

CHAPTER ONE

INTRODUCTION TO THE STUDY

1.1 INTRODUCTION

The past two decades has seen a shift in science education reforms from teaching that emphasises helping students acquire scientific knowledge to teaching that enhances development of conceptual understanding among students (Tanner & Allen, 2005). These reforms seem to draw from the notion of constructivism (Cimer, 2007). Waggins & McTighe (1998) argue that when teaching for conceptual understanding in biology, teachers need to first understand students' prior knowledge, identify issues that may cause confusions and then create opportunities for the students to integrate the old and new ideas. Tobin, Tippins & Gallard (1994) acknowledge the importance of verbal interaction when teaching for understanding which they claim helps the teachers to monitor students' understanding of the science concepts. According to Waggins & McTighe (1998) when students understand the concept, they should be able to answer questions that require explanations, interpretation and application of the knowledge learnt. Furthermore, they should be able to argue for a particular stand, share their understanding with others and reflect on their thinking. Drawing from constructivist teaching practices, Cimer (2007, p. 21) lists the following as main principles of effective teaching in science especially biology:

- Dealing with students' existing ideas and conceptions,
- Encouraging students to apply new concepts or skills into different contexts,
- Encouraging student participation in lessons,
- Encouraging student enquiry,
- Encouraging co-operative learning among students, and
- Offering continuous assessment and providing corrective feedback.

Malawi like other developing countries is striving to provide the "ideal" science education system, one that considers students as active participants in the teaching and learning process over traditional teacher-centred approaches. The Malawi government reviewed the secondary school curriculum and implemented a new curriculum in 2000. The new curriculum draws from the constructivist theories of learning. The senior secondary Biology teaching syllabus emphasises

active student involvement and the use of students' experiences in lessons to enhance the comprehension of science concepts. The emphasis on student involvement and building on their prior knowledge in the teaching and learning process is in line with the constructivist theories of learning (Carr, Barker, Bell, Biddulph, Jones, Kirkwood, Pearson & Symington, 1994; Brodie, Lelliott & Davis, 2002).

There are a number of potential factors that may contribute to the success or failure of teachers' adoption of the constructivist teaching practices. Firstly, the teachers' understanding of the nature of change required. Fullan (2001) points out that a reform can only succeed if implementers understand the concepts in the new practice. Secondly, time available for teaching in relation to content to be covered (Mbano, 2003; Msimanga & Lelliott, 2009). Thirdly, teaching and learning resources available. Lack of basic equipment for teaching science can be a contributing factor to the use of transmission methods instead of active learning methods in secondary school science (Lungu, 2005). Fourthly, national examinations do influence classroom practices (Isaac, 1993). Last but not one, students' background can limit their participation in the classroom (Shumba, 1999). Finally though not exhaustive, physical resources and school ethos and management are contributing factors to the school's capacity to implement a curriculum innovation (Rogan & Grayson, 2003; Rogan, 2007). These factors will be explored in detail in chapter two and linked to the findings of this study in chapter four. This chapter presents the research problem but first, here is the context within which this study was conducted.

1.2 THE CONTEXT OF THE STUDY

1.2.1 The education system in Malawi

Malawi follows an 8-4-4 system of education. At the end of the eighth year in primary school, students write the Primary School Leaving Certificate Examination. Some get selected to secondary schools while those not selected either repeat year eight till they get selected to secondary schools or drop out. Secondary education is for four years with two national examinations, the Junior Certificate Examination at the end of year two and the Malawi School Certificate Examinations at the end of year four.

National examinations are very important in the Malawi education system as they are used for selection from one level to another. For most Malawian students, secondary education is the last

level of education as very few get selected to tertiary institutions. Therefore, the future of these students is determined by the Malawi School Certificate Examinations hence passing this examination is a need not a want. Teachers' ability to teach is judged by the pass percentages of their students at each of the national examinations. Examinations can influence the way the curriculum is implemented (Mbano, 2003). Chalira & Nkhoma (2003) report that teachers in Malawi teach to the examinations.

Malawi has two types of government secondary schools, the community secondary schools and conventional secondary schools. From my observations as I visited these schools, the major difference between these schools is resources, both physical and human. The conventional secondary schools have qualified teachers and adequate infrastructure that include science laboratories and furnished libraries. On the other hand in community secondary schools, most teachers are under-qualified; there are no science laboratories except in a few cases where there may be mobile laboratory equipment; and libraries are just small rooms where books are kept and lent to students. The community secondary schools and the quality of education offered in these schools are considered inferior to conventional secondary schools. This perception is due to the lack of teaching resources and the fact that most teachers in community schools are under-qualified to teach in secondary schools (Chakwera, Khembo & Sireci, 2004).

The situation in community schools stemmed from the introduction of free primary education. In 1994 Malawi elected the first democratic government and the new government did not waste time before making major changes in the education sector. The new government introduced free primary education and embarked on a secondary education curriculum review process.

The introduction of free primary education saw the enrolment in primary schools increasing by a million (Chimombo, 2005). The existing secondary schools were not sufficient to cope with the influx of scholars from the primary schools. In an effort to address the problem, the government decided to convert the distance learning centres into community secondary schools. The distance learning centres did not have subject teachers. The centres only had staff trained to teach in primary schools who acted as supervisors (Mwakapenda, 2002) to oversee the distribution of learning materials. When the centres became secondary schools with face-to-face contact, they needed more teachers in various subject areas. However, the already stretched human resources could not accommodate staff for the new secondary schools. To solve the problem, the government decided to pull out some teachers from primary schools to teach in the community secondary schools despite their being under-qualified for that level.

In Malawi the academic qualification of primary school teachers is the Malawi School Leaving Certificate which is an equivalent of O-level. This is supplemented by a two-year professional training to obtain a teaching certificate from a teacher training college where most staff hold a first degree or a diploma in education. Some of the under-qualified community secondary school teachers with good Malawi School Leaving Certificate results have since gone for professional development at a college of education for a diploma in education. The teachers in the conventional secondary schools possess either a diploma in education or a degree obtained from either a university institution or a college of education. If knowledge of subject matter can indeed determine the teachers' choice of teaching and learning strategies (Carr *et al.*, 1994), then the under-qualification of most teachers in community secondary schools may have a bearing on the implementation of the required teaching and learning approaches in Biology. Since the community secondary schools are the principal secondary education providers as they outnumber conventional secondary schools, the majority of secondary school students are taught by under-qualified teachers. Currently Malawi has 116 conventional and 620 community secondary schools (Ministry of Education, Science & Technology, 2008).

Despite the large numbers of community secondary schools, the secondary schools are still too few for the large number of students who write the Primary School Leaving Certificate Examination. This leads to very large enrolment numbers for each school. The number of students per class, in government secondary school classrooms, range from forty to sixty students. However, in some extreme cases of over-enrolment in urban schools, there can be as many as seventy or more students in one class. Large classes can be challenging when it comes to learner-centred teaching approaches due to inadequate space and materials for class activities (Mbano, 2003; Allen & Tanner, 2005).

Textbooks are very few in most secondary schools. For senior Biology the situation is worsened by the fact that it was an **elective** subject when the curriculum was being reviewed and only gained the **core** status after the curriculum reform process in 2004 (Nampota, Thompson & Wikeley, 2009). During the curriculum reform process, textbooks were only written for **core** subjects. As an **elective** subject, only reference books were recommended for Biology. This implies that Biology teachers are expected to use more than one title of the recommended books in delivering the current curriculum. Since many titles are required, schools may not have adequate numbers under each title for group tasks. Some schools only have copies for teachers.

The medium of instruction in secondary schools is English. Students start to use English as a medium of instruction in year five of their primary education but most of them still struggle to express themselves in English in the secondary schools. Ability to express themselves is in some cases further hindered by the students' cultural backgrounds.

The prevailing cultural expectation from the part of Malawi where this study was conducted, does not expect young people to argue with or oppose adults. This may limit students' participation in class activities as culturally teachers are viewed as adults with knowledge to be imparted to students. If students fail to express themselves, then teachers may have difficulties in eliciting prior knowledge as well as getting the students to participate in class activities as expected.

1.2.2 Curriculum change

The government embarked on a secondary school curriculum review process which in 2000, saw a new curriculum being ushered in. Biology is one of the science subjects offered in the new curriculum. Educational change is complex and is affected by several interrelated factors which influence the success or failure of the innovation (Fullan, 2001). Fullan (2001) indicates that educational change can occur when new or revised materials are put to use; when there is change in classroom practices; and when there is an alteration of beliefs or understanding of curriculum and learning practices. In the case of Malawi, the current curriculum brought changes in all these three areas.

According to the Biology syllabus (Ministry of Education, Science & Technology, 2001, p. 1) the objectives of the Biology curriculum are to enable students to:

- Develop an understanding of themselves, the world around them, and natural phenomena
- Develop investigative skills and techniques applicable to biology and everyday life
- Develop the spirit of inquiry, innovation, invention and independent thinking
- Develop skills that will enable them to apply biological knowledge to solve personal and community problems related to health, population and environment
- Develop thinking, communication and study skills
- Understand the impact of human activities on the environment
- Appreciate Malawi's natural resources and the need to manage and conserve them
- Appreciate the application of biology in everyday life

The objectives listed above show that the new Biology curriculum in Malawi is more skills and value oriented than the previous one which was mostly content oriented. Development of skills requires conceptual understanding not just knowledge acquisition (Carr *et al.*, 1994). Teaching for conceptual understanding requires a shift in the teaching approach from the traditional knowledge transmission practices to ones that enable students to develop their own knowledge. Nyirenda (2005) points out that the Malawian teachers are expected to play the role of facilitator in the new curriculum. The curriculum is expected to be delivered using strategies that actively involve students and to draw upon their everyday experiences. For example the learning tasks suggested in the senior Biology teaching syllabus are mostly learner-centred as section 1.2.3.1 of this report explains. This expectation is contrary to what teachers are used to from the old curriculum.

In the old curriculum, teachers were guided by an examination syllabus provided by the Malawi National Examination Board which administers national examinations. The examination syllabus indicated examinable content hence teachers taught to the examinations in that their context and examples were drawn from past examination papers and chief examiners' reports. In short, teachers were drilling students to pass examinations. In that curriculum students were often passive recipients of knowledge and rote learning was encouraged. Therefore, to guide teachers in the implementation of the new curriculum, a teaching syllabus was developed.

1.2.3 The Biology teaching syllabus

The Biology teaching syllabus is presented in table form with six columns which include:

- Topic
- Objectives
- Content
- Suggested teaching and learning activities
- Suggested teaching and learning resources
- Suggested modes of assessment.

An analysis of the teaching syllabus shows that the current Biology curriculum requires change in teaching practices. Two areas that require change are: the nature of teaching and learning activities and type of teaching and learning resources.

1.2.3.1 Nature of activities promoted in the Biology teaching syllabus

The nature of teaching and learning activities, suggested in the Biology teaching syllabus, require active student involvement in lessons. The teaching syllabus expects teachers to use more than the traditional explanation and possibly experimental practical work that prevailed in the old curriculum. For example for *parts of leaf* content, a sub-topic of *plant structure and function*, the syllabus suggests that students should:

- Examine the cross section of a fresh leaf using magnifying glass and light microscope
- Draw and label the parts of a leaf
- Read about parts of a leaf; and
- Discuss the leaf structure (Ministry of Education, Science & Technology, 2001).

Other activities suggested in the Biology teaching syllabus involve brainstorming; listing; labelling; designing, planning and carrying out investigations; observing; collecting data and presenting it in tables or graphs; and role playing just to cite a few (Ministry of Education, Science & Technology, 2001). These activities emphasise the need for *student involvement* in learning the new Biology curriculum, a practice that was not emphasised in the previous curriculum.

1.2.3.2 Type of teaching and learning resources

The Biology teaching syllabus suggests the use of textbooks; resource persons; charts; students' experiences where applicable; and relevant materials for the different investigations as teaching and learning resources. Fourteen out of sixteen topics in the senior secondary Biology curriculum have content where students' experiences are suggested as a resource in lesson presentation (Ministry of Education, Science & Technology, 2001). The previous curriculum did not emphasise the need to build on students' experiences hence using *Students' experiences* is a new requirement that teachers have to adapt to in their teaching practices in implementing the current Biology curriculum.

1.3 THE RESEARCH PROBLEM

The motivation behind this research study came from the observation that most Biology teachers seemed to fail to implement new teaching practices emphasised in the teaching syllabus: drawing from students' everyday experiences; and to actively involve students in their teaching. This observation came from my professional experience. I worked as an education methods

advisor for Biology and Physical Science in the Ministry of Education, Science & Technology for the first five years of the implementation of the new curriculum (2000-2005).

As an education methods advisor, I participated in the development of the new curriculum as well as in school inspections which are part of the monitoring procedures for implementation of education policies which include the new curriculum. Most lessons I observed when the education methods advisors team visited schools showed lack of consideration of students' prior knowledge even where it was applicable and important in enabling conceptual understanding. Student involvement was limited to whole class question-and-answer sessions. In cases where groups were used, they were often mere seating plans and not learning forums. Reports from other education methods advisors for Biology and Physical Science showed similar observations hence I felt the need to find out what was behind the teachers' failure in adopting the new teaching practices.

1.4 AIM OF THE STUDY

Active student participation and drawing from students' experiences seem to be quite a big challenge for science teachers in Malawian secondary schools due to large classes; inadequate teaching and learning resources; and cultural backgrounds of students which may limit their participation in class discussions. This study aimed at investigating teacher-related factors affecting the implementation of the constructivist approaches required by the senior secondary Biology teaching syllabus in Malawi. This included investigating the teachers' understandings and application of the required approaches to teaching and learning; and their perception about what they believe promotes/ hinders them from using the required approaches. The following research questions were addressed:

1. What are four Biology teachers' understandings of the phrases *students' experiences* and *active student involvement*?
2. How do the four biology teachers use active student involvement strategies and students' prior experiences to promote conceptual understanding in Biology?
3. What factors promote/hinder the use of the constructivist approaches by the four teachers in teaching Biology in Malawi?

1.5 DELINEATING THE STUDY

The study investigated two teaching practices emphasised in the senior secondary Biology teaching syllabus: using students' experiences as a resource in lessons where applicable and active student involvement in lessons for comprehension of Biology concepts. These aspects of teaching are new for the teachers as mentioned earlier and they draw from the constructivist theories of learning. The study sample was limited to four teachers from different schools and the topics for lesson observations depended on what each of the four teachers was teaching at that time. This was because it is small scale research and time was limited as data was collected during a three week visit to Malawi.

1.6 IMPORTANCE OF THE STUDY

The school inspectors' reports bear testimony to the fact that teachers are struggling with implementation of the new curriculum. Little is known as to what problems/challenges these teachers are facing as no research seem to have been done on how teachers are implementing the new curriculum in the classrooms. The findings of this research provide insight into the understanding and interpretation of the senior secondary Biology teaching syllabus by four teachers in four different secondary schools; reveal the nature of activities these four teachers use in implementing the new approaches and outline some factors the four teachers perceive as barriers to the use of students' experiences and active student involvement strategies in Biology lessons. This information would be useful to education methods advisors as a resource for further investigations on what a larger population of teachers, from environments similar to the four teachers in this study, may be struggling with.

1.7 SEQUENCE OF THE RESEARCH REPORT

This research report is divided into five chapters. Chapter one describes the context of the study; the problem that motivated the study and the questions that guided the research process. This chapter provides the reader with the rationale that necessitated the conduct of this research in the Malawian context.

Chapter two provides the theoretical framework that assisted me in making sense of the information obtained in this study and a review of literature on studies that drew from constructivism and those that focussed on effective teaching practices in science. The emphasis in the literature review is on roles of students' prior experiences and active student involvement strategies in learning Biology at secondary school level and some factors that promote or hinder the use of constructivist practices in teaching science.

In chapter three I describe the methods used in conducting this study and the reasons for choosing them. Issues of rigour and ethics in research are discussed in this chapter. The chapter also provides information on the participants and their schools to enhance the readers' understanding of the report.

Chapter four provides the results obtained and the discussion of these results in themes that represent the three research questions being answered. The chapter begins with a description of how the data was analysed.

Finally, chapter five has a summary of findings, my reflection on the research process, some recommendations and suggestions for future research.

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 INTRODUCTION

Judging from the literature on reforms in science education, it seems common knowledge that students come to instruction including high school biology with prior conceptions. Learning is meaningful when new knowledge is linked to what exists already (Cimer, 2007) but it seems that teachers spend little time on investigations of what their students already know (Tanner & Allen, 2005). Cimer (2007) argues that for teaching to be effective teachers need to be aware of their students' alternative conceptions or misconceptions and plan learning activities that can help students to reconstruct their knowledge. Effective teaching therefore, requires that students be actively involved in their own learning. However, a number of factors come to play when it comes to the use of active student involvement strategies in science classrooms especially in developing countries.

This study explored the meanings that four biology teachers attach to students' experiences and active student involvement, the extent to which the four teachers build on students' prior experiences and involve their students in their teaching to enhance conceptual understanding and the factors the four teachers perceive to be hindering / promoting these constructivist practices in their biology classrooms. This chapter explores research conducted in this field and describes the theoretical framework that guided my research.

2.2 THEORETICAL FRAMEWORK

A theoretical framework assists the researcher in drawing and summarising findings of the study in order to make the information meaningful for those who would like to use the findings for further studies (Bell, 2005). A theoretical framework explains the key factors, constructs or variables and the presumed relationship between them (Bell, 2005). Therefore, the theoretical framework has to match the nature of research questions being addressed and the methods of

data collection and data analysis. Consequently, this study drew from the constructivism theoretical framework.

The constructivism theoretical framework provides a basis for understanding how human beings integrate new knowledge into the existing cognitive structures and then make sense of that knowledge (Ferguson, 2007). Studies that use constructivism as a theoretical framework set out to answer questions on how people construct reality in a particular setting and the effects of people's constructions on their behaviour and those they interact with (Ferguson, 2007). Also studies on reported perceptions, truths, explanations, beliefs and worldviews do use the constructivism theoretical framework (Ferguson, 2007).

The constructivist theory of learning

Constructivism considers learning as the construction of knowledge by individuals. In this theory of learning it is acknowledged that students may bring prior ideas to instruction. In science education, the students' prior ideas may be in conflict with scientific knowledge being taught hence would affect the students' conceptual understanding (Smith, DiSessa & Rosachelle, 1993; Carr *et al.*, 1994; Fensham, Gunstone & White, 1994; Scott, Asoko, Driver & Emberton, 1994). In constructivism, knowledge construction is an active process and social interactions among students are central in construction of knowledge by individuals. Cakir (2008) adds that where students have some prior knowledge on the concept, such knowledge is crucial to the students' understanding of the new information or concepts. Therefore the teaching and learning process should be an active negotiation-for-meaning process involving finding out and engaging with students' ideas where possible (Carr *et al.*, 1994; Fensham *et al.*, 1994; Scott *et al.*, 1994).

The constructivist theory of learning has its roots in Piaget's cognitive and Vygotsky's social-cultural perspectives on teaching and learning science. In Piaget's cognitive perspective on learning, human beings are active, independent meaning makers who construct their knowledge as opposed to receiving it (Piaget, 1964, 2003; Hatano, 1996; Moore, 2000). When an individual constructs knowledge the new information is either integrated into the existing understanding, a process Piaget calls assimilation or if the new information contradicts existing knowledge, restructuring of knowledge occurs to adapt new information in a meaningful manner in what he calls the accommodation process. In the cognitive view, human beings achieve a balance between assimilation and accommodation through their interactions with the physical and social environments and Piaget calls this process equilibration or self-regulation (Moore, 2000). From the cognitive perspective, equilibration (self-regulation) entails comprehension of science

concepts. Therefore, to assist students, the teacher should be aware of the students' existing knowledge and any cognitive conflicts that students may experience so as to engage them in meaningful activities. Such activities should help students to work with their prior ideas during the teaching of the scientific concepts being explored in the topic in order to resolve their conflict and enhance conceptual understanding.

Vygotsky's socio-cultural perspective of teaching and learning emphasises the process of social interaction in one's construction of knowledge. In this view, learning occurs when the student interacts with people who are more knowledgeable than him / her (Vygotsky, 1978; Wertsch, 1985). For Vygotsky, language is a tool that a student uses to construct knowledge during social interactions with others in order to develop a personal understanding. According to Vygotsky, the students have two levels of development: the actual developmental level that refers to the already mature mental abilities which enable the student to solve problems independently and the potential development level that refers to higher mental functions that are not matured. The student can use these higher mental functions to solve problems only with the help of an adult or a peer who is more knowledgeable than him/her. The difference between these two levels is what Vygotsky calls the zone of proximal development (Vygotsky, 1978; Wertsch, 1985). The zone of proximal development is accessed through student- teacher interaction or cooperative problem-solving with peers (Liang & Gabel, 2005). From this perspective, the teacher can help students understand scientific concepts by assigning challenging tasks and engaging students in small groups and whole class discussions with guidance from teacher through scaffolding. Therefore knowledge is personally constructed in the process that is mediated by social interaction (Driver, Asoko, Leach, Mortimer & Scott, 1994; Hewson, Beeth & Thorley, 1998; Windschitl, 2002).

The rest of the chapter provides a review of literature on the constructivist approach in science education. The emphasis is on the role of students' prior knowledge and participation in the teaching and learning science for conceptual understanding as well as the possible factors that affect teachers' use of constructivist practices in science education.

2.3 THE CONSTRUCTIVIST CLASSROOM PRACTICES

Students' prior conceptions and social interactions with peers and teachers are very central in the constructivist theory of learning. The assumption is that students use prior ideas as a

foundation for new knowledge and during interaction with others, students use their previous ideas to negotiate for meaning of what is being taught (Carr *et al.*, 1994; Driver *et al.*, 1994; Windschitl, 2002; Ferguson, 2007; Cakir, 2008). Therefore, working with students' prior experiences and using active student participation strategies are fundamental classroom practices in the constructivist teaching and learning process. These are further explored in the sections that follow.

2.3.1 Students' prior experiences

Students' experiences come from their observations, perceptions, culture, language, prior teachers' explanations as well as prior instructional materials (Cakir, 2008). For Jegede (1998), prior knowledge is determined by one's cultural beliefs, traditions and customs in relation to one's worldview. According to Jegede, students' prior knowledge differs due to cultural diversity. Jegede further recognises that prior knowledge can be either a capital or a handicap in learning science. It becomes a capital if the student can use the ideas to construct meaning without hindrances and is a handicap if the student experiences conflicts between prior ideas and new meaning which in turn impede cognitive development. Furthermore, prior knowledge can be a source of misconceptions that may be a cognitive constraint in the process of knowledge acquisition (Smith *et al.*, 1993; Hatano, 1996). For Smith *et al.* (1993) teaching should identify students' misconceptions and provide conceptual information that can enable students to modify their misconceptions. Modification of misconceptions occurs through restructuring of prior knowledge in relation to science concepts to achieve conceptual change during instruction.

The conceptual change model perceives learning as a process through which an individual swaps prior ideas with new ideas received during instruction based on intelligibility, plausibility and fruitfulness (Hewson *et al.*, 1998; Liang & Gable, 2005). However, Driver *et al.* (1994) caution that teaching for conceptual change does not result in students abandoning their prior ideas of scientific knowledge as often the students keep such ideas and use them in the appropriate social context. This observation is shared by Jegede (1998) and Aikenhead & Jegede (1999). They assert that, for most African students, prior knowledge is in conflict with school science. This is because school science is presented within the Western worldview framework that differs from the African worldview (Jegede, 1998; Aikenhead & Jegede, 1999).

A worldview is the way in which a group of people construct knowledge in their environment (Jegede, 1998; Aikenhead & Jegede, 1999). In the African worldview, the knowledge base, i.e. the information and practices that the learner draws on to enhance learning (Jegede, 1998),

includes the learners' environment whereas in the scientific worldview the context is excluded. (Jegede, 1998). Context is important for conceptual understanding hence its absence makes students fail to integrate prior ideas with new ideas as suggested by Piaget's cognitive view on learning science. Instead the two knowledge bases are compartmentalised in students' mental schema for use either during examinations or when dealing with indigenous knowledge issues (Jegede, 1998; Aikenhead & Jegede, 1999). Lewin (1992) reports that teaching science in a way that bridges the gap between culture and science instils positive attitudes in the learning of science. For this reason, Lewin (1992) suggests that teachers should link science and culture.

2.3.1.1 Eliciting students' prior experiences

Eliciting students' prior experiences can help the teacher to gain insight into the students' levels of understanding on a topic. Such knowledge would enable the teacher to determine the difficulties students may experience to understand the concepts (Lobato, Clarke & Ellis, 2005). Cimer (2007) adds that elicitation of students' ideas revitalises students' awareness of their prior ideas which is important in construction of new knowledge. There are different ways in which teachers can use to uncover their students' prior ideas. According to Cimer (2007), some of the strategies teachers can use to elicit students' ideas are: revising previous work, question and answer, group discussions, debates, brainstorming, use of familiar examples and experiments just to mention a few. On use of question and answer, Cimer (2007) indicates that open-ended questions are more effective in eliciting students' prior knowledge because they expose deficiencies in students' responses. This is probably because open-ended questions allow students to express their opinions unlike closed questions which seek predetermined responses.

2.3.1.2 Working with students' prior experiences

Working with students' ideas is the key to constructivist practices. Brodie (2004) suggests that understanding teacher-student interactions assists in understanding how learning and teaching take place in the classroom. Different frameworks have been used by researchers to track teacher-student interactions in constructivist science classrooms with a focus on either the students or the teachers. Lord (1997) used Bybee's five instructional phases: engage, explore, explain, elaborate and evaluate (5Es) to compare traditional and constructivist teaching in college biology. In this model, the *engage* phase presented activities that excited students in the topic; the *explore* phase directed students to examine their work in groups; the *explain* phase allowed students to inform others of their findings; the *elaborate* phase encouraged students to investigate the topic further; and the *evaluate* phase gave students an opportunity to assess their learning (Lord, 1997). This model focuses on the students' contributions during instruction.

Brodie (2004) carried out a study on working with learner contributions but focussed on teacher moves by coding teacher responses. Brodie (2004, p.693) outlines a framework with five codes that reflect main moves made by the teacher as a response to contributions made by students. These codes with brief explanations are:

- *Affirm*- a teacher affirms the student's response as right or good then moves to another idea.
- *Direct*- a teacher asks a student to do something.
- *Initiate*- a teacher tries to get an idea from students but it is not a follow-up to a previous response.
- *Inform*- a teacher gives information.
- *Follow-up*:
 - *Confirm*-a teacher checks if what s/he heard from the student is correct.
 - *Maintain*- a teacher repeats the student response or tells the student to continue talking.
 - *Press*- a teacher probes the student for more information on the idea for clarification or justification.
 - *Elicit*- a teacher asks the same student to give more ideas.
 - *Insert*- a teacher adds something to a student's response.

Drawing from Brodie (2004)'s framework, it appears that working with students' ideas requires a student-teacher dialogue that is explicit on both teachers' and students' perspectives to enhance a shared conceptual understanding (Kinchin, 2003). Waggins & McTighe (1998) point out that teaching for conceptual understanding in biology require teachers to be aware of their students' prior conceptions and to take note of issues that may cause confusions. In this way, Waggins & McTighe (1998) claim, teachers would be able to engage their students in activities that would enhance integration of students' prior ideas and new knowledge. Waggins & McTighe (1998) consider students' ability to answer questions that require explanations, interpretations and application of knowledge learnt among others, as indicators of understanding the concepts taught. With reference to Lord (1997), Waggins & McTighe (1998), Cimer (2007)'s principles of effective teaching (outlined in section 1.1 of this report) and Brodie (2004), I consider the following teacher moves as essential when a teacher is working with students' prior experiences in a biology classroom: elicitation of students' ideas as explained in section 2.3.1.1 of this chapter, provision of information that would enhance construction of new knowledge (insertion), use of examples that would facilitate the use of knowledge gained (application), providing

opportunities for students to reflect on their own ideas and those from other students (metacognition) and teacher-student as well as student-student dialogue (social interactions).

Insertion

Insertions allow teachers to add essential information on students' responses in order to elaborate the ideas given, to answer the questions from students and to introduce new ideas for conceptual understanding (Brodie, 2004; Lobato *et al.*, 2005). While it is important for teachers to provide vital information to guide the construction of new knowledge, when too much is told repeatedly the practice shifts towards the traditional transmission model of teaching (Lobato *et al.*, 2005).

Application

Effective and meaningful learning occurs when students' prior ideas are known, dealt with and linked to what is being learnt (Cimer, 2007). The link between students' ideas and scientific knowledge is often achieved through the use of examples from students' everyday contexts (Kasanda, Lubben, Gaoseb, Kandjeo-Marenga, Kapenda & Campbell, 2005).

Metacognition

Reflection on one's thoughts is important when negotiating for a shared understanding in the classroom as well as for conceptual change on alternative conceptions (Hewson *et al.*, 1998). Mbano (2004) suggests that explicit demands for justifications from students stimulate the ability to think of their thoughts or ideas. Herrenkohl & Guerra (1998) add that clarifying, disputing and coordinating theories and evidence are vital metacognitive practices in science classrooms.

Social interaction

Social interaction is at the heart of knowledge construction by students. Verbal interaction is the key to teaching for understanding because it enables the teachers to monitor their students' understanding of scientific concepts (Tobin *et al.*, 1994).

I used these teacher moves as codes in analysing information mainly obtained through lesson observations. The analytical scheme is explained in chapter four.

2.3.2 Student involvement

Construction of knowledge is an active process (Cakir, 2008, Schiro, 2008). This implies that students need to be actively involved during instruction to enable them construct new

knowledge. Lord (1997) claims that active involvement of students improves their interest and understanding of science. It should be noted though that engaging students in hands-on activities without conversations about the purpose of the activities, methods and results of the findings does not promote construction of knowledge (Windschitl, 2002). Negotiation of meaning is an important aspect of constructivism. To achieve this, students need to be given an opportunity to make sense of what is learned through comparing what is known to the new experiences and attempting to resolve the discrepancies that may exist between their prior experiences and new experiences (Lorsbach & Tobin, 1992). A study by Kinchin (2003) on effective teacher-student dialogue found that in a classroom a shared understanding on concepts is enhanced by a teacher-student dialogue that makes explicit both students' and teacher's perspectives.

Creating opportunities for students to express their opinions in most African countries can be challenging. Shumba (1999) notes that in most African societies there is great respect for adults. Elders are looked upon as sources of knowledge that should be transmitted to young people without questions. Such authoritarianism, Shumba (1999) warns, limits the extent to which students can exercise their own thoughts in learning science as teachers are considered as adults who know-it-all.

When students are given less opportunity to discuss their ideas, it becomes difficult to build on existing ideas (Herrenkohl & Guerra, 1998). Teachers often use question and answer and group discussions strategies to involve students in science lessons. While the question and answer technique seems viable for most teachers, Herrenkohl & Guerra (1998) express concern over the use of what they call test questions. These are questions that the teacher already has answers to but asks them to check if students know the answers too. Such questions, Herrenkohl & Guerra (1998) claim, do not help students in using prior knowledge to develop conceptual understanding. Carr *et al.* (1994) add that test questions give an impression that there is a single definition of a concept which is contrary to the nature of science as seen from a constructivist view. In the constructivist view, scientific knowledge is dynamic and cumulative; can be studied using different methods; is driven by curiosity and creativity; and is socially and culturally embedded (Carr *et al.*, 1994). Carr *et al.* assert that open negotiations should be encouraged and partial responses appreciated as these would help achieve the right image of science. For this reason, Brodie (2004) suggests use of authentic questions which do not have predetermined responses. Authentic questions shows that the teacher is interested in what

students think and can also check students' ideas as well as help the students to declare them (Brodie, 2004).

Discussions among students and with the teacher enhance comprehension of scientific concepts. Herrenkohl & Guerra (1998) report that clarifying; disputing and coordinating theories and evidence are vital metacognitive practices for successful group discussions. Metacognition encourages students to think scientifically as evidence is crucial in development of scientific knowledge. For Herrenkohl & Guerra (1998), asking clarification questions encourages dialogue which promotes establishment of a shared meaning in the classroom; disputing helps students to challenge ideas raised by others which promotes conceptual change; and coordinating theory and evidence assists students to construct well grounded scientific arguments that characterise conceptual understanding in science education. In short, discussions would give students a chance to monitor their understanding on personal ideas as well as other students' ideas, challenge ideas they question or doubt and link theories to available evidence. Furthermore, Herrenkohl & Guerra (1998) point out that students speak freely in small groups as opposed to whole class discussions. While small groups are encouraged, Brodie & Pournara (2005) disapprove of groupwork with tasks based on already taught work as such groupwork does not help students in construction of new meaning.

2.4 POSSIBLE FACTORS AFFECTING THE USE OF CONSTRUCTIVIST CLASSROOM PRACTICES

Since knowledge is constructed in an active process, constructivist teaching practices value students' involvement in their own learning. However, involving students and using their prior experiences in lessons seem to be a daunting task for many science teachers. Factors such as inadequate knowledge of subject matter, misconceptions about the concept of constructivism itself, lack of fluency in the language of instruction especially on the part of students, inadequate teaching and learning material, pressure from assessment demands that often do not match the constructivist expectations, indiscipline and cultural conflicts seem to have an effect on using constructivist approaches. (Jegede, 1998; Aikenhead & Jegede, 1999; Fabiano, 1998; Windschitl, 2002; Lobato et al., 2005). The next sub sections elaborate each of these factors.

2.4.1 Teachers' understanding of the concept of constructivism

Although this study has drawn from cognitive and socio-cultural constructivism, there are other forms of constructivism such as radical, critical and contextual constructivism (Ferguson, 2007). Windschitl (2002) indicates that if teachers do not understand the theoretical underpinnings of the cognitive and socio-cultural constructivism that govern most classroom practice reforms, they would experience difficulties in understanding their roles and that of their students leading to some misconceptions about constructivist practices.

One misconception about constructivist practices is that teachers should not be “telling” students (Lobato *et al.*, 2005). In their study about “Initiating and eliciting in teaching: A reformulation of telling”, Lobato *et al.* (2005) point out that most teachers have interpreted the shift from the transmission model of teaching to constructivist teaching in terms of “no telling” from teachers. Teachers have understood the shift to mean that they should just be listening to the students’ ideas. While not supporting knowledge transmission, Lobato *et al.* (2005) argue that if learning is enculturation into a new culture, then teachers need to facilitate the enculturation of students by making ideas and conventions of the new community available to the students. Such a process would be possible through “telling” the students what they need to know about the community they are becoming part of.

In South Africa, Nykiel-Herbert found that South African teachers commonly understood prior knowledge as being what the learners learnt from their homes and communities leaving out what was learnt in school (Nykiel-Herbert, 2004). This led to teachers emphasising use of prior knowledge at the expense of helping the students to acquire new knowledge.

In Malawi, a report by Saiti (2007) indicates that teachers from community secondary schools, who were attending a Secondary School Teacher Improvement Programme (SSTIP) intervention programme at Mzuzu University, thought pupil-centred approaches are for primary schools. These teachers felt that secondary school science teaching needed more serious teaching methods such as lecturing and other passive techniques. Nampota *et al.* (2009) notes that lecturing and copying notes is very dominant in Malawian science classrooms and that in most cases these notes are poorly prepared.

2.4.2 Teacher knowledge of subject matter and experience

According to Stoll (1994), insufficiently qualified teachers are rigid in their teaching styles and stick closely to their prepared notes or textbook with minimal teacher-student interaction. Carr *et*

al. (1994, p. 148) adds that “*teachers who are themselves insecure in their knowledge of science can find the uncomplicated transmission of knowledge attractive*”. Teaching science in this manner overlooks both students’ prior conceptions and their active involvement which are central in constructivist learning theory.

Constructivist teaching requires teachers to select content and contextualised activities that can challenge students in order to create the zone of proximal development (Liang & Gabel, 2005). Shulman (1986), Geddis, Onslow, Beynon & Oesch (1993) and Geddis & Wood (1997) note that the selection and delivery of science content is affected by the teacher’s mastery of subject matter as well as his/her ability to transform this subject matter into content that his/her learners can understand. Tobin *et al.* (1994) add that knowledge of subject matter influences the way teachers can modify and sequence information from the textbooks to suit the level of their students. Stoffels (2008) reports that experienced teachers’ plans are richer, more detailed and show more expertise in selection and use of resources than novice teachers. This may suggest that qualification and experience have an effect on teacher’s ability to use constructivist practices.

An assessment of under-qualified science teachers from the community secondary schools at the start of the SSTIP programme at Mzuzu University showed that their subject matter knowledge was limited to the content of textbooks in use (Saiti, 2007).

2.4.3 Teaching and learning materials

Teaching and learning materials are tools used by teachers to mediate the construction of knowledge in the classrooms (Windschitl, 2002). For students to be actively involved there is need for adequate equipment and textbooks. However, most schools in Africa have inadequate or no equipment at all due to the governments’ low funding of the education sectors (Fabiano, 1998). Environments like these can make it difficult for teachers to implement constructivist practices.

Malawian secondary schools especially community secondary schools lack laboratory equipment (Mbano, 2003; Lungu, 2005; Saiti, 2007; Nampota *et al.*, 2009). Lack of basic equipment for teaching science is seen as a contributing factor to the use of transmission methods when teaching secondary school science (Lungu, 2005).

2.4.4 Language of instruction

Communication is central in teaching and learning for conceptual understanding as it facilitates knowledge construction. Language is a tool that students use to construct knowledge during social interactions. This knowledge is later internalised in one's mind using names assigned in the language in use (Vygotsky, 1978; Wertsch, 1985). This implies that fluency in the language of instruction greatly impacts on students' ability to construct knowledge in science classrooms. Rollnick (2000) asserts that students need good fluency in the language of instruction for comprehension of concepts being taught. Research findings support the use of the student's home language in teaching and learning of science for conceptual understanding (Dlodlo, 1999; Rollnick, 2000). In Africa, some of the students' prior knowledge is constructed using students' home language (Jegede, 1994; Jegede, 1998). Therefore, the use of home language would enable students to be aware of all their alternative conceptions and to build on these existing conceptions where possible. However, lack of scientific registers in most African languages cause problems in using home languages as a medium of instruction for science (Dlodlo, 1999) resulting in the use of second or third languages in instruction.

Malawi, a former British protectorate, uses English as a medium for instruction from year five of primary education to tertiary education (Chilora, 2000; Kamwendo, 2000). Despite this early introduction of the English language as a subject and language of instruction, students still struggle in using it throughout the education system. Saiti (2007) found that teachers who came for a Secondary School Teacher Improvement Programme (SSTIP) (an intervention programme) at Mzuzu University had very poor English language skills. The teachers made numerous errors in spelling, grammar and pronunciations. Lack of adequate fluency in English implies that teachers may struggle with language used in reference books that were written for first language speakers of English. Difficulties in the language of textbooks may contribute to a lack of conceptual understanding (Mbano, 2003).

Research findings show that science has its own language demands due to the complexity and abstract nature of concepts as well as its special terminology (Gray, 1999). As such problems in science are also experienced by first English language speakers as it differs from their everyday language (Rollnick, 2000). The problems should be worse for second language students than first language speakers as they have to learn the English and scientific languages at the same time.

For Lemke (1990), learning science implies learning to “talk science” (i.e. observing, describing, comparing, analysing, discussing, questioning, writing, challenging, reporting, etc) and to use the specialised language in writing, reasoning and problem-solving. In addition to this, Lemke (1990) points out that “talking science” recreates a community of people with shared beliefs and values. Language is a system of resources people use to make meanings (Lemke, 1990).

Verbal communication among students and between students and the teacher is essential for negotiation of meaning in a science classroom (Jegede, 1998; Dlodlo, 1999; Gray, 1999). Rollnick (2000) adds that students need to have good fluency in the language of instruction for comprehension of concepts being taught. Consequently, there is a growing support from research findings for the use of student’s home language in teaching and learning of science (Dlodlo, 1999; Rollnick, 2000). However, because most indigenous languages do not yet have scientific registers, in most countries science is taught in a second or third language for both students and teachers (Dlodlo, 1999; Rollnick, 2000). Use of unfamiliar language limits verbal communication in most science classrooms hence some students and teachers in some South African schools expressed the wish to use home languages instead of the English language in order to understand concepts (Setati, 2008).

2.4.5 Cultural conflict

To learn science is to acquire the culture of science (Aikenhead & Jegede, 1999) and every culture has its own standard practices, tools and language as well as ongoing concerns (Bowen, 2005). As such science has its own standard practices, equipment and language that may be different from students’ indigenous practices. Therefore in learning science, students cross cultural borders from their everyday practices into the scientific practices. If there is harmony between science and their home culture, students smoothly cross borders and get enculturated in the science culture (Aikenhead & Jegede, 1999). However, if the two cultures disagree, then the students may experience cognitive conflict which may lead to students neither declaring their ideas nor taking part in classroom activities as expected in the constructivist learning approach.

2.4.6 Assessment style

Constructivism promotes use of high cognitive demand assessment where students can demonstrate their application of acquired knowledge in solving everyday problems (Lewin, 2000; Lewin & Dunne, 2000; Liang & Gabel, 2005). Science being a practical subject should also assess practical skills. However, Lewin (2000) and Lewin & Dunne (2000) found that most countries in Africa use lower cognitive demand multiple choice questions without assessment of

practical skills at primary school level. For Malawi, the use of multiple choice questions extends to the Junior Certificate Examinations at secondary school level (Chalira & Nkhoma, 2003).

In Malawi, Chalira & Nkhoma (2003) report that teachers in secondary schools adopt assessment formats of the Malawi National Examination Board (MANEB) and that there is high demand for MANEB question papers (pre-tests and past papers). This implies that teachers are teaching to the examinations and may be using same lower cognitive level questions to assess learning which does not reflect understanding. Chalira & Nkhoma (2003) further mention that when teachers apply for participation in the national marking exercise, their main reason is to improve teaching. In African societies teachers are judged by their ability to enable learners pass examinations (Rollnick, 1998). Improving teaching in the Malawian context may refer to adopting classroom practices that focus on helping learners memorise facts relating to examinations. This practice would not promote teaching advocated by constructivism.

2.4.7 Discipline

Misbehaviour of students during class activities can deter use of strategies that involve students. Tobin *et al.* (1994), reports that in a classroom teachers may spend more time on monitoring student' behaviour than on helping individuals understand concepts being taught. Tobin *et al.* (1994), attributes disruptive behaviour to lack of motivation as a result of failure.

2.5 CONCLUSION

This chapter has provided a review of literature on the constructivism framework in science education, a discussion of the expected constructivist classroom practices and some possible factors that may affect the use of these practices. The analytical scheme used in this study, is provided in chapter four of this report.

CHAPTER THREE

RESEARCH METHODS USED IN THE STUDY

3.1 OVERVIEW OF THE CHAPTER

My aim was to find out how four biology teachers understood of students' experiences and active student involvement in biology lessons, how their understandings affected their classroom practices and the factors the four teachers considered obstacles to their abilities to actively involve students and build on students' experiences. I set out to obtain this information through verbal conversations and observation of the four teachers' classroom practices. At the conception stage of the research study I had to think about the nature of information to be sought and the appropriate procedures that would be used in collecting the desired information. I had to choose the appropriate research design for my study. According to McMillan & Schumacher (2006), a research design describes procedures used in conducting the study. Furthermore, a research design provides insight on how the collected data should be analysed and some possible limitations in interpreting the results of the study. The rest of this chapter provides a description of the procedures followed in conducting the research that enabled me to answer the three research questions for my study. Figure 1 on page 26 outlines the research paradigm, methodology, methods and research instruments that were used to collect and analyse data in this study.

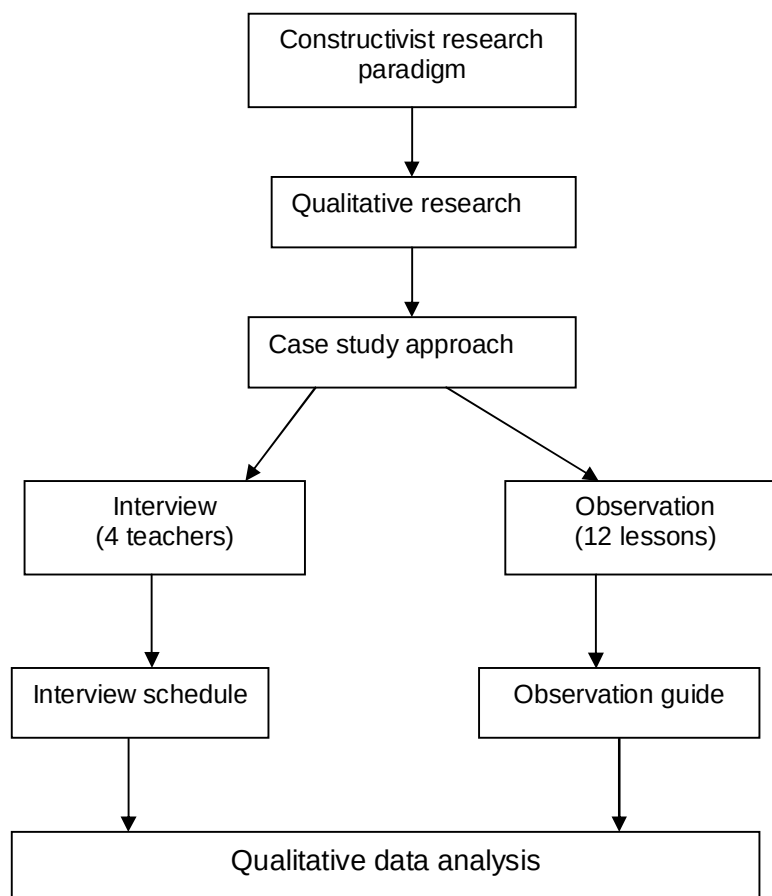


Figure 1: Flowchart of the research design for the study.

3.2 RESEARCH PARADIGM

A paradigm refers to a set of beliefs or assumptions about the nature of knowledge that guide the researcher's actions when conducting the study (Sikes, 2004) and helps a researcher to make sense of the data collected (Morrison, 2007). A research paradigm is defined by answers to questions about knowledge (epistemology); nature of reality (ontology); how knowledge about that reality is solicited (methodology); and the forms of knowledge produced (products) (Hatch, 2002; Sikes, 2004; Morrison, 2007). According to Hatch (2002), there are five research paradigms: positivist; postpositivist; constructivist; critical or feminist; and poststructuralist paradigm. This study was developed within a constructivist research paradigm. Table 1 below shows the perspective from which the constructivist paradigm operates with reference to

ontology, epistemology, methodology and the product. This is distinctive information that answers the four questions for this research paradigm.

Table 1: The research paradigm (Hatch, 2002, pp 13). Italics are my own additions

	Ontology (What is the nature of reality?)	Epistemology (What is known and what is relationship of the known to the knower?)	Methodology (How knowledge can be gained)	Product (What forms of knowledge are produced?)
Constructivist	Multiple realities are constructed— <i>depending on who is observing</i>	knowledge as human construction; researcher and participant co-construct understanding	Naturalistic qualitative methods	Case studies, narratives, interpretations, reconstructions

In the theory of constructivism, it is believed that knowledge is constructed by individuals (Hatch, 2002). This study assumed that teachers perceive the curriculum differently as they construct their own meaning from the teaching syllabus in spite of sharing some information about the curriculum within the school's social groups. Hence the teachers' understanding of the Biology teaching syllabus varies as they experience the curriculum change differently from their respective school environments.

Why qualitative research

Qualitative research studies collect data in natural settings through observations and in the form of written accounts or pictures. Qualitative studies are concerned with processes as opposed to products, explore how people make sense of their practices and emphasise interpreting patterns and themes that emerge from data as opposed to numbers (Fraenkel & Wallen, 1990; Morrison, 2007). In this study, I collected data in the form of field notes during lessons and recorded conversations with teachers on how biology concepts are taught and how teachers understand some aspects of the Biology teaching syllabus. This study attempted to establish how four teachers are implementing the new Biology curriculum. I therefore consider this study qualitative.

3.3 RESEARCH APPROACH

The study used a case study approach which is an empirical enquiry hence often starts with data collection through observations, document analysis and interviews (Bassey, 2007). A case is a study conducted within a bound system in terms of space and time during which more than one technique may be used to collect data (McMillan & Schumacher, 2006; Bassey, 2007; Denscombe, 2007). This study collected data through lesson observation using field notes to record observations and tape-recorded interviews with teachers. The study drew its participants from one city and the data collected reflect the views and practices of these teachers during the three weeks research period. Other characteristics of case studies that apply to my study include being conducted in natural settings; taking a holistic approach when exploring social processes and relationships; being studied within several sites and being chosen due to its uniqueness (McMillan & Schumacher, 2006; Bassey, 2007; Denscombe, 2007).

In this study each teacher was a case. While the four teachers were all teaching senior Biology in one city, each case is unique in that professional qualifications; physical resources; size of classes; and cultural backgrounds of the students they teach are different. Therefore each school had its own context. According to Stake (2006) multiple case studies provide diversity across contexts and give an opportunity for the researcher to gain insight into issues, and understanding them would lead to better understanding of more cases.

Advantages of the case study approach

The case study approach was used because it provides an opportunity for the researcher to have an in-depth study of one instance of a problem (Bell, 2005; Bassey, 2007; Denscombe, 2007). A case study approach allowed me to carry out this investigation in the classroom which is a natural setting where the new practices being studied can be examined holistically. The case study approach also enabled me to understand the four teachers' classroom practices in their respective school settings and factors influencing the situation (Opie, 2004a; Denscombe, 2007). Furthermore with a case study, I was able to collect data through more than one technique, which improves the validity of the data through triangulation (Bell, 2005; Bassey, 2007; Denscombe, 2007).

Disadvantages of case studies approach

The main disadvantage of using the case studies approach is that generalisations of findings may not be possible (Bell, 2005; Bassey, 2007; Denscombe, 2007).

3.4 SAMPLING

3.4.1 Main sample

A sample is a group of people from whom research information is collected (Fraenkel & Wallen, 1990; McMillan & Schumacher, 2006). Sampling, a process of selecting a group of people from a large population to provide research information, can be done in different ways. For this study, convenience and purposive sampling were used. In convenience sampling participants are chosen because of their availability to the researcher while in purposive sampling the researcher chooses the sample because of specific reasons (Fraenkel & Wallen, 1990; McMillan & Schumacher, 2006; Fogelman & Comber, 2007). I chose convenience sampling because this is a small scale study and time for data collection was limited hence accessibility of participants was an essential factor. Data was collected during a three weeks period. The sampling was also purposive because I intentionally wanted to draw teachers from both types of government secondary school. The qualifications of teachers and teaching resources in community and conventional secondary schools are different. Therefore, drawing from both types of schools enabled me to check how the teachers' qualifications and the resources available to them impacted on their use of constructivist approaches.

The sample had four teachers from secondary schools within one city. Two teachers were from the conventional secondary schools and the other two were from the community secondary schools. The sample was drawn from both types of government schools in order to capture the teachers with different qualifications. I wanted to check how qualification influences the teacher's ability to use active student involvement strategies and to build on students' prior knowledge in Biology lessons. Since this is a convenience and purposive sample, it cannot be considered a representation of the teachers in all government secondary schools hence the findings of this study may not be generalised to the wider population of teachers in similar schools (McMillan & Schumacher, 2006; Fogelman & Comber, 2007). The numbers are limited to two for each type of school because of time constraints as mentioned earlier. Table 2 outlines the teachers' profiles and the schools they were teaching at during this study's period.

Table 2: Teachers' profiles and their schools during data collection

Name of teacher (pseudonym)	Type of school	Qualification	Laboratory status	Reference books	Size of class
Christina (Mrs) (taught Bio for 3 yrs)	community school	Diploma in Education from a college of education (SSTEP)	nil	10 copies of a single title	About 80
Michael (Mr) (taught Bio for 3 yrs)	community school	a teaching certificate from a teacher training college	nil	about 40 in five titles in the "library"	12
Kelvin (Mr) (taught Bio for 18 yrs)	conventional school	Bachelor of Education Degree (sciences) from a university institution.	2 reasonably equipped science laboratories	few copies of different titles in library	30-40
Miriam (Ms) (taught Bio for 5 months)	conventional school	Bachelor of Science Degree (Agriculture) from a university institution	3 poorly equipped science laboratories	2 titles-teacher's copies only	about 75

NOTE: SSTEP stands for Secondary School Teacher Education Project. The project supports under-qualified teachers in community schools (only) to upgrade to a diploma in education level through distance learning over a period of three years.

3.4.2 Pilot sample

I drew my pilot sample from one conventional secondary school within one city. Although the two teachers in the pilot sample came from one school, they had qualifications that were similar to the main sample of my study. One teacher had a diploma in education obtained from a college of education through the SSTEP programme and the other teacher had a Bachelor of Education (science) Degree from a university institution. The pilot sample did not draw from the community schools because most community schools were on mid-term holidays in the first week of my three week visit to Malawi. Since I needed to pilot the instruments in that week in order to start collecting data in the second week of my visit, I used one school that was not on holidays and was also not in the main sample. Selection of the pilot sample was purposive sampling as well as convenience. The pilot study helped me to validate the instruments and to estimate the duration of interviews which was important when booking appointments with the teachers.

3.5 RESEARCH METHODS AND INSTRUMENTS

3.5.1 Observation

Observation as a strategy in data gathering relies on what the researcher sees and hears and the recording of that information (McMillan & Schumacher, 1993). Lesson observation was chosen as a data gathering strategy because it provides the researcher with first-hand information as opposed to reports given by participants (Opie, 2004a; Denscombe, 2007). First-hand information is important because what people say may be different from what they do (Cohen, Manion & Morrison, 2007). Lesson observation enabled me to analyse the classroom interactions in relation to student involvement and use of students' prior experiences where it was applicable.

Three lessons were observed for each of the four teachers in the sample using a lesson observation guide. The lesson observation guide assisted me in capturing aspects of the lessons that related to student involvement and use of students' experiences in Biology. Convenience sampling was used in selection of lessons. I agreed with each teacher on lessons that were convenient to both of us as I had to accommodate all the four teachers within the time available.

The data collected from lesson observations has mostly been used to answer the second research question: how do the four biology teachers use active student involvement strategies and students' prior experiences to promote conceptual understanding in Biology? The observations were also used to note any observable factors that might promote or hinder the use of the required approaches in teaching senior secondary Biology. These factors were investigated further during interviews.

Information during lesson observations was recorded through note-taking under predetermined themes on a lesson observation guide (see Appendix 1). Note-taking was used over tape-recording and video recording because note-taking is economically cheap and allows one to record essential information. Video recording and tape-recording on the other hand would record a lot of data that would require a lot of time to transcribe which is not viable in a small study like this one. Equally important, Opie (2004a) mentions that the use of the video camera and tape-recorder can threaten respondents with the possibility that data collected would be used against them.

Limitations of the observation technique

The limitations to observation include the tendency of people to change their behaviours when under observation and missing vital information when data is recorded through note-taking. Also linked to note-taking is the possibility of observer bias in selection of facts to be recorded (Opie, 2004a; Denscombe, 2007). To overcome these constraints, the four teachers were not told the exact focus of my observations i.e. active student involvement and use of prior experiences, and more than one lesson was observed to increase chances of observing the four teachers' natural behaviours. On accuracy of recording, it is hoped that the use of the observation guide reduced observer bias. The themes outlined on the lesson observation guide focused my attention to the information that was relevant to my study. Furthermore, an effort was made to write down as much information on each theme as possible in an attempt to collect adequate information.

3.5.2 Interviews

An interview is a data collection strategy that involves the interchange of views between the researcher and the respondent (Cohen *et al.*, 2007). Interviews allow researchers to explore the views of respondents on issues (Ribbins, 2007). For Cohen *et al.* (2007) interviews enable participants to express their opinion on situations. The interview was used due to its ability to enable researchers collect in-depth data from respondents (McMillan & Schumacher, 1993; Breakwell, 1995; Opie, 2004a; Bell, 2005) hence interviews enabled me to get more information on teachers' perceptions about their approaches in teaching Biology.

Interviews can be structured, semi-structured and unstructured. In this study, semi-structured interviews were done with each of the four teachers individually and in a place free of disturbances, for confidentiality purposes. The interviews were done after observing three lessons for each teacher. The semi-structured interview is less controlled, more flexible and not completely predetermined by the interviewer (Opie, 2004a). The semi-structured interview is adaptable as such it allows the researcher to follow up on ideas raised by teachers; to probe responses for clarity and to investigate motives and feelings as the interview progresses (Breakwell, 1995; Opie, 2004a; Bell, 2005). Adaptability is the major advantage of the interview technique over the questionnaire in data collection (McMillan & Schumacher, 1993; Breakwell, 1995; Opie, 2004a; Bell, 2005).

I used an interview schedule to guide the interview. An interview schedule is a list of questions that are asked during an interview to ensure that the interview achieves its intended purpose (Opie, 2004a). When constructing this interview schedule (see Appendix 2), I took into account

the nature of information being sought, clarity of the questions to the respondents and sensitivity of the questions so as not to offend my participants. I was also mindful of the duration of the interview as these have a bearing on the success of interviews (McMillan & Schumacher, 1993; Breakwell, 1995; Opie, 2004a; Bell, 2005). Table 3 outlines the rationale for each question on the interview schedule.

Table 3: Rationale for the interview schedule

QUESTION	REASONS FOR ASKING THE QUESTION
1. What do you understand by students' experiences?	To elicit the four teachers' understandings on students' experiences (first research question)
2. Do you use students' experiences in your Biology lessons? If yes, how often? If no, why not?	To find out the extent to which the four teachers made deliberate attempts to build on students' experiences or not and their reasons behind such practices (second research question)
3. Did you use any students' experiences in the lessons that I observed? Give me some examples.	To further explore teachers' understandings on students' experiences in relation to their practice (first research question)
4. In your opinion why do you think it is important to use students' experiences in Biology lessons?	To find out if teachers linked building on students' experiences to conceptual understanding (second research question)
5. What difficulties do you face/ would you face (if not using them) in using students' experiences?	To elicit what teachers perceived as factors influencing their ability to build on students' experiences (third research question)
6. What does it mean for students to be actively involved?	To elicit teachers' understandings on active student involvement (first research question)
7. Do you think students in your class are actively involved? If yes, how do you involve them? (Describe some of the activities you do in class to involve students) If no, why are they not involved? Explain why you find it difficult to involve students.	To find out the extent to which the four teachers used active student involvement strategies and what the four teachers considered as active student involvement strategies (second research question & also first research question) Also to find out reasons for not involving students (third research question)
8. Where were students actively involved from the lessons that I observed?	To find out what teachers considered as active student involvement strategies (first research question)
9. I find it difficult to involve students. What are your experiences? Why is it difficult to involve students? Please explain.	To elicit what teachers perceived as factors influencing their ability to actively involve students (third research question)

In brief, the interview schedule had questions that assisted me to interrogate teachers' understanding of active student involvement and students' experience as well as eliciting some of the factors that promote or hinder the use of required approaches in teaching senior secondary Biology in Malawi. The interviews were done after observing all the planned lessons

for each teacher. This allowed me to incorporate issues, specific to each teacher from classroom observations, which needed to be probed further.

Conducting the interviews

The four teachers in the main sample were interviewed at their schools after I had observed three of their lessons in Biology. In each case a quiet and secluded place was used for the interview for confidentiality purpose as well as to prevent noise during the recording process. The interview durations ranged from 16 – 20 minutes. In addition to the questions on the interview schedule, follow-up questions also focused on the status of reference books and science equipment as teachers raised these issues in their description of students' experiences and active student involvement in biology lessons.

Recording of the interview proceedings was done by tape-recording. I preferred tape-recording to note-taking because, according to Opie (2004a), tape-recording accurately captures all the possible responses from respondents along with the questions and probes; reduces bias in selection of responses by the researcher; and original data can be re-examined at a later time if the need arises. In addition to these advantages tape-recording gave me time to listen to teachers during the interviews without the interruptions of taking notes. Having undivided attention during the interview helps the interviewer to follow the conversation hence the interviewer would be able to ask pertinent questions for clarity (Opie, 2004a).

Limitations of interviews

Opie (2004a) considers the disadvantages of tape-recording to be collection of too much data that would require a lot of time to transcribe and that tape-recording can put off respondents who may fear that the information they give may be used against them. I hope that prior mention of why I tape-recorded the interview; assurance that no record of names of teachers and schools would be kept and that tapes and transcripts would be kept confidentially while being used, got rid of their fears.

Opie (2004a) warns that flexibility in the interview schedule can bring in researcher bias when the researcher tries to probe respondents in a way that would push them to provide responses expected by the researcher. Also interviews are time consuming especially where information is tape recorded as transcribing the tapes require a lot of time (Cohen *et al.*, 2007).

3.6 VALIDITY AND RELIABILITY

Reliability is defined as the extent to which the research instruments could produce similar results in a constant setting and validity as the degree to which the research instruments measure what they are intended to measure (Scaife, 2004; Bell, 2005). In qualitative research, reliability and validity are understood in terms of trustworthiness, rigour and quality (Golafshani, 2003). Scaife (2004) explains trustworthiness of a case study research in terms of credibility.

3.6.1 Credibility

Credibility in case study research is achieved through thoroughness in explaining data-gathering procedures and how data have been analysed; reporting all instances in the research process including negative aspects; acknowledging biases; supporting claims with evidence; separating researcher's own data from that obtained from other people and distinguishing interpretation from description (Scaife, 2004).

In this study, credibility has been achieved through transparency at all stages of the research process. I have thoroughly explained how data was collected, the four teachers and their headteachers were well informed of the purpose of the study and the data-gathering procedures, claims made in my discussion of the findings are well supported by evidence from the data I obtained and the research report separates my interpretation from what the four teachers said through use of quotes/ excerpts where necessary. Also, I have included a section on my stance in the research where I discuss how my previous professional relationship with the teachers involved, may have affected the data I collected. Furthermore, content validity of the research instruments, piloting of the research instruments and triangulation contributed to achieving credibility of this study.

3.6.2 Content validity

Content validity of the research instruments is important in enabling the researcher to collect the intended information. The interview schedule and the lesson observation guide were checked for content validity by some members of my research group which consisted of the Masters in Science Education students and three course lecturers. Then the two instruments were checked by my supervisor. Thereafter, the lesson observation guide and the interview schedule were piloted on two teachers in Malawi before using them with the research sample.

3.6.3 Piloting instruments

Both the lesson observation guide and the interview schedule were piloted before using them in collecting data. Piloting was done to check if the instruments were clear and if they would capture relevant data for the research questions being answered (Scaife, 2004; Bell, 2005). For each teacher in the pilot sample, one lesson was observed and information recorded using the observation guide followed by an interview. The interview schedule was used to guide the interview and information was tape-recorded. After piloting the instruments no modifications were made to the instruments as they seemed to be clear to the pilot respondents and captured the intended information.

3.6.4 Triangulation

Collecting data using multiple procedures helps to address validity through triangulation (Golafshani, 2003; Scaife, 2004; Bell, 2005). In this study data was collected through observation of lessons and interviews with teachers, consequently I saw the same issues from different perspectives and the findings from one method was checked by the other resulting in improved validity.

3.6.5 My stance in the research

As pointed out in chapter one of this research report, I worked as an education methods advisor in the education division where the teachers in my study sample are working. I was also involved in the curriculum review process including orientation to the new curriculum (for some of these teachers) and the follow-up inspections to monitor the implementation process. While I went into these schools as a researcher, a position I clearly explained before inviting them to participate in my study, there is a possibility that teachers still considered me as an official from the inspectorate section which might have affected their behaviour in the lessons I observed and the responses they had given during interviews. I also acknowledge that my previous work experience might have contributed in the way I interpreted classroom activities during lesson observations and the teachers' responses obtained from interviews.

3.7 ETHICS

Ethics deals with application of moral principles to avoid harming others in the process of doing research (Sikes, 2004). Qualitative research tends to be more intrusive in personal lives than

quantitative research. Ethical guidelines regarding issues such as informed consents; confidentiality; anonymity; and privacy therefore need to be adhered to (McMillan & Schumacher, 2006). The University of Witwatersrand ethics guideline requires that participants be informed clearly about the nature of the research, consent forms be signed by participants before data collection commences and permission from organisations where the participants work or are affiliated, be obtained. Research only commences after one gets approval from the designated ethics committee of the University of Witwatersrand.

To adhere to research ethics for the University of Witwatersrand, I applied for clearance to conduct the research from the Human Research Ethics Committee (non-medical) of the University of Witwatersrand for the University of Witwatersrand. The committee cleared me to conduct this study in a letter Protocol: 2009ECE42 (see Appendix 10). I sought permission from the Ministry of Education, Science and Technology in Malawi to conduct the research in the government schools selected (see Appendix 3). The Ministry of Education Science & Technology gave me permission to carry out the research in four selected public schools. To maintain anonymity of the schools involved in this study, the letter from the secretary for Education, Science and Technology has not been appended to this report as it specifies schools where I was allowed to conduct my research. Information collected during the study was treated confidentially. Interviews were conducted individually and in secluded places to avoid interruptions as well as to keep information given confidential. Information obtained was kept confidentially by the researcher and used for the purpose of the research report only. Pseudonyms have been used where reference has been made to the teachers or their schools and no record of names of teachers and schools was kept.

The purpose and nature of my study was well explained to the manager for the Northern Education Division in Malawi where the schools involved are located, to the heads of the schools involved and to the teachers in the sample. This was done because transparency is important to ensure that people involved make informed decisions regarding their participation in the research study (Sikes, 2004). The following information sheets were given out and informed consent forms were signed before data collection started: Information sheet for the head teachers; Information sheet for teachers; Informed consent form for the head teachers and Informed consent forms for the teachers (see Appendices 4-9).

3.8 CONCLUSION

The chapter has given a detailed account of what was done and why it was done in the research process prior to and during data collection to assist the reader in understanding the choice of the research design. The data analysis process will be discussed in the next chapter.

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 OVERVIEW OF THE CHAPTER

This chapter begins by explaining how data was analysed before presenting results and the discussion. The results are presented in themes that reflect the research questions and each outcome of the study is discussed before moving to the next one. Names of teachers used in this chapter are pseudonyms as outlined in the teachers' profiles (Table 2) in chapter three of the report.

4.2 DATA ANALYSIS

Data analysis involves a systematic search for meaning from the data collected in order to communicate the findings to others effectively (Hatch, 2002). Data differs depending on the instruments used to collect it. In this study qualitative data was collected through lesson observations using an observation guide and through interviews using an interview schedule. Hitchcock & Hughes (1995) indicate that qualitative data analysis involves working with data, organising it, breaking it into manageable units, synthesising it, finding patterns, identifying what is important and what can be learnt so that the researcher can inform others. To achieve this, Hitchcock & Hughes (1995) and Opie (2004b) suggest open-coding as a way of analysing qualitative data. Open-coding involves reading of data collected; identifying categories/ domains into which data can be grouped; adapting and improving categories as the analysis progresses; and identifying excerpts from the data that support the categories of information created.

In this study data from interviews were transcribed then sorted into two categories i.e. what teachers said about students' experiences and active student involvement. Then information on students' experiences was broken down into three sub-categories: teachers' understandings; working with students' ideas; and factors that affect teachers' working with ideas from students. Similarly, the information on active student involvement was further broken into sub-categories: teachers' understandings; student involvement strategies for conceptual understanding; and

factors that affect teachers' ability to involve students. Drawing from principles of effective teaching in science (Cimer, 2007), indicators of learning for conceptual understanding in biology (Waggins & McTighe, 1998) and Bybee's five instructional phases (Lord, 1997), I then adapted Brodie (2004)'s framework for coding teacher moves as they work with students' contributions during lessons, to develop a scheme of analysis on how teachers in this study worked with students' ideas for conceptual development. I did not adopt Brodie (2004)'s framework which coded teacher moves as they worked with students contributions much as I was also coding teacher moves as they worked with students' ideas. This is because Brodie (2004) coded all moves made by the teacher but I was interested in specific teacher's moves. I focused on moves that promote student involvement and building on their prior experiences to enhance conceptual understanding in biology lessons. Table 4 shows the scheme of analysis that I developed.

Table 4: Scheme of analysis for how the teachers worked with students' ideas (Adapted from Brodie, 2004)

CODE	EXPLANATION
Initiation/ Elicitation	Draws ideas from students on concepts and probes students for more information on their conceptions. Teacher may introduce an idea and probe students understanding
Insertions	Provides feedback through adding essential information to students' contributions in order to elaborate the ideas, adds information through answering questions, builds on students ideas
Metacognition	Challenges students with ideas from others to help them reflect on own ideas; asks for justification and clarifications from students; encourages debates on scientific facts, principles and theories
Application	Links scientific knowledge to students' everyday experiences through the use of familiar examples
Social interactions	Assigns individual and group activities that help students to discover relevant knowledge, encourages students to express their opinions, students are free to ask and answer questions, gives students time to think before giving answers

I used this scheme of analysis to code data obtained through lesson observations and the information from interviews that referred to how teachers worked with students' ideas.

In this study, I started data analysis with predetermined categories in order to save time and to be more efficient as suggested by Hatch (2002). However, I also created new categories from the data to accommodate important information left out by the initial categories in line with suggestions from Hatch (2002). Therefore, this was an iterative process as I went through my data several times to ensure that I captured as much information from it as possible according to the categories and codes developed (Hitchcock & Hughes, 1995; Hatch, 2002).

4.3 RESULTS AND DISCUSSION

I set out to find out the meanings the four biology teachers attach to students' experiences and active student involvement, the extent to which the four teachers build on students' prior ideas and involve their students in their teaching to enhance conceptual understanding and the factors the four teachers perceive to be hindering / promoting these constructivist practices in their biology classrooms. These form the three themes that I use to present and discuss my study's findings in order to answer the following three research questions:

- What are four Biology teachers' understandings of the phrases *students' experiences* and *active student involvement*?
- How do the four biology teachers use active student involvement strategies and students' prior experiences to promote conceptual understanding in Biology?
- What factors promote/hinder the use of the constructivist approaches by the four teachers in teaching Biology in Malawi?

The teachers were observed teaching different topics in Form 3 except for Michael who was teaching Form 4. Table 5 shows the topics taught by the teachers during the data collection period and the students' prior knowledge.

Table 5: Topics taught during data collection period

TEACHER'S NAME	FORM	TOPICS TAUGHT	STUDENTS' PRIOR EXPERIENCES
Christina	3	- Dangers of carbon monoxide - Effects of smoking on lungs - Locomotion in humans and fish.	- student aware of people who died of carbon monoxide through use of braziers - smoking familiar concept as many people smoke - human and fish movement familiar concepts in everyday life experiences
Michael	4	Genetics: - heredity and environment - working out ratios of genotype and phenotype of offspring in monohybrid crosses up to F2 generation.	Students had experience on how organisms differed despite sharing parents especially differences among members of same family
Kelvin	3	circulatory system - structural differences between arteries and veins - movement of blood in veins and exchange of gases through the blood vessels	Circulatory system taught at junior level Students familiar with exchange of gases during breathing
Miriam	3	- Joints in the human body - Locomotion in fish and birds	Student familiar with their joints and how fish and birds move.

4.3.1 Teachers' understandings and practices with reference to students' experiences and active student involvement

Information for this theme came from both interviews and classroom observations. For easy presentation and discussion of the results under this theme, two sub-themes were created: students' experiences and active student involvement.

4.3.1.1 Students' experiences

The biology teaching syllabus suggests that teachers should use students' prior experiences as a resource in teaching some content from fourteen out of the sixteen topics in the senior secondary Biology curriculum. Bearing in mind the fact that each individual constructs their own knowledge (Cakir, 2008), I asked each of the teachers in an individual interview what they understood by students' experiences (Appendix 2, Section A, question 1). Table 6 summarises the responses from the four teachers.

Table 6: Four teachers' understandings of students' experiences

Name of teacher	Response
Christina	"When I look at students' experiences, I feel it is like they know already what is there so we should use their experiences but in actual fact when we say students' experiences that is too wide, because students bring some ideas in the class which are not suitable for that topic. They are just interested to bring fun in the class because that is too wide"
Michael	"This is similar to learner-centred teaching whereby we have to get how much the students know already it's when we can go ahead and when they do not know much about the topic it is when the teacher can come in. So we move from what they know to what they do not know".
Kelvin	"Students wherever they are they have these concepts, some of the things we use in the laboratory, they use in their homes and some of what we discuss in biology, they have already experienced. So students' experiences mean using what they already know to bring out new concepts so that they can understand more".
Miriam	"It is like most students they know.. (pause).. they at least have knowledge of each topic that I teach but may be to link them is a problem."

As a follow up to the responses on the teachers' understandings of students' prior experiences, I asked them what they thought was the source of students' prior experiences. All except Kelvin said that the prior knowledge comes from previous teachings that students have experienced. Kelvin extended the source to students' homes:

Interviewer: When you look at students' experiences where do you think it comes from?

Kelvin: One, it comes from what they have already learnt starting from primary schools, secondly from their backgrounds-their homes as they brush shoulders with family.

The impression one would get from these responses is that the four teachers are aware that concepts taught in year three and year four Biology curricula are a continuation of the junior Biology curriculum as Miriam put it when I asked her the source of prior knowledge:

“Comes from their previous syllabuses as this is just a continuation of what they covered say in Form 1 only that this time it’s just deep as in Form 1 it was general”. (Miriam)

However, this was not the impression I got when I observed lessons taught by these teachers. All the four teachers began with a recap of work covered in the preceding lessons not the work on that particular topic that students may have covered in previous years. Interestingly, even where a new topic totally different from the previous lesson was being introduced, the lesson began with a recap of what was taught in the previous biology period. The recap was mostly done through question and answer sessions that aimed at helping students to recall what was taught in the previous lessons as Kelvin mentioned when I asked him how often he drew from his students experiences:

“Usually that is a must because you have to build on what they already know so what we do is ask questions to provoke recall of what they have learnt and proceed from there”. (Kelvin)

Although during the interview Kelvin seemed to realise that students’ prior experiences also originate from informal learning outside the classroom, his teaching did not reflect this understanding. Kelvin did not elicit students’ prior ideas from outside the classroom on the concepts that he taught. He only helped them to recall what was taught in the lesson before.

The findings suggest that while the four teachers’ perceptions on teaching from what was already known by their students to the unknown may include prior knowledge from both formal and informal learning, their practices are selective. They seem to only draw from previous formal learning. While revising previously taught work is a way of determining students’ prior knowledge (Cimer, 2007), the strategy excludes prior ideas that come from informal learning (Nykiel-Herbert, 2004). Therefore, the four teachers’ understandings of students’ experiences and the subsequent classroom practices would not assist them in becoming aware of the alternative conceptions held by their students. Bearing in mind that prior knowledge can be in conflict with scientific knowledge (Smith *et al.*, 1993; Carr *et al.*, 1994; Fensham *et al.*, 1994; Scott *et al.*,

1994) and that it may be a source of misconceptions (Smith *et al.*, 1993; Hatano, 1996), the four teachers' understandings of students' experiences would not help them address these conflicts and misconceptions for conceptual understanding.

The four teachers' understanding of students' prior knowledge differs from Nykiel-Herbert's findings about South African teachers' understanding of prior knowledge (Nykiel-Herbert, 2004). In her study on the learner-centred pedagogy in South Africa, Nykiel-Herbert found that South African teachers commonly understood prior knowledge as being what the learners learnt from their homes and communities leaving out what was learnt in school. Nykiel-Herbert (2004) adds that the South African teachers' understanding of prior knowledge resulted in teaching that has more emphasis on eliciting what learners bring from their communities than on the acquisition new knowledge. Teachers in this study indicated that while they are aware of the importance of building on their students' prior experiences in teaching for conceptual understanding, they also needed to complete the syllabus to help their students pass examinations as Kelvin alluded when explaining why he did not often build on his students' prior experiences.

Kelvin: I am also looking at the exams which are approaching, so to involve every student within such less time is difficult to cover the syllabus. So we sometimes rush through to cover more, much as we appreciate the importance of students' prior knowledge.

4.3.1.2 Active student involvement

Construction of knowledge is said to be an active process (Cakir, 2008, Schiro, 2008) and the Biology teaching syllabus for senior secondary school in Malawi suggests teaching and learning activities that require active participation of students (Ministry of Education, Science & Technology, 2001). I asked the four teachers what they understood by active student involvement in biology lessons (Appendix 2, Section B, question 1). The responses I got from them are summarised in Table 7.

Table 7: Four teachers' understandings of active student involvement

Name of teacher	Response
Christina	"On involving students in lessons, as a biology teacher I feel it is good because if students are involved, the retention is just too high rather than when they are just listening to what the teacher is saying. So if you put them in groups and they discuss among themselves, they learn a lot from their friends. Also some students are shy so they cannot raise hands in class but if they are among themselves even the shy ones contribute to the discussions."
Michael	"It is like giving them a topic or an assignment while they are still in class and asking them to go in groups to discuss that issue and then we draw a conclusion"
Kelvin	"For us to involve students we have to use a lot of experimental work and sometimes preparatory work can involve students like giving them work to be done as homework before the lesson."
Miriam	"Like many should do experiments themselves but now the challenge is, we do not have the materials to do the experiments. It is like most of the topics they (the school) do not have the materials for the students to work on for their better understanding."

As a follow-up to their understanding, I asked the teachers if their students are involved (Appendix 2, Section B, question 2) and this is what they said:

- **Christina:** Very much
- **Kelvin:** Ah not to a great extent. Yes I have been trying to involve them but it also depends on the nature of the topic. Some topics need that you have to expose the students to the materials before you teach them. Secondly you can not involve the students if you do not have the materials and time to do experiments. So I try to involve them.
- **Michael:** That much I would say yes
- **Miriam:** No, coming to think of it, it's just theoretically not practically

Kelvin and Miriam understood active student involvement in terms of their students doing practical / experimental work. According to Kelvin and Miriam if students are not doing practical work, then they are not actively involved. As indicated in the teachers' profiles, Kelvin and Miriam are university graduates where science is mostly studied in the laboratories. Furthermore, at the time of this study the two were teaching at conventional secondary schools that had a Biology laboratory although the one at Kelvin's school was better equipped than one

at Miriam's school. The presence of laboratory facilities may have impacted on the way Kelvin and Miriam understood active student involvement in Biology. This understanding relates to the claim by Onwu (1998) and Gray (1999) that most teachers and parents consider science as something that has to be done in a laboratory/ classroom with specialised equipment.

Christina and Michael were teaching at community secondary schools which had neither laboratories nor basic equipment for science experiments. They had a different view about active student involvement. For Christina and Michael active student involvement meant use of group discussions and the two were confident that their students were involved. It could be said that all the four teachers conceived their understandings in relation to their environment.

The four teachers' understandings of active student involvement seem to have informed their classroom practices. In all the lessons observed, Kelvin and Miriam did a lot of talking with student involvement being limited to the question and answer technique while Christina and Michael had at least a group activity in their lessons in addition to question and answer sessions. The possible impact of these strategies on the students' understanding of concepts being taught will be discussed in the next section.

4.3.2 The extent to which teachers actively involved students and used their experiences for conceptual understanding in Biology

While the four teachers acknowledged the importance of students' prior knowledge and active participation during biology lessons for conceptual understanding, in some cases their practices did not reflect the beliefs they held. Table 8 provides a summary of my interpretation of how the four teachers worked with students' ideas in the lessons observed as guided by the scheme of analysis developed and outlined in Table 4. I then discuss each code with specific examples from the lessons observed.

Table 8: How the four teachers worked with students' ideas

CODE	CHRISTINA	MICHAEL	KELVIN	MIRIAM
Initiation/Elicitation	-invited ideas from students and attempted to probe for more but rejected them if not familiar to her -shelved ideas if they were not under that topic in the syllabus or if she did not have an explanation at that time.	- Michael sought ideas from one student per question then progressed despite teaching a very small class of twelve students,	-asked students to recall what was learnt in lesson before -probed students for more information if responses were not clear or incomplete	-rarely gave her students an opportunity to make contributions yet students were very familiar with the concepts being taught: human joints and locomotion in fish and birds
Insertions	-rarely elaborated on the ideas from students even when doing so was critical for conceptual understanding. -gave out facts from reference book without explanations or simplifications	-did not give students enough information to guide their knowledge construction -provided a lot of inaccurate facts that may have perpetuated misconceptions	-corrected students' diagrams on chalkboard -rephrased and elaborated students' ideas - gave students a lot of information which made them passive listeners for a greater part of his lessons	-gave students a lot of information within a short time of a double period followed by copying a lot of notes during the second 40 minutes.
Metacognition	-did not ask for justification from students even where students' ideas showed some misconceptions -if ideas were not clear, she would ask other students to help rephrase the sentence	-allowed students to debate on some ideas they raised but he did not provide vital information to help students construct relevant knowledge	- asked students to comment on ideas from others before his input but it was more like finding out who accurately remembered what was taught	-did not ask for justification from students and in cases where students' responses were wrong or inaccurate, she just provided "correct" responses without explaining why the responses given were not accepted

CODE	CHRISTINA	MICHAEL	KELVIN	MIRIAM
Application	-used examples from books and either ignored or dropped examples from students that were not found in the books she was using even if they were appropriate.	-attempted to use examples from students' everyday lives but sometimes the link to science was inaccurate	- attempted to use examples that students were familiar with in explaining concepts being taught	-presented locomotion in birds and fish concepts abstractly without considering the fact that students are familiar with birds and fish -attempted to link human joints to students' everyday
Social interactions	-engaged students in group discussions and question and answer - students presented reports on what groups came up with, after presentations the teacher replaced ideas from students with information from reference books even where the difference was just wording. -Students who could not complete sentences due to inadequate vocabulary in English were being told to sit down and then she chose other students to talk -She went around the groups to discipline the students and check the progress and not to offer guidance that could enhance negotiation of meaning -did not answer some questions due to lack of knowledge	-engaged students in group discussions and in question and answer but did not provide appropriate guidance to direct group activities hence groups were copying from each other -engaged students in a practical investigation on determining phenotype ratios using different coloured beans -did not provide answers to some critical questions	-only engaged students in brief whole class discussions and he did much talking -asked questions that required students to recall learnt facts (test questions) - little effort was made to ask students who did not raise their hands to contribute to the class discussions -did not give students enough time to think before responding to questions as he quickly passed the questions to others	-lectured for a greater part of the lesson -few questions asked. Mostly asked students if they were following to which student answer yes or no in a chorus

The four teachers worked with the students' ideas variously as described under each response expected. I discuss patterns observed under each aspect of the analysis scheme.

Initiation /Elicitation

All the four teachers attempted to find out what the students knew before the lessons began. However, the teachers asked questions that, at most, made students recall facts learnt in the lesson before. Lobato *et al.* (2005) claim that when eliciting is used as a probe to enhance recall of ideas given by the teacher, it fails to serve the purpose of shedding light on the students' understandings. Cimer (2007) claims that open-ended questions are helpful in eliciting students' ideas as such questions are capable of exposing shortfalls in students' conceptions. Since the four teachers in this study asked closed questions, they may have failed to use elicitation as a tool for unveiling their students' prior conceptions. Nevertheless the four teachers worked within their understandings of students' prior experiences discussed earlier. It is suggested that the teachers' understandings and beliefs on how students learn determine the choice of instructional strategies in the classroom (Tobin *et al.*, 1994). This implies that the four teachers' misconception of the meaning and source of prior knowledge may have given rise to this situation.

Insertions

All the four teachers gave the students some information on the concepts they were teaching. However, the nature of information and the way it was given varied among them. Lessons observed for Miriam's were generally dominated by information giving followed by students copying notes in the second half of the eighty minutes double periods which she had read through in her teaching. Nampota *et al.* (2009) assert that lecturing and copying notes is a common teaching strategy among science teachers in Malawi and in other countries too. Cimer (2007) argues that copying teacher's notes does not engage students and suggests that students should be encouraged to write their own notes to enhance application of acquired knowledge. It appears that Miriam felt her students knew very little on the topic she was teaching so there was need for her to inform them as this excerpt portrays:

Interviewer: I have observed you teach joints, locomotion in fish and birds. Can you tell me some of the ideas you drew from students and how you built your lesson on them?

Miriam: Generally I know that students have to know that there are movable and immovable joints-that is what they just know. But I was there to explain to them what movable joints are, the relevant examples and what immovable are and that there are others that are

slightly movable the thing they didn't know. What they knew was just movable and immovable.

Interviewer: What makes you think this is all they knew?

Miriam: The syllabus indicates that I should teach this information which means the students do not know it.

Interviewer: Don't you think you should have asked these students what they know before telling them what you planned?

Miriam: These students often say nothing when you ask them, so I just tell them what they need to know.

Kelvin listened to the students in the first phase of his lessons as he recapped previously covered work and would only come in to correct, rephrase or elaborate the students' contributions. For example, when recapping the structure of the blood vessels, Kelvin drew transverse sections of the artery and the vein and asked students to label some parts and list the structural differences. Two students went to the chalk board to label the diagrams and where they were wrong others went to correct mistakes. Kelvin only came in where none of his students seemed ready to make corrections. Similarly when Kelvin asked some questions to recap what he taught previously, one person would be asked to answer and the teacher would come in only to elaborate. His elaboration was mainly on accuracy of facts i.e. making sure that what was said is what he would like to see during examinations because he could say "ok but in an examination I would like you to write this". However, thereafter he also did more talking with sporadic questions to the students who I would consider passive listeners for a greater part of the lessons. The way Miriam and Kelvin provided information is more of the transmission model of teaching than constructivist teaching (Lobato *et al.*, 2005).

Christina and Michael's lessons lacked insertions that could have enhanced conceptual understanding. Christina gave her students a lot of opportunities to make contributions in the lessons. However, she fell short of correcting or elaborating some ideas given by her students especially where they showed some errors or misconceptions. For example, during the discussion of dangers of carbon monoxide, students argued as to whether people die of carbon monoxide when awake or asleep with majority being for asleep. After listening to the students, the Christina progressed without commenting on the issue. In Malawi there are significant cases of people dying of carbon monoxide poisoning at night in winter as they keep braziers in bedrooms. This could have been a source of the students' understandings so the teacher needed to have helped them realise that even when awake the effect of carbon monoxide is the same although people rarely die during the day because windows are open making rooms well

ventilated. Lord (1998) claims that in constructivist-based cooperative learning, the teacher should acknowledge correct information and help students restructure inaccurate ideas. By not identifying and correcting mistakes, Christina failed to mediate the process of knowledge construction in her lessons.

Michael did not provide enough information to guide his students in the class and group discussions too. What was most worrying though is that Michael gave students inaccurate facts that may have either perpetuated misconceptions or obstructed conceptual understanding of genetics. For example, a student wanted to know why white couples always gave birth to a boy first before a girl. Michael made no effort to dismiss the race claims by asking other students to give situations where black couples gave birth to boys first and white couples to girls first too. Instead he responded by saying it was a matter of family policies dominant in Europe. Then the student wanted clarifications on why white people are allowed to follow their home policies in Malawi to which Michael just laughed off. At one point Michael worked out ratios of genotype and phenotype of offspring in monohybrid crosses up to F₂ generation as shown in Figures 2A & 2B.

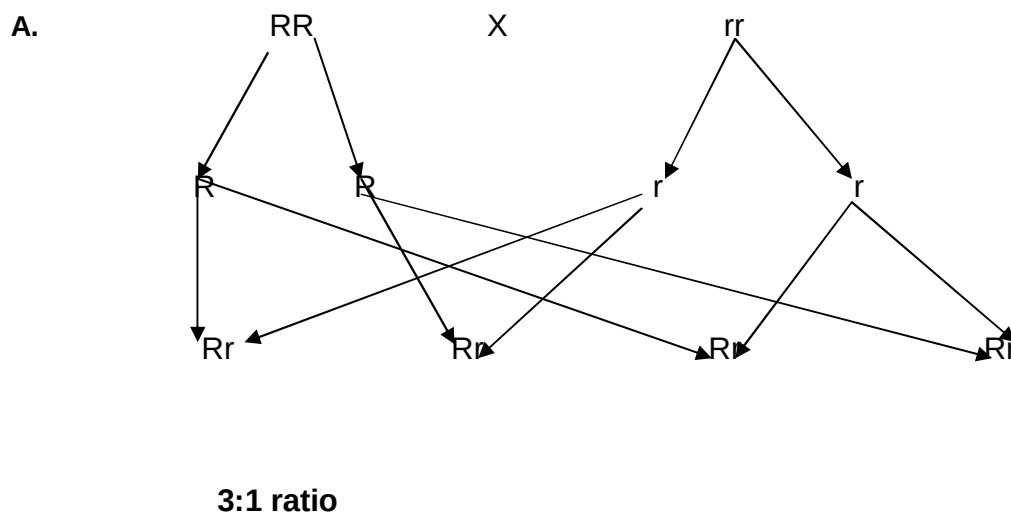


Figure 2A: Monohybrid crosses up to F₂ generation

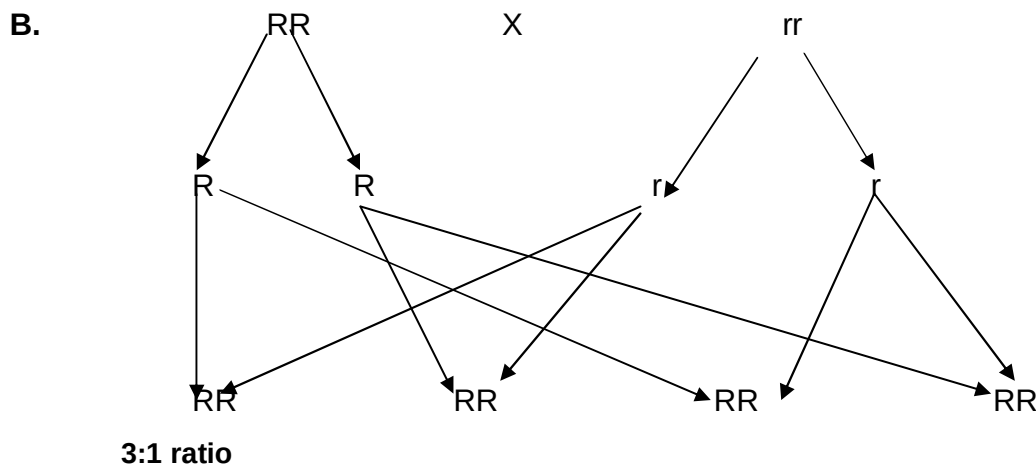


Figure 2B: Monohybrid crosses up to F2 generation

Michael did not indicate P1, F1 and F2 on the chalkboard. He verbally referred to what is supposed to be F1 as the offspring which he said was in a 3: 1 ratio. In a similar pattern, Michael crossed SS and ss to determine sex of a child. S was the male gamete while s was the female gamete. He ended up with the Ss genotype and some students concluded that the children would neither be boys nor girls which seemed to have confused Michael who did not comment.

Despite protests from some students that the offspring (F1 generation) in both Figures 2A & 2B cross diagrams should have the same genotype as gametes from parents were the same, Michael insisted that what he had on the chalkboard was correct. Of course other students agreed with Michael. It was clear that Michael did not understand what he was teaching. While inserting is meant to enhance meaningful learning, in Michael's case it was counteractive to the learning for conceptual understanding. Wandersee, Mintzes & Novak (1994) assert that teachers may hold similar alternative conceptions to their students often due to inadequate teacher training education or as a result of poorly written books they use. As indicated in the teachers' profiles in chapter three, Michael trained as a primary school teacher so his incompetence on content can be attributed to his being under-qualified for the level he is teaching. Teachers from community secondary schools with qualifications similar to Michael's, assessed on entry into a Secondary School Teacher Improvement Programme (SSTIP) intervention programme at Mzuzu University in Malawi, showed knowledge of subject matter limited to textbooks used for teaching (Saiti, 2007). This suggests that relying on text book information only might not be enough to teach biology concepts at senior secondary education level for the under-qualified teachers.

Inadequate knowledge of subject matter negatively impacts on the teacher's ability to modify text book information in a way that would promote conceptual understanding (Tobin *et al.*, 1994).

Metacognition

The four teachers in this study did very little to stimulate metacognitive abilities of their students. Christina and Miriam did not attempt to ask for justification from their students even where student responses inevitably attracted a “why” or “what makes you think so” follow-up from the teacher. For example, when Christina invited contributions from students on effects of smoking on lungs, one student said that smoking causes madness. The teacher just moved on to the next person without probing why this student thought so. Christina's school is located near a mental rehabilitation facility and the common cause of mental illness of the people treated at this facility is the use of drugs such as Indian hemp or marijuana. The student's thinking line could be coming from this. Asking for justification or clarification would have revealed misconceptions and enhanced conceptual understanding for the student and others with similar understandings.

Kelvin attempted to ask for comments from students on questions or responses from others which promoted reflection on one's ideas. However, Kelvin's effort was not enough as a limited number of students were allowed to comment per idea. Michael allowed his students to debate over issues that the class seemed to disagree on but little was achieved in terms of understanding as there was little input from the teacher to guide the students in constructing relevant knowledge. For example, at one point one student wanted to know why in a family that stays together and eats same food everyone could be short but only one tall. The student wondered if the father of the tall child could be someone else. Michael engaged his class in a debate over the suggestion but did not give the students clues on the scientific line of argument hence general understanding at the end was that the mother got impregnated by someone else.

Herrenkohl & Guerra (1998) argue that asking clarification questions encourages dialogue which promotes establishment of a shared meaning in the classroom; disputing helps students to challenge ideas raised by others which promotes conceptual change; and coordinating theory and evidence assists students to construct well grounded scientific arguments that characterise conceptual understanding in science education. This suggests that absence of these and other metacognitive activities in lessons does not help students to use their ideas for conceptual understanding.

Application

All except Christina attempted to link concepts being taught to students' everyday life experience through use of contextualised examples. For instance, Kelvin linked the temporary blockage of flow of blood in veins (stasis) to numbness of legs that is sometimes experienced after sitting at one place for a long time which everyone in the class was aware of. Miriam explained the way the hinge joints work using the door hinges. Michael tried to demonstrate the random combination of alleles using beans of different colours but unclear instructions and misinterpretation of results left students confused instead. Christina was less flexible with examples. She at most used examples from the reference books. Since these reference books are adopted, the examples used lack local context hence Christina used unfamiliar examples which did not enhance conceptual understanding.

McGinn & Roth (1999) argue that science education is an entry into participation in a community of science practitioners as such there is need to use authentic activities that would provide continuity from science in school to science in students' everyday lives. In their study on the role of everyday context in learner-centred teaching in Namibian secondary schools, Kasanda *et al.* (2005) found that teachers in senior levels used context only after students failed to understand textbook examples. The finding was attributed to the difficulties teachers face in contextualising texts in imported books which do not reflect local situations. The same would be said for the four teachers in the study as the reference books in use were adopted hence carry unfamiliar texts. Failure to help the students to link scientific knowledge to their everyday life experiences negatively impacts on conceptual understanding.

Social interaction

The four teachers in this study acknowledged the importance of student involvement in Biology lessons however their practices were not as emphatic as their words. Michael and Christina tried hard to engage their students in both whole class and small group discussions in addition to question and answer strategy. According to Lord (2001) cooperative learning, which sometimes is achieved through the use of small groups instruction (Liang & Gabel, 2005), enhances thinking and students' understanding of practical relationships in teaching Biology. However, in some cases Christina postponed students' questions that sought for clarifications of what was being discussed. For example when she told the class that one effect of smoking is that it causes harm to the unborn baby if the mother is pregnant, one student wanted to know the link between smoking mother and the unborn baby. Christina told the student to hold the question until in term three, which was almost two months away, when they would be learning about

human reproduction. When we left the classroom, Christina told me that she did not understand the link herself but mentioned the point just because it is indicated in the teaching syllabus. Like Christina, Michael too did not answer some student questions. In a study on secondary school teachers' responses to student questions, Durham (1997) found that when a teacher ignores, dismisses or postpones student questions, the students become silent while if the teacher clarifies or repeats questions, the discussion continues. It can be suggested that Christina and Michael's failure to provide answers to students' question made their effort to engage students in group discussion activities less productive in promoting conceptual understanding. I noted in both Christina's and Michael's lessons that during group discussions students from different groups copied responses from each other. This defeated the purpose of engaging in group discussions. Working in groups is supposed to give students a platform to negotiate their understanding with others and reach a consensus (Tobin *et al.*, 1994).

Kelvin used a whole class discussion strategy through question and answer. Kelvin often asked questions that required students to recall facts learnt within the shortest time as he quickly transferred the questions to other students when students delayed to give responses. A similar pattern was observed in lessons taught by Miriam. According to Lord (1998) productive questions when teaching are those that call for more than one answer that are not from textbooks, allows students to express their opinions and require students to interpret or apply what has been learnt. A study by Gaigher (2009) on teacher responses to learner questions in South Africa, found that extended responses encouraged learner participation in science classrooms. In another study on exemplary practice in science and mathematics education in Australia, Tobin, Treagust & Fraser (1988) found that a Biology teacher achieved maximum student involvement and elicited students' thinking by effectively using questions. Tobin *et al.* (1994) argue that exemplary teachers ask questions that stimulate thinking and probes students' responses for clarifications and elaborations. Consequently, Tobin *et al.* (1994) suggests that students should be given enough time to think before answering questions. Both Miriam and Kelvin gave students very few opportunities to ask questions. Student questions can be a useful tool in promoting meaningful learning and in helping the teacher to assess the students' understanding (Chin, 2004).

4.3.3 Factors that affect the use of constructivist approaches in teaching Biology in Malawi

I asked the four teachers what they perceived as factors that promoted or hindered their ability to actively involve students and to draw on and use students' ideas in biology lessons (Appendix 2,

Section A, question 6 & Section B question 4). From their responses, the following were pulled out as what affects the use of constructivist practices by the four teachers in the study:

Background knowledge

Three of the teachers (Christina, Michael and Miriam) that felt the knowledge the students have on the topic may either make a teacher use their ideas and involve them in the lesson or not. The three teachers however had different understandings of background knowledge. An excerpt from the interview I had with Michael illustrates that background knowledge is what students had before formal instruction.

Interviewer: How often do you draw from the students' own experiences in your day to day teaching?

Michael: Sometimes a lot if the topic is a familiar one like those topics of everyday life like HIV/AIDS these are topics which students hear about a lot on the radio.

Interviewer: I have observed you teach genetics, is it a familiar topic? How do you rate it?

Michael: Ah! This one is not very familiar to them.

Interviewer: So did you try to draw some of your students' experiences or you just felt this was not a familiar topic so let me just help them learn it?

Michael: Ya in the first place I wanted...ah .. I enlightened them where we were going and after they had known that, it's when I gave them a chance to give me their views.

What was striking about the conversation I had with Michael was the assumption he had that his students were not familiar with the topic before enquiring first from the students. When Miriam was teaching types of joints, she assumed that her students' knowledge was limited to naming movable and immovable joints only as this was what the students were taught in lower grades. For Miriam background knowledge meant what students learnt in lower grades as this excerpt indicates:

Interviewer: What challenges do you face in trying to get what they already know and teaching what you planned before coming to the class?

Miriam: In most cases say the topics are a continuation as I have already said so it depends on their background if their background is poor then I will have difficulties explaining the topic.

Interviewer: What do you mean by background?

Miriam: The background on what they learnt before. If it is poor it means I have to start from step one like if I want to talk about osmosis I would ask what is osmosis and if they know it, I proceed

but if they do not then I have to explain what osmosis is first before giving more information on it.

Like Michael, Miriam went ahead giving students information on differences between movable and immovable joints without any attempts to find out if her students knew something already. The two teachers (Michael and Miriam) used their assumptions to inform their teaching strategies. Hence while the two teachers were aware that students brought some prior ideas to the instruction, they did not give their students an opportunity to bring out prior conceptions.

Christina also gave students background as a challenge in using their prior experiences in her biology lessons but her focus was on discipline. Christina indicated that students who come from disciplined backgrounds are easy to draw prior ideas from as they give constructive ideas. She was worried with students who come from homes that do not care much about education. Christina said most of the students from undisciplined homes take everything as a joke in class hence just provoke laughter among peers resulting in time wastage. During lesson observations, I noted that Christina spent a significant amount of time controlling noise levels in her class. Some of the issues students talked about during group discussions were not related to the task assigned. Tobin *et al.* (1994) attributes disruptive behaviours during lessons to students' lack of motivation which is a result of failure in their work. Tobin *et al.* (1994) acknowledge that teachers with such disruptive students tend to spend a lot of teaching time on monitoring student behaviour to maintain order hence they rarely probe their students for understanding.

It was interesting to note that students' cultural background in terms of the respect they give to elders was not mentioned by any of the four teachers. Being an area where students are culturally expected to be so obedient and respectful to adults including teachers, I expected that they would not easily share their views in classes (Shumba, 1999). Except for Miriam's class, in the other three classes that I went to, students were able to share their ideas if given a chance to speak. Miriam's class was generally passive as I discuss under the students' interest factor.

Teaching and learning materials

Shortage of, or inadequate, teaching and learning materials were highlighted by all the four teachers and this is what Kelvin said:

Interviewer: What are the challenges you face when you try to involve students?

Kelvin: It is quite challenging as I have already mentioned we against time....Secondly we look at the materials, do you have enough to prepare the lesson and enough for the number of students you have? Also materials like books: in the past government would supply enough books at least for each student to have a copy but not now. Even if you want to do an experiment if you have only two books where the procedures are, how would students share the books? So we have a lot of challenges: large number of students and lack of materials both textbooks and material for experiments.

Lack of teaching and learning materials in Malawian secondary schools especially community secondary schools is an old story. The shortage of teaching materials is attributed to poor funding by government (Mbano, 2003; Lungu, 2005; Gwayi, 2009). Gwayi (2009) further suggests that large enrolments worsen the shortage of teaching and learning resources. Shortage of science equipment is experienced in most developing nations. Gray (1999) blames the imported curriculum in these nations which does not match the economic ability to provide such expensive laboratory equipment. Gray (1999) proposes curricula that develop scientific skills through open-ended investigations that should focus on contextual issues as these would use locally available resources. In a study by Tlala (2006) on the impact of using low cost resources to teach high school biology in some South African schools, Tlala found that the low cost materials helped to achieve meaningful learning. Furthermore, low cost available materials provide an opportunity for students to do some practical work which is an essential component of science education. Of course Tlala (2006) indicates that such materials would not solve all the problems associated with lack of appropriate science equipment.

When the current Malawian curriculum was being introduced, teachers were encouraged to teach it using locally available resources. However, as mentioned earlier in reference to Kelvin and Miriam's understanding of student involvement, most teachers associate teaching of science with sophisticated expensive laboratory equipment. In his study in Malawi, Gwayi (2009) found that the "teaching and learning using locally available resources" (TALULAR) concept was not reinforced enough as, despite its effectiveness in teaching science, teachers chose whether to use locally available resources or not.

Students' interest

This factor was raised by Miriam and Michael. Michael indicated that students selected to community schools like where he was teaching feel that they are the rejects and that demoralises them. Michael had only twelve students in his Form four class and such a small

class is very unusual in Malawi. When I informally chatted to him about it, Michael indicated that the Ministry of Education Science & Technology selected fifty Form three students to the school in the year before but most students had transferred to other schools. Michael mentioned lack of basic resources at the school and not learning much as the reasons given by students who left the school. I felt that it was possible that the remaining students were not motivated. While it may be true that Michael's students are not motivated by being at a community secondary school, in the three lessons I was with Michael, I found his students anxious to contribute in the class deliberations.

Miriam's students however, were very passive for the time I was there and this is what she said on involving her students:

Interviewer: So what are your major challenges/ barriers/ hindrances in trying to involve students in the Biology lessons?

Miriam: The major challenge is that most students have a negative attitude towards Biology and others feel inferiority complex so even if they know something but because of language background they fail to say something. So while I want to involve them I fail as they say nothing mostly.

Interviewer: In the short time you have taught them Biology, what do you think contributes to their negative attitude towards the subject?

Miriam: I think it is just the perception they have in general that sciences are difficult so we can not handle it even if they have not read anything about biology, they will say Biology is difficult because it is a science subject.

Interviewer: You have mentioned reading; does your school have books that you can use to assign

Miriam: No. Currently we only have copies for teachers

Msimanga & Lelliott (2009), based on their study that explored the challenges and potential of working with learner's ideas in science classrooms in South Africa, argue that when students are used to teacher-centred teaching styles, they may not easily adopt models that require their active participation hence they may abstain from participation. My observations in Miriam's class and the school in general showed that there may be more to the passive attitude of the class she was teaching than the description in the excerpt.

Miriam's class had about seventy-five students and the class was very full. The worst part was that Miriam's class had very few desks hence about a quarter of the students stood at the back

due to shortage of furniture. Generally her students came late to classes. In one lesson, some students came thirty minutes late. The coming in movements of late students was disruptive as they had to find their way within a fully packed class to the back where they could stand. The school has three science laboratories with one being specifically for senior biology but I learnt that none of them was in use due to lack of furniture, equipment and chemicals.

An informal enquiry on shortage of furniture and students' late coming to class at Miriam's school revealed that the management and staff have adopted a laissez-faire management style due to poor working conditions that prevail in government schools. Miriam seemed frustrated with the environment she was working in. I would feel the same if I was in her shoes. What was clear is that Miriam's class as well as the school as a whole did not provide an environment conducive to learning. Physical resources and school ethos and management are contributing factors to the school's capacity to implement a curriculum innovation (Rogan & Grayson, 2003; Rogan, 2007). However, it is beyond the scope of this study to tell how much this impacted on students' attitudes displayed in Miriam's biology lessons.

Time

Kelvin, Christina and Michael cited time as one of the factors that make it difficult for teachers to either work with student ideas or involve them in lessons. Time was linked to size of classes and pressure to complete the syllabus before students sit for national examinations. Christina indicated that if a teacher would listen to all students' ideas in a large class, then they would not make progress. Michael's concerns were that the senior syllabus is very long and it would be impossible to complete it if one uses learner-centred teaching strategies.

Interviewer: What are the challenges you face in trying to incorporate ideas from students in your lessons in Biology?

Michael: First of all the topics in MSCE syllabus is hard to cover within two years now if we go by learner-centred which is a good way of teaching, to cover that syllabus is practically impossible that is why most of times teachers would tend to use the lecturing type of methods so that we can speed up the work but in that way most of the students are left without understanding the biological concepts however I think the little they get from this learner-centred way will help.

Mbano (2003) agrees that teachers struggle to finish the long syllabus hence they consider active learning methods as time consuming. Msimanga & Lelliott (2009) also report that teachers

are reluctant to use learner-centred activities because such activities are time consuming and results in failure to complete planned work.

Kelvin linked the time factor with the pressure to help students pass examinations. Rollnick, (1998) alludes to the fact that in African societies teachers are judged by their ability to enable learners pass examinations. Judging teachers based on examination results, leads to classroom practices that focus on helping learners memorise facts relating to examinations. A study by Isaac (1993) which investigated the influence of the senior certificate examinations on methods of teaching biology in Indian secondary schools in South Africa, found that qualified biology teachers abandoned strategies that would promote understanding of concepts because of the pressure to produce good examination results. Isaac (1993) indicates that teachers opted for teaching that focused on objectives that were tested in national examinations. Chalira & Nkhoma (2003) assert that Malawian teachers teach to the examinations. In their paper on the Malawi National Examination Board (MANEB) presented at the Association of Educational Assessment in Africa (AEAA), Chalira & Nkhoma (2003) indicate that teachers in Malawi adopt MANEB assessment styles and wish to participate in marking national examination in order to improve their teaching. This may suggest that teachers pay more attention to examination demands than to teaching requirements for conceptual understanding. The worst part is that examinations in Malawi emphasise recall of scientific principles instead of application of knowledge acquired consequently promoting the knowledge transmission approach in teaching science (Mbano, 2003).

Miriam did not mention the problem of time. This might be due to the fact that she was only five months into her teaching experience and had not yet been exposed to the examination pressure. It could also be because the environment in which she works does not seem to value time as indicated earlier. A study by Clark (1999) on school-based factors inhibiting a science teacher's implementation of curriculum innovation in South Africa, found that absenteeism and delays in going to classes reduced time available for learning. Such practices most likely contribute to teachers' failure to complete the syllabi even if a lecturing strategy is deployed.

Language

The issue of language was raised by Miriam. She indicated that language problems could have made her students to be non-responsive in her lessons. Despite being aware of her students' incompetence in spoken English Miriam was not flexible in her teaching. For example, at one point Miriam asked the students what a ball and socket joint was, one student wanted to

demonstrate it as he could not describe it but Miriam said she was not interested in drama and picked another student. I feel this was discouraging to those who could not fluently express themselves. If learning science is indeed learning to talk science (Lemke, 1990; Rollnick, 2000) then teaching for conceptual understanding is greatly challenged by inadequate fluency in the language as Miriam indicated.

From my analysis of the lessons observed and interview information, I identified two extra factors that were not mentioned by teachers i.e. teachers' knowledge of subject matter and misconstruction of knowledge about constructivist practices.

Knowledge of subject matter and experience

From the lessons I observed, I noted that Michael and Christina's efforts to involve students was affected by their inadequate knowledge of subject matter. Failure to insert appropriate information and provide responses to student questions at the right time reduced the effectiveness of their classroom discussions in promoting conceptual understanding. The two teachers depended so much on the information in the textbooks they were using which was a barrier in their use of students' ideas that did not match textbook information as mentioned earlier. My observations seemed to agree with Stoll (1994) who suggests that insufficiently qualified teachers are rigid in their teaching styles and often stick closely to their prepared notes or textbook with minimal teacher-student interaction. Total dependence on prescribed books limits the teacher's ability to question the content in these books in terms of possible misconceptions. Abimbola & Baba (1996) found that a biology textbook written by prominent science educators for the Nigerian curriculum, contained a number of misconceptions and alternative ideas. Abimbola & Baba (1996) define misconceptions as "an idea that is clearly in conflict with scientific conceptions and is therefore wrong" and an alternative conception as "an idea which is neither clearly conflicting nor clearly compatible with the scientific conceptions but which has its own value and is therefore not necessarily wrong" (p. 16). Teachers like Christina and Michael would therefore not be able to identify and filter out such misconceptions and alternative conceptions in the books they use to enhance students' conceptual understanding (Abimbola & Baba, 1996).

Miriam's teaching seemed to have been affected by the lack of knowledge on teaching and learning theories. Miriam, who had not done any courses in education during her university studies, was still unfamiliar with the teaching syllabus at the time of the interview I had with her. When I mentioned the teaching syllabus, she did not know what I meant until I showed her the

hard copy. In her teaching she basically read through the notes that she copied from the recommended reference books without recognisable alterations. Liang & Gabel (2005) indicate that constructivist teaching requires teachers to select content and contextualised activities that can challenge students in order to create the zone of proximal development. But the selection and delivery of science content is affected by the teacher's mastery of subject matter as well as his/her ability to transform this subject matter into content that can be understood by the students. Transformation of subject matter content knowledge into teachable content knowledge requires one to have pedagogical content knowledge (PCK) (Shulman, 1986; Geddis *et al.*, 1993; Geddis & Wood, 1997). "Pedagogical content knowledge is knowledge that plays a role in transforming subject matter into forms that are more accessible to students" (Geddis *et al.*, 1993, p.582). PCK is a combination of content and pedagogy (Geddis *et al.*, 1993) and the fact that Miriam had neither gone through some education courses nor an induction into the teaching process may have affected her pedagogical knowledge hence her PCK.

Misconstruction of knowledge about constructivist practices

This study has shown the four teachers' understandings of students' prior experiences and active student involvement which seems to have shaped their classroom practice although not in all cases as described earlier. For example, emphasis on recall of facts from previous lessons was within their understanding of working from the known to the unknown. This misconstruction of knowledge about students' prior experiences may have affected their classroom practices in teaching biology. Miriam and Kelvin's understanding that student involvement in their lessons meant engaging them in experimental work, denied their students opportunities to work in groups. Group discussions are important because firstly, they allow students to share their ideas which clarify their understanding of scientific concepts and resolve some misunderstandings. Secondly, group discussions give students an opportunity to negotiate differences and opinions consequently reach a consensus. Lastly, group interactions enhance the development of students' abilities to speak and defend their opinions (Tobin *et al.*, 1994) hence they may learn to talk science (Lemke, 1990; Rollnick, 2000).

4.4 CONCLUSION

This chapter has explained how data obtained from interviews with teachers and lesson observation was analysed and has presented and discussed results in three themes: teachers' understandings of students' experiences and active student involvement, the extent to which

teachers actively involved students and used their experiences for conceptual understanding in biology and factors that affect the use of constructivist approach in teaching biology in Malawi. These themes correspond to the three research questions that the study addressed. The summary of results, implications and my reflection on the research process are given in chapter five before the conclusion remarks.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The Malawi government reviewed the secondary school curriculum in 2000. The current curriculum draws from the constructivist approaches to teaching and learning. In constructivism, learning is considered as the construction of knowledge by individuals. Students' prior knowledge and social interactions with the teachers or among themselves are considered important in the construction of new knowledge during instruction.

In Malawi the Biology teaching syllabus emphasises the need for biology teachers to actively involve students and build on their prior experiences where possible when teaching the new Biology curriculum. However, reports from school inspectors who monitor the implementation of the new curriculum indicated that teachers were neither drawing from students' prior experiences nor actively involving them in lessons as expected. This study set out to find out some of the factors that could be affecting the teachers' use of constructivist approaches when teaching the new Biology curriculum in Malawi.

The study explored four teachers' understandings of students' experiences and active student involvement, the extent to which the four teachers use constructivist approaches when teaching biology and what these teachers perceived as factors that hinder or promote the use of constructivist approaches in their biology lessons. This chapter presents a summary of this study's findings, research limitations, reflection on the research process, recommendations and suggestions for future research.

5.2 SUMMARY OF THE FINDINGS

5.2.1 The four Biology teachers' understandings of the phrases *students' experiences* and *active student involvement*

Students' experiences

All the four teachers in the study understood students' experiences in terms of what students already knew on the topic from previous teachings and all the four teachers began instruction by recapping what was taught in the previous lessons. Only one teacher mentioned that students' prior experiences can also come from informal teaching at students' homes but his teaching did not reflect this knowledge. It is interesting that the four teachers' understandings of students' prior experiences differ from the South African teachers' understanding of students' prior knowledge. Nykiel-Herbert (2004) found that teachers in South Africa mostly understood prior knowledge as what learners brought from their communities leaving out what came from previous teachings.

Active student involvement

The four teachers seem to have conceived their understanding of active student involvement from their school environments. The two teachers from the schools without laboratory facilities understood active student involvement in terms of engaging their students in group discussions and did involve their students. Those from the schools with laboratory facilities understood active student involvement to mean engaging their students in experimental or practical work and their students were less involved. Gray (1999) indicates that to most teachers, teaching science means doing experiments using expensive laboratory equipment and in the absence of these materials, the transmission model is used which encourages rote learning.

5.2.2 The four biology teachers' use of active student involvement strategies and students' prior experiences to promote conceptual understanding in Biology

The four teachers' classroom practices did not really reflect their convictions. While these teachers emphasised the importance of students' prior experiences for teaching to progress from what was known to the unknown, very little was done to unveil and engage with their students' prior ideas. Of the five codes: insertion, elicitation, application, metacognition and social interactions used to analyse the teachers' classroom practices, insertion and social interaction were reasonably attempted while metacognition was the least attempted.

Closed questions were used to elicit students' knowledge on previously taught concepts. According to Lobato *et al.* (2005) and Cimer (2007), use of closed questions in eliciting students' ideas does not adequately expose students' conceptual understandings as it just enables students to reproduce what the teacher told them. However, the four teachers worked within their understandings of prior knowledge as discussed in chapter four.

The way new information was inserted during lessons varied among the four teachers. At most, lecturing was a dominant strategy of inserting information especially among the qualified teachers. Addition of essential information on students' responses is vital in order to elaborate the ideas given, to answer the questions from students and to introduce new ideas (Brodie, 2004; Lobato *et al.*, 2005). However, too much lecturing makes the students passive and leads to the view that learning science implies memorising facts (Cimer, 2007). Failure of the less qualified teachers to provide answers to some students' questions, deprived students of the pertinent information that could have enhanced conceptual understanding. Chin (2004) found that students' questions can promote meaningful learning and the way teachers respond to students' questions determines the effectiveness of these questions as a tool for meaningful learning (Gaigher, 2009).

Generally the four teachers in this study did very little to develop their students' metacognitive abilities. Students were not given opportunities to either justify / clarify their ideas or dispute ideas they did not agree with. According to Mbanjo (2004), explicit demands for justification, stimulates metacognitive abilities in students. Waggins & McTighe (1998) add that teaching that cover a lot of new ideas without engaging in metacognitive analysis, is counterproductive. Students' ability to reflect on their understanding is essential for negotiation of a shared understanding in the classroom (Herrenkohl & Guerra, 1998) and for conceptual change on alternative conceptions (Hewson *et al.*, 1998).

Three teachers attempted to use examples from students' everyday experiences. Ability to apply scientific knowledge to everyday contexts is an indicator of understanding the concepts learnt (Waggins & McTighe, 1998). Dependence on textbook information affected one teacher's use of familiar examples as the adopted reference books contain decontextualised examples. Abimbola & Baba (1996) found out that textbooks contain misconceptions and students may get these misconceptions if teachers fail to filter textbook information.

All the four teachers made an effort to involve their students but they generally struggled to engage in dialogues that could enable students to express their opinions as they used closed questions. Liang & Gabel (2005) consider an effective dialogue in the classroom as an ingredient to constructivist approaches. Kinchin (2003) found that an effective dialogue in biology education is one that enhances a shared understanding on concepts. The common strategy used by the four teachers to involve their students was the question and answer technique. While Tobin et al. (1988) found that question and answer can achieve maximum student involvement in high school classrooms, it is open-ended questions that can allow students to express their views and negotiate for a common understanding (Tobin et al., 1994; Lord, 1997; Cimer, 2007). Tobin et al. (1994) adds that teachers who consider clear and logical explanations of content as effective learning activities, rarely involve their students. Lungu (2005), reports that in Malawi science is mainly taught through transmission where students are engaged in listening and taking notes.

5.2.3 Factors that affect the use of the constructivist approaches by the four teachers in teaching Biology in Malawi

The four teachers seemed to be aware of the importance of actively involving the students and building on their students' experiences when teaching the new Biology curriculum. The teachers also indicated that they had an obligation to implement policies in place. However, based on their teaching experiences, the teachers listed the challenges they face when using constructivist approaches. The factors varied among the four teachers as explained in section 4.3.3 of chapter four. Here is a list of the factors provided by the teachers:

- ❖ Shortage or inadequate teaching and learning materials due to poor funding by government and large enrolments.
- ❖ Inadequate time due to pressure to complete the syllabus in time for national examinations and large classes which made it difficult for teachers to involve all students
- ❖ Students' background in terms of: unfamiliarity with the topic, indiscipline and inadequate knowledge from prior teachings
- ❖ Students' lack of interest in cases where they were unwilling to contribute to classroom discussions.
- ❖ Inadequate fluency in the English language used as a medium of instruction

In addition to what the teachers mentioned, I noted that knowledge of subject matter and the four teachers' understandings of prior knowledge and active student involvement influenced their classroom practices. Inadequate knowledge of content leads to rigidity in teaching strategies

(Stoll, 1994) and such teachers prefer transmission methods to those that involve students when teaching science (Carr *et al.* (1994).

Lack of laboratory equipment does contribute to use of transmission methods in teaching science (Gray, 1999; Lungu, 2005). Tlala (2006) found that in South Africa, use of low cost available materials gave learners an opportunity to engage in some practical work. In Malawi the use of locally available resources is not reinforced in schools (Gwayi, 2009).

In a survey on cooperative learning in biology, Lord (1998) found that teachers stopped using methods that involved students due to inadequate time to cover content. Boddy *et al.* (2003) indicate that constructivist approaches are not used in primary science because time is not enough to cover the over-loaded curriculum. Mbano (2003) alludes to the fact that teachers in Malawi consider active learning methods as time consuming. Wideen *et al.* (1997) found that in British Columbia schools, high stake examinations made science teachers to focus on preparing students for examinations by involving them less and encouraging rote learning. In South Africa, Isaac (1993) found qualified biology teachers abandoned classroom practices that promoted conceptual understanding because of pressure to produce good examination results.

5.3 RESEARCH LIMITATIONS

I consider the following as main limitations of my study:

- The sample is small and was drawn from one education district hence was not representative of all teachers from similar schools and with similar qualifications. Therefore, I can not generalise my findings.
- The four teachers were observed teaching different topics. The level of difficulty of the content may influence the choice of teaching strategies. Consequently, it may not be appropriate to compare the four teachers' classroom practices.

5.4 REFLECTION ON THE RESEARCH PROCESS

In this study, data was collected mainly through lesson observation and interviews with teachers. I also took field notes on teacher-related issues that I felt were vital in providing a clear picture of my sample and the environment under which the teachers worked. I observed lessons in order

to get first hand information on how teachers were involving the students and building on their students' prior knowledge. Firstly, I was aware that teachers may change their classroom practices while being observed hence decided to observe three lessons hoping that with more visits, the teachers would behave normally. However, it is possible that I may have observed only the teachers' best practices.

Secondly, the interviews I had with the teachers were meant to follow-up issues that I observed in lessons in addition to seeking the teachers' understandings of students' experiences and active student involvement. I further wanted to elicit what the four teachers viewed as hindrances to using constructivist approaches in biology lessons. While when being observed teachers did not know what practices I was looking for, during the interview, the questions and probes may have rekindled their knowledge on the requirements for the new curriculum. This may have led to the gap between what I was told and the practices I observed prior to the interviews.

Lastly, conducting this study has been an enriching experience for me. During school supervision visits as an education methods advisor in secondary schools, I focused on highlighting shortfalls more than acknowledging the good practices in order to help the teachers improve their teaching. Visiting the schools as a researcher has been a learning curve for me especially that I had to stay focussed within the parameters of my study.

5.5 RECOMMENDATIONS

With reference to this study's findings, I would like to suggest these recommendations:

To the Ministry of Education Science & Technology

1. There is need for schools to be supplied with different biology reference books in reasonable numbers for use during teaching and learning activities
2. Effort should be made to supply all schools with basic science equipment and teachers should be trained to use them especially the under-qualified teachers in community secondary schools
3. There is need for the Malawi National Examination Board (MANEB) to use more items that demand explanations, interpretations and application of scientific knowledge than those that ask for recall of facts in national examinations so as to encourage teachers to teach for conceptual understanding

To the education methods advisors

1. Regular workshops should be conducted for teachers to revitalise their content and pedagogical knowledge on the new curriculum and to induct those just joining the teaching profession
2. There is need for reinforcement of support structures in schools at departmental or subject level for new teachers especially those that come from non-education training backgrounds

To the biology teachers

1. In spite of the pressure to complete the syllabus, students should be involved and their prior experiences drawn upon during instruction to enhance understanding of the concepts
2. Effort should be made to use open-ended questions when teaching to stimulate thinking and metacognitive abilities among students
3. There is need for flexibility in use of language during instruction to encourage students with inadequate fluency in the English language to express themselves
4. Where possible, in the absence of “laboratory equipment”, locally available resources should be used in teaching to engage students in some practical work which is an essential component of science education

5.6 SUGGESTIONS FOR FUTURE RESEARCH

This study focused on teacher-related factors that may be affecting the use of constructivist approaches in teaching the senior Biology curriculum. Only the views of four teachers in four urban schools were sought. While these findings provide some insight into what teachers in community and conventional secondary schools may be experiencing, a larger sample that would include teachers from rural schools would paint a bigger picture.

Some of the factors given by the teachers involve students. It would be interesting to find out what students may indicate as factors that affect their involvement in biology lessons and building on their prior experiences.

I have claimed that knowledge of subject matter and the teachers’ understanding of the constructivism framework affected the use of constructivist approaches when teaching the

Biology curriculum in Malawi. There is need for research in this area that can lead to appropriate recommendations to the government on the use of under-qualified teachers in secondary schools and the effectiveness of some teacher training programmes such as the Secondary School Teacher Education Project (SSTEP).

5.7 CONCLUSIONS

From the findings of this study, it appears that biology teachers are struggling to fully implement the constructivist practices in teaching the new Biology curriculum in Malawi irrespective of their qualifications and type of school they teach at. The teachers' classroom practices do not reflect their knowledge on the requirements in the Biology teaching syllabus. Although my sample was not a representation of all teachers in government secondary schools, at most, the findings are similar to what other studies in this field found in Malawi and elsewhere. Biology teachers in Malawi need to make use of the knowledge they have on the current curriculum demands. Nearly a decade has gone since the examination syllabus was replaced by the Biology teaching syllabus in Malawi but it appears the teachers are still succumbing to the pressure to produce good examination results. Teacher-centred methods are favoured over those that actively involve students. Could it be that if the teachers implemented the suggestions in the teaching syllabus, their students would not do well in national examinations? Are the biology teachers in Malawi missing the link between national assessment styles and teaching for conceptual understanding? Is there a gap between the teaching requirements for the current biology curriculum and the Malawi National Examination Board's assessment style? The answers to these questions are beyond the scope of this study. More research is needed to establish facts that can expose the actual cause for the teachers' practices.

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1. Elicitation/ recognition of students' prior knowledge
2. Building on students' existing ideas (referring to students' everyday experiences)
3. Engaging students in activities that allow them to develop conceptual knowledge and competence

4. Regular feedback on questions/ responses from students that enables them to reconstruct conceptual knowledge (management of errors & misconceptions)

Section B: Active involvement of students

5. Strategies used to involve students & appropriateness to the concepts being taught.

6. Mediation/ facilitation of class activities

7. Difficulties/ opportunities to involve students

Appendix 2

INTERVIEW SCHEDULE

Section A: Use of students' experiences

The Biology teaching syllabus suggests that you should use students' experiences as a resource during lessons.

1. What do you understand by students' experiences?
2. How do you use / would you use (if not using them) students' experiences in your Biology lessons?
3. Did you use any students' experiences in the lessons that I observed? Give me some examples.
4. In your opinion why do you think it is important to use students' experiences in Biology lessons?
5. What difficulties do you face/ would you face (if not using them) in using students' experiences?

Section B: Active involvement of students

The teaching syllabus also emphasises active involvement of students during lessons.

6. What does it mean for students to be actively involved?
7. Do you think students in your class are actively involved?
If yes, how do you involve them? (Describe some of the activities you do in class to involve students)
If no, why are they not involved? Explain why you find it difficult to involve students.
8. Where were students actively involved from the lessons that I observed?
9. I find it difficult to involve students. What are your experiences? Why is it difficult to involve students? Please explain.

Appendix 3

C/O Dr A.E. Mdolo
Department of Obs & Gyn.,
Chris Hani Baragwanath Hospital,
P.O. Berthsham,
2013.
Republic of South Africa.

Cell: +27725010937
Email: margaretmdolo@yahoo.co.uk
1st May 2009.

The Secretary,
Ministry of Education, Science & Technology,
P/Bag 328,
Capital City,
Lilongwe 3.
Malawi.

Through:
The Education Division Manager,
Northern Education Division,
P.O.Box 133,
Mzuzu
Malawi.

Dear sir/ madam,

**REQUEST FOR PERMISSION TO CONDUCT A RESEARCH IN SOME SCHOOLS IN THE
NORTHERN EDUCATION DIVISION.**

I am Mrs Margaret Mdolo, an Education Methods Advisor in the Northern Education Division from 2000-2005. I am currently studying towards an MSc degree in Science Education with the University of Witwatersrand in Johannesburg, RSA. As part of my degree requirements, I am conducting a research on factors that affect the use of constructivist approaches when teaching the new Biology curriculum in Malawi.

My study's focus is on two aspects of constructivist teaching approaches encouraged in the senior Biology teaching syllabus: building on students' experiences and active participation of students in the lessons. My study explores how Biology teachers understand and use students' experiences in their teaching and how they involve students in their lessons as well as the challenges these teachers face when these aspects are incorporated in Biology lessons.

This research involves observing some lessons for four, form 3 Biology teachers from four different schools and interviewing these teachers to follow-up some issues observed and those

not observed concerning their understanding of students' experiences and how they use them as well as student involvement in Biology lessons. I would like to work with two community secondary schools and two conventional secondary schools within the Northern Education Division. It will take me 2-3 weeks to collect data through lesson observation and interviews with teachers. Collection of data will commence as soon as permission to access the schools and clearance from the ethics committee of the University of Witwatersrand are granted.

All information collected in this research will be treated with strict confidentiality and will be shredded/ deleted once the study report is completed. The names of schools and teachers will not be used. They will only be identified by a pseudonym in the research report if reference is made to their views. In addition, any persons they refer to in the interview and the name of the school will be confidential.

I believe this research will give the teachers involved an opportunity to reflect on their teaching practices and deepen their understanding of the suggestions made in the teaching syllabus leading to some improvements in their classroom practices. Further to this, teachers' responses will contribute to an understanding of the factors that affect the implementation of suggestions made in the senior Biology teaching syllabus. This will hopefully assist teachers, head teachers and education methods advisors to address the issues or difficulties associated with the teaching of the current Biology curriculum.

Looking forward to your favourable consideration on my request.

Yours Faithfully,

Margaret Mdolo (Mrs.)

Appendix 4

INFORMATION SHEET FOR HEAD TEACHERS

Research study on factors that affect use of constructivist approaches when teaching the new Biology curriculum in Malawi.

I **Margaret Mdolo** am conducting research for my MSc degree at the University of the Witwatersrand. I am carrying out a study that investigates factors that affect the use of constructivist approaches when teaching the new Biology curriculum in Malawi. I would like to conduct this research among Form 3, Biology teachers at two conventional secondary schools and two community day secondary schools.

I would like to find out what are the teachers' understandings of active student involvement and using students' experiences as implied in the senior Biology teaching syllabus, the extent to which this required approaches are used in senior Biology lessons and the factors that promote their use.

I would like to observe lessons by Form 3, Biology teachers and take notes on aspects that relate to active students' involvement and use of prior knowledge. I would also like to interview these teachers on their understanding of the suggestions made in the senior Biology teaching syllabus on the required approaches and factors that promote the extent to which they use the suggestions. I would like to tape-record the proceedings of the interviews in order to save time if the teachers accept.

My research will benefit your school in that the responses from the Biology teachers will contribute to an understanding of the factors that affect the implementation of suggestions made in the senior Biology teaching syllabus. This will hopefully assist teachers, head teachers and education methods advisors to address the issues or difficulties associated with the teaching of the current Biology curriculum.

If you allow your school to take part in my study, I would like to make it clear that your participation is entirely voluntary, no negative consequences will result from your participation, and all information will be treated with confidentiality. If you do accept to participate, please remember that the Form 3, Biology teachers may decline to answer any questions, and you may withdraw from the study at any time. In order to protect confidentiality, all names I use will be fictitious.

I will provide you with a summary of my research results on completion if you would like me to.

Thank you.

Name: Margaret Mdolo (researcher)

Cell No. 2772 501 0937

Signature: _____

School of Education, University of Witwatersrand

Appendix 5

INFORMATION SHEET FOR TEACHERS

Research study on factors that affect the use of constructivist approaches when teaching the new Biology curriculum in Malawi.

I **Margaret Mdolo** am conducting research for my MSc degree at the University of the Witwatersrand. I am carrying out a study that investigates factors that affect the use of constructivist approaches when teaching the new Biology curriculum in Malawi. I would like to conduct this research among Form 3, Biology teachers at four schools including your school.

I would like to find out what are the teachers' understandings of the senior Biology teaching syllabus, the extent to which suggestions made in the teaching syllabus are used in Biology lessons and the factors that promote their use.

I would like to observe your Biology lessons in Form 3 and take notes on aspects that relate to some suggestions made in teaching syllabus. I would also like to interview you on your understanding of these suggestions and factors that promote the extent to which you use them in your teaching in Biology. I would like to tape-record the proceedings of the interviews in order to save time if you accept.

My research will benefit your school in that your responses will contribute to an understanding of the factors that affect the implementation of suggestions made in the senior Biology teaching syllabus. This will hopefully assist you and other teachers, head teachers and education methods advisors to address the issues or difficulties associated with the teaching of the current Biology curriculum.

If you take part in my study, I would like to make it clear that your participation is entirely voluntary, no negative consequences will result from your participation, and all information will be treated with confidentiality. If you do accept to participate, please remember that you may decline to answer any questions, and you may withdraw from the study at any time. In order to protect confidentiality, all names I use will be fictitious.

I will provide you with a summary of my research results on completion if you would like me to.

Thank you.

Name: Margaret Mdolo (researcher)

Cell No. 2772 501 0937

Signature: _____

School of Education, University of Witwatersrand



Appendix 6

marang centre for maths + science education
university of the witwatersrand private bag 3 wits 2050 Johannesburg sa t+27 11 7173414 f+2711 7173259

Margaret Mdolo
Email: margaretmvolo@yohoo.co.uk
Cell: 27725010937

Informed Consent Form for head teachers

Lesson observation and teacher interview in Form 3 Biology class.

I, _____ consent to the research conducted by Mrs Margaret Mdolo on factors that affect the use of constructivist approaches when teaching the new Biology curriculum in Malawi in a Form 3 class. I realise that no negative consequences will arise as a result of my school's participation in this study, and that the study is being conducted for purposes of improving the teaching of Biology in Malawian schools. I give permission for the material to be used for research or teaching only. My school participates voluntarily and I understand that my school may withdraw from the study at any time.

Interviews:

I further consent to my Form 3 Biology teacher being interviewed as part of the study. I also understand that the teacher has the right to review the notes made of the interview before these are used for analysis if s/he so choose. The teacher can delete or amend any material or retract or revise any of their remarks. Everything the teacher says will be kept confidential by the interviewer. S/he will only be identified by a pseudonym in the research report. In addition, any persons they refer to in the interview and the name of the school will be kept confidential.

Observations:

I consent to notes being made of observations of the Form 3, Biology teacher's lessons, and the use of these notes for research purposes only. All references to the teacher will be anonymous. The teacher will be identified by a pseudonym if specific reference is made to his / her views. The school will also be identified by a pseudonym if specific reference is made to it.

Name: _____

Signature: _____

Date: _____

Appendix 7



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Margaret Mdolo
Email: margaretmvolo@yohoo.co.uk
Cell: 27725010937

Informed Consent Form for teachers of Form 3 Biology **Use of constructivist approaches when teaching Biology.**

I, _____ consent to participate in this study conducted by Mrs Margaret Mdolo on factors that affect the use of constructivist approaches when teaching the new Biology curriculum in Malawi in a Form 3 class. I realise that no negative consequences will result from my participation in this study, and that the study is being conducted for purposes of improving the teaching of Biology in our schools. I give permission for the material to be used for research or teaching only.

I participate voluntarily and understand that I may withdraw from the study at any time.

Observations:

I further consent to being observed while teaching Biology in Form 3 class as part of the study. I also understand that I have the right to review the notes made of my teaching before these are used for analysis if I so choose. I can delete or amend any material or retract or revise any of my remarks. Everything I say will be kept confidential by the researcher. I will only be identified by a pseudonym in the research report. In addition, any persons I refer to in my teaching and the name of the school will be kept confidential.

Name: _____

Signature: _____

Date: _____

Appendix 8



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university of the witwatersrand private bag 3 wits 2050 Johannesburg sa t+27 11 7173414 f+2711 7173259

Margaret Mdolo
Email: margaretmvolo@yohoo.co.uk
Cell: 27725010937

Informed Consent Form for teachers of Form 3 Biology **Use of constructivist approaches when teaching Biology.**

I, _____ consent to participate in this study conducted by Mrs Margaret Mdolo on factors that affect the use of constructivist approaches when teaching the new Biology curriculum in Malawi in a Form 3 class. I realise that no negative consequences will result from my participation in this study, and that the study is being conducted for purposes of improving the teaching of Biology in our schools. I give permission for the material to be used for research or teaching only.

I participate voluntarily and understand that I may withdraw from the study at any time.

Interviews:

I further consent to being interviewed as part of the study. I also understand that I have the right to review the notes made of our conversations before these are used for analysis if I so choose. I can delete or amend any material or retract or revise any of my remarks. Everything I say will be kept confidential by the interviewer. I will only be identified by a pseudonym in the research report. In addition, any persons I refer to in the interview and the name of the school will be kept confidential.

Name: _____

Signature: _____

Date: _____

Appendix 9



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university of the witwatersrand private bag 3 wits 2050 Johannesburg sa t+27 11 7173414 f+2711 7173259

Margaret Mdolo
Email: margaretmdolo@yohoo.co.uk
Cell: 27725010937

Informed Consent Form for teachers of Form 3 Biology **Use of constructivist approaches when teaching Biology.**

I, _____ consent to participate in this study conducted by Mrs Margaret Mdolo on factors that affect the use of constructivist approaches when teaching the new Biology curriculum in Malawi in a Form 3 class. I realise that no negative consequences will result from my participation in this study, and that the study is being conducted for purposes of improving the teaching of Biology in our schools. I give permission for the material to be used for research or teaching only.

I participate voluntarily and understand that I may withdraw from the study at any time.

Tape-recording interviews:

I further consent to being tape-recorded during my interview as part of the study. I also understand that I have the right to review the information recorded of the interview before these are used for analysis if I so choose. I can delete or amend any material or retract or revise any of my remarks. Everything I say will be kept confidential by the researcher. I will only be identified by a pseudonym in the research report. In addition, any persons I refer to in my teaching and the name of the school will be kept confidential.

Name: _____

Signature: _____

Date: _____

Appendix 10



Wits School of Education

27 St Andrews Road, Parktown, Johannesburg, 2193 • Private Bag 3, Wits 2050, South Africa

Tel: +27 11 717-3007 • Fax: +27 11 717-3009 • E-mail: enquiries@educ.wits.ac.za • Website: www.wits.ac.za

STUDENT NUMBER: 0708922V

Protocol: 2009ECE42

29 July 2009

Ms. Margaret M Mdolo
Marang Centre
WSOE

Dear Ms. Mdolo

Application for Ethics Clearance: Master of Education

I have pleasure of advising you that the Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate has agreed to approve your application for ethics clearance submitted for your proposal entitled:

Factors that affect the implementation of a learner-centred Biology curriculum in Malawi.

Recommendation:

Research Ethics granted

Yours sincerely

Matsie Mabeta

Wits School of Education

Cc Ms. M Doidge (Supervisor)