil participation	4(17.4)	3(13.0)	2(8.7)	8(34.8)	6(23.0)
J	In classes with learners more than 40, it gives less opportunity for individual projects.	11(47.8)	7(30.4)	1(4.3)	2(8.7)	2(8.7)
K	Lecture, demonstrations and Question and Answer are best for classes with learners more than 40.	2(8.7)	2 (8.7)	0	6(23.0)	13(56.5)

D. Inadequate Training in Teaching Methods

About half 12 (52.2%) of the respondents felt that the pre-service teacher training did not prepare them adequately in the use of learner-centered strategies. They indicated that the training in the use of learner-centered strategies they received through the workshops and in-house training was inadequate and was a constraint in the use learner-centered strategies. In general the teachers felt that the training programmes they had undergone were shallow and did not equip them with skills and knowledge on how to use the various learner-centered strategies, especially in large classes and under resourced Science laboratories.

E. Poor Conditions of Service

Almost half of the teachers, 11 (47.8%) felt that poor conditions of service and low salaries did not motivate them to use learner-centered strategies. The teachers felt that the salaries were not adequate to have a decent living and as such were not motivated enough to do more in their teaching because to use learner-centered strategies one required good preparation and hard work. The poor conditions of service and low salaries could lead the teachers not to concentrate on their work but to use the time to earn extra income through private jobs.

The following section is about the lesson observation of a sample of nine (9) teachers of Chemistry in the target schools who had indicated in the self-administered questionnaire that they were using learner-centered strategies in large classes to a great extent. The data collection instruments were the lesson observation schedule and video recording of the lessons. This was a way of triangulating the two data collection instrument and establishing whether what the

teachers said in the self-administered questionnaire was actually what they practiced while teaching large classes.

4.3 Lesson Observations of the Teachers' Use of Learner-Centered Strategies in Large Classes

Only nine (9) teachers out of the twenty-three (23) who participated in pilot study were observed teaching in large classes. The nine teachers who responded to the questionnaire had indicated that they to a large extent were using learner-centered strategies and were teaching large chemistry classes.

The first research question investigated the type of learner-centered strategies the teachers used in the teaching of Chemistry to large classes. To address the research question the following data came from the video recording of lessons and the lesson observation schedule sheet (Appendix II). To maintain the confidentiality of the schools and the teachers who participated in the study, the schools have been numbered from one to three, while the teachers have been given codes. The nine (9) teachers were given the code names A, B, C, D, E, F, G, H and I.

4.3.1 Demographic Characteristics of the Sample

The demographic characteristics of the teachers of Chemistry who took part in the study are given in tables 4 to 7.

A. **Sex of the Teachers**

Table 4 shows sex distribution of teachers.

Table 4: Teachers by Sex

Sex	Frequency	Percentage
Male	4	44.4%
Female	5	55.5%
Total	**9**	**100%**

As can be seen in table 4, slightly above 50% of the teachers were females.

B. **Age of the Teachers**

Table 5 shows the age characteristic of the teachers who took part in the study.

Table 5: Teachers by Age

Age	Frequency	Percentage
Less than 30 years	5	55.5%
31 -40 years	3	33.3%
41 – 50 years	1	11.1%
Total	**9**	**100%**

It can be seen that more than 50% of the teachers were below 30 years of age.

C. **Professional Qualification of the Teachers**

Table 6 is showing the professional qualifications of the teachers who took part in the study.

Table 6: Professional Qualification of the Teachers

Qualification	Frequency	Percentage
Diploma	6	66.7%
Advanced Diploma	2	22.2%
Degree	1	11.1%
Total	**9**	**100%**

The majority of the sample (66.7%) had a secondary teacher's diploma.

D. **Teaching Experience of the Teachers**

Table 7 shows that the majority of the teachers observed in the study were relatively new having less than five years of teaching experience (33.3%) and 44.4% had between six and ten years of teaching experience.

Table 7: Teaching Experience of the Teachers

Years of Experience	Frequency	Percentage
1 –5 years	3	33.3%
6 – 10 years	4	44.4%
11 – 15 years	1	11.1%
16 – 20 years	1	11.1%
Total	**9**	**100%**

4.3.2 Class Sizes

The study established that the class sizes in the three schools under study were large. The teachers taught classes with more than 40 learners. Using the Teaching Strategies Observation Schedule (Appendix II), the number of learners who were present in each lesson observed was recorded. Table 8 shows the sizes of the classes the individual teachers taught.

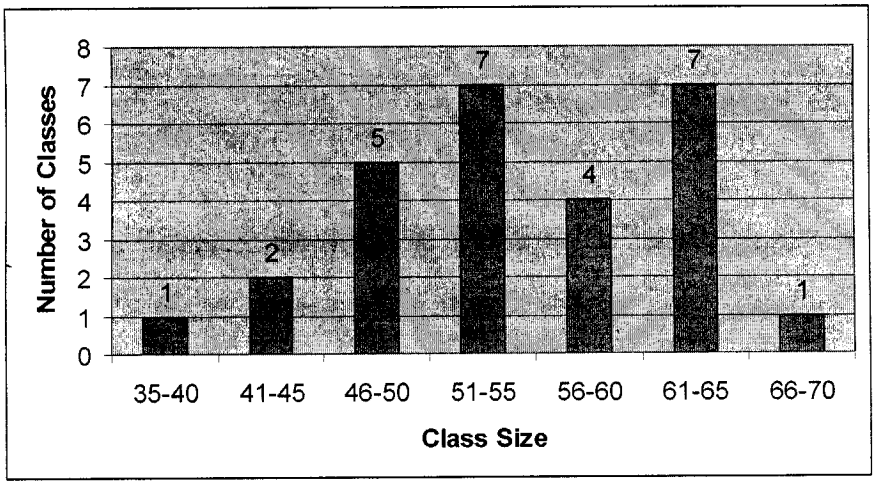
Table 8: Size of Classes Taught

Teacher	Number of Learners in the Classroom			
	Lesson 1	Lesson 2	Lesson 3	Average class size
A	49	58	63	57
B	44	55	43	47
C	47	51	38	45
D	57	52	61	57
E	67	54	55	59
F	48	65	54	56
G	64	61	58	61
H	47	48	54	50
I	62	63	58	61
Total	485	507	484	55

The average class size of each of the nine teachers observed ranged from 45 to 61. This shows that the issue of large classes was a reality in the selected High schools of Kitwe District. The findings also showed that the Chemistry classes were large,

having on average 15 learners more than the Ministry of Education recommended class size of 40 learners. The distribution of class sizes was that only 1 (3.7%) of the classes had less than 40 learners. The majority of the classes, 25 (92.6%) had class sizes of 41 to 65 learners. The extreme end also had only one class (3.7%) which had 67 learners. Figure 1 shows class size distributions for the lessons observed in the study.

Figure 1: Class Size Distribution (N= 27)



4.3.3 Learner-Centered Strategies Used by the Teachers

To answer the first research question about the learner-centered strategies the teachers used in the teaching of Chemistry to large classes Teaching Strategies Observation Schedule (Appendix II) and video recording of the lessons were employed. The observation of the lessons revealed that of the teachers had employed Question and Answer, Group work, Project work, Demonstration by learners, Discussion and Problem solving (table 9).

Table 9: Learner-Centered Strategies Used by the Teachers

S/N	Learner-Centered Strategy	Frequency
1	Question and Answer	9
2	Group work	6
3	Project work	7
4	Demonstration by learners	7
5	Discussion	3
6	Problem solving	4

The following sections of this chapter present how the teachers in the study used each one of the above strategies in a learner-centered way. The presentations include narratives of how each strategy was used, verbatim reporting of what was said and the time used on the strategies.

Each of the nine teachers was observed teaching three Chemistry lessons. The lessons were either 40 minutes or 80 minutes long. The overall time in which each teacher was observed is shown in table 10.

Table 10: Observation Time of the Nine Teachers

Teacher	Observation Time in Minutes			
	Lesson 1	Lesson 2	Lesson 3	Total
A	40	40	80	160
B	40	40	40	120
C	40	40	40	120
D	40	80	40	160
E	40	40	40	120
F	40	40	40	120
G	40	40	40	120
H	40	40	40	120
I	80	40	80	200

The length of a single period of Chemistry lasted for 40 minutes and double period lasted for 80 minutes. Teacher I was observed in one single and two double periods, which brought the total time to 200 minutes. This was the longest observation time. Two other teachers A and D were observed in a total time of 160 minutes. The others, B, C, E, F, G and H were observed in a total time of 120 minutes.

4.3.4 Question and Answer

Effective questioning is in itself a learner-centered teaching strategy. When the teacher asks questions during the lesson the learners are involved in the learning process and are made to think critically. This strategy can be useful in classes that are under resourced as the case was with most of the classes teachers observed in this study. The questioning and answer technique was used by all the nine teachers in their lessons observed, which gave a 100% usage of this strategy. Table 11 shows the use of this strategy by each teacher.

Table 11: Use of Question and Answer Strategy by Chemistry Teachers (N=9)

Teacher	Time spent on questioning in minutes per lesson (percentages)			
	Lesson 1	Lesson 2	Lesson 3	Total time on strategy
A	6 (15.0)	22 (55.0)	33 (41.5)	61(38.1)
B	5 (12.5)	10 (25.0)	7 (17.5)	22(18.3)
C	10 (25.0)	5(12.5)	5 (12.5)	20(16.7)
D	8 (20.0)	8 (10.0)	0	16(10.0)
E	2 (5.0)	4 (10.0)	4 (10.0)	10(8.3)
F	12 (30.0)	12(30.0)	2 (5.0)	26(21.7)
G	12(3.0)	5 (13.0)	4 (10.0)	21(17.5)
H	4 (10.0)	13(33.3)	7(17.5)	24(20.0)
I	0	2 (5.0)	6 (8.0)	8(4.0)

From tables 10 and 11 it can be seen that teachers A and F used more time on question and answer as a learner-centered strategy. Teacher A was female, who held a Secondary Teachers' Diploma with four years of teaching experience. The demographic characteristics of teacher F who also ranked second in the use of this strategy were exactly the same as for teacher A. It seemed that female and newly

qualified teachers with Secondary Teachers' diploma found classroom questioning easy to use compared to other strategies.

Overall, the teachers observed asked questions, which focused on the salient elements of the lesson. The teachers used both lower and higher cognitive level questions. The lower cognitive level questions were used when the teachers were dealing with material, which was new and not very familiar to the learners. However they employed higher cognitive questions when dealing with familiar material and higher ability learners. Teacher D had a large class of 61 learners and was teaching a topic of separation techniques. The introduction was a story of a child who had spilled sugar in the sand. Part of the introduction had a high level question:

> *"...if you were the child, how could you get back the sugar from the sand?"*

The learners answered back with a variety of answers and the teacher gave many learners a chance to answer the same question:

One pupil attempted to answer the question by saying:

> *"...It is very difficult to get back the sugar, because if you use that sugar from sand it will still have sand."*

Another pupil also tried to explain by saying:

> *"... You first get the spilled sugar and try to put in water...and ...remove the sand using a filter paper."*

At this point the teacher then posed a leading question by saying:

> *"...Have you now gotten the sugar back? How can we get back the sugar crystals back from the solution?"*

Another teacher whose question was understood the way he had asked it was teacher G. He was teaching a grade 11 class of 61 learners and the lesson topic was

'Acids, Bases and Salts'. In the introduction to Acids he asked a number of questions on the tastes of certain foodstuffs. One of the questions of lower cognitive type was;

"...Can you tell me the taste of an orange, lemon...?"

Another aspect of questioning were the teachers did well was wait time. Most of them gave their pupils enough wait time before pointing at a person to answer the question. They allowed for more than three seconds (Liman et al., 2001), the recommended wait time. This gives chance to those who are shy and low ability learners to participate in the lesson.

The study also tried to establish what teachers did when it came to redirecting questions when initial responses were unsatisfactory or incomplete, probing for more complete responses, and providing reinforcement of responses. The teachers redirected, probed further and reinforced weak answers of the learners. The teachers observed also did well on the aspect of dealing with questions, which came from the learners. The teachers rarely answered such questions but the questions were redirected to the whole class to engage the learners to answer and hence become active in the learning process.

4.3.5 Group Work

The nine teachers in the study used group work as a learner-centered teaching strategy. The teachers used group work depending on the situations at hand. For example, low-ability learners were mixed with high-ability ones when the teachers wanted the learners to learn from each other. The teachers formed groups according to learner abilities (low-ability learners with low- ability learners and high-ability



learners with fellow high-ability learners) when they wanted to help the learners' progress at a rate determined by their abilities. Group work was also used in situations where there was likelihood of having different opinions among the learners. In these settings the learners were made to challenge their own opinions and beliefs.

Group work was appropriate in large classes in that the teachers had no problems in having to deal with a lot of marking when it came to assessing the learners. The learners were assessed as groups as opposed to being assessed individually.

The learners when in groups seemed relaxed and could be seen actively involved in the tasks assigned. In the groups, peer-peer interaction helped the learners to take responsibility for their own learning. In doing the group work, learners become more confident than in a whole class situation. It was observed that the learners also became more comfortable to discuss things with their fellow learners than in the whole class arrangement.

The use of group work by the teachers seemed to have been dictated also by the type of materials they were dealing with. In instances where there was need to carry out Chemistry practical work, group work was used. The teachers' organisation of the group work involved giving clear instructions to the learners in the groups so that they were able to proceed with the work. The teachers also paid attention to the time allocated for the group work. The time was not unnecessarily long or too short. Table 12 shows the time the teachers spent using group work.

Table 12: Use of Group Work by the Teachers (N=9)

Teacher	Time spent on group work in minutes per lesson (percentages)			
	Lesson 1	Lesson 2	Lesson 3	Total time on strategy
A	25 (62.5)	0	7 (8.75)	32(20.0)
B	0	0	0	0
C	7 (17.5)	16 (40.0)	0	23(19.2)
D	0	0	22 (55.0)	22(13.8)
E	10 (25.0)	0	23(57.5)	33(27.5)
F	0	0	0	0
G	12 (30.0)	10(25.0)	15(37.5)	37(30.8)
H	0	0	0	0
I	30 (37.5)	0	18(22.5)	48 (24.0)

From tables 10 and 12, three teachers, B, F and H did not use group work in any of the three lessons in which they were observed. Meanwhile the other six, A, C, D, E, G and I used the group work strategy and they used it to a large extent. Teacher G for example used a total of 37 minutes (30.8%) of the total recording time of 120 minutes on group work. In summary, group work was well used by the teachers because:

1. The number of learners in each group was balanced, so that there were no groups, which were too large or too small.
2. The teachers did not waste time on the formation of the groups because the learners already knew the groups they belonged to.
3. Gender balance was put into consideration in the formation of groups in the schools that were co-education.
4. The roles each member of the group would play were clearly spelt out.
5. The teachers managed the groups as they went around checking on the activities and gave the required supervision.
6. After the learners worked in their groups, they presented their work to the whole class. The other learners and the teachers would then re-emphasis and correct things which were not correctly done.

4.3.6 Use of Demonstration as a Learner-Centered Strategy

Demonstrations used by the teachers in the study could be considered to be learner-centered, because they involved the learners in the demonstrations. After the teachers demonstrated, they would pick on certain learners to demonstrate certain aspects of an activity to their peers. The learners demonstrated to their fellow learners when it came to situations of handling laboratory equipment and other scientific procedures. These demonstrations by the learners were done in situations were the science laboratories were not resourced enough even to have a group of learners share pieces of apparatus or chemicals. Instead of the teachers demonstrating all the aspects of the activities to the class, they involved the learners to demonstrate. Use of demonstration in this way made it to be a learner-centered

strategy. Table 13 shows how much of the teaching time was used on demonstrations by the learners.

Table 13: Use of Demonstrations by the Learners

Teacher	Time spent on demonstration in minutes per lesson (percentages)			
	Lesson 1	Lesson 2	Lesson 3	Total time on strategy
A	4 (10.0)	0	15 (18.8)	19(11.9)
B	7 (17.5)	4 (10.0)	15 (19.0)	26 (21.7)
C	0	0	0	0
D	0	21(26.3)	0	21(13.1)
E	11 (27.5)	0	0	11(9.2)
F	0	0	0	0
G	4 (3.3)	0	0	4(3.3)
H	0	12(30.0)	19 (47.5)	31(25.8)
I	12 (15.0)	18(45.0)	11 (13.8)	41(20.5)

From tables 10 and 13 it can be seen that the demonstration strategy was used by seven teachers out of the nine. The teachers involved the learners in the

demonstrations to make their lessons learner-centered because their science laboratories were under resourced.

4.3.7 Use of Class Discussions as a Learner-Centered Strategy

The teachers in the study used discussion as a learner-centered strategy as a whole class and at times in small groups. The teachers would draw learners into discussion of a topic so that the teachers were not the only ones doing all the talking during the lesson. The strategy was used by the teachers to discuss why certain phenomenon occurred the way they did in Chemistry. This gave the teachers the choice to find out what the learners knew. The strategy was used at the beginning of the lessons to find out learners' ideas about a subject matter and also towards the end of the lesson by presenting the learners with new situations and then letting them explain these in terms of what they had just learnt. The use of this strategy by the teachers in terms of time is shown in table 14.

Table 14: Use of Discussion by the Teachers (N=9)

Teacher	Time spent on discussion in minutes per lesson (percentages)			
	Lesson 1	Lesson 2	Lesson 3	Total time on strategy
A	0	0	0	0
B	0	10 (25.0)	0	10(8.3)
C	6 (15.0)	0	12 (30.0)	18(15.0)
D	8(20.0)	0	7 (17.5)	15(9.4)
E	0	0	0	0
F	0	0	0	0
G	0	0	0	0
H	0	0	0	0
I	0	0	0	0

From tables 10 and 14 it could be seen that only three teachers, teachers B, C and D used this strategy in their teaching spending 10 minutes (8.3%), 18 minutes (15%) and 15 minutes (9.4%) of the total time respectively using discussions.

The teachers used this strategy well because the discussions were characterized by structured conversations among the learners. It was an effective way to promote higher-level thinking, and develop student positive attitudes. What also made the

discussions effective was the way the teachers allowed the learners to take control of the discussions and at the same time directed the learners to have meaningful discussion. The learners were made to compare similar and diverse ideas about issues under discussion. In addition to the learners talking amongst themselves, the teachers, at times, provided input that encouraged and promoted deeper and focused thinking, which in turn enhanced discussions. Among the topics which were discussed by the learners of teachers B, C and D included "Characteristics of metals and non-metals", "Properties of alkanes and alkenes" and those of "Acids and Bases" respectively.

4.3.8 Use of Project Work as Learner-Centered Strategy

When project work is used, it makes the learners to take responsibility for their own learning (Liman et al., 2001). In the study the teachers gave the project work to the learners as individuals or groups. The teachers used project work to supplement or to let the learners apply what was learnt during the lessons. The teachers asked the learners to find other information not given in the lesson when they had knocked off from school. The learners could find most of that information if they researched in their school libraries. The teachers grouped the learners if the project work involved was challenging. One of the teachers in the study used the project work by letting the learners to make write ups on topics such as; how to separate different inks and dyes, immiscible from miscible liquids, ferrous from non-ferrous metals and liquids having different boiling points under the topic "Separation Techniques". Another teacher gave the learners project work that involved each learner in the class to make a molecular model of either graphite or diamond after they had learnt the topic "Metals and Non-Metals".

Most of the times the teachers gave project work to the learners so that the learners could apply what they had learnt in class. The teachers, for example would concentrate on the principles underlying the topic but they would give project work on how to apply the principles. In doing so the teachers let their learners build or create knowledge on their own. Hence it could be said that the teachers used project work as a learner-centered strategy.

The cognitive levels of the work given was high enough, for example researching and writing up how to separate chemicals given above involved higher levels such as application and analysis. The psychomotor level of the work given was high also. Learners worked with their hands when they were given to make molecular model of the non-metals such as graphite and diamond. The learners did these projects after the classroom time. Table 15 shows the use of project work by the teachers with respect to the time they spent on this strategy.

Table 15: Use of Project Work by the Teachers (N=9)

Teacher	Time spent on project work in minutes (percent)			
	Lesson 1	Lesson 2	Lesson 3	Total time on strategy
A	0	19 (47.5)	0	19 (11.9)
B	0	0	3 (7.5)	3(2.5)
C	4 (10.0)	7 (17.5)	0	11(9.2)
D	8(20.0)	0	11 (27.5)	19(11.9)
E	0	2 (5.0)	5 (12.5)	7(5.8)
F	0	9 (22.5)	7 (17.5)	16(13.3)
G	0	6 (15.0)	0	6(5.0)
H	22 (55.0)	6 (15.0)	11 (27.5)	35(32.5)
I	18 (22.5)	23(57.5)	0	41(20.5)

From the surface it seemed that the time the teachers spent on project work was not sufficient. The fact was that the time recorded time was used by the teachers to give the work and instructions to the learners. The work was done outside the class time.

4.3.9 Use of Problem Solving as a Learner-Centered Strategy

The teachers in the study used problem solving in two main ways. Firstly, when teachers introduced the lesson or a topic, they presented problems to the learners to

come up with the solutions before the teachers gave the correct solutions. Presenting a problem in the introduction made the learners became involved in the learning process just from the start of the lesson.

Secondly, the teachers used problem solving as a learner-centered strategy during the course of their lessons. The teachers would not give all the details of a topic, but would present problems from time to time in the lessons. The problems presented involved learners finding solutions to practical activities or solutions to quantitative problems in Chemistry such as balancing a chemical equation or finding the reacting masses. In using problem solving in this way the teachers were helping their learners to learn and think logically. Therefore it was observed that the teachers had planned the activities in such a way that they emphasized not only the acquisition of knowledge, but also problem solving skills. The teachers also planned problem-solving activities so that the learners became involved in the Bloom's cognitive domains of application and analysis, which are considered to be of higher-level thinking skills. In this way the teachers used the problem solving strategy not only involving simple problems such as games and puzzles but involved processing information. From what has been presented above, it could be said that the teachers in this study used the problem solving strategy in achieving two processes:

1. Retrieval from the learners' memory important information, and
2. Correct application of the information to solve the problem.

Table 16 shows the teachers' use of problem solving, showing the time spent on the strategy.

Table 16: Use of Problem solving by the Teachers (N=9)

Teacher	Time on problem solving in minutes (percent)			
	Lesson 1	Lesson 2	Lesson 3	Total time on strategy
A	0	0	0	0
B	0	0	0	0
C	0	6 (15.0)	16 (40.0)	22(18.3)
D	0	0	0	0
E	0	0	3 (7.5)	3(2.5)
F	0	0	14(35.0)	14(11.7)
G	0	0	0	0
H	6 (15.0)	0	7 (17.5)	13(10.8)
I	0	0	0	0

Of the nine Chemistry teachers observed, four teachers employed problem solving as a learner- centered strategy. Teachers C and F used this strategy extensively spending about 18 percent and 12 percent of the total time respectively on this strategy. As a result the learners had interest in the activities and it was assumed responsibility for their own learning. The teachers were friendly and the learning environment was not intimidating to the learners.

In the study it was further observed that the teachers did not focus on quantitative problems, i.e. those involving mathematical calculations only but also on how the learners solved qualitative problems and as such they paid attention to the learners' conceptual understanding of Chemistry content. The problem solving tasks the teachers had given to the learners were in the form of class exercises and homework. Homework which is part of problem solving learner-centered strategy had the following advantages:

1. It provided the learners with the opportunity to work on their own and therefore emphasizing learner-centered teaching.
2. It gave the learners the opportunity to practice things and learn at their own rate.
3. It created the opportunity for the parents and guardians to become more involved with their children's work.

4.4 Extent of Use of Learner-Centered Strategies in Large Classes by the Teachers of Chemistry

The second research question was about the extent to which the teachers were using learner-centered strategies in teaching Chemistry. It was observed that in almost all the lessons the teachers varied their strategies. The teachers utilised group work, which worked well because the large classes were split into manageable groups, which the teacher supervised. In the same groups the learners worked independent of the teacher and as such the lessons turned out to be learner-centered. The teachers also used problem solving in large classes well, in that the learners were made to work on their own when doing class exercises and also when they were

given homework. In using problem solving as a learner-centered strategy the learners were given tasks to work out on the chalkboard or in groups to manipulate apparatus and chemicals. After working in groups the teachers let the learners present their work to the whole class. The whole class then discussed the solutions to the problems.

Other learner-strategies that were used to a large extent in large classes by the teachers in the study were: Question and Answer, Demonstration, Discussion and Project work.

The use of question and answer sessions directly involved the learners in the lesson. In this study the teachers extensively used the strategy. They used 158 minutes (13.8%) of the total time using the question and answer strategy (table 17). The teachers' effective use of oral questioning was observed. The teachers used not only recall or knowledge level questions, but higher order ones also. The teachers also employed good wait time so that they allowed even shy learners to participate. The distribution of questions in the classrooms was also wide. In so doing it was concluded that the teachers used the question and answer strategy as a learner-centered strategy. The teachers were also very skilful at handling the questions that came from the learners. Questions that came from the learners were redirected back to the class. The learners then took turns in trying to answer the questions.

The learner-centered strategy such as practical group work was also used to a large extent in large classes. The teachers used 170 minutes (14.7%) of the total recording time on practical group work (table 17). They made groups, which were in most

cases big due to the large classes. They made groups big to allow the limited chemicals and apparatus to go around. The teachers in most cases also improvised, for example where conventional laboratory gas burners systems were not adequate or missing, the teachers used home made lamps. From the practical group work done, the learners produced results. The teachers also made sure that each member did a task in each of those groups. Some learners were in charge of making sure that the instructions were being followed, others were involved in recording the data, and still others took turns to work in manipulating apparatus and materials.

Demonstrations and discussions were also appropriate to be used in large classes as learner-centered strategies because they did not require any expensive teaching and learning materials to be used. The teachers used what was at their disposal to effectively employ these strategies. At times the learners and the teacher were the only resources available for the strategies to be used. When using demonstration as a learner-centered strategy, the teachers first demonstrated to the whole class for example, how to separate soluble from insoluble substances. Then the teachers would call upon selected learners to the front bench of the Science laboratory to repeat what he or she had done or to apply what the teacher did to another situation.

The discussion was a learner-centered strategy since the learners discussed with each other or as a whole class. In this study this strategy was used and teachers used 33 minutes (2.9%) of the total time using demonstrations (table 17). The teachers directed the discussions and created situations involving all the learners to participate. The discussions happened as a whole class and at times in small groups. Discussions did not require any special teaching and learning materials and as such

they were suitable in the large classes and the under-resourced science laboratories in which the teachers operated. The way discussion and demonstrations strategies were used showed that they were greatly adaptable to large classes.

Project work worked well as a learner-centered strategy in large classes also because not much material or other resources were needed for the teachers to use the strategy to their many learners. The teachers in the study used this strategy in form of homework and for the learners to research topics and information to be discussed in the lessons to follow. The teachers gave project work to the learners so that the learners could apply what they had learnt in class. The teachers used problem solving as a learner-centered strategy in large classes in solving quantitative problems. The teachers at times picked on individual learners to go to the front and attempt to solve the problems they presented. The teachers gave the work to pairs or groups of learners to solve. The strategy was appropriate in the large classes because the teacher did not need to have special teaching or learning materials to use. The teachers were also not limited by factors such as having a large number of exercise books to mark, since the learners were assessed as groups.

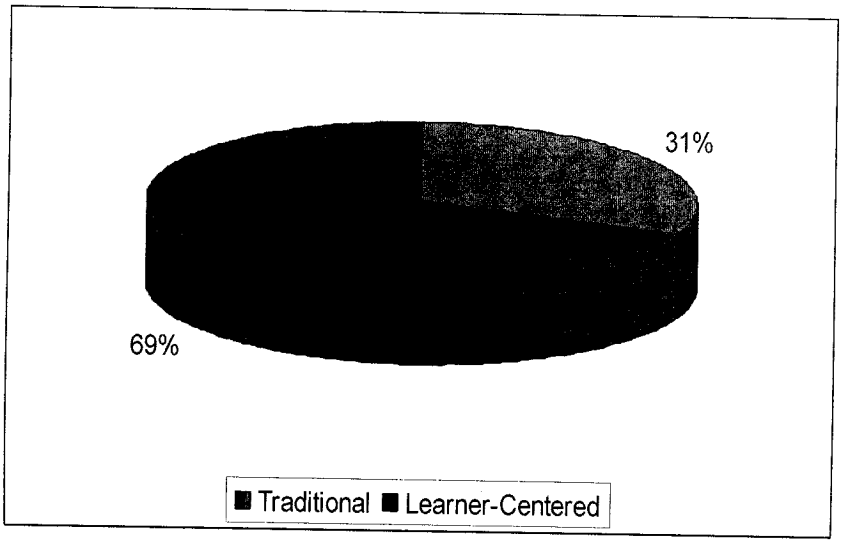
Table 17 shows the amount of time the teachers used learner-centered strategies and their rankings.

Table 17: Combined Times the Teachers Used on Each Strategy (N=9)

	Strategy	Time (Minutes)	Percentage of Time	Rank
a.	Problem Solving	174	15.2	1
b.	Group Work	170	14.7	2
c.	Question & Answer	158	13.8	3
d.	Demonstration	145	12.7	4
e.	Project	76	6.6	5
f.	Discussion	33	2.9	6
		$\Sigma = 756$	$\Sigma = 65.9$	

Table 17 shows that the teachers were observed in a total of 1,240 minutes of teaching time. Of the total time, 756 minutes were used on learner-centered strategies, which is 66 percent, compared to the 34 percent, which teachers used on none learner-centred activities. This shows that the teachers used almost two thirds of the total time on learner-centered strategies. Figure 2 shows the pictorial view of the scenario presented above.

Figure 2 Ratio of Time Spent on Learner-Centered Strategies



The third research question was about the frequency of the use of learner-centered strategies. The strategies which were most frequently used by all the teachers were question and answer, demonstration and group work. The other strategies which teachers also used were discussions, problem solving and project work. The teachers changed their strategies more than 90 times during the twenty-seven (n=27) lessons observed. From these figures it could be said that each teacher on average used at least three (3) different learner-centered approaches during a lesson. This was very good enough putting into consideration the conditions of large and under resourced classrooms they worked in. Table 18 shows the frequency in the use of the learner-centered strategies by the nine Chemistry teachers.

Table 18: Frequency Use of Learner-Centered Strategies

	Strategy	Frequency Use of Learner-Centered Strategies by Individual Teachers									Total
		A	B	C	D	E	F	G	H	I	
1.	Discussion	0	1	2	2	0	0	0	0	1	**6**
2.	Group work	2	0	1	0	0	0	3	0	0	**6**
3.	Demonstration by learners	1	3	0	1	2	0	1	2	3	**13**
4.	Practical group work	0	0	1	1	2	0	0	0	1	**5**
5.	Project	2	1	1	0	1	0	0	2	0	**7**
6.	Question and answer	2	2	3	3	5	2	2	5	4	**28**
7.	Problem solving	3	1	4	2	3	4	3	6	2	**28**
	Total	**10**	**8**	**12**	**9**	**13**	**6**	**9**	**15**	**11**	**93**

Table 18 shows that the teachers most frequently used Question and answer and Problem solving strategies. Demonstration by learners strategy was also frequently used by the teachers.

4.5 Constraints in the Use of Learner-Centered Strategies

The fourth and last research question was about other factors, which affected the use of learner-centered strategies in large classes. The factors, which came up, included qualifications of the teacher, the years of teaching experience and the resources available in the classroom or science laboratory.

Teacher H of school 3 had a bachelor's degree with fourteen (14) years of teaching experience. The teacher was a female and had used learner-centered strategies for the most time of her lessons 108 minutes (90%) to compare with the other two female teachers, teachers A, 100 minutes (65%) of School 1 and teacher F of School 2, 49 minutes (41%). Teachers A and F were relatively new in the teaching profession and had only secondary school teachers' diplomas. The same trend was observed with the male teachers. Teacher C had an advanced diploma and twelve (12) years of teaching experience. Teacher C spent 98 minutes (82%) of the total time using learner-centered strategies compared to a male teacher, D who only had a two (2) years secondary teachers' diploma with four (4) years teaching experience. Teacher D spent only 84 minutes (53%) of the total time on learner-centered strategies.

In general teachers H, B and C who had higher qualifications and many years of teaching experience spent more time, (108 minutes, 98 minutes and 65 minutes respectively of the total 120 minutes each was observed) using learner-centered strategies (table 12). The same teachers were also comfortable with the subject matter they were dealing with and frequently varied the learner-centered strategies they employed. Teacher H had varied the strategies 11 times, teacher B 12 times and teacher C 8 times) (table 12). However the findings showed that there were no significant differences in the use of learner-centered strategies between male and female teachers.

Another constraint which affected the teachers' use of learner-centered strategies was the lack of learning and teaching materials. When the teachers taught in ordinary classrooms, they used fewer learner-centered strategies compared to when they conducted their lessons in the science laboratories. Therefore, under-resourced classrooms and science laboratories were a factor in the teachers' use of learner-centered strategies. It was observed that in schools which were relatively better resourced the teachers more frequently used learner-centered strategies than in those which were not well resourced. For example in School 3 which was better-resourced of the three, the teachers varied learner-centered strategies more frequently (32 times) than teachers from School 2 which was poorly resourced (26 times).

The size of the class was not a constraint in the teachers' use of the learner-centred strategies contrary to what the teachers had indicated in the questionnaire. It was established that the teachers who taught class sizes of 40 to 45 and 55 to 60 used learner-centered strategies almost the same number of times. The size of the classes therefore did not seem to affect the teachers' use of learner-centered strategies.

4.6 Summary of the Findings

The chapter on findings has shown that:

4.6.1 In addressing the first research question about what learner-centered strategies teachers used in large chemistry classes, it was found that the teachers used a varied of learner-centered strategies. These included; Question and Answer, Group work, Demonstration by learners, Project, Problem solving and Demonstration.

4.6.2 The second research question sought information on how the teachers of Chemistry were using learner-centered strategies in large classes. The data showed that the teachers varied their strategies depending on the material that was being covered.

4.6.3 The third question attempted to established how frequently the teachers were using the learner-centered strategies in the large Chemistry classes. It was found that the teachers used on average three (3) different learner - centered strategies in each lesson.

4.6.4 Lastly, the fourth research question was concerned with identifying some other factors that affected the use of learner-centered strategies. The qualification of the teachers, years of teaching experience and the availability or non-availability of learning/teaching materials were identified as affecting the use of learner-centered strategies in large Chemistry classes. The study did not establish conclusively whether the poor conditions of service of teachers and the inadequate induction in their use of learner-centered strategies were constraints in the use of learner-centered strategies.

The next chapter discusses the findings.

CHAPTER FIVE: DISCUSSION OF THE FINDINGS

5.1 Preview

This chapter presents the discussion of the findings of this study. The discussion is arranged according to the findings based on the main themes of the study, namely; learner-centered strategies teachers used in large Chemistry classes, how the teachers used the identified learner-centered strategies, the frequency of use of the strategies and lastly the constraints in the use of learner-centered strategies.

5.2 Learner-Centered Strategies Used in Large Chemistry Classes

The teachers in the large and under resourced Chemistry classes used several learner-centered strategies. Each one of the strategies used is considered separately.

The teachers in the study used demonstration as a learner-centered strategy. This finding is similar to those found by Mehta (1995; 1998). Seven teachers who employed demonstrations used this strategy in situations when the apparatus and materials were limited and when time was a limiting factor. The use of demonstration by the teachers observed in this study was good (12.7%) and the frequency was 48% of the time. For some lessons the teachers demonstrated and then learners went in groups, to do the practical work based on what they saw. This finding is in line with what was suggested by Yager and Englen (1965) and Stork (2001).

The teachers in this study used group work. They did not just put their learners in groups, but they made sure that the numbers of pupils in each group was almost the same. The teachers varied the way they made the groups to accomplish their

objectives. Sometimes higher ability learners were mixed with low ability learners. The teachers also supervised the groups to ensure learning took place. From the lesson observations, the group work had pupil-pupil interactions. From the 27 lessons, 11 (14.7%) of the lessons observed involved group work. The group work at times involved Chemistry practical work. Practical work in small groups afforded the learners with "hands on" experience and developed in the learners the psychomotor skills required in Chemistry. The negative aspect observed was that the teachers in forming groups overlooked the issue of gender. These findings are similar to some extent with the results obtained by Lifalalo (1995) about teaching Geography in large classes in Zambia.

The teachers in this study used question and answer strategy in large classes also. The teachers in the study elicited subject matter from the learners and by so doing they let the learners think critically. All the nine teachers used the question and answer technique in their lessons observed, which gave a 100% usage of this strategy. This is in line with the findings of the baseline study by Haambokoma et al (2002) and Koshimura (1997) about teaching strategies used in Zambian High Schools. The teachers however used the strategy in this study effectively, in that the questions were of high order and the distribution to the class was very good. The teachers took into account the waiting time of at least three (3) seconds before pointing at a learner. This encouraged slow learners and those who were normally shy to participate in answering the questions. The questions were well constructed in that they were clear and showed that they had been planned well in advance by the teachers. The learners also asked questions, which the teachers answered or redirected to the whole class. The way the teachers in the study used the question

and answer strategy made it very appropriate in large classes as suggested by Koshimura (1997).

The teachers in the study also used discussion as a learner-centered strategy. The teachers despite their classes being large used this strategy. This method is a learner centered strategy in that the teacher is not the only one who talks. The teachers observed pointed at certain learners in their classes to take part in the discussions. The teachers used to create issues and then elicit information from the learners to enhance whole class discussions. The teachers in the large classes effectively used this method to let the learners get involved by discussing issues which were raised during the lessons. From the twenty-seven lessons observed four (2.9%) held class discussions of the total time recorded. The fact that this method was used shows that the teachers in the study involved their learners in the learning process. Liman et al. (2001), discussing learner-centered strategies and the importance of having discussions in the class states that, "*...These are very important activities used by all teachers. You may have been told that chalk and talk is wrong, that is not correct! What is wrong is to use chalk and talk all the time as the only activity...*" (p. 4.4).

Studies by Alonge (1985) and Ministry of Education (2003) reported of teachers who used discussion when teaching large and under resourced classes. Discussions are well suited for such classes because no special teaching and learning materials are needed. The teachers in this study also did not require special materials to use the strategy in their large classes.

Project work as a learner-centered strategy was also used by the teachers in the study to encourage the learners to work on their own. Giving tasks to the learners and marking the work in large groups is a challenge to many teachers. The teachers observed despite teaching the large classes gave work to be done outside the class time. It was observed that the teachers also marked the work they had given. Of the twenty-seven lessons observed, six (2.5%) of the total time had home tasks. Tasks given by the teacher to be done outside the class made the learners take responsibility for their own learning, and therefore it could be said that such activities were learner-centered. The teachers observed did well on this strategy although some were not able to mark the work of all the learners in the class due to the large number of learners. The teachers in the study used project work in line with what Lifalalo (1995) found in the Southern Province of Zambia and the positive aspects of the use of the strategy reported by Imenda (1984).

Problem solving is also a learner-centered strategy. If the teacher can give problems to the learners during the lesson and give the learners feed back, it helps the learner and the teacher to see if learning has taken place or not. Homework and class exercises make the learners take responsibility for their own learning, so it could be said that it is a learner-centered strategy. These two strategies in this study have been classified as problem solving. From the twenty-seven lessons observed, eleven (10.6%) of the total time had class exercises. This was a good indicator that showed that the teachers used learner-centered strategies. Most teachers in large classes rarely give exercises and if they do, they do not get feed back. The direct solving of problems by the learners is one of the strategies that make them take responsibility for their own learning. The teachers in the study gave guidelines and then the

learners worked out the solutions to the problems. The learners also solved the problems on the chalkboard as well as in their exercise books. Hanushek (1988) however reported that the teachers faced the challenge of having to assess a big volume of work while using the problem solving strategy. This was true with the teachers in this study. After giving the problems to the learners, in most instances they had the challenge of marking the work. However the study by Alonge (1985) found that the teachers with training could be able to use the problem solving strategy even in large classes. In this study, the problem solving strategy was used four times totalling 33 (2.9%) minutes of the total time. Despite the large numbers of learners in the classes, the teachers used this strategy.

It was also found that the learners presented the work they did independent of the teacher to the whole class. This showed power sharing in the classroom, in that the teacher gave responsibilities to learners to stand in front of other learners while the teacher took a low profile. Involving the learners in the learning process in this way made the lessons to be learner-centred. Of the twenty-seven lessons observed seven (4.1%) of the total time had learner presentations. This shows that the teachers in the study varied their methods and were adding cooperative learning in their lessons as suggested by McCombs (1997) and Felder and Brent (1983). The studies by McCombs and Felder and Brent suggested that learners present their work to the whole class to minimize teacher domination.

5.3 Extent of Teachers Use of Learner-Centered Strategies in Large Classes

From the data presented, it is seen that the teachers in the study used various teaching methods in the large classes, which were also under resourced. Shanyinde (2001) and Bain (2004) suggested that to avoid monotony of the teacher centered teaching, the learners must be involved in the lesson and that the teacher must change or vary their strategies in each lesson taught. In this study the strategies used by the teachers were interactive or learner- centered. Comparing the times the teachers in the study used the lecture 'talk and chalk' and other strategies, showed that the teachers used less talk and chalk (39% of total time) compared to learner-centered strategies (61% of total time). It is also worthy noting that a lesson to be learner centered has to use a variety of learning or teaching strategies including the lecture strategy. The teachers used the lecture strategy well in that it did not dominate their lessons. In some lessons the teachers only lectured for less than ten minutes.

The choice of a strategy to use by the teachers in the study depended on the topic of the day and the materials and apparatus available. In situations where the schools had no materials or apparatus, the teachers used question and answer as well as discussion to make the lessons learner-centered. Where the materials and apparatus where limited the teachers employed demonstration together with question and answer. The demonstrations were learner-centered in that the learners took part in the demonstrations. The teachers also used group work to do practical work in instances where both material and apparatus were enough to go around. To make their lessons learner-centered the teachers used project and problem solving strategies, which made the learners do most of the work during the lessons and

afterwards on their own. The way the teachers used these strategies was according to what was recommended by Ajowelo (1995), Tobin (1984), and Trowbridge et al (1996). According to them, teachers need to use an appropriate strategy for particular situation. The teachers need to use strategies which would work well for the topic of the day and the prevailing situations in terms of learner numbers and resources available.

In the study the total recording time of the lessons and the observation schedule sheet was 1240 minutes and the 27 lessons were observed. The data presented showed that the teachers varied their strategies 90 times for the lessons observed and that for each lesson the teacher on average used three different learner-centered strategies. The frequently used strategies were: question and answer, group work, class discussions, problem solving and project work. These strategies were frequently used by the teachers because the classes were large and under resourced. These strategies were appropriate because they did not require a richly resourced classroom for the teachers to use the strategies. This finding appears to support those by Darden (2003) and Thekwane (2001). The strategies enhanced the learners' interaction with the teacher and among themselves. It is through such interactions that wrong beliefs of the learners are exposed and corrected as opposed to lecturing where the teacher dominates.

Problem solving strategy is best suited at letting the learners construct their own ideas and in the end they learn. This strategy was also frequently used by the teachers. The teachers had well constructed tasks which stimulated the thinking of the learners and at the same time the teachers gave minimum guidance, so that the

learners came up with their own solutions to the tasks. The teachers also frequently used the project work which gave learners more time even at home to work on their own. From these findings it could be said that the teachers in the study frequently used the learner-centered strategies in their teaching.

5.4 Teachers' Constraints in the Use of Learner-Centered Strategies

The data showed that the main factors which affected the teachers' choice of a teaching strategy were: years of teaching experience and the professional qualification of the teacher. The data presented showed that the teachers who had more than five years of teaching experience used more learner centered strategies than those who had less than five years. Also the teachers who had more than ten years of teaching experience were even more proficient at using learner centered strategies than those having ten or less years of experience. The findings also showed that the higher the teaching qualification the teacher had the more learner-centered strategies the teacher used in a large class. It was found that teachers with the Advanced Teachers' Diploma and, three years Teachers' Diploma and a University degree used more frequently learner-centered strategies than those who only had the Secondary Teachers' Diploma. These findings are in line with those by Maliwatu (2006). Maliwatu found that University graduate teachers were more competent handling the content, while College teacher graduates were more grounded in the teaching methodologies. However Lifalalo (1995) found that teaching experience and higher teacher qualification were important for the teacher to use interactive teaching strategies. The results of this study seem to suggest that higher teacher professional qualification and the number years of teaching experience have a bearing on the teachers' use of learner-centered strategies.

Lastly it was found out that the unavailability of teaching and learning materials hindered the teachers' use of learner-centered strategies. The teachers in schools which were better off in terms of learning and teaching materials and well-stocked Chemistry laboratories spent more time using learner-centered strategies than those from poorly stocked laboratories. The findings are in line with the experiences in Namibia (Kasanda, 2003) and South Africa (Brodie et al., 2003).

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The conclusion of the study followed the following objectives:

- Teachers' use of learner-centered strategies in large classes
- Extent of use of learner-centered strategies
- Constraints to the use of learner-centered strategies in large classes.

6.1.1 Teachers' Use of Learner-Centered Strategies

The research revealed that the teachers used learner-centered strategies in large and under resourced Chemistry classes in selected high schools in Kitwe District. The learner-centered strategies used by the teachers were:

1. Question and answer.
2. Demonstration by learners.
3. Group work.
4. Discussion.
5. Problem solving, and
6. Project work.

Question and answer was one of the strategies that the teachers used to involve the learners. This strategy made the learners to be active participants in the learning process. The demonstration strategy was also used by the teachers in instances where the materials and apparatus were not enough to go around due to the large number of learners in the classes. Group work, discussions, problem solving and project work were also used in large classes by the teachers. During group work the teachers made sure that all groups had the same number of learners and that all the

learners were taking part in the activities at hand. The teachers also gave learners work and problems to solve making lessons more learner-centered. The learners took responsibility of their own learning.

6.1.2 **Extent of Use of Learner-Centered Strategies in Large Classes**

The research revealed that the situation of large classes and under resourcefulness and the topic under consideration dictated the teachers' choice of a learner-centered strategy. The teachers varied the strategies in the teaching of Chemistry to large classes. On average the teachers used three different learner-centered strategies in each lesson. The teachers also used 61 percent of the total time on learner-centered strategies.

6.1.3 **Constraints in the Use of Learner-Centered Strategies**

The study identified the following as the main constraints in the use of learner-centered strategies in the teaching of Chemistry in large classes in Kitwe District.

6.1.3.1 Lack of higher teaching qualifications in Chemistry was a constraint in the use of learner-centered strategies in large classes. Teachers with a University Degree or Advanced Diploma used more learner-centered strategies than those with Secondary Teachers' Diploma.

6.1.3.2 Years of teaching experience: The teachers who had fewer years of teaching experience used less learner centered strategies compared to those with more years of teaching experience.

6.1.3.3 Under-resourced Science Laboratories: Lack of learning and teaching materials hindered teachers from planning and conducting practical activities which enhance learner-centered teaching.

6.2 Recommendations

From the findings of this study, the following recommendations are proposed to the following stakeholders in the provision of education in Zambia:

6.2.1 Policy markers

6.2.1.1 The Ministry of Education must initiate the preparation, production and distribution of teachers' guide or handbook on learner-centered strategies. These will guide new and less qualified teachers on how to use learner-centered strategies in large and under resourced science rooms.

6.2.1.2 The Directorate of Standards and Curriculum at the Ministry of Education should encourage the use of the Lecturing strategy in conjunction with other teaching strategies.

6.2.1.3 Teacher training institutions i.e. Universities and Colleges of Education, should train trainee teachers as well as in-service teachers in the use of learner-centered strategies in large classes.

6.2.1.4 The identified learner-centered strategies, which worked well in large and under resourced classes need to be taught to practicing teachers using in-

serving programmes by the Teacher Education Department of the Ministry of Education.

6.2.2 For further Research

6.2.2.1 Another research should be conducted to establish whether the use of learner-centered strategies in large classes makes the learners construct their own ideals and take responsibility of their learning.

6.2.2.2 A similar research needs to be undertaken which will take into account the learners' views on which learner-centered strategies make them learn better in large classes.

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APPENDIX I – QUESTIONNAIRE

Dear Respondent,

I am a student of the University of Zambia pursing a Master of Education programme in Science Education. I am currently researching on teaching practices in High schools on the Copperbelt. Your forthright answers to the questions below will be highly appreciated, and all the responses will be treated confidentially and the data will be used for academic purposes only.

On filling in this questionnaire tick on the option you think apply to you and write the brief details were the question demands giving a reason or other information.

Thanking you in advance.

It should take you not more than 20 minutes to complete the questionnaire. Please respond to the items in terms of your *own* and *present* opinion.

1. School: .....

2. Name: .....

3. Age: .....

4. Gender: ☐ Male ☐ Female

5. Highest qualification:

   ☐ Degree

   ☐ Advanced Diploma

   ☐ Diploma

   ☐ Certificate

6. How many years have you been a Chemistry teacher?

0-2	3-5	6-10	10 or more
☐	☐	☐	☐

7. Have you ever inducted in learner-centered strategies in your career?

   ☐ No ☐ Yes

8. Do you regularly use these strategies in your teaching?

□ No □ Yes

9. To what extent did the workshop help you to understand about teaching strategies and using them in your teaching? Choose which one is appropriate for you in each part below.

Teaching Strategies	Not at all	Somewhat	Not sure	Fairly well	To a great extent
a) I have knowledge and understanding of what is involved in learner-centered strategies.					
b) I understand the connection between learner-centered teaching and reflective practice and its link to professional development					
c) I use a variety of teaching strategies despite the number of learners in class					
d) I always lecture in my Chemistry lessons					
e) I use a lot of questions in my lessons					
f) I know how to demonstrate in Chemistry teaching and use demonstrations.					
g) I use whole class discussions in my teaching of Chemistry					
h) I regularly give projects like hoe work to my learners					
i) I always engage learners in problem solving e.g. exercises					
j) Despite shortage of resources I engage learners in practical group works.					
k) I use role plays in my teaching					
l) I use inquiry method in teaching Chemistry					
m) I use simulations, games and role plays in teaching Chemistry					

If you have any further comments about the teaching strategies workshop, please write them down:

.....

.....

.....

Please list three major *barriers (concerns)*, which have stopped you getting started teaching in a learner-centered way if any, starting with your major concern.

a. .....
b. .....
c. .....

10. To what extent do you agree with the statements below about teaching?

Statement	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
a) Classes with less than 40 learners result in higher achievement					
b) In classes less than 40 learners, the teacher easily assists learners with problems					
c) Classes having less than 40 learner have learners who are behaved					
d) A teacher can use a variety of teaching methods in classes having learners less than 40.					
e) With learners less than 40 in class it is easier to give feedback.					
f) In classes with learners less than 40, there are good teacher-learner interactions.					
g) Classes with learners more than 40 result in higher failure rate.					
h) Classes with learners more than 40 make teaching exhaustive.					
i) If learners are more than 40 in a class, it hinders active pupil participation					
j) In classes with learners more than 40, it gives less opportunity for individual projects.					
k) Lecture, demonstrations and question and answer are the best methods for classes with learners more than 40.					

11. In order of preference, list below five important teaching strategies you feel should be used in Chemistry teaching in large classes.

1. .....
2. .....
3. .....
4. .....
5. .....

THANK YOU

Appendix II. Teaching Strategies Observation Schedule

Date ..... Time ..... Class ..... No. Learners.....
School ..... Teacher..... Observer..... Topic .....

				Time in Minutes											
				5	10	15	20	25	30	35	40	45	50	55	60
	Org		Whole class												
			Small group												
			Individual												
Knowledge dissemination	What Learners are doing	Ed. cntrl	Learner listening to educator												
			Learner observing demonstration												
			Learner copying from board/paper												
			Learner reading												
			Learner writting (exercise)												
			Learner doing practical												
			Preparing/clearing away												
		Lnr cntrl	Discussing amongs peers												
			Learner creative writing												
			Listening to whole class feedback												
Teacher Control	Class Management	Ed. cntrl	Educator talks to organise class												
			Educator talks to give content												
			Educator elicits from learners												
		Lnr cntrl	Learners asks questions												
			Learners give explanations												
			Learners work without teacher												

NOTES