AN EXPLORATION OF SCIENCE TEACHER EDUCATORS' INTERPRETATION OF ACTIVITY-BASED TEACHING AT KITWE COLLEGE OF EDUCATION

by

MUMA ELIAS

THESIS
M. Ed.
Mum
2007
C.1

A Thesis submitted to the University of Zambia in Fulfilment of the Requirements for the Degree of Master of Education in Science Education.

The University of Zambia
Lusaka
2007
AUTHOR'S DECLARATION

I.............................., do hereby declare that this thesis represents my own work and that it has not previously been submitted for a degree at the University of Zambia or any other university.
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CERTIFICATE OF APPROVAL

This thesis of ELIAS MUMA is approved as fulfilment of the requirements for the award of the Master of Education in Science Education by the University of Zambia.

Examiners’ Signatures

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19th October 2007

19th October 2007

2007

2007

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This study sought to describe respondents’ conceptions of activity-based teaching, discuss how their conceptions of activity-based teaching influenced their own classroom practice and find out which activities respondents focused on as they employed their version of activity-based teaching. The research methodology of the study involved qualitative data which was collected through open-ended interview Schedule, open-ended Questionnaire, a Science Teaching Observation Schedule, and curriculum materials. The sample comprised nine science educators that were selected purposively to take part in the study. The data collected was analysed by both qualitative and quantitative techniques. The major findings of this study revealed that respondents’ interpretation of activity-based teaching was associated with the teaching of both ‘hands-on’ activities and ‘minds-on’ activities to students. The study also revealed that group discussions were the most frequently used teaching style by the respondents. From these findings the study concluded that respondents’ had fully grasped theoretical aspects of activity-based teaching of science, which was associated with the use of ‘hands-on’ activities as well as ‘minds-on’ activities of teaching. This study, therefore, argued the need for the respondents to ‘marry’ their ‘verbal’ interpretation of activity-based teaching with their actual classroom practice so that their teaching could cover ‘hands-on’ experiences as well as ‘minds-on’ experiences.
To my mother and father,

I dedicate this piece of work to them for their love, care, guidance, support and several other things that have enabled me to be what I am today. I will forever be indebted to them. Above all, may the almighty God be honoured. Jehovah Shammar!
ACKNOWLEDGEMENTS

I should like to acknowledge with gratitude the expert guidance and help I received from the supervisor of this study. Dr. C. M. Namafé throughout the research period. His commitment to work highly inspired me to do all I could so that I did not fail him especially in meeting the deadlines for submission of various aspects of my work. I really learnt a lot from him under his tutelage. I am also grateful to the following colleagues: Messrs H.M. Ulaya, B. Hangala and G. Simufukwe for their efforts in proof reading some sections of the manuscript. Furthermore, I would like to thank Mr. J. Jumbe, the then principal of KCE for committing the college to meet part of the financial costs of this study. My thanks are also due to Mr. D.L. Chileshe for helping in initial drafting of graphs and general editing of the manuscript, and St. Jones typists, both the current, Ms Chanda Songwe and the former late Wajipa Banda for helping in the initial typing of the report.

Finally, I am grateful to my wife, Mirriama and my three lovely daughters, Nissi, Matotelo, and Grace for their encouragement and support during the duration of the study. May the good Lord bless all the persons mentioned above without measure.
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<tr>
<td>CDC</td>
<td>Curriculum Development Centre</td>
</tr>
<tr>
<td>DANIDA</td>
<td>Danish International Development Agency</td>
</tr>
<tr>
<td>DoE</td>
<td>Department of Education</td>
</tr>
<tr>
<td>ECZ</td>
<td>Examination Council of Zambia</td>
</tr>
<tr>
<td>GRZ</td>
<td>Government of the Republic of Zambia</td>
</tr>
<tr>
<td>JICA</td>
<td>Japan International Co-operation Agency</td>
</tr>
<tr>
<td>KCE</td>
<td>Kitwe College of Education</td>
</tr>
<tr>
<td>MARK</td>
<td>Mathematics Rainbow Kit</td>
</tr>
<tr>
<td>MSE</td>
<td>Mathematics and Science Education</td>
</tr>
<tr>
<td>MOE</td>
<td>Ministry of Education</td>
</tr>
<tr>
<td>NBTL</td>
<td>New Breakthrough To Literacy</td>
</tr>
<tr>
<td>NISTCOL</td>
<td>Chalimbana National In-Service Teachers' College</td>
</tr>
<tr>
<td>OBE</td>
<td>Outcomes-Based Education</td>
</tr>
<tr>
<td>R1,R2,R3,R4,R5-</td>
<td>Respondents one, two, three, four and five respectively</td>
</tr>
<tr>
<td>SAARMSE</td>
<td>Southern Africa Association for Research in Mathematics and Science Education</td>
</tr>
<tr>
<td>SAARMSTE</td>
<td>Southern Africa Association for Research in Mathematics, Science and Technology Education</td>
</tr>
<tr>
<td>SCIM</td>
<td>Science Curriculum In-Service Modules</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
</tr>
<tr>
<td>STE</td>
<td>Science Teacher Educator</td>
</tr>
<tr>
<td>TESS</td>
<td>Teacher Education and Specialized Services</td>
</tr>
<tr>
<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organisation</td>
</tr>
<tr>
<td>ZASE</td>
<td>Zambia Association for Science Education</td>
</tr>
<tr>
<td>ZATERP</td>
<td>Zambia Teacher Education Reform Programme</td>
</tr>
<tr>
<td>ZPC</td>
<td>Zambia Primary Course</td>
</tr>
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<td>ZBEC</td>
<td>Zambia Basic Education Course</td>
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CHAPTER ONE

INTRODUCTION

1.0 Introduction

Context of the study

This section starts by describing the general context of Kitwe College of education (KCE) for readers who may not be familiar with the college. KCE is situated on the Copperbelt region of Zambia. As a result, it is multicultural. It is one of the ten public colleges of education in Zambia that provides pre-service teacher education to would-be primary school teachers.

Teacher education, in general and science education in particular has undergone significant changes at KCE since independence. The landmark change that characterizes science teacher education at KCE since independence is one that involved the integration of 'traditional subjects', namely, agricultural science, environmental science and mathematics into Mathematics and Science Education (MSE) study Area. According to Silwimba et al (1998) this integrative approach to teaching of science at KCE has three key concepts, these are; activity-based teaching, integration and team work in planning/teaching. This 'new' primary science teacher education curriculum embraces learner-based teaching as opposed to teacher-centred teaching which was the main feature of the previous two programs namely, Zambia Primary Course (ZPC) and Zambia Basic Education Course (ZBEC). Other features that are found in Zambia Teacher Education Course (ZATEC), a programme which is currently running at KCE, include problem-solving, shared meaning of teaching/learning experiences and the use of continuous assessment by the teacher educators in addition to the final examination. Furthermore, the contemporary science education expects a science teacher educator at KCE to remain in the background and assume the role of a facilitator, adviser, observer, challenger, respondent, evaluator, presenter, manager and enabler (Silwimba and Tindi, 1998). On the other hand, the learners are expected to take a lead as they manipulate physical materials in their learning process.

1
All the science teacher educators at KCE have taught science education for more than three years. In addition, they have been inducted into ZATEC programme in general, and in activity-based teaching of science, in particular. In terms of environmental context, KCE has limited laboratory space (has only one laboratory with basic facilities) for all twenty four classes of first year students. Each class has an average of (a population ) twenty-five students. Some classrooms with large seating capacity accommodate two combined classes. With regards to group-dynamic context, group thinking in problem solving is expected to be more predominant in any teaching/learning activity rather than solitary (independent) thinking among the learners. In view of this, activity-based teaching at KCE involves student participation in group activities such as discussion. Such group activities are rooted in the Outcomes Based Education (OBE) which fully embraces the principles of ZATEC. With regards to the societal context of this study, activity-based teaching at KCE takes place in a decentralized and liberalized manner in which democratic principles guide the science teacher educators as they construct their classroom practice. Having provided the context of KCE, the rest of this chapter describes the background to the study. In doing this, the chapter outlines different programmes in science education which primary school colleges in Zambia have undergone since 1966. This year (1966) marked a new era in the development of teacher education in Zambia in which teacher education curriculum for primary teacher training colleges had just shifted from being largely practically-based (associated with colonial period) to theoretical subjects (associated with white collar jobs). The chapter also sets out to describe the statement of the problem, purpose of the study and its objectives, as well as research questions and significance of the study. Finally, the chapter sets out to define the operational terms.

1.1 Background to the Study

There have been three different primary teachers’ training courses in Zambia since 1966. Each course had its own specific focus and was deliberately designed to respond to the objectives defined by the national education policy documents of its time. Therefore, each of the three primary teachers’ courses influenced the use of activity-based teaching in class by science teacher educators differently. In other words, a change from one primary teacher training programme to another is expected to have a corresponding influence in the manner teacher educators organize their knowledge and teaching methodology. In this regard, how science teacher educators at primary school colleges of education, in general,
and at Kitwe College of Education (KCE), in particular, interpret their own practice with regard to activity-based teaching will form the background to this study.

The first primary teachers’ training course in Zambia after independence was known as the ‘Zambia Primary Course’ (ZPC). This course ran from 1966 to 1973. The course was ‘strictly’ teacher-centred, content-focused and highly prescriptive in nature. In addition to this, the leadership style of science teacher educators in this paradigm of curriculum was authoritative (MOE, 2000). During the period of the ZPC, educators of science in primary colleges interpreted activity-based teaching largely as consisting of making students to listen and copy notes as they lectured (MOE, 1999). Learners’ knowledge was essentially at the verbal level, and yet science is a doing subject (Young, 1988). Some educationists, both local and international, tend to view the teacher-centred approach to teaching any subject, in general and science, in particular, as being inflexible, and incapable of equipping the learner with the ability to cope with the real world (Haambokoma et al, 2002; Fraser et al, 1993; Wellington, 1989). Wellington (1989, p. 15) claims ‘that the content-led approach has failed.’

The second primary teachers’ training course in Zambia was the ‘Zambia Basic Education Course’ (ZBEC). It ran from 1974 to 1997 at Kitwe, Mufulira and Solwezi primary teacher training colleges. When these three colleges stopped offering ZBEC in 1997, the rest of the primary teacher training colleges in Zambia continued with ZBEC until 2000. At Kitwe, Mufulira and Solwezi colleges, there was a pilot project known as Zambia Teacher Education Reform Project (ZATERP) for the two years from 1998 to 1999 inclusive. In ZBEC, science teacher educator’s orientation in class was very much similar to ZPC but was slightly less teacher-centred, less prescriptive and a bit more liberal in its approach than ZPC. Essentially, this course had some features of both teacher-centred and learner-centred approaches. It can be said to be a kind of middle of the road approach. This meant that lecturers introduced some level of creativity in their teaching of science. In ZBEC, science teacher educators interpreted activity-based teaching as mainly consisting of introducing practical science activities to students, such as simple problem solving tasks. Like ZPC, however, ZBEC failed to produce an ‘integrated scholar’ who could adequately grasp science content and acquire the necessary science process skills for use in real life situations because the science curriculum still remained examination-driven coupled with rote learning of facts simply for the purpose of passing an examination (MOE, 2000).
In 2000 ZATERP ‘gave birth’ to a third primary teachers’ training course in Zambia. The third primary teachers’ training course was known as the ‘Zambia Teacher Education Course’ (ZATEC). ZATEC was still in force at the time of conducting this study. ZATEC marked a major shift from a teacher-centred approach to a learner-centred and activity-based approach to teaching. In ZATEC, science teacher educators were expected to interpret activity-based teaching by giving students opportunities to learn science through doing hands-on and minds-on science activities so that they could use what they had learnt to solve practical problems in real life situations (Fraser et al, 1993). Science teacher educators were also expected to remain in the background and assume the role of a facilitator, co-learner, co-researcher, guide and mediator rather than that of knowledge givers (MOE, 2001). Learners in this programme were expected to take a lead in doing hands-on and minds-on science activities.

ZATEC was underpinned by principles of Outcomes-Based Education (OBE). In OBE the focus of teaching is on learners. According to Nomsa, 2002, in Jacobs et al (2002) science teacher educators using OBE are expected to organise most of their lessons around group work, research and learner-self activity. In summary, the above described teacher education courses could be said to be orientations to learner-centredness, and the level of learner participation in each course can be summarised using the following adaptation from Barnes et al (1987).

Table 1 The participation dimension in Science Education

<table>
<thead>
<tr>
<th>Teacher Education Programme in Zambia</th>
<th>Closed</th>
<th>Framed</th>
<th>Negotiated</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPC</td>
<td>Tightly controlled by teacher. Not negotiable.</td>
<td>Teacher controls the topic, frames of reference and tasks; criteria made explicit</td>
<td>Discussed at each point; joint decisions</td>
</tr>
<tr>
<td>ZBEC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZATEC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Focus</td>
<td>Authoritative knowledge and testing; processes</td>
<td>Search for justifications and</td>
<td></td>
</tr>
<tr>
<td>Students’ role</td>
<td>Acceptance; routine performance; little access to principles</td>
<td>Join in teachers’ thinking; make hypotheses, set up tests; operate teachers’ frame</td>
<td>Discuss goals and methods critically; share responsibility for frame and criteria</td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Key concepts</td>
<td>‘Authority’: the proper procedures and the right answers</td>
<td>‘Access’: to skills, processes, criteria</td>
<td>‘Relevance’: critical discussion of students’ priorities</td>
</tr>
<tr>
<td>Methods</td>
<td>Exposition; worksheets (closed); note- giving; individual exercises; routine practical work. Teacher evaluates.</td>
<td>Exposition, with discussion eliciting suggestions; individual/group problem solving; lists of tasks given; discussion of outcomes, but teacher adjudicates</td>
<td>Group and class discussion and decision making about goals and criteria. Students plan and carry out work, make presentations, evaluate success</td>
</tr>
</tbody>
</table>

Source: Adapted from Barnes et al., 1987.

**The Place of Science Education at KCE**

The curriculum that was running at KCE, at the time of this study, comprised six study areas, namely, MSE study Area, Expressive Arts, Education, Literacy and Language, Technology and Social Spiritual and Moral Education. Formation of these study areas mentioned above was based on the principle of integration of ‘traditional’ subjects. Science education is a component of MSE study Area. It is composed of environmental science and agricultural science.
According to Muzumara (2007, p.3) 'science education is concerned with the teaching and learning of science. It is concerned with the methods and theories of teaching and learning of science.' In view of this, the place of science education at KCE with respect to ZATEC curriculum, at the time of this study, was to enable student-teachers plan, implement and evaluate their lessons in science using the most appropriate methods of teaching a given topic and learners particularly during their peer teaching and their school teaching practice (school experience).

Unlike other study areas in the college, science education deals with the nature of science as a discipline, its structure and its ethics. The above named aspects of science are important, if not imperative to be known by people who are training to become teachers of science at KCE. This is due to the point that the nature of science as a discipline and its structure have implications for methods of teaching to be employed in their classroom practice. Concerning the structure of science, the advantage of understanding it is that knowledge of the said structure would enable a science teacher educator select appropriate methods of teaching, suitable seating arrangements, and the appropriate science teaching/learning activities for a given class. In doing so, a science teacher educator will be faced with a question as to whether she/he should teach science through a process approach or through a content-led approach. If one chooses either one of the two or a combination of them, what are the implications concerning development of science process skills in their learners? Against this background, the place of science education at KCE is to produce a scholar that would use a scientific method in solving problems in real life situations. In that way, science education at KCE seeks to produce a scholar that would be useful to oneself as well as to the country through the correct application of science.

Science education also attempts to describe the nature of science. According to Wellington (1989) scientific knowledge is tentative. As a result, it may change depending on the availability of empirical data. In addition to scientific knowledge being tentative, Muzumara (2007) claims scientific knowledge to be replicable, empirical, holistic, unique, historic, humanistic, probabilistic and public. It is also important for science teacher educators to know the nature of science because its knowledge can affect the choice of the teaching approach as well as the methods of teaching of a given topic by a particular teacher. For instance, if a science teacher educator knows that science knowledge is tentative in nature, such an individual may choose to teach science using
hands-on activities rather than using or emphasizing science knowledge which might change with the advancement of science.

With reference to ethics of science, the reader is reminded that ethics are actions that scientists display when they are working, within the discipline of science. The following is an example of ethics in science: science begins with the empirical data to which rational thought is applied. It should, however, be noted that science education does not expect a science teacher educator to operate in the exact manner as a scientist. This is because a science teacher educator unlike a scientist is expected to be responsible to his/her students. In this regard, science education adds other components such as class management to the already acquired scientific ethics noted above.

Another important role played by science education at KCE, is one that is concerned with the development of the student-teachers which is a positive attitude towards science as stated by Milner, 1986, p.7, in Muzumara (2007)

"a positive attitude to science would enable pupils to value the practical benefits afforded by scientific understanding and a scientific approach, while at the same time being aware of the limitations of science, familiarize themselves with and have confidence in their handling of scientific knowledge to be able to willingly contribute to public discussions on scientific issues of interest to the society as a whole. Develop life-long interest in science and aspire for science-related job."

Other scientific attitudes that are worth developing in learners by science teacher educators through science education include the following: open-mindedness, intellectual honesty, respect for evidence, persiverence, humility and curiosity (Muzumara, 2007)

Another important place of science education at KCE is concerned with the promotion of the use of science language during science lessons and in real life situations. This is because science language is important in communicating with learners and amongst science teacher educators themselves, as a community of science academicians, regarding the teaching/learning of concepts, principles, law and process skills. In this view, science education encourages the use of scientific terms accurately as may be required by a science
`register`. For instance, the word `force`, has a different meaning in the way it is used in English. It is, therefore, in science education that common barriers associated with language in the teaching of science are addressed.

It can therefore, be stated here that the role of science education at KCE is essentially concerned with preparing a student-teacher, by the science teacher educators, to plan, implement and evaluate science lessons in a manner that would help learners to learn concepts of science and apply them in real life situations in a society. In doing so, the student-teacher, as noted above, may become useful to himself/herself as well as to the society where such an individual lives.

1.2 Statement of the Problem

ZATEC demands the use of learner-centred and activity-based teaching approaches in the teaching of science. This approach to science education focuses its attention on the use of practically based activities when teaching. This means that all learning takes place through some form of physical and mental application. Various attempts have been made in the past at KCE through in-house and national workshops to orient science teacher educators towards activity-based teaching so that they would focus their teaching on developing science process skills in their students. What is, however, not clear is whether the knowledge gained from such encounters is actualised by science teacher educators in their classroom practice or whether their conception of activity-based teaching tallies well with the meaning of the term as used by contemporary writers and science educationists such as Fraser et al (1993). It should also be noted that even so KCE has some literature arising from workshops and the donor community that highlights the role of science activities in the teaching and learning of science. There has been no research conducted locally at KCE to explore science teacher educators’ interpretation of activity-based teaching. The personally held interpretation of activity-based teaching by science teacher educators is crucial to its implementation in a classroom situation. Whatever version of activity-based teaching that one employs largely depends on his or her conception of the same. It can, therefore, be noticed that it is important to describe in detail the type of interpretation of activity-based teaching which is held by science teacher educators at KCE. At the time of the study, the kind of interpretation of activity-based teaching science teacher educators at
KCE had was not known. Therefore, there was information gap on this issue, which this study attempted to fill.

1.3 Purpose of the Study

This study sought to explore science teacher educators’ interpretation of activity-based teaching at KCE.

1.4 Objectives

The objectives of this study were:

1. To describe science teacher educators’ conceptions of activity-based teaching at KCE?

2. To discuss how science teacher educators’ own conceptions of activity-based teaching influenced their classroom practice?

3. To find out which activities science teacher educators focused on as they employed their version of activity-based teaching?
1.5 Research Questions

The following research questions guided the study:

1. What are science teacher educators’ interpretations of activity-based teaching at KCE?

2. How do the science teacher educators’ interpretation of activity-based teaching influence their own classroom practice?

3. Which activities do science teacher educators focus on as they employ their interpretation of activity-based teaching?

1.6 Significance of the Study

The findings of this study could be useful to curriculum designers, science teacher educators, standards education officers, KCE administration, the Examination Council of Zambia (ECZ) and students. The curriculum development unit, for instance, may find the study to be particularly useful as far as selection of science activities for their inclusion in the ZATEC syllabus is concerned. In addition to this, the study could enable curriculum designers to make appropriate adjustments to the ZATEC syllabus so as to address the contextual factors surrounding the implementation and assessment of activity-based teaching in colleges of education. With reference to assessment of activity-based teaching, there would be need for a strong liaison between CDC and ECZ so that major curricular issues involving the teaching of science process skills and their assessment are harmonized. Against this background the study may, therefore, bring the above mentioned parties together for the purpose of consulting one another a bit more often than before. As for the administrators of basic schools, high school and basic school colleges the study may generate valuable data that could help them plan ahead of time in as far as the use of activity-based teaching in classroom situations is concerned. The science teacher educators who are expected to interpret and implement the above stated teaching style in their classroom situations would also find the study useful. This is due to the point that the research findings of this study might arguably call for some re-adjustments to the science teacher educators’ practice in class. Furthermore, the study may enlighten the
Standard Education officers with regards to what they would be expecting to at find KTC when they go out for monitoring, especially that the current national education policy document called *Educating our future* (MOE, 1996) strongly recommends the use of activity-based teaching in classroom situations. The students, who are the reason for using activity-based teaching in classroom situations, may also find the study to be useful in helping them to know their roles during activity-based teaching. In addition to this, the study would add more literature to this domain of knowledge which, in the past, attracted scant attention among researchers in Zambia.

1.7 Operational Definitions of Terms

The terms 'activity-based teaching', science process skills, 'hands-on' activities', 'minds-on' activities' and 'outcomes-based education' are key to this study. Therefore, they need to be clarified as done below.

1.7.1 Activity – Based Teaching

Activity-based teaching of science, for the purpose of this study, is defined as teaching which is focused on imparting science process skills on to the learners. This type of teaching places emphasis on the process of teaching of science rather than its end product (knowledge). In other words, in activity-based teaching factual knowledge is subservient to the process of obtaining that same science knowledge. This, therefore, entails that activity-based teaching involves exposing students to direct or first-hand experience of whatever phenomenon is being taught in class by that particular teacher especially that ZATEC science syllabus is entirely a 'method syllabus'. This implies that students are expected to learn science by physically participating in the planned teaching/learning of 'hands-on' activities. In view of this, a teacher of science is expected to provide opportunities that would enable his/her students examine and/ or manipulate objects individually or in small groups. This explicitly indicates that in activity-based teaching of science learners 'learn science essentially by 'doing'. Meanwhile the teacher supervises the activity being undertaken by the students. As a result of this, physical manipulation of concrete materials is an important element of activity-based teaching. In this study, activity-based teaching also included those complementary activities to physical manipulation of concrete materials known as mental activities which are meant to provide opportunities for the
materials known as mental activities which are meant to provide opportunities for the
students to reflect upon laboratory activities they have done in class. In this regard,
activity-based teaching involves the teaching of science using science process skills
employing both ‘hands-on’ and minds-on activities. Activity-based teaching of science, in
this study, therefore, is synonymous with ‘hands-on’ teaching of science, ‘material-
centred’ science and the use of ‘science process skills’ in the teaching of science.

1.7.2 Science Process Skills

In this study, science process skills refer to intellectual science activities that are conducted
in class by the student to create a body of knowledge. These science intellectual activities
involve the application of a range of skills that students can be taught during science
lessons by their respective teachers. Teaching science using science process skills, in this
study, is synonymous with ‘hands-on’ teaching of science and involves teaching science
through the use of science activity that allows students to handle or manipulate so that they
get first-hand experience of the concepts being taught. This means that students will use
their own hands, and other sense organs as they perform such activities. It, therefore,
implies here that, teaching of science using science process skills will provide the students
with the ‘thinking tools’ that are not only applicable to science, but to life in general. The
science process skills in this study included the following: observing, communicating,
measuring, counting numbers, experimenting, using space/time relations, classifying,
making hypotheses, inferring, predicting, controlling and manipulating variables and
interpreting data.

1.7.3 ‘Hands-on’ activities

For the purpose of this study, ‘hands-on’ activities refer to ‘materials-centred’ activities,
‘manipulative’ activities, and ‘science laboratory’ activities in which students interact with
teaching/learning materials during a science lesson. Such handling or manipulation, for
instance, of apparatus and specimen is likely to enable students to get first-hand experience
regarding what they are learning about. Use of ‘hands-on’ activities in the teaching of
science, therefore, enables students to be actively involved in learning science concepts. In
this way, ‘hands-on’ activities are crucial to ‘learning of science by doing’ and, therefore,
provides a basis for teaching of science process skills using a science process approach. In
this study. ‘hands-on’ activities, therefore, form a basis for activity-based teaching of science.

1.7.4 ‘Minds-on’ activities

‘Minds-on’ activities in this study, refer to mental activities that are involved in translating information variously presented in a table, a histogram, a graph and/or a pie graph. ‘Minds-on’ activities also include activities involving thinking of hypothesis (variable of factors) to explain a given phenomenon, and thinking critically about data collected by a student as a result of him/her carrying out laboratory activities. ‘Minds-on’ activities in this study serve as follow-up activities to the ‘hands-on’ activities. In this way, ‘minds-on’ activities complement ‘hands-on’ activities in the teaching of science through activity-based teaching of science.

1.7.5 Outcomes-Based Education

In this study, outcomes-based education refer to a curriculum theory that is built around the performance (competency) of the learners arising from a lesson taught by a particular teacher. In OBE, the process of learning science is regarded to be relatively more important than the facts yielded from science lessons. OBE in this study, is concerned with teaching students the ‘how part’ of learning rather than the content of the lesson. In view of this, activity-based teaching is a very important principle in OBE practice. In OBE, a teacher organizes science activities for class work in such a way that is essentially aimed at providing the learners with an opportunity to ‘learn by doing’. In view of this, a teacher employing OBE in his practice builds his/her lessons around ‘hands-on’ activities in which his/her students are expected to actively participate as they interact on a given phenomenon that is being taught.

The version of OBE used in this study employs a ‘method syllabus.’ This means that the process of teaching/learning is more important than the facts or knowledge arising from such teaching. In other words, the ‘how’ part of teaching is more important than the ‘what’ part. Another point worth noting is that OBE in this study uses group work as a means of increasing student participation in the intended teaching/learning activities. In this respect, group work is the main form of class organisation.
CHAPTER TWO

REVIEW OF LITERATURE

2.0 Introduction

This chapter reviews literature on activity-based teaching of science. The literature will be reviewed with respect to Zambia and across its boarders from 1970 to 2006. In this chapter the theory and conceptual framework underpinning activity-based teaching is presented and discussed. Attention will also be focused on outcomes based education, which advocates the use of activity-based teaching in ZATEC.

2.1 Theory Underpinning Activity-Based Teaching

The conceptual framework of Constructivism guided this study. This framework was used to examine the science teacher educators’ interpretation of activity-based teaching at KCE. This portion of the report looks at different perspectives of constructivism regarding activity-based teaching of science.

2.1.1 Introduction to Constructivism

This study is informed by constructivist framework. Constructivism is a very broad conceptual framework in philosophy and science education. Constructivist framework has different perspectives regarding how teaching/learning occurs or the factors that influence teaching/learning of science. According to Asheena (2004) constructivism occurs in the following perspectives: cognitive constructivism, social constructivism and socio-transformative constructivism. Asheena (2004, p.13) further supports this claim by indicating that ‘there are differing views on whether constructivism is an epistemology, a theory, a method or referent.’

Silwimba and Tindi (1998, p.12) regard constructivism as an approach to teaching in which tutors are expected to adapt to the role of ‘enablers, managers, presenters, advisers, observers, challengers, respondents, evaluators and facilitators’ and not teachers. Anthony (1963) describes an approach as the nature of subject matter to be taught. This same
author further claims that an approach is axiomatic in nature. Fosnot (1986) claims that epistemology deals with the nature of knowledge in science. As a method, constructivism is procedural (Anthony, 1963) in dealing with concepts being taught by a teacher. It should, however, be noted that within one approach, there can be many alternative methods of teaching a given concept in science. Furthermore, Laurie (1985) presents the view that constructivism is both a model and a theory. According to Boyd (1977, p. 5,6) a model refers to ‘representing an idea with something that you can see and think about easily and ...a theory as a system that can explain observations and measurement.’

Although there are differing views on constructivism among different educationists and authors regarding teachers' construction of their classroom practice, these same educationists and authors all share the same view of the theory of constructivism which suggests that learners should be helped to construct their own knowledge by their respective teachers. This means that a teacher operating in constructivist paradigm is expected to encourage his/her students to discover principles by themselves. In addition, most constructivists agree with most of the ideas propagated by the critical inquiry theory, but develop them in greater detail, especially their application in solving real life problems using a scientific method. In view of this, constructivism can be regarded as process-oriented rather than content-based. That is, what is regarded to be important in constructivism is not so much ‘what’ learners learn, but ‘how’ they learn. Constructivist approach to teaching, therefore, explicitly calls for ‘hands-on’ teaching of science in which learners are actively involved or participate.

A teacher who constructs his/her practice employing constructivism is guided by some principles. According to Brooks and Brooks (2000) there are four guiding principles in constructivist paradigm. These are: first, a teacher should construct the learning outcomes that specify the competencies to be attained by his/her learners. A second principle of constructivism is that a teacher should organise teaching/learning activities that will enable his/her learners to understand the ‘whole’ as well as ‘parts’ of a given concept being taught in class. To enable the learners’ understanding of the ‘whole’ as well as the ‘parts’ Bruner (1977) advocates the use of a spiral curriculum in which the material covered in the previous year forms the pre-requisites to the next year’s academic work. A third principle is that teachers must have knowledge of students’ mental models. According to Brooks and Brooks (2000) knowledge of mental models would be important in helping learners
learn and integrate new understanding. Finally, the fourth principle of constructivist approach is the use of continuous assessment rather than the terminal one. In other words, assessment, measurement and evaluation should be an ongoing process or be a natural part of the teaching process. The fourth principle advocates the use of projects and portfolios as means of demonstrating competence of learning that a given learner has undergone.

Since this study is located in the constructivist framework, the researcher felt it necessary to review the works of some notable people that are associated with the theory of constructivism, namely, Piaget, Bruner, Vygotsky and Driver. The above named educationalists, though constructivists, are noted to have different views on constructivist approach to teaching as observed in the subsequent pages of this report. Piaget is regarded as the ‘pioneer of the constructivist theory of knowing’. This theory is also known as the piagetian theory of intellectual development. Then, Bruner’s constructivist theory draws much from Piaget’s work of child’s cognitive development. Vygotsky’s (1978) view on constructivism is that society and culture play some important role in teaching/learning process. Piaget, Bruner and Vygotsky, as noted above, provide the theoretical underpinnings for constructivist approach to teaching/learning, a conceptual framework which guided this study.

2.1.2 Cognitive Constructivism, Social Constructivism and Sociotransformative Constructivism

As noted above, Asheena (2004. p.15) gives the following examples of different perspectives of constructivism: ‘radical constructivism, cognitive or individual constructivism and sociotransformative constructivism.’ Another aspect of constructivism noted by Vygotsky (1986) is social constructivism. Each of the above stated perspectives of constructivism impact differently on how one constructs his/her practice regarding the teaching of science. Cognitive constructivism, social constructivism and sociotransformative constructivism formed the conceptual framework of this study.
2.1.2.1 Cognitive constructivism

Cognitive constructivism is based on the work of Piaget (1967). Piaget was a Swiss nationality and originally trained in the areas of biology and philosophy. He regarded himself as a 'genetic epistemology.' As a biologist, Piaget (1967) was mainly interested in the biological influences on how we 'come to know.' As a result, he did not focus so much on the fact of children's answers being wrong, but that young children kept making the same pattern of mistakes that the older children and adults did not. Piaget's research on the child's concepts of number, space, volume, weight and time shows that these concepts are constructed from a series of experiences (Peter, 1982).

There are two major aspects to Piaget's theory of intellectual cognitive development. These being, the process of 'coming to know' and the stages we move through as we gradually acquire this ability. The construction of knowledge, in Piaget's view, is entirely an individual-driven mental activity and progresses through a universal and definite sequence of intellectual developmental stages (Piaget, 1967; Peter, 1987; Fosnot, 1989).

According to Piaget (1967), as an infant starts to interact with the environment two phenomena emerge: those of organization and adaptation. The former refers to the tendency of the infant to systematise its processes into coherent systems which may be either physical or psychological. The latter, refers to the tendency of an organism to respond to the environment. Adaptation occurs in different ways from one individual to another or from one stage to another within any individual. Piaget (1967) believed that adaptation occurs in two complementary processes known as assimilation and accommodation. According to Peter (1982) accommodation is a modification of the existing concept and assimilation refers to an absorption of the new materials. In terms of learning, Piaget (1967) believes that a person incorporates (assimilates) new materials into his/her own structures, and while this takes place, he/she has to modify or adjust his/her cognitive structures to comprehend the learnt concept. Once room has been made (accommodation) the schema now meaningfully incorporates the new experience (assimilation) into the entire framework of the learner's cognitive structure.

Piaget's (1967) theory of intellectual cognitive development has four developmental stages. Piaget's developmental stages are sequential and one can not skip any during his/her
cognitive development. According to Piaget (1967) much of this knowledge construction (and later reconstruction) is in fact done subconsciously. For Piaget (1967) a child's mental growth matures into abstract thought through his/her direct experience with the physical environment. That is, when she/he internalizes mental activities in his/her brain. As far as Piaget (1967) is concerned, maturation for every child is determined by biological structures that are independent of the environment. Piaget explicitly sees a child as an active knowledge-seeking and information-finding being that should be accorded the right conditions to invent and discover. One point worth noting is that when a child develops from one stage to another the old skills/concepts learnt are not discarded, but exist with the child.

Piagian theory of how people construct knowledge can be regarded as a framework which is intra-individual and therefore, concerns the individual construction of the meaning of knowledge, following the cognitive constructivist model. Consequently, Piaget (1967) substantiates that the invariability of sequence derives from the the idea that knowledge is not simply acquired from outside the individual, but is constructed from within. That is, knowledge is constructed internally. This perspective of constructivism does not, however, acknowledge the role of society in one's construction of knowledge. This view of teaching and learning is at variance with Dewey (Laurie, 1985) who sees education as a process in which learners co-exist in a democratic manner and in which group effort in problem solving is appreciated (Laurie, 1985; Jacobs et al 2002). Since this perspective of constructivism ignores the role of socio-cultural aspects of teaching and learning, it falls short of the view of outcomes-based education, which embraces activity-based teaching. As a result of this, this study saw the need to consider a much more inclusive perspective of constructivism.

2.1.2.2 Social Constructivism

A much more inclusive perspective of constructivism with regard to activity-based teaching under outcomes-based education is social constructivism. Social constructivism starts with a cognitive constructivist position (i.e. Piagetian constructivist theory of mind) and add on some aspects of classroom interaction. That is, to prioritize the individual aspects of knowledge construction and the role of society and culture as 'impactors' of cognitive development. In this way, as we move from individual constructivism to socio-
constructivism there is an assumed shift from a sole (individual) learner to a learner located in a social context. This aspect of constructivism is congruent with the interaction model (Laurie, 1985). According to Laurie (1985, p. 141) the interaction model is defined as ‘a model of teaching which emphasizes learning accruing as a result of the pupil’s interaction with other people and with society.’ It can, therefore, be noted that in social constructivism great emphasis is to be placed on learners themselves to explore non-routine tasks in groups. Group thinking is central to this paradigm (Jacobs et al, 2002).

Social constructivism is associated with Vygotsky (1986). Other educationists/authors that are considered to be social constructivists include Bruner and Driver. In this study, social constructivist theory of Vygotsky, and that of Bruner and Driver have been discussed.

2.1.2.2.1 Vygotsky’s Social Constructivist Theory

Vygotsky (1986) regards the role of society and culture as central to the construction of knowledge in an individual. He uses the social interaction as a framework for all learning and cognitive development in an individual. In his view, ‘cognitive development is an interplay of biological development of the body and the appropriation of the cultural/ideal/material heritage which exists in the present to co-ordinate people with each other and the physical world’ (Cole and Werten, 1996, p.2). According to Wint and Putney (2002) there are three major principles underlying Vygotsky’s social development. These are:

- Social interaction of learners plays an important role in the construction of their own knowledge. Vygotsky (1986) regards this principal to be crucial to the learning/teaching process.
- ‘The idea that the potential for cognitive development is limited to a certain time span’ (Kearsley, 2001b, p1).
- That reliable way to understand how humans construct their own knowledge is to study teaching/learning in an environment where the process of teaching/learning is taking place. The third principle emphasizes the study of the process of teaching/learning rather than its product.

Vygotsky (1986) focused on the ‘how’ aspect of teaching/learning rather than on ‘what’ the children learnt. That is, he looked at how children go through the process of problem
solving and what societal tools are employed in their solutions. Like Piaget (1967), Vygotsky (1986) was not concerned with whether or not a correct answer was achieved. His major concern was how that particular child arrived at his/her solution. In this regard he behaved like Piaget (1967) who also considered the thinking process to be more important than its products.

2.1.2.2.2 Bruner’s Social Constructivist Theory

Bruner’s (1987) theory incorporates many of Piaget’s ideas such as the idea of sequential stages of intellectual development which Piaget (1967) claims are necessary in ones cognitive development. Both Piaget (1967) and Bruner (1987) are of the view that each stage of cognitive development is incorporated and built upon by succeeding stages. That is, ‘learners construct new ideas or concepts based upon their current or past knowledge. The learner selects and transforms information, constructs hypotheses, and makes decisions, relying on cognitive structures to do so’ (Kearsley, 2001a,p.1). It, therefore, follows that Bruner’s (1987) theory advocates process approach to teaching. The above noted view regarding the process approach to teaching is shared by Piaget (1967) and Vygotsky (1987).

Participation, through ‘learning by discovery’ is one of the salient features of his theory. Bruner (1987) wants learners doing mathematics to think like mathematicians. Implicitly, Bruner would want those doing science to think like scientists. Further, Bruner (1987) suggests to teachers that they should be encouraging their learners to go beyond the content or information provided and fill in the gaps in their knowledge through exploration and inquiry. According to Bruner (1987), by implication, learners of science should assume the stance of a scientist by thinking in symbolic manner and reverting at times to using iconic stage to enactive stage as he/she attempts to find the solution to the problem given to him/her by the teacher. Moving from symbolic to iconic and back emphasizes that Bruner’s (1987) three stages of cognitive development are not completely sequential. This is one aspect where Bruner’s (1987) theory of cognitive development is at variance with Piaget’s (1967) theory of cognitive development which is strictly sequentially-based. Bruner’s (1987) work also suggests that a child is capable of learning any material so long as the child is appropriately taught. The point of Bruner (1987) noted above is also a sharp disagreement with Piaget, and perhaps with other stage theorists.
Although Bruner (1987) agrees with Piaget (1967) on certain areas regarding a child’s cognitive development, namely, the presence of developmental stages in cognitive development, ‘learning by doing, and spiral curriculum, bruner goes beyond Piaget’s ideas. For instance, Bruner (1987) embraces the importance of social interaction in the teaching/learning of individuals. In other words, Bruner (1987) embraces the intra-individual framework of cognitive development, which reflects Piaget’s (1967) view. But Bruner (1987) further embraces the inter-personal constructivist model which concerns itself with social interaction and negotiation between persons as they construct their knowledge. Since Bruner (1967) adds the sociological aspects to teaching/learning, he is also regarded as a social constructivist.

2.1.2.2.3 Driver’s Perception of Social Constructivism

Driver is also a social constructivist. Her work regarding constructivism is very important in science education. She respects a learner as an individual and at the same time acknowledges that learning is a social activity. In this view, she regards a learner as a unique individual with specific needs of different nature. As a result of this, she considers learners’ background that learners bring to the classroom to be an important factor in teaching/learning, which he suggests must be considered by a science teacher as he/she plans and implements his/her teaching. Explicitly, Driver acknowledges the individual aspects involved in the construction of knowledge as well as social context in which teaching/learning occurs. Murray et al (1993) supports Driver’s constructivistic view as he argues that mathematical knowledge is both an individual and a social construction. Both Murray et al (1993) and Driver, 1986, in Brown et al (1986) are of the view that an individual needs social supports as he/she interacts with different learning materials or phenomena. In this perspective of constructivism a teacher takes the role of a facilitator as he/she engages his/her learners in their construction of their own knowledge. In view of this, a teacher is expected to guide and steer students’ interactions in fruitful directions with regard to their acquisition of science process skills.

While socio-cultural theory is suitable for representing social interactions, it tends to ignore issues relating to group dynamics, namely gender, equity, diversity, among others, which are equally important in activity-based teaching under outcomes-based education. In
view of these factors, the researcher felt the need to work through a much more inclusive perspective of constructivism than the two perspectives discussed above.

2.1.2.3 Sociotransformative Constructivism

In the view of the researcher, the perspective of constructivism, which is more inclusive than individual constructivism and social constructivism, is sociotransformative constructivism. This is due to the point that this aspect of constructivism tends to consider, among other things, group dynamics. According to Vithal (2000), power relations always exist in a group of learners interacting on some given task. Knowledge of this perspective by a teacher is assumed to bring awareness in learners about issues such as freedom, equity, diversity, gender, leadership and race that may be experienced in science classroom teaching. For instance, the issue of equity may be dealt with when there is insufficient laboratory equipment, apparatus and chemicals to carter for students in groups. With regard to equity, Kelly (1999, p.272) thinks that ‘... the desired goal is unequal treatment of unequals ...to increase participation.’ In other words, a given group with more educational needs may require more apparatus, chemicals and attention from the science teacher in all fairness than higher achievers. According to Rodriguez (1998) sociotransformative constructivism can make science teaching more socially relevant and accessible to all learners. This is due to the point that teaching in this perspective is geared at transforming a learner, in particular, and society, in general, Brodie (1996). Against this backdrop, sociotransformative constructivism fully embraces the outcomes-based education from which ZATEC draws its principles regarding activity-based teaching (Lubisi et al, 1998; Jacob et al, 2002; GRZ and DANIDA, 1997)

2.1.3 Constructivism and Activity-Based Teaching

According to Specter (1993), the approach of constructivism represents a shift from product-oriented curriculum to a process-oriented one. In process-oriented curriculum, the emphasis is placed on self-activity and learning by doing (Fraser et al, 1993). A teacher teaching from this paradigm is expected to give his/her students learning activities that would enable them to explore, investigate and manipulate. When a teacher constructs his/her practice this way, the learners will acquire both basic and integrated science process
(Staer et al. 1995). To do this, teachers are faced with ‘...the challenge of organizing their lessons around group work, research and learner self-activity’ (Jacobs et al. 2002, p.105).

2.1.4 Constructivism and Outcomes-Based Education

ZATEC is based on the outcomes-based education curriculum (GRZ and DANIDA, 1997). As stated earlier on, the activity-based approach used at Kitwe College of Education is rooted in ZATEC itself. In Outcomes-Based Education, a teacher seeks to put learners at the centre of the learning process. The role of a teacher in such a curriculum is that of a facilitator. In this type of curriculum, formal examinations and tests form only part of a wide range of assessment strategies (ibid), and teaching is mainly done by organizing activities that involve group thinking, in particular, and group work, in general. Individual contribution towards finding a solution to a task under consideration is highly ‘respected’.

According to OBE, an individual is deemed to have constructed knowledge from a given learning activity if she/he can demonstrate a skill or task learnt in an observable manner (Lubisi et al, 1998). As far as OBE is concerned, qualifications attained by an individual reflects competence which, according to (Lubisi et al, 1998), is explained as a combination of thinking, doing and attitude all of which are involved in the construction of knowledge. OBE as employed by science teacher educators in basic school colleges fully embraces the conceptual framework of constructivism.

Lessons in OBE are expected to be taught using group work as opposed to whole class teaching. It, therefore, follows that the version of OBE in this study, included group work as a form of class organization. According to MOE (1999) group work provides an opportunity for teaching different types of science process skills or science laboratory activities such as observing, classifying, hypothesizing, and experiments. The teacher who uses small-group focus can perceive teaching as the organization of pupil activities and that a teacher will focus on the process involved in the teaching a given science concept rather than the product. It should be noted, therefore, that group work as practiced under OBE creates room for social collaboration. In view of this, learners in a group share their experiences and contrast sharply with any schooling which reduces the learner to a merely receiver of authoritative knowledge.
2.2 Past Studies on Activity-Based Teaching of Science

This section concerns itself with the literature on activity-based teaching reviewed from local and international sources.

A relatively large portion of literature on activity-based teaching arises from outside Zambia and only a smaller volume is locally based. This could be due to the point that activity-based teaching as a principle is not an indigenous initiative originating from Zambia but a 'borrowed' one from the western world and South Africa, among other places. As a result of this, the 'activity-principle' has somehow attracted little attention among researchers in Zambia.

2.2.1 Literature from outside Zambia

Most of the literature on activity-based teaching from abroad comes from South Africa and the Western world. A good number of books and articles from South Africa has covered various aspects of activity-based teaching in one way or another. In addition to this, South Africa appears to be conducting more studies in science education studies than Zambia. This in part reflected the degree of concern by science teacher educators in South Africa to move away from the 'traditionally' teacher-centred approach to a much more 'contemporary' learner-based teaching. It was also worth noting that South Africa seemed to be taking a lead in science education studies among the countries in the southern sub-region because facilities to enable such studies were apparently available there.

It should, however, be pointed out that much of this literature does not explicitly talk about activity based teaching, but covers some features of activity-based teaching of science. For instance, activity-based teaching in science calls for the exclusive use of practical work, in general, and science process skills, in particular.

Kasanda et al (2005) at the proceedings of the 13th annual SAARMSTE conference on the use of science process skills in primary schools in Masvingo District, Zimbabwe revealed that the majority of the respondents had the right conception of the role of science process
skills in the teaching of science activities, and consequently preferred to use science process skills in their teaching. However, their actual practice in classroom did not reflect much use of the science process skills. As a result of this, science teaching in the district was heavily focused on content. These findings indicated that the respondents' interpretation of activity-based teaching was congruent with many contemporary authors and educationalists such as Parkinson (1994); Fraser (1993); Brimer and Pauli (1971) and Haambokoma et al (2002). However, the respondents' actual classroom practice was 'poles apart' from the contemporary expectation of science teaching whose emphasis should be on the teaching of science process skills through the use of activity-based teaching.

Asheena’s (2004) study of biology teachers’ practice with regard to the use of practical work in South African High Schools represents an attempt to explore science teachers’ conceptions of activity-based teaching with regards to practical work. He used a sample of forty-five biology teachers. In addition to this, the methodology used for data collection and analysis was quite ideal for the nature of the study. An analysis of the data indicated that the teachers’ conception of practical work was at variance with their own classroom practice. Against this background one would ask: what would be activity-based teaching if it is devoid of practical activity in the teaching of science?

Dekker and Maboyi (2002) in their study on the purpose of science teachers doing practical work in natural science observed that teachers seemed to be divided on the role of practical activities in the teaching of science. Some teachers considered practical work as something meant to scaffold theory work and still others were of the view that practical work was important in the teaching of 'hands-on' related skills. The above account implies that different conceptions of activity-based teaching by teachers through the use of practical task could result in non-uniformity in the way the science curriculum is covered.

Parkinson (1994) makes an attempt to divide science teaching activities. According to him, there are two types of such activities: those where a learner is actively involved and those in which a learner is passive. As for the first type, he says that a learner should actively be involved physically and mentally in the task in order to increase his or her knowledge. His description of a teaching activity as one involving the ‘hands-on’ and ‘minds-on’ components is in accordance with Haambokoma et al (2002) and Peter (1982).
His conception of activity-based teaching therefore, covers both ‘hands-on’ and ‘minds-on’ activities. In view of this, John appeared to make an appeal that science teacher educator should be considering the two above mentioned components of a science activity for inclusion in their teaching of science. Parkinson’s (1994) interpretation of a science activity was, therefore, relevant to this study due to the point that one’s interpretation of a science activity had some implications on his/her classroom practice as to whether that particular educator would make his/her students ‘know’ science or ‘know about’ science. In view of this, Parkinson (1994) appeared to have placed some emphasis on the use of practical work in the teaching of science alongside the teaching of science content.

Fraser et al (1993) outlined the principle of active participation. This principle is also referred to as the activity principle by the same authors. The principle emphasizes self-activity and learning by doing in which learners ‘...gain first-hand experience of reality’ (Fraser et al. 1993, p.73). Their conception of activity-based teaching is inclusive of ‘hands-on’ and ‘minds-on’ activity. Their work on activity-based teaching is similar to the work of Parkinson (1994); Brimer and Pauli(1971) and Peter (1982).

Peter’s (1982) work mirrors that of Fraser et al (1993). According to him, mental activity is important for a learner to learn anything. Added to this is that a physical activity is meant to support a mental activity. As far as he is concerned, activity methods tend to cover physical activities as well as mental ones. The interpretation of activity-based teaching according to Peter (1982) is two dimensional. That is, ‘hands-on’ and ‘minds-on’.

Young (1979) regards science as a ‘doing subject’. In view of this, he advises teachers that as they construct their practice they should be allowing their students to manipulate concrete materials as a starting point in their teaching of science. He further suggests the procedure that teachers might employ in the teaching of science using ‘hands-on’ activities. According to him, the procedure of activity-based teaching of science should start with a teacher selecting a science process skill such as measurement, followed by choosing the concept to teach to the learners such as weight. Finally, a teacher should select the subject matter such as ‘using a spring balance’ to teach the same concept identified above. The figure below clarifies the procedure of activity based teaching of science as proposed by Young (1979).
Table 2: Procedure of activity-based teaching of science.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Examples(a)</th>
<th>Examples(b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Select science process skill</td>
<td>Measurement</td>
<td>Classification</td>
</tr>
<tr>
<td>2. Select concept to teach</td>
<td>Weight</td>
<td>Mammals</td>
</tr>
<tr>
<td>3. Select subject matter to teach</td>
<td>Using a spring balance</td>
<td>Using a classification key</td>
</tr>
</tbody>
</table>

Source: Adapted from Young(1979)

According to Young (1979), if such a procedure (the one stated above) was used in the teaching of science, the learners would be in a position to apply what they have learnt in class to real life situations and subsequently, these same learners would become critical thinkers. Abbott (1979) also expresses the same view as Young (1979) regarding the merits involved in employing activity based teaching of science to learners by a teacher.

While Young (1979) feels that activity-centred science or ‘hands-on’ approach to teaching of science can make learners become critical thinkers, he does not, however, clearly indicate how such critical thinking can be imparted onto such learners. Unlike Young (1979), Carre (1981) attempts to explain how activity-centred science can yield critical thinking in learners. His assumption is that direct experience with the natural phenomenon and concrete materials tend to stimulate curiosity and thinking in the learners. Carre (1981) further indicates that students’ reflection upon laboratory activity in the light of their personal experience is vital in ‘learning by doing’ due to the point that the said reflection provokes the learners’ thinking.

Abbatt (1980) advocates the use of activity-based teaching of science as a means of improving retention of the concepts learnt by student nurses. He stresses the importance of training nurses how to ‘do’ things rather than acquiring facts on the concepts being taught. To stress the importance that he attaches to activity-based teaching or ‘hands-on’ experience, Abbott (1981, p.35) quotes the chinese proverb ‘...hear and forget...see and remember...do and understand.’ Some other educationists that strongly subscribe to the ‘1
understand when I do’ philosophy of science education include Young (1979), Hambokoma et al (2002) and Carre (1981)

Abbatt (1980) and young (1979) have identified deficiencies of teaching science that surface when a teacher of science ignores the use of ‘hands-on’ activities in his/her practice. According to these authors, majority of students are unable to apply the theory they have learnt in class to practical situations and retention of the facts accrued from such lessons is greatly reduced. According to Abbatt (1980) and Young (1979), focus on theory or facts in the teaching of science promotes rote memory. Fraser et al (1995) also strongly supports this view.

Fox and McCarthy (1974) stress the importance of participation of an individual learner in the laboratory activities that a teacher has prepared for his/her class. The above authors advise learners to do the experiments by themselves rather than watching others perform the same experiments on their behalf. By implication, Fox and McCarthy (1974) are appealing to the teachers of science that they should build their teaching of science by using ‘hands-on’ activities such as experiments so that each individual learner can have first-hand experience of the concept being taught. In the view of the researcher, these same authors can be regarded as advocates of activity-based teaching. This is due to the point that these authors noted above, claim that performing of experiments by learners will allow them (learners) to explore the broader implication of their (learners’) practical findings. It can, however, be argued that a broader implication, in the view of the researcher, of practical findings of science activities can only be realised by a learner if such a particular learner is exposed to all the science process skills. One science process skill, namely, experiment as alluded to by Fox and McCarthy (1974) above is not sufficient enough to produce an all-rounded scholar of science. Regarding this, a more practically constructive approach to the teaching of science that covers all science process skills is one that is advocated by Clark (1978) and Wellington (1989) which emphasizes the use of a scientific method in the teaching of science. In view of this, Clark (1978) makes an appeal to teachers of science that they should teach their learners how to tackle problems using a scientific method in which learners can either individually or in small groups interact with the concrete materials they are exploring in their science lessons. To stress the importance of using a scientific method in the teaching of science (Clark, 1978) uses the term ‘method syllabus’ as one such syllabus which emphasizes the use of a process approach in the
teaching of science. Literature arising from Clark (1978) and Wellington (1989) does not, however, indicate specific skills and attitudes that can be imparted onto the learners as a result of keeping their hands ‘busy’. In addition, these authors have remained silent on things which can add value to the ‘hands-on’ activities in one’s teaching of science through science activities such as field trips and project work.

‘Activity-centred’ science emphasizes the process of arriving at the answer rather than the answer itself. In view of this, Carre (1981) says that the procedure that is used in generating knowledge in science is much more supreme than the knowledge yielded from such a given activity. He further emphasizes that teachers should focus their teaching of science on developing of science process skills in their learners. Particular science process skills that he mentions, among several others, are as follows: classifying, communicating, designing experiments, interpreting data, hypothesizing, predicting and observing, the most basic of all. Studies reported by Asheena (2004), Dekker and Maboyi (2002) and Hambokoma et al (2002) also place great emphasis on the use of science process skills during the teaching of science. In all these studies, the use of ‘hands-on’ activities in the teaching of science is noted as a way of improving the quality of teaching science. The nature of science activities given to the learners is not, however, clarified. That is, whether a given activity was prescribed or ‘free’. Unlike these authors, Lumpe and Oliver (1991) attempt to give three different dimensions of an activity as applied to ‘hands-on’ teaching, namely, ‘the inquiry dimension’ where a learner uses science activities to make discoveries. The second dimension is the ‘structure dimension’ which relates to the amount of guidance given to the learner. The third one is ‘experimental dimension’ which involves the aspect of proving some law or theory by employing a controlled experiment.

Calderhead and Sharrock (1977) claim that ‘hands-on’ experience is central to the teaching of science in this contemporary era. These authors further indicate that science as a discipline involves practical activities. Calderhead and Sharrock (1977) make an assumption that in activity-based teaching learners will work directly with concrete materials that they will feel, touch and see. That is, learners will manipulate the concrete materials with their own hands. In this respect, these authors claim that learners will then learn ‘the what’, ‘the how’, ‘the when’ and ‘the why’ of things which they interact with. By implication, these authors suggest that activity-based teaching of science can result in the development of science process skills in the learners. Added to this is that activity-
based teaching implicit in the above account has a constructivist view of teaching, which stresses what the learners ‘do’ (learners’ activity) in a lesson rather than what learners listen or hear.

De Beer (1993) conducted a study on the value of practical work in biology teaching in South Africa. One of the principal findings of his study was that practical work in biology was heavily prescribed. As result of this, learners doing practical work in biology were required to strictly adhere to the instructions from the laboratory manual or textbook. According to De Beer (1993) if each step or instruction is very detailed the learners’ capacity to develop science process skills is negatively impacted. Consequently, the learners’ ability to solve problems in real life situations is hampered with as well. In view of this, this author recommends that teachers should be encouraging their learners to design their own experiments. Fox and McCarthy (1994) have a similar view to that of De Beer (1993) noted above. For instance, Fox and McCarthy (1994, p.1) have stressed the importance of the learners’ participation in the various stages of learning science when they advise the learner that ‘you will be the one who does the experiments. You will be the one who tries to solve problems. You will be the one who finally finds the answer.‘

According to Yu and Bethel (1991), and Jegede and Brown (1980) science process skills form a foundation for a scientific method of teaching science. This is due to the point that science process skills are intellectual activities that people doing science engage in to produce the knowledge that is known as science as opposed to other type of knowledge such as history, bamba and expressive arts. In view of this, these authors regard science process skills as ‘thinking tools’ required for one to answer questions in a systematic way. Jegede and Brown (1980) argue that since ‘thinking tools’ involve an active process, the science process skills should be taught using ‘hands-on’ approach in which learners need to develop manipulative skills such as setting up of apparatus (equipment) and handling of specimen in a given science lesson are done properly and accurately. In this regard, Roberts and Sayer (1981) claim that the teaching of science process skills through ‘hands-on’ activities should match the intellectual development of the learners. Roberts and Sayer (1981), however, have not specifically suggested how the science process skills can properly and appropriately be matched to the learners’ intellectual development.
Silwimba *et al* (1998) have made an attempt to classify science process skills into two groups, namely, basic science process skills and integrated science process skills. This classification noted above has made the task of matching the science process skills to the learners' intellectual development relatively easier. According to Silwimba *et al* (1998), the basic process skills include the following: observing, communicating, inferring, classifying, measuring, using numbers, predicting, and using space/time relationships. These same authors claim that the above named science process skills can be developed in grade one to seven learners. Concerning integrated science process skills, Silwimba *et al* (1998) list the following: interpreting data, defining operationally, controlling variables, hypothesizing and experimenting. These integrated science process skills, according to Silwimba *et al* (1998), Jegede and Brown (1980) go beyond the mere classification of science process skills noted above. Jegede and Brown (1980) give an explanation as to why basic science process skills are suitable to lower grades in primary schools as opposed to integrated science process skills. In their view, basic science process skills are suitable for lower primary school classes because the learners in these grades are at the concrete operational stage of their intellectual cognitive development (Piaget, 1967). As for integrated science process skills, these authors claim that these named science process skills are suitable for higher grades in primary schools due to the point that learners in grades five to seven are now capable of abstract thought. While Silwimba *et al* (1998) and Jegede and Brown (1980) indicate that integrated science process skills are suitable for grades five to seven, Wellington (1989) argues that both integrated science process skills and basic science process skills are essential requisites for scientific investigation whether by a learner in a basic school or a research scientist. For instance, observing, classifying and measuring, though basic, tend to be used by all learners doing science and research scientists inclusive. This is due to the fact that observations, classifications and measurements occupy a very fundamental position during scientific investigations. Moreover, classifying, for instance, can occur at different complexities across different grades and also within the same grade. In the same vein, methods and systems of measuring, for instance, range from simple to complex ones. As an example, a grade four learner can measure the length of a table using a ruler, while a grade ten pupil can make use of a micrometer screwgauge to measure the diameter of a small wire and a grade twelve pupil can measure the time taken for one complete swing during a pendulum experiment designed to determine the acceleration due to gravity of a metal bob. It can be argued, therefore, that all individual science process skills are important to any person
doing science whether at a lower or higher grade. In the view of the researcher, the critical issue here is the designing of the appropriate activity that would match the learners’ intellectual development. With regard to this point noted above, Jegede and Brown (1980), and Silwimba et al (1998) are at variance with their own classification of science process skills regarding which bands of grades would be suitable to teach basic and integrated science process skills. Jegede and Brown (1980) have noted earlier on that experimenting, as a science process skill, is an integrated science process skill which could be suitable to teach grades five to seven, but later on turns around to say (Jegede and Brown, 1980, p.34) ‘simple experiments can be designed and carried out by children even in primary schools.’ If these authors denoted primary schools to mean grade five to seven, then the above statement was either misleading or ambiguous. This is because the above statement appears to cover all grades in a primary school and yet according to their classification of science processes, experimenting as an integrated process skill, is suitable for grades five to seven learners. Implicitly, Jegede and Brown (1980), Silwimba et al (1998) and Roberts and Sayer (1981) are, however, of the view that activity-based teaching of science to the learners through the use of science process skills such as designing and carrying out experiments, would enable learners to have first-hand experience of the concept that is being taught. Consequently, depriving learners of science process skills (science activities) would imply denying these same learners the opportunity to develop manipulative skills and critical thinking that would enable them (learners) to solve problems in real life situations using a scientific method. In addition, the use of science process skills in the teaching of science encourages learners to reflect, think and ‘do’ science rather than learn about science (MOE, 2000).

In the Newsletter of the United Nations Educational, Scientific and Cultural Organisation’s (UNESCO’s) (2004) education sector entitled ‘Science Education in Danger,’ it has been reported that a good number of teachers is turning away from science subjects. Further, it reveals that most countries are facing the ‘biggest lack of students’ (UNESCO, 2004, p.7) interest in science in the recent times due to the point that majority of the young people perceive science as dull, abstract and theoretical. As a result, the development of a scientific way of thinking in learners is abandoned by teachers in favour of the teaching of definitions and routine procedures, that is, science activities that are heavily prescribed. In order to reverse this waning interest in science by learners the report proposes the use of learner-based practical work in the teaching of science. This UNESCO’s (2004) Newsletter
refers learner-based practical work to ‘learning by doing.’ This report further indicates that ‘learning by doing’ movement is inspired by an American nobel prize winner Leon Lederman (in 1988) who founded ‘Inquiry-Based Science Education’ in schools in poor neighbourhoods of Chicago. As noted earlier on by Young (1979), Abbatt (1980), Calderhead and Sharrock (1977) and Fox and McCarthy (1974) ‘learning by doing’ is closely associated with activity-centred science, material-centred science and ‘hands-on’ science. This report furthur argues that ‘hands-on’ teaching forms the basis of ‘learning by doing’ due to the fact that in order for a teacher to teach science, learners must ‘do’ science or else these same learners will be learning about science as opposed to learning science. The principal message of this report is, therefore, that the use of activity-based teaching as implied above, can revive learners’ interest in learning science.

2.2.2 Literature from Zambia

One of the largest studies in recent years in science education in Zambia was that carried out by Haambokoma et al (2002). Their study aimed at generating data which could be used to strengthen mathematics and science education in secondary schools with regard to learner-centred and problem solving strategies. While not directly concerned with activity-based teaching, the study drew attention to the use of learner-centred practical activities: ‘hands-on’ and ‘minds-on’ activities such as laboratory experiments, which are also cardinal in the teaching of science through the activity-based teaching approach. In the opinion of the researcher, Haambokoma et al (2002) emphasized pupil participation in the teaching of science process skills so that teachers could develop manipulative skills in their pupils. Haambokoma et al’s (2002) findings revealed, among other things, that teachers were aware that teaching science through individualized or group practical work was better than teaching laboratory work by using the demonstration method. The study emphasizes that, although the respondents were fully aware of the importance of ‘hands-on’ activities in the teaching of science, science teaching and learning still remained largely teacher centred and content-based. Further more, the research revealed that most staff handling learners were under qualified. In view of this, the study recommended that the respondents needed further training on the teaching of science through ‘hands-on’ activities. It is apparent, therefore, that data arising from this study is sufficient to enable useful conclusions to be drawn by the researcher. The study, for instance, identified areas for action in the teaching of science through practical activities in schools; these being, use of
a learner-centred approach, and in-service training for the respondents in the use of process skills in teaching. A contrast to this is that teaching science without the use of science process skills and a learner-centred approach was not exclusively confined to the under qualified respondents. Non-application of activity-based teaching to the respondents’ classroom practice in their teaching of science could therefore be accounted for by lack of science instructional materials, content-based examination, long syllabus, poor quality of supervision, associated variables of time, unfavourable attitudes by respondents, among several other reasons. Kasanda et al (2005) and Asheena (2004) reached similar conclusions to this study in which similar difficulties surrounded the use of science process skills in the teaching of science. If, on the other hand, the above stated variables, which impeded the use of ‘hands-on’ activities in Zambia were taken care of, would the teaching of science through process skills be historically enduring or long lasting?

Tindi et al (2002) in module 5 emphasized the use of activity-based teaching methods in teaching lessons to grade one to four pupils. This module, Environmental Education, is one of the six modules that constituted the ‘Primary Teachers’ Diploma by Distance at National In-Service for Teachers’ College (NISTCOL). The module placed particular emphasis on ‘learning by doing’ for all students undertaking the above named programme. What seems to come out clearly from this literature is that activity-based teaching was interpreted as learning by physically and mentally doing some learning activity. Their conception of activity-based teaching was, therefore, inclusive of ‘hands-on’ and ‘minds-on’ activities. Parkinson (1994) shares this view. It should be noted, however, that ‘learning by doing’ was a wide concept that could have had different influence on its readers’ classroom practice. This was due to the point that having ‘head’ knowledge about ‘learning by doing’ was one thing and practicing it could have been another thing. A similar discrepancy of this kind was noted by Kasanda et al (2005).

Silwimba et al (1999) emphasized the use of learner-centred and activity-based teaching in the teaching of science in ZATEC. Their conception of activity-based teaching appears to be limited to ‘hands-on’ activities because they seemed to encourage science teacher educators to be teaching science through practically oriented activities that, in their view, appeared to involve only manipulative skills. In the opinion of the researcher, activity-based teaching goes beyond manipulative skills. The authors’ interpretation of the above stated teaching style, therefore, fell short of Peter’s (1982) understanding of activity
principle which, in his opinion included 'hands-on' activities as well as 'minds-on' activities. Added to this, was the point that this publication was unable to identify specific physical activities that could be referred to as science process skills. The emphasis on the use of physical activities in teaching of science whose nature was not even clearly defined, in the view of the researcher, could have had influenced the ZATEC stakeholders, in general, and science educators, in particular, differently regarding the teaching of science. It can, therefore, be assumed that emphasizing manipulative skills only when teaching science activities would be a significant deficiency in the use of activity-based teaching. Questions one would ask, could be; is it possible to have an integrated scholar with deficiency in 'minds-on' activities? And what kind of learners does ZATEC curriculum want to produce?

The use of activity-based teaching in primary teacher training colleges has a blessing from the national policy on education called *Educating our Future* (MOE, 1996). MOE (1996) in this document, associated activity-based teaching with increased active participation of learners in class activity. This assertion was strongly supported by (MOE, 2002) which also assumed that learners should learn by doing. The interpretation of activity-based teaching by MOE in this document tallied so well with Parkinson (1994); Crennel (1953); Brimer and Pauli (1971); Peter (1982); Asheena (2004); Fraser et al (1993) and Laurie (1985). As a reminder, *Educating our Future*, recommended the use of activity-based teaching methods in classroom teaching. In the view of the researcher, the recommendation of this kind revealed contradictions, these being, ZATEC syllabus was long and yet learning through activities required more time than other teaching styles, and teaching/learning materials were hard to come by especially specialized laboratory materials. meanwhile the ZATEC curriculum designers had strongly proposed that the science teacher educators should be resourceful. Further more, science teacher educators had only one year in which to cover such a botted syllabus. It should be noted at this point in time that in real life covering a botted syllabus in too short a time is not practical; the two are incompatible in practice because of time related variables, among several other reasons.
Several studies such as the Asheena’s (2004); Dekker and Maboyi’s (2002) focused their attention on the implementation of activity-based teaching, in general, and practical work, in particular, assuming that the practitioners’ conception of the variable under their investigation was automatically in line with the contemporary meaning of the term in science education. It should, however, be remembered that one needs to interpret something before she/he can translate it into ‘action’ or else mis-application of the above stated teaching style might arise. Inappropriate interpretation of activity-based teaching by science teacher educators would obviously impact negatively on their classroom practice. In the view of the researcher, this has obvious pedagogical implications to their classroom practice, and that of their students who pass through their hands when they start teaching their pupils through science activities.

The literature presented above strongly suggests that the implementation and interpretation of activity-based teaching in science still poses a challenge to science teachers, in general, and science teacher educators, in particular. According to the literature available, non-implementation of activity-based teaching by science teachers was largely due to the insurmountable problems arising from the contextual factors surrounding its use in the classroom situations both at basic school and high school levels. The science teachers’ conception of practical work, which is a very important aspect of activity-based teaching, for instance, did not tally with their own classroom practice. This was observed in the literature from both Zambia and South Africa. The reasons for this could be many, but one obvious reason is that most contemporary science teachers in both South Africa (Asheena, 2004) and Zambia (MOE, 1999) were initially trained in a ‘content era’. Some literature from South Africa such as Asheena’s (2004) and that from Zambia such as MOE (1999) have acknowledged the difficulty that teachers might experience in ‘abandoning’ content-based science for a process-based one. As a result of this, in the opinion of the researcher, these educators find it hard to adjust to a learner-centred and activity-based teaching approach (Asheena, 2004). Finally, it has been brought to light by Peter (1982) and Fraser et al (1993) that mental activity is much more supreme to physical activity because the later is meant to scaffold the former. This interpretation of activity-based teaching is crucial to the practicing science teachers, in general, and science teacher educators, in particular, as well as curriculum designers at CDC. This study, therefore, sets to address
science teacher educators’ interpretation of activity-based teaching at KCE. This area of science education has not yet been explored at KCE. As a result, this study attempted to fill in the knowledge gap that existed, at the time of this study, at KCE regarding the science teacher educators’ interpretation of activity-based teaching of science.

The next chapter describes the research methodology employed in this study to answer the three specific questions, which the study posed earlier on.
CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This chapter describes the research methods that were employed in the collection and analysis of data for this study. In addition to this, this chapter discusses the credibility of the data collected and the limitations of the study.

3.1 Research Design

The research design that was used in this study was primarily a descriptive survey. This study involved qualitative data that was basically collected through the application of open-ended questionnaire, open-ended interview schedules, science lesson observation schedules, and curriculum material analysis, namely, respondents' teaching files, respondents' schemes of work and the students' note books. The 'open-ended questions' were used in the construction of the questionnaire and the interview schedule. As a result of this, detailed responses were obtained in this study. This is due to the point that open-ended survey questions are associated with detailed responses in which the use of words other than numbers is important (Rosen and west, 1973). The research instruments used in this study complemented each other with regard to the collection of the qualitative data that the study sought to find. Hence, strengthening the research design for the study.

3.2 Target Population

All science teacher educators at KCE from Mathematics and Science Education Study Area (MSE) formed the target population for this study. These teacher educators were considered to be ideal for this study by the researcher because they had been teaching science education at KCE, at the time of this study, for at least three years. As a result of this, these science teacher educators were regarded to be a rich source of information by the researcher concerning the interpretation of activity-based teaching of science at KCE, a research topic which this study sought to explore.
3.3 Sample

A sample of nine science teacher educators participated in this study to answer the research questions the study posed. All the participants were males. The absence of females in this sample was due to the point that MSE study area, at the time of this study, did not have any female at all. Five of those respondents were degree holders and the rest were diploma holders in science education from the university of Zambia and secondary teachers’ training colleges respectively.

The respondents who formed this sample were chosen because of their vast experience of teaching science at the basic college level, in general, and at KCE, in particular. All the science teacher educators in the sample had taught science at KCE for more than three years. Kelly (1999, p.312) puts it that ‘… teachers in a school are considered capable when they have taught for a few years (experience) and the majority of them have taught together in the school for some time (stability).’

3.4 Sampling Procedure

Sampling was done purposively by identifying all the science teacher educators from the population described above. A purposively selected sample was used in this study because, as noted earlier on, the science teacher educators who formed this sample were regarded to be a rich source of information this study sought to find. A small sample was used in this study because the researcher had decided to employ open-ended interviews and focus group discussion to follow-up open-ended questionnaire responses that needed clarifications. As noted below, each open-ended interview on average took thirty minutes. In addition to this, these open-ended interviews and focus group discussion yielded a lot of qualitative data that required a lot of time to be processed. According to (Langley, 1987), open-ended questions (that were use in the open-ended interviews and open-ended questionnaires) tend to yield detailed information that require a lot of time to process
3.5 Research Instruments

After looking at the methods of data collection available to the researcher and how they could be used to answer the questions this study posed, the researcher developed the following research instruments:

3.5.1 Open–Ended Questionnaire

After reading extensively on the preparation of questionnaires (Bell, 1993; Cohen et al (2000) and the Central African Correspondence College (CACC, n.d.) an adapted version of Dekker’s and Maboyi’s (2000) questionnaire was made. This is appearing in appendix A of this report. This open–ended questionnaire covered all the three critical questions of this study noted earlier on. An open–ended questionnaire was chosen by the researcher for this study because, in the view of the researcher, open–ended questions in this study provided the opportunity for the respondents to qualify their answers and thus give a more adequate indication of how they interpreted the question.

3.5.2 Open–Ended Interview Schedule

The questionnaire of Kampamba (2004), which formed part of the research instruments in her study entitled the Role of Language in the Teaching and Learning of Science was studied very carefully by the researcher. The researcher was inspired by its structure and item construction. As a result of this, the structure (lay out) was adopted as appearing in appendix C. but different question items to suit this study were constructed by the researcher. This instrument was aimed at obtaining additional data regarding science teacher educators’ interpretation of science at KCE. In addition, this instrument was also meant to generate data that would serve as supporting evidence to the data obtained through the open-ended questionnaires. It was a kind of triangulation.

3.5.3 Science Teaching Observation Schedule

In order to determine if what the respondents claimed in the open–ended questionnaire and open–ended interviews was congruent to their actual classroom practice, an observation schedule of Eggleston et al (1975) called A Science Teaching Observation Schedule from which one can generate data to search for patterns or themes in the events taking place in
classrooms. was found to be very suitable to this study. Because of this merit, particularly over other known observation schedule, like the one in Bell (1993), Eggleston et al’s (1975) instrument was adapted for use in this study.

3.5.4 Justification for the use of the above Research Instruments

The open-ended questionnaire was ideal for this study because the researcher wanted the respondents to state their responses much more freely and honestly than it would have been the case if a closed questionnaire was used. According to cohen et al (2000), an open-ended questionnaire is ideal in generating data which is authentic, rich and honest. According to cohen et al (2000) authenticity, richness, depth and honesty of a response are some of the hallmarks of qualitative data. Furthermore an open-ended questionnaire is known to go ‘... beyond statistical data or factual information into hidden motives that lie behind attitudes, interests, preferences and decisions’ (CACC, n.d; p.105).

In order to strengthen the design of this study, the researcher saw it necessary to follow-up the open-ended questionnaire responses that were not clear to the researcher with the open-ended interviews. Against this background, the researcher saw open-ended interview schedule to be necessary in carrying out follow-up probes in order for the respondents to make their answers obtained in the open-ended questionnaire clear and much more meaningful to this study. The open-ended interview schedule, as noted earlier on, served as a kind of triangulation to the open-ended questionnaire in this study. Added to this was that focus group discussion also allowed the participants of this study to discuss further issues, which the respondents themselves thought were important concerning activity-based teaching. Since science teacher educators’ interpretation of activity-based teaching is one such area in science education which has attracted little attention in research, the researcher wanted to have an in-depth discussion of the research topic of this study so as to obtain as much information about it as would be possible. Open-ended interview schedule, therefore, fitted in well to provide such detail information regarding activity-based teaching of science at KCE.

Analysis of curriculum materials, namely, teaching files, schemes of work and students’ note books were seen to be crucial to this study because they yielded evidence of whether or not what the respondents claimed in the interviews and open-ended questionnaires was
or not what the respondents claimed in the interviews and open-ended questionnaires was actually being practiced, at least at the preparatory stage as well as the implementational stage in their teaching of science.

3.6 The Pilot Study

The research instruments involving open-ended questionnaire, open-ended interview schedule and science teaching observation schedule were piloted to determine their suitability for data collection. The pilot study was carried out at Nkana College of Education (private college near KCE) from 3rd January to 7th February 2006. Five science teacher educators participated in this study. The pilot study was conducted at Nkana College of Education because of its proximity to KCE.

Before the commencement of data collection, the respondents were briefed on the purpose of the study and were humbly requested to participate in the exercise. The open-ended questionnaires were piloted on five science teacher educators at a nearby basic college of education, namely, Nkana College Education, in order to check the wording of instructions and the question items and time needed for the respondents to fill in their answers. This was done in an effort to remove any item or words, which would not yield usable data. Upon piloting the questionnaires the following observations were made, namely, that:

i. The questionnaire was found to be too long as all the respondents complained about its thickness. So some questions were removed. The removal of excess questions was found to be necessary by the researcher because he noted earlier on that those questions appearing at the end of the questionnaire were left blank without being answered.

ii. Ambiguities and unfamiliar terms were ‘dropped off’ and replaced with familiar ones. This was necessary because questions in the questionnaire needed to be clear enough to the respondents if their answers were to be valid regarding this study.

iii. Open-ended interview schedule needed to be designed so as to follow-up open-ended questionnaire responses that were not clear to the researcher. In addition to this, the researcher saw open-ended interviews as an alternative source of data for this study (triangulation).
After addressing the above stated issues arising from a pilot study of the open-ended questionnaire, the open-ended questionnaire was revised to take into consideration the above stated issues in readiness for its distribution for the main study. In view of this, the researcher designed an open-ended interview schedule and subsequently tested for its suitability for use in the main study using the same sample. In the same vein, a science teaching observation schedule appearing on page 112 of this report was piloted even though the instrument had been in use for some time in Britain. The reason for piloting it was because this instrument was modified to make it suitable for this study. The researcher also felt that since this observation schedule was used in a foreign setting, it was important to find out if it could also work in a localized context. Furthermore, it was necessary for the researcher to familiarize himself with the above named instrument.

3.7 Data Collection Procedure

After conducting the above described pilot study, the main study commenced. Data collection took place at KCE from 14th February to the 3rd April 2006. Data collection procedures are described below.

3.7.1 Administration of the Open-Ended Questionnaire.

The open-ended questionnaires were distributed personally by the researcher to the above noted nine science teacher educators at KCE on Tuesday the 14th February 2006. Thereafter, the purpose of this study and what would happen to the data that was being collected was communicated to the respondents individually.

In addition to this, all the respondents were assured of confidentiality and anonymity by the researcher. The return date of duly filled-in questionnaires was given to the respondents as 28th February, 2006. All the nine respondents returned their questionnaires without any follow-up requests to them by the researcher. These questionnaires were answered individually by each respondent. The information collected from the questionnaires was then transferred onto pieces of paper in readiness for data analysis. The results of open-ended questionnaires are presented on pages 113 to 116 of this report.
3.7.2 Open–Ended Interviews

The individual open–ended interviews were conducted as a follow–up to the open–ended questionnaire responses that needed further clarifications from the respondents. The respondents were interviewed in their tutorial rooms at KCE after sixteen hours of each interview day.

During interviews, the researcher encouraged the respondents to give detailed answers as much as they wanted. The researcher also could adjust questions and change direction as the interview was taking place. In other words, a clarifying remarks from the researcher was always made when the respondent misunderstood the question. These interviews averaged thirty minutes in length. The results of these interviews were recorded on tape with the permission of the respondents. The reasons for recording these interviews on tape were basically as follows: to aid memory after the interviews was over and also to allow the researcher to repeatedly examine the respondents’ responses. These interviews were conducted from the 1st March to 6th March. The results of these interviews are presented on pages 110 to 112 and were transferred onto pieces of paper in readiness for data analysis.

Due to some college commitments, only five of the nine respondents made themselves available for these interviews. As a result of this, the researcher decided to conduct focus group discussion for the purpose of getting further clarifications on certain responses that were still not clarified yet.

3.7.3 Focus Group Discussion

A focus group discussion was used to further clarify specific terms that emerged from the data obtained from the analysis of the open–ended questionnaire and open–ended interviews. The terms that needed to be clarified by the respondents were as follows:

- Practical - based teaching
- Inquiry - based learning
- Experimental Process skill.

In order for these terms to be fully explained, respondents were asked to shed more light on each one of them. Again, the researcher could probe the respondents further in order for them to express their responses fully.
The focus group discussion consisted of five respondents. The other four respondents in the sample could not make it for the interview because of other college duties and private commitments. This discussion took place in the college computer room. This interview was audio recorded and later on transcribed. The interview discussion took place on 20th March 2006 in the computer room from 16:00hrs to 18:00 hours. The results of the focus group interview are presented on pages 120 to 130 of this report. In the verbatim transcripts (appendix G) the respondents were denoted STE 1, STE 2, STE 3, STE 4 and STE 5 to protect their identity and the researcher assumed the label of Mum. Quotes from the focus group interview were used by the researcher to highlight certain points in presentation and interpretation of some results.

3.7.4 Lesson Observations

As regards lesson observations, the researcher observed the implementation of lessons of five science teacher educators. The other four respondents could not make it for this exercise due to some college and personal commitments they had. Science lesson observations were conducted by the researcher to find out whether the respondents practiced what they claimed in the open-ended questionnaire and the interviews.

The two respondents observed were teaching combined classes with a total student population of fifty each. The other three respondents had normal classes with a population of twenty – five students each. At the time of this study, all the respondents were covering the same topic called the soil. All lessons that were observed were conducted in non-specialized science rooms at various times according to the respondent’s timetable. Concerning the sort of lessons that were observed by the researcher, they were all ‘contact one.’ It should be noted here that ZATEC syllabus in all basic colleges of education, at the time of this study, had two forms of lessons: ‘Contact’ and ‘non-contact’. ‘Contact’ required the physical presence of a science teacher educator and ‘non-contact’ did not necessary require the presence of the science teacher educator. The researcher chose the ‘contact – type’ of science lessons because he wanted to see how the respondents physically constructed their practice in their respective classrooms.
During lesson observations, the respondents' behaviour whenever identified was ticked off in a corresponding cell (appendix E). In three minutes, only one cell could be ticked off. In discriminating between teaching styles employed by the respondents, the researcher's score was obtained by adding the ticks obtained in each sampling unit to arrive at a composite score for a category. In other words, the researcher could only tick off what was happening each minute as he referred to the observation schedule. In addition to this, the sub-categories in the schedule served as headings which were meant to cover every possible occurrence during the respondent's presentation of the lesson. After each observation, the researcher made brief notes using headings regarding different aspects of activity – based teaching of science at KCE. The focus of these brief notes was on classroom organization particularly seating arrangement(s) used for each lesson observed, the dominant teaching styles employed and the class management. The data obtained from such observations of each respondent consisted of detailed information regarding the interpretation of activity – based teaching of science by science teacher educators at KCE. The results of such observations are reported on page 65 of this report. Lesson observations for these respondents took place from 21st February to 19th March 2006.

3.7.5 Data Collection from Curriculum Materials

The respondents' teaching files and their schemes of work, and note books from students of these respondents, though not methods of collecting data, were seen by the researcher to be a rich source of information that this study sought to find. This was due to the point that the researcher sought to establish the nature of science activities these same respondents had planned for their students concerning their teaching.

Teaching files and schemes of work for five respondents and students' note books coming from the classes handled by these five respondents of this study were carefully studied to find out if the respondents' interpretation of activity-based teaching was congruent with their classroom practice. The study of these named curriculum materials took place from 25th March to 3rd April 2006 in room 27 at KCE. Only the afternoons were used for this exercise.
3.7.5.1 Respondents’ Teaching Files

The respondents’ teaching files were studied critically by the researcher on the 25\textsuperscript{th} March 2006. At the time of this study, the teaching files of MSE study area reflected the following principal items: ‘Curriculum coverage’ which dealt with work covered by the respondents and their reflections (appendix J), and lecture notes, learning outcomes and students’ learning activities were covered too. The researcher specifically examined the following parts of each of the teaching files: the learning outcomes, students’ learning activities and assignments given to the students. The researcher focused on the named items because he wanted to find out as to whether the above stated items were content – based or process – based or a combination of the two.

The Knowledge of whether learning outcomes and learning activities were either content-based or process-based, as revealed in the teaching files, was thought by the researcher to be crucial to this study. This was due to the point that content-based science is characterized by different methods of teaching from those used in the teaching process-based science. Data was collected from the teaching files of the respondents using a method known as content analysis. After studying the teaching file of each respondent, the researcher made brief notes on the principal findings. The findings obtained from the teaching files were reported on page 63 of this report.

3.7.5.2 Respondents’ Schemes of Work

The schemes of work were closely studied on 27\textsuperscript{th} March 2006 by the researcher in room 27. Only term one (2006) schemes of work formed part of this study. This was due to the point that the Section Head of MSE study area at KTC claimed that the format of the above stated document had been the same since the inception of ZATEC.

At the time of this study, all the respondents had one uniform schemes of work which they were using in preparing their lessons. The researcher checked for the schemes of work to see the nature of methods of teaching and types of activities that the MSE study area had planned for use in the teaching of science at KCE. Time planned for each topic was also noted. After studying the schemes of work carefully brief notes under various headings
concerning activity–based teaching were made and later on reported on page 62 of this report.

3.7.5.3 Students’ Note Books

Five students’ personal note books for science from each class of the five respondents were closely examined by the researcher in room 27 at KCE. This exercise took place from 29th March 2006 to 3rd April, the same year. The researcher examined the students’ note books page by page to see the sort of science activities that students had been doing in their science lessons. The findings from this exercise were written under the appropriate headings by the researcher in his note book and reported on page 64 of this report.

3.8 Data Analysis

The data collected was analysed by both qualitative and quantitative techniques. A combination of the above mentioned techniques was used in this study because, as noted earlier on, the researcher felt that these two techniques would complement each other in the processing of the collected data (Asheen, 2004).

The study used qualitative techniques in data analysis because this study yielded detailed information from the open–ended interviews, open–ended questionnaires and from lesson observations. As a reminder open–ended interviews and open–ended questionnaire employed ‘open–ended questions’ in this study in which respondents could answer such questions in as much detail as they wanted (Langley, 1987).

In addition to this, Langley (1987, p.31) claims that ‘observational data usually consists of detailed information …’ In view of this, the researcher felt that such detailed information could be meaningfully analyzed through qualitative techniques.

The data obtained from the open–ended questionnaires, open–ended interviews and lesson observations was analysed by reviewing it repeatedly to establish sub–themes and themes in the data. Such themes or patterns that emerged in the data collected from this study were referred to as response categories in this report.

Although this study involved qualitative data, the researcher found it necessary to analyse some data using quantitative technique. The simple quantitative techniques employed in
this study involved frequency counts. It was important to use frequency counts because this study involved only a small sample. After the response categories of each research question were established, the frequency of each of the response categories was determined by counting the number of times such a response category had occurred in the analysed data. The frequency count of each response category was then entered into a data spreadsheet of a computer as raw data to generate relevant graphs as indicated on pages 53, 58, and 60 of the next chapter of this report.

The teaching files, schemes of work of the respondents and students’ note books were analysed by using a method known as content analysis. According to Langley (1987, p.53) ‘Content analysis is one method social scientists use to analyse products of the mass media and other secondary data.’ Content analysis was used in this study in determining the number of times each activity appeared in each of the above named curricular material. The results of the content analysis of the above stated curricular materials were presented in this report by using a content analysis frame presented in form of tables appearing on pages 63, 62 and 64 respectively, of this report.

3.9 Credibility of Data Collected

This study was more concerned with validity of the responses obtained rather than reliability of the research findings. This was due to the point that the research design of this study employed open-ended questions to answer the research questions. Open-ended questions were used in the in-depth interviews and open-ended questionnaires to get respondents’ real views regarding the interpretation of activity-based teaching at KCE. The following steps were used to increase validity of the responses obtained in this study.

Multiple data collecting techniques were used in this study to increase the worth of data as well as to provide a check on validity (Kampamba, 2004). This is because different data sources complement each other and tend to provide a check on other alternative sources of data (David, 1993).

Another step that was taken to increase validity was to pilot the data collecting instruments used in this study. Cohen et al (2000), among several other authors, fully endorse these procedures.
The validity of the in-depth interviews was further increased by the researcher by avoiding asking leading questions to the respondents. The respondents were not given hints to the questions asked during the interviews whatsoever. In addition to this, the researcher had established a friendly atmosphere in which respondents were reasonably relaxed enough to give their in-depth views regarding the questions asked. Furthermore, some questions were deliberately repeated to find out if the respondents were consistent in their responses. Further, the researcher subjected all the respondents to the same questions. Responses that were not clear to the researcher (arising from the open-ended questionnaires) were clarified during the interviews. The above stated steps were meant to increase the validity of the data collected.

3.10 Limitations of the Study

The researcher had some limited amount of money to use in this study. And yet this study needed a lot of money to cover stationery, tuition and transport costs both from Kitwe to Lusaka and back, for research and consultations with the researcher’s principal supervisor at the University of Zambia. In addition to this, the computer which the researcher had access to did not have a Programme called Statistical Package for Social Studies (SPSS) version 11.5 that would have been used to analyse quantitatively the data obtained from open-ended questionnaires. As a result of this, the researcher had to settle for the ‘data spreadsheet’, an alternative strategy for analyzing such collected data. Drawing graphs using data spreadsheet required specialized skill and patience from the researcher. If enough money was available the researcher would have hired a SPSS for use in analyzing open-ended questions. Another point worth mentioning is that the researcher experienced some difficulties in meeting all the purposively selected science teacher educators for both individual and group interviews, and for lesson observations. This was due to the point that some respondents claimed to be committed to either personal programmes or other college duties in addition to their routine one of teaching.
CHAPTER FOUR

PRESENTATION OF RESULTS

4.0 Introduction

In this chapter, the results of the study are presented according to research questions, namely,

♦ What were science teacher educators’ conceptions of activity-based teaching at KCE?

♦ How did the science teacher educators’ conceptions of activity-based teaching influence their own classroom practice?

♦ Of these practices, which activities did science teacher educators focus on as they employ their version of activity-based teaching?

Headings were used in presenting the data and each heading covered a certain aspect of the study. Use of headings was thought to be ideal in this study for the purpose of keeping the presentation of the findings relevant to the objectives of the study. During the presentation of the findings, quotes from in-depth interviews were used in order to highlight certain points that needed clarifications. In addition, graphs and tables were used in presenting some data that was collected. Graphs were used to indicate how one category response compared to other category responses concerning each critical question the study was seeking to reveal. Then the tables served as ‘content analysis frames’ for results arising from content analysis of curriculum materials, namely, teaching files and schemes of work of the respondents and students’ exercise books. As a reminder, the content analysis was used to count the number of times (frequency) certain classroom activities appeared in the concerned curriculum material. As noted earlier on, the data was not expressed into percentages because the sample involved in the study was quite small. As a result, only frequencies were used in this study. Even so percentages appear in the graphs of this study, the raw data that was entered into the computer spreadsheet were only frequency figures.
4.1 Respondents’ understanding of Activity-Based Teaching

From the respondents’ reactions to questions B1 and B2 of the open-ended questions appearing in appendix B and the focus group interviews in appendix G, six categories of responses were generated. As a reminder, the frequency of each response category was determined by counting the number of times such response category appeared. Thereafter, the frequency of each response category was entered separately onto a data spreadsheet of the computer to generate a graph of KCE science teacher educator’s conception of activity-based teaching. The graph that was produced using these frequencies is appearing on page 53 of this report. The categories generated from the open-ended questionnaires and the interviews were as follows:

- ‘Hands-on’ activity
- ‘Minds-on’ activity
- Learner-centred teaching
- Inquiry-based teaching
- Process skill – Focused teaching

The above listed categories were relevant to the other sections of this study due to the point that these particular categories formed part of the answer of the research question the study posed to find, namely, what are the science teacher educators’ interpretation of activity-based teaching at KCE?
The distribution of the above responses was as indicated in Figure 1. This graph has been derived from data present in the frequency tables which were generated from the raw data obtained from open-ended interviews and open-ended questionnaires (appearing in the appendix F) of this report.

![Graph showing the distribution of responses to questions about the conception of activity-based teaching at KCE.]

**Figure 1 STE's conception of activity-based teaching at KCE**

As can be seen in figure 1 the majority of the respondents associated activity-based teaching with practical-based teaching. According to the science educators in the Focus Group Discussions, practical-based teaching referred to teaching that used 'hands-on' activities. During the focus group interviews one of the respondents stated that

"practical-based teaching is the teaching that will involve mostly concrete objects as opposed to abstract teaching. You, the teacher, will have to provide the materials, the resources ... we are talking about the apparatus and the children as alluded to earlier on will have to manipulate the objects ... that is, hands-on activity."
Respondents who subscribed to this category seemed to emphasize the importance of first-hand experience of reality in the teaching and learning process. The second lowest response associated with activity-based teaching with process skills-focused teaching. A variety of reasons were cited during Focus Group Discussions for employing process skills in general and employing experiments in particular, in their science teaching.

A further scrutiny of Fig 1 indicated a large difference in percentage response between practical-based teaching and process skills-focused teaching categories, and yet practical-based teaching of science was said to be rooted in the employment of science process skills such as experiments, classification, observation, hypothesis and time-space relationships in the classroom practice of the respondents, as noted during the Focus Group Discussions. Against this background, one would deduce that the respondents were not fully aware of all the facets of practical-based teaching of science.

The other three categories, namely, inquiry-based teaching, minds-on activity and hands-on activity scored the lowest. It is worth noting that all the above science educators’ conception of activity-based teaching seemed to be essential to learner-centred teaching. Fig 1 therefore, suggested that the respondents’ conception of activity-based teaching was almost exclusively associated with practical-based teaching. It should be noted, however, that the respondents’ interpretation of activity-based teaching did not tally with the results obtained from their actual classroom teaching.

4.1.1 Activity Based Teaching in science

Most respondents perceived activity-based teaching in science to be essentially different from that practiced in other study areas. They claimed that the type of activity-based teaching used in science had more practical tasks than the other brands of similar teaching in other subjects. The respondents claimed that science activity-based teaching was essentially focused on development of process skills. To highlight this point one of the respondents claimed that “… in the teaching of science we use processes such as classification, measurement, formulation of hypotheses … experiments … concluding, predicting.”
In addition to this, the respondents clarified in the focus group interviews that science activity-based teaching involved both ‘hands-on’ and ‘minds-on’ activity. This notion was exemplified by one of the respondents as follows:

*in order to use hands automatically the intellectual part of it should be involved otherwise one would be doing things not in line with question. ... First he uses the brains, then the hands. ... where he has to now analyse what he has ... the activity he has been doing. The reasoning is actually there*

The smallest percentage of respondents, however, felt that activity-based teaching was the same in all the study areas taught in the college. The differences in opinion regarding the relationship between the science version of activity-based teaching and the activity-based teaching in other subjects reflected different conceptions of process-based science teaching that existed in the science educators’ minds.

4.1.2 Ultimate value of Activity-Based Teaching

Table 3 shows what the respondents of this study regarded as the ultimate value of activity-based teaching of science at K.C.E. This table was derived from the open-ended questionnaire responses appearing in appendix F2 of this report.

Table 3: Ultimate value of Activity-Based Teaching at KCE
(N=09)

<table>
<thead>
<tr>
<th>Ultimate Value of Activity-Based Teaching</th>
<th>Frequency of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhances the learning process</td>
<td>5</td>
</tr>
<tr>
<td>Increases participation of students</td>
<td>1</td>
</tr>
<tr>
<td>‘Learning by doing’ makes learning enjoyable</td>
<td>4</td>
</tr>
<tr>
<td>Easy retention of material learnt</td>
<td>3</td>
</tr>
<tr>
<td>TOTAL</td>
<td>13</td>
</tr>
</tbody>
</table>
The table reveals that science educators appear to view the ultimate value of activity-based teaching differently. The largest portion of the responses indicated that the ultimate value of activity-based teaching was associated with enhancing the learning process.

‘Learning by doing makes learning enjoyable’ as a response ranked second. The respondents who gave this response seemed to suggest that it was not only the destination of the learning process that was critical but also that the different portions of the ‘journey’ needed to be enjoyable in order to raise enthusiasm and participation by students in a learning activity. It was interesting, however, that only one out of thirteen responses regarded the issue of increasing student participation in a given task as the ultimate value of employing activities in science teaching.

4.1.3 Ways of implementing Activity-Based Teaching at KCE

Regarding implementation of activity-based teaching, the study found that respondents implemented activity-based teaching in different ways. The responses collected regarding the respondents’ implementation of activity-based teaching were as presented in table 4 below. This table was derived from open-ended questionnaire responses appearing in appendix F2 of this report.

Table 4: Manner of implementing Activity-Based Teaching at KCE
(N=09)

<table>
<thead>
<tr>
<th>Manner of implementation of activity-based teaching</th>
<th>Frequency of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guided investigations in groups</td>
<td>5</td>
</tr>
<tr>
<td>Unguided investigations in groups</td>
<td>3</td>
</tr>
<tr>
<td>Both guided and unguided investigations in groups depending on the nature of activity</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
</tr>
</tbody>
</table>

There were big differences in the responses of science educators at KCE with regard to the way they implemented science activity-based teaching as can be seen in table 2.
The majority of the respondents indicated that they preferred to prescribe instructions of how students should go about carrying out science activities in class. Their justification of this practice was that students might work on the task at hand much more effectively if prescriptions were given to them. In addition, they felt that more time could relatively be saved if their students were guided through activities rather than letting them wander about. An excerpt from the focus group interview highlighted the point noted above in the following terms: “Activity-based teaching is whereby like in science, you do something practical, for example, you give instructions how to go about the experiment…”

The least number of respondents felt that both guided and unguided investigations were important in science teaching. This group believed that the choice of whether guided or unguided investigations were used in teaching basically depended on the nature of any activity and the safety surrounding it. With regard to the role of science educators during science activity-based teaching, the majority of them stated that one should essentially remain in the background as his/her students interacted on a given task so as to allow them to explore as much as they could.

4.2 Influence of Interpretation of Activity-Based Teaching on the Respondents’ own Classroom Practice

Arising from the responses of the science teacher educators to questions C4, C1, C2, (i), C2(ii) and B5, B3, B2, appearing in appendix B and appendix D respectively the following five response categories were realized.

- Conception is related to practice
- Conception will determine student participation
- Conception is related to mode of assessment
- Conception is related to methods of teaching
- Conception is related to teaching materials used in teaching.

The above response categories represented the responses obtained from the respondents in this study. These responses also formed part of the respondents’ interpretation of activity –
based teaching which this study explored. Upon generating these categories, the data was then used to draw the frequency table and finally, the frequency values were entered into the data spreadsheet of the computer to generate the graph appearing below.

Fig. 2 below shows the distribution of responses showing the relationship between conception of activity-based teaching held by respondents at KCE and their actual classroom practice. This graph has been derived from data present in the frequency tables which were generated from the raw data obtained from interviews (appendix D) and open-ended questionnaires (appearing in appendix F) of this report.

Legend:
A - Conception is related to the teaching methods used.
B - Conception is related to mode of assessment.
C - Conception will determine student participation.
D - Conception is related to teaching material employed in teaching.
E - Conception is related to practice

Science Teacher educators who believed that activity-based teaching was related to their own classroom practice formed the largest percentage of the responses. This result only echoes what is expected of the respondents by MOE regarding the use of activity-based teaching methods in constructing their own practice that would serve as a means of implementing the National Policy on Education in Zambia called ‘Educating Our Future.’
The second highest percentage response indicated that there was some relationship between the choice of materials intended to be used in science teaching and the science educators' conception of activity-based teaching. This response suggests that different brands of activity-based teaching may require different material resources.

The lowest percentage of the responses felt that activity-based teaching was also related to the teaching methods employed by individual science teacher educators in their teaching of science at KCE. This result suggests that majority of the respondents did not feel that their interpretation of activity-based teaching was crucial to their classroom practice regarding selection of methods of teaching to be employed.

4.3 Activities which Respondents focused on in their Activity-Based Teaching

Arising from responses of science teacher educators to questions A2, C1 appearing in the appendix B which focuses on group interviews, the researcher came up with the following six response categories regarding what respondents claimed to focus on in their classroom practice:

- Measurement
- Communication
- Observation
- Inference
- Experiments
- Investigative skills

The above listed categories of responses obtained in the study were relevant to the subsequent subsections, as they were also contributory to the respondents' interpretation of activity based teaching of science at KCE which this study explored. The frequency counts of the above categories were entered into the data spreadsheet of the computer to generate the graph appearing on next page of this report.
The largest percentage response indicated that experiments were the most frequently used in the teaching of science at KCE. In this regard, a variety of reasons were cited for employing experiments in their classroom practices. The first respondent claimed that “…when learners do experiments, what happens is that they get information first hand, not second hand, from a teacher…” To highlight the significance of experiments in the respondents’ classroom practice at KCE the second respondent emphasised the point that “…through experiments the learners are able to … to sort of verify… generalisations which come up…” This same respondent further justified the use of experiment in a classroom situation that “… experiments help to prove certain laws and principles…” while the third respondent stated that “At basic school college level, it is very vital … I think when people get used to doing experiments at a tender age, it will be instilled in them that they ought to.” And finally the fourth respondent also claimed “… through experiments, actually learners are forced to think like the original thinkers of that particular concept that they are talking about.”
The category, which was second highest in terms of ranking, was the ‘investigative skills.’ This, therefore, shows that the respondents focused their teaching of science on the integrated science process skills rather than the basic process skills. This is due to the point that in integrated science process skills experiments and investigative skills rank very highly compared to the basic science process skills stated by the respondents.

Figure 3 clearly indicates that science educators least frequently used communication and measurement in their teaching and yet measurement and communication are at the core of practical work in science teaching.

4.4 Processes of Teaching and Learning Science at KCE

In this study the following curricular materials were analysed as a way of determining further the processes of teaching and learning science at KCE: schemes of work, teaching files/records of work and students’ exercise books. The analysis of schemes of work, teaching files and students’ exercise books revealed the following data:

4.4.1 Teaching-Learning Activities used by Respondents at KCE

An evaluation of schemes of work used by science teacher educators revealed the following results presented in table 5 below. This table shows respondents’ planned teaching-learning activities for term one. This table was derived from one schemes of work for term one of 2006 appearing in appendix H of this report. Content analysis method was used to obtain this table. All the respondents had one common schemes of work.
Table 5: Teaching-learning activities outlined in the five respondents’ schemes of work at KCE.
(N=05)

<table>
<thead>
<tr>
<th>Teaching-Learning Activities as outlined in the respondents’ schemes of work</th>
<th>Frequency of activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research and Consultation</td>
<td>10</td>
</tr>
<tr>
<td>Group work (Discussion)</td>
<td>3</td>
</tr>
<tr>
<td>Lectures</td>
<td>10</td>
</tr>
<tr>
<td>Investigative work</td>
<td>2</td>
</tr>
<tr>
<td>Demonstrations</td>
<td>8</td>
</tr>
<tr>
<td>Field trips</td>
<td>2</td>
</tr>
<tr>
<td>Serial school visit</td>
<td>6</td>
</tr>
<tr>
<td>Formative assignment</td>
<td>1</td>
</tr>
<tr>
<td>Peer teaching</td>
<td>8</td>
</tr>
<tr>
<td>TOTAL</td>
<td>50</td>
</tr>
</tbody>
</table>

Research and consultation as well as lectures formed the largest percentage of all the planned activities for term one. The schemes of work (appendix II) also clearly indicated that research and consultation, as well as lectures were intended to take place every week of the term except the first two weeks of induction of students into the college.

It was also worth noting that investigative work and field trips were among the least frequently employed means of teaching science at KCE, at least for term one. Each of the above mentioned activities had only a frequency of two compared to demonstration and peer teaching which had a frequency of eight.

Another interesting point to note was that formative assignment had the lowest frequency of all the planned activities for term one. Additionally, there was no indication of planned work to serve as summative assignment for the stated term.
4.4.2 Teaching-Learning Activities in the Respondents’ Teaching Files

A critical analysis of the respondents’ teaching files revealed the following data presented below in table 6 of this report. Table 6 indicates the teaching-learning activities that were present in the respondents’ teaching files for term one of 2006.

Table 6: Teaching-Learning Activities in the Respondents’ Teaching Files at KCE. (N=05)

<table>
<thead>
<tr>
<th>Activities science educators claimed to have used in their teaching</th>
<th>Frequency of the activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group discussion</td>
<td>9</td>
</tr>
<tr>
<td>Experiments/Practical work</td>
<td>6</td>
</tr>
<tr>
<td>Demonstration</td>
<td>5</td>
</tr>
<tr>
<td>Field trip</td>
<td>1</td>
</tr>
<tr>
<td>Lecture notes</td>
<td>9</td>
</tr>
<tr>
<td>Peer teaching</td>
<td>0</td>
</tr>
<tr>
<td>Problem solving</td>
<td>1</td>
</tr>
<tr>
<td>Project work</td>
<td>0</td>
</tr>
<tr>
<td>Serial school visits</td>
<td>0</td>
</tr>
<tr>
<td>Investigative tasks</td>
<td>6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>37</strong></td>
</tr>
</tbody>
</table>

Table 6 shows that science educators at KCE most frequently used group discussion and lecture notes as their teaching activities. Experiments or practical work did not score highly they ranked second together with investigative tasks. This is a departure from what the same respondents had earlier on claimed in the open-ended questionnaire. This situation shows some discrepancy between claimed and actual practices of science teaching at KCE. The table also reveals that the respondents ignored project work, serial visits and peer teaching and yet these activities were clearly intended or planned in the schemes of work of the same term being referred to.
4.4.3 Learning Activities Recorded by Students in their Note Books

An evaluation of students’ exercise books revealed the following results as presented in Table 7 below. This table was derived from twenty five students’ note books for work done by five respondents in term one by using content analysis method. The number under each activity represents the frequency of its occurrence in the students’ exercise books. This table was drawn using twenty five students’ note books who were under the tutelage of the five respondents of this study.

Table 7: Learning activities recorded in the KCE students’ note books in term one of 2006.

<table>
<thead>
<tr>
<th>Class</th>
<th>Group Discussion tasks</th>
<th>Lecture note writing</th>
<th>Demonstration activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>4</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>C2</td>
<td>6</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>C3</td>
<td>4</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>C4</td>
<td>5</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>C5</td>
<td>6</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>C6</td>
<td>6</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>C7</td>
<td>7</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>31</td>
<td>53</td>
<td>3</td>
</tr>
</tbody>
</table>

Analysis of the students’ note books revealed that the most prominent activities students were exposed to by their science teacher educators were mainly group discussion and lecture note writing. All the seven classes recorded group discussions and note taking from lectures. As for demonstrations, only some classes (i.e. three classes) showed signs of work covered by the demonstration teaching style. There were no signs whatsoever in students’ exercise books of experiments or practical work, formative assignment (tasks), project work, investigative tasks, field trips, serial school visits as well as research and consultation tasks or tutorial sheets. The absence of research and consultation tasks in the students’ exercise books may suggest that the time meant for such activities was spent on something else other than the planned work in the schemes of work.
4.5 Major Observations made in Science Lessons

The principal observations made during science lessons presented by the respondents of this study revealed the following results as presented in table 8 below.

The figure entered in this table for each category of science teacher educator behaviour reflects the number of times that particular category was used by that particular respondent. The figure for each category in this table also represents the number of ticks scored in the original data appearing in appendix E of this report. Each tick covered a period of three minutes of the lesson time as indicated in appendix E. This table was derived from the observations made during the respondents' actual teaching. Five respondents were observed.

Table 8: Principal observations made during science lessons at KCE.

<table>
<thead>
<tr>
<th>Category of science teacher educator's behaviour</th>
<th>Frequency of each category scored by each individual respondent (R ) during teaching.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher asks questions which were answered by recalling facts and principles to problem solving</td>
<td>R1 2 R2 2 R3 1 R4 2 R5 1</td>
</tr>
<tr>
<td>Teacher makes statements of fact and principle</td>
<td>R1 5 R2 1 R3 4 R4 4 R5 3</td>
</tr>
<tr>
<td>Teacher makes statements of problem</td>
<td>R1 1 R2 1 R3 2</td>
</tr>
<tr>
<td>Teacher makes statement of speculation</td>
<td>R1 1 R2 2 R3 1 R4 1 R5 1</td>
</tr>
<tr>
<td>Teacher asks questions which were answered speculation</td>
<td>R1 1 R2 1 R3 2</td>
</tr>
<tr>
<td>Teacher directs students of information for the purpose of acquiring facts and principles</td>
<td>R1 2 R2 3 R3 3 R4 1 R5 1</td>
</tr>
<tr>
<td>Teacher directs students of information for the purpose of solving problems</td>
<td>R1 1 R2 1</td>
</tr>
<tr>
<td>Students refer to teacher for the purpose of seeking guidance when solving problems</td>
<td>R1 1</td>
</tr>
<tr>
<td>Teacher asks question which were answered by applying facts and principles</td>
<td>R1 1 R2 1</td>
</tr>
</tbody>
</table>
Legend
R1- First science teacher educator observed
R2- Second science teacher educator observed
R3- Third science teacher educator observed
R4- Fourth science teacher educator observed
R5- Fifth science teacher educator observed

The actual observations made by this researcher during lesson presentations revealed that science teacher educators generally dominated their lessons. They talked for more than half of the lesson time. It was generally observed that teacher-talk was excessively longer than the combined ‘student-talks’ in any of the lessons observed. Students were mainly allowed to make their contributions during answer and question sessions, which in most cases took root toward the end of the lesson as a way of summarising the lesson taught. Where group work was used, it was mainly in form of discussion.

All the classes observed had identical seating arrangements involving eight desks clustered together so that the students were facing one another. This arrangement was used whatever the nature of lesson being taught. Although the stated seating arrangement called for the use of group work during teaching, science teacher educators were surprisingly using lecture method mostly and rarely used other forms of teaching, such as group work. The students’ group discussion were largely concerned with seeking information for the purpose of acquiring or confirming facts.

It was also noted that science teacher educators did not employ field trips in their teaching. Another interesting point to note was that students did not do experiments and yet the topic they were teaching, namely, ‘the soil’ could be taught entirely by activity-based approach in form of experiments. The lessons observed were, therefore, generally content-led rather than practically based. The science educators seemed to be more concerned with covering the content rather than paying due attention to the process of acquiring that ‘book-knowledge’. It was observed that the majority of the science educators gave homework to their classes. Much of the work given was, nonetheless, ‘book-based’.
CHAPTER FIVE

INTERPRETATION OF RESULTS

5.1 Introduction

In this chapter, the results of the study collected were interpreted by referring to the relevant literature and principal data sources, namely, the open-ended questionnaires, open-ended interviews, focus group interviews, science teaching observation schedules and analyzed curriculum materials, which included the teaching files, schemes of work of the respondents and students’ exercise books.

5.1 Association of Activity-Based Teaching with Practical-Based Teaching

This study showed that most of the respondents associated activity-based teaching with practical-based teaching. This response was consistent with the GRZ and DANIDA (1997, p.13) proposed teaching style ‘... which emphasizes students learning through practical activities, particularly through physical activity using various kinds of material and equipment...’ This emphasis on practical activities was partly due to the point that all the respondents in this study had been inducted into OBE, in general, and activity-based teaching, in particular, from the inception of ZATEC at KCE in 1998. Furthermore, there had been national as well as in-house workshops that called for all teacher educators in their respective Study Areas to attend the workshops without fail. At such workshops, various aspects of activity-based teaching had been either demonstrated by resource persons or discussed by all teacher educators themselves. In addition to this, the initiators of ZATEC, namely, DANIDA in conjunction with GRZ, funded the ZATEC course particularly in reading materials concerning activity-based teaching. The reading materials were made available to all primary teachers’ training colleges in Zambia. As a result of this, one would say that through such workshops that Teacher Education and Specialised Services (TESS) had made sufficient awareness about activity-based teaching as a teaching style to all the respondents. According to the MOE (2001, p. 3) ‘college tutors have undergone a major retraining programme in order to adopt the changed methodology. Methods ... based on learner-centered principles and the emphasis is on encouraging teaching approaches that are practically oriented.’ It is important at this stage, therefore, to remind ourselves that the majority of these respondents had been teaching science at the
college right from the inception of ZATEC and as a result, many aspects of ZATEC were at their 'finger tips', practical-based teaching being no exception. This study had, however, indicated that the knowledge obtained from such workshops concerning the interpretation of activity-based teaching of science did not explicitly influence the respondents' classroom practice. From the point of view of the researcher, this particular finding suggests that a respondent could have an appropriate interpretation of activity-based teaching, but still prefer to use other approaches other than activity-based teaching due to contextual factors, and other things that surrounded its implementation.

The effectiveness of workshops alluded to above could, however, be questioned as to whether their objectives regarding implementation of activity-based teaching were being met or were just another form of 'window dressing'. This point is made in view of the point that the lesson observations conducted in the study had surprisingly shown that the respondents' classroom practice was at variance with their interpretation of activity-based teaching. The teaching of such respondents generally did not include physical activities such as experiments, project work and field trips in relation to the topic they were teaching. The topic 'soil' at the time of the study provided good opportunities for respondents to use 'hands-on' activities noted above in their classroom practice. One would, therefore, question the validity of the in-service workshops that were used to induct science teacher educators into ZATEC outcomes-based syllabus at KCE. The non-actualization of respondents' interpretation of activity-based teaching in classroom practice could not, however, be blamed entirely on the nature of the workshops that had been conducted in ZATEC. This study noted that respondents' non-application of 'hands-on' activities in the teaching of science was as a result of insufficient time to cover the syllabus or lack of resource books, among several other contextual factors. Since 'hands-on' activities were not being covered in the respondents' classroom teaching, it might help matters if the college management through the MSE head of section would come up with a programme of action that would 'revive' the use of activity-based teaching of science at KCE.
5.2 Predominant Methods of Teaching Science at KCE

The research findings of this study also showed that the discussion method was the most frequently used method in the teaching of science at KCE. All the respondents of this study used group discussion at some stage of their teaching. It was, however, worth noting that there were some minor differences in the presentation of their discussions as some discussions were ‘free’, while others were ‘strictly’ controlled. Such differences in the application of the discussion method could have been partly as a result of the respondents themselves having different intentions or purposes that they wished to accomplish through its use. Some respondents, for instance, used discussion sessions to elicit information as opposed to the exploration of the science concepts at hand. According to Bentley (1989) two types of discussion have been identified, namely, horizontal discussions and vertical discussions. Horizontal discussions have been associated with those discussions which ‘serve to alert the pupils to the width of topics, test knowledge and comprehension...vertical discussions ... enable the sharing of ideas and theories about science and scientific phenomenon’ (Bentley 1989, p. 43).

In view of this, group discussions that were intended by the respondents to seek information were ‘tightly’ controlled as opposed to those in which learners were given the freedom to explore concepts. Most respondents at KCE were, however, using horizontal discussions at the exclusion of the other type of discussion stated above. This was largely due to the point that these respondents were noted to have chosen topics for their students’ discussion that potentially had some high degree of consensus, such as ‘Discuss the Various Components of Soil’. A topic of this nature did not have a lot of areas for ‘disagreement’ from students who formed such discussion groups in class. From the lessons observed, it was evidently clear that not every topic in the ZATEC science syllabus could be taught well entirely through the discussion method. A topic such as the one mentioned above could have been taught much more easily through a laboratory method in which students could have carried experiments to analyse the soil. Group discussion would then have been conducted as a follow-up activity with the aim of consolidating the findings arising from students’ laboratory activity. The reasons why respondents frequently used group discussion in their teaching were not given in the study. It can, therefore, be deduced that the discussion method was most frequently used by respondents because discussion sessions were far easier to organise than physical science activities such as experiments.
This was partly due to the fact that KCE did not have a laboratory technician. Added to this was the fact that the methodology adopted in non-science study areas like literature and languages through New Breakthrough To Literacy (NBTL), in which group work was a ‘must’ to undertake during their teaching, was fast spreading to other Study Areas. For instance, ‘Mathematics Rainbow Kit’ (MARK) which is a new approach to the teaching of numeracy in basic school colleges in Zambia is essentially rooted in NBTL regarding classroom practices. Of late, there has been efforts at KCE to extend MARK to science teaching. As a reminder, MARK operates like NBTL which was designed to address pedagogical problems that were being experienced in literacy and languages, and not in science. The above described scenario might have influenced the respondents concerning the use of group work in their classroom practice. Another important factor that could have influenced respondents in using the stated teaching-learning activity in the teaching of science were the basic principles of OBE to which ZATEC ascribed to.

In their application of group discussion to science teaching, some respondents clearly defined the roles of members of each group and categorically gave some time limit for the discussion while some respondents did not do any of these things, apart from giving students a problem for discussion. Defining roles for members of the group was important in ensuring order during such discussions. This was because learners needed to know what the respondent expected of them. What was, however, common amongst all respondents was that each group of learners was asked to make presentations of their findings to the rest of the class. Against this backdrop, it was quite clear that, in general, respondents were teaching science process skills through group discussion. Sadly, such group discussions did little in developing the manipulative skills in the students of respondents at KCE. It should, however, be pointed that such group discussions yielded verbal information in form of facts, concepts and principles. It is important to note at this point that respondents could have used better teaching options at their disposal that were practically based than using discussion method. As already stated in the report, topics for discussion should preferably have a low degree of consensus. The topic that respondents were teaching at the time of this study, namely, ‘The Soil’ did not, however, meet that criterion. In view of this, the respondents could have used science practical activities such as experiments, field trips among several other practically based teaching methods.
5.3 Respondents’ Justification for using Group Discussion in their Teaching of Science

It should, however, be remembered that this study had earlier revealed that shortage of time, long syllabus and absence of laboratory technician at KCE were among several contextual factors that could have led respondents to resort to the use group discussion in their classroom practice. The study noted that lack of time was a very important constraint regarding the completion of ZATEC syllabus by the respondents at KCE. In the minds of the respondents ZATEC syllabus was too broad to be covered in one year particularly through activity-based teaching. To this end, the respondents complained that they were racing against time to complete content in the bloated science syllabus. This was due to the point that at the time of this study ZATEC syllabus was examination-based for college based students. It might then be noted that insufficient time, among several other factors, could have made respondents to attach undue importance to the teaching of science content rather than science process skills. Emphasis on science content by respondents in their teaching, as noticed earlier on, was impacting negatively on the development of manipulative skills in their respective students. It was, therefore, noticed that respondents seemed to have totally ignored the importance of ‘hands-on’ experience in the teaching of science in the area of solving problems encountered in our communities, such as measuring the mass of an object using a beam balance and determining the weight of a body using a spring balance.

While it might be true to say that the factors which impeded the teaching of science through physical activities were ‘external’ to the respondents, it would equally hold water to state here that the respondents’ personal characteristics such as developing of a positive attitude toward the use of activity-based teaching style in their classroom practice might have had some influence in the manner the respondents themselves at KCE taught science. It could therefore be inferred here that, other than external ‘forces’, there were ‘internal’ ones that affected the actualisation of activity-based teaching at KCE by the respondents. In view of this, it could be argued that the above stated quantities would be taught in a much more meaningful and interesting way by letting the students themselves manipulate the beam balance and spring balance physically before doing the mental activity regarding the concepts of mass and weight.
5.4 ‘Hands-on’ and ‘Minds-on’ Teaching of Science at KCE

In the opinion of the researcher, ‘minds-on’ experience of the reality of the topic done at the time of the research was catered for through exposing the learners to group discussions and writing of the theory-based summative assignments (appearing in appendix I) by respondents of this study. Unfortunately, the summative assignment (appearing in appendix I) that was given to students of the respondents was entirely book-based. Furthermore, the exercise books of students of the respondents showed no indication of laboratory activities to have been done. Only scientific facts were noticed. In view of this, the science process skills at KCE were entirely covered theoretically and yet some notable educationists such as Haambokoma et al (2002) have stressed the need for teaching science process skills to the learners by using laboratory method among other practically based methods. Furthermore, (Peter 1982, p. 68) claims that ‘to learn anything a pupil has to use mental activity, which is often supported by physical activity.’ As noted earlier in chapter 2 of this report, Peter’s (1982) claim is shared by Parkinson (1994) who also claims that a science activity has two components, namely, mental (minds-on) and physical (hands-on) experiences. In view of this, ‘hands-on’ activities and ‘minds-on’ activities are complementary to each other. In this regard, teaching of ‘minds-on’ experiences at the expense of ‘hands-on’ as was the case with respondents of this study at KCE may be regarded as a ‘misnomer’ of the term activity-based teaching of science by these same respondents. The above claim is at variance with GRZ and DANIDA (1997) who strongly emphasised the use of physical activity in the teaching of science. Since ZATEC science curriculum has two components, namely, the content and the process, it is the opinion of the researcher that a balance between content (‘minds-on’) and process (‘hands-on’ or physical activity) is achieved when teaching science as opposed to teaching it (science) exclusively either through ‘minds-on’ experience or ‘hands-on’ experience at the expense of the other. As a reminder, a science curriculum which is process-based is concerned with the students ‘knowing how’ and a curriculum that is content-based is theoretically concerned with the students ‘knowing what’. Against this backdrop, it can be stated that the ‘knowing how’ and ‘knowing what’ components of science curriculum would be necessary in producing an ‘integrated’ science scholar at KCE who might be useful to himself/herself and the community at large. Hence, there is need for the respondents of this study to consider the process as well as the product whenever they are teaching their students science.

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study to consider the process as well as the product whenever they are teaching their students science.

5.5 Respondents' Conception of Investigative skills

Analysis of science activity respondents claimed to be focusing on in their teaching revealed one anomaly, namely, (respondents) referring science process skills to investigative skills. This, in the view of the researcher, was a 'misnomer' of the term. In other words, referring science process skills to investigative skill by some respondents was a 'serious' mis-application of the term as far as science education was concerned. This was due to the point that science process skills are specific and restrictive in their meaning and their application compared to investigative skills which seemingly are general and applicable to all study areas. In fact, in all the available literature no tangible reference was made to refer investigative skills to science process skills. This finding, therefore, implicitly called for science teacher educators at KCE to revisit and urgently update their 'head knowledge' of science process skills except if only, the term, on their part, meant to cover some special science process skills best known to them 'locally' at KCE as 'Investigative Skills.'

Furthermore, analysis of the students' note books (on page 64) showed no evidence or indication of students having been exposed to investigative tasks. No trails of research and consultation tasks were observed in the students' exercise books whatsoever. And yet the two named activities occupied very prominent slots in respondents' schemes of work (Appendix H). Again, these findings revealed a serious break between the planned or intended work for term one and the respondents' classroom practice.

5.6 Seating Arrangement in Relation to Activity-Based Teaching

The science lesson observations revealed a very interesting point to note regarding the students' seating arrangement. It was noted that same seating arrangement was used in every class observed whatever the sub-topic of soil they were teaching on. It should be stated here that the nature of the groups noted in this study was generally 'friendship groups/social groups'. As a result, these groups were expected to produce good working relationships in which student-to-student interaction during science lessons would be
‘active’. Regrettably, science lessons were taught using more often than not whole class teaching as opposed to teaching using groups even though students could be seen physically in groups during science lessons. This, therefore, indicates that although the respondents had the head knowledge of ZATEC principles they did not actualize group work in their teaching as expected under OBE to which, as stated earlier on, ZATEC subscribes.

Same seating arrangement (eight students facing one another formed a group) whether the respondent was using group discussion or lecture method was observed in all the classes that were involved in this study. While use of such groups in one’s teaching is an indication of ‘abandoning’ the traditional way of putting desks in straight lines, one desk behind the other, teaching of science generally remained teacher-centred at KCE. For instance, as noted on page 65 of this report, the respondents talked for more than half of the lesson time in each of the classes observed. As a result of this, student to student interaction was minimal for most of the lesson time except when these same students were given a question to answer through discussion. Surprisingly, such discussions were mostly conducted near the end of a given lesson. When these same respondents were asked why they generally preferred whole class teaching to group teaching as outlined by OBE principles, most of them felt that the bloated syllabus, time-related variables, and large classes were the main factors that were seen to impact negatively on the use of learner-based methodology at KCE. Despite ZATEC science curriculum being based on activity-centred teaching, which calls for the use of group work in the teaching of science more than any other seating arrangement, its syllabus and duration implicitly support the exclusive use of whole class teaching. This is due to the point that every teacher, particularly in Zambia, has to satisfy the syllabus requirements concerning the coverage of specific objectives within a specific time frame. This study, therefore, indicates that it’s one thing to have students arranged physically in groups and yet another thing for a teacher to employ the same group work in their teaching of science.

Use of same seating arrangement regardless of the nature of the lesson and students’ characteristics makes someone wonder as to whether one seating arrangement could be ideal to all kinds of teaching styles used in the teaching of different sub-topics concerning soil. It is worth noting here that, while it is not essential to seek different seating arrangements for different lessons or teaching methods, it might be important to know
whether a given seating arrangement of students would be appropriate for activity-based teaching in general and 'hands-on' activity in particular. In the view of the researcher, use of the same seating arrangement for every sub-topic of soil by these respondents is a clear indication of their non-consideration of student individual differences that normally occur across various learners within the same classroom. In fact, every science teacher educator is expected to understand his students individually. According to Peter (1982, p. 117) the teacher's knowledge concerning the students' characteristics in each class may help him/her make a decision '...that some arrangement ... satisfy the individual needs.' That is, rearrangement of groups to meet student individual needs in their science concept formation is sometimes important in science teaching. In view of this, perhaps a survey on the impact of different seating arrangements with regards to activity-based teaching of science would appear to be important, if not necessary. It could, however, be wrong to conclude that the whole class teaching that was most frequently used by these respondents was yielding a lower academic outcome for students than it would have been if the respondents of this study had used group work in construction of their classroom practice.

5.7 Contextual Factors regarding the use of Activity-based Teaching of Science at KCE

This study also revealed a number of hindrances that respondents at KCE faced in their teaching of science through ‘hands-on’ activities. Amongst the contextual factors that respondents felt were negatively impacting on their classroom practice regarding the use of activity-based teaching were, namely, large classes, lack of time, lack of teaching materials (resources) and language effect. Large classes and lack of time had the highest frequency response. In the view of the researcher, non-application of laboratory activities by respondents to their classroom practice can be explained in terms of the following reasons. These being, the laboratory at KCE could seat a maximum of twenty-five students in one session and yet two combined classes used in the study had seventy students. Furthermore, the laboratory room at the time of this study, was ill-equipped regarding laboratory apparatus and chemicals for use in laboratory tasks. The non-inclusion of hands-on activities in the respondents' teaching of science could also be attributed though implicitly to their unwillingness (respondents) to improvise teaching and learning resources. This study also, regretfully, noted that the respondents were equally unable to make use of the local environment in their execution of science lessons. The case in point was the
respondents inability to exploit such teaching methods as field trips to cover some elements of the topic they were teaching, namely, 'The Soil'. Against this background, one would perhaps wonder as to whether the reasons for teaching science theoretically by respondents was largely due to the contextual factors the respondents themselves 'implicated' in this study or was as a result of these same contextual factors stated above coupled with other issues. It can only be implied here that despite respondents of this study being faced with contextual factors in their implementation of activity-based teaching at KCE. There could have been other 'hidden' factors such as lack personal interest or morale on the part of the respondents that might have had affected the use of activity-based teaching of science.

5.7.1 Bloated Classes

Bloated classes were also a challenge to respondents of this study regarding the use of activity-based teaching. The principal concern in organising practical work for overcrowded classes is availability of resources for the task as well as security for students. Surprisingly, even the other three classes with twenty-five students were not exposed to 'hands-on' activities by their respondents when teaching science. A further point to note was that some respondents felt that shortage of laboratory materials was one of the hindrances in their teaching of science process skills through activity-based teaching. As a reminder again, the study noticed that all the respondents could, sadly, not make use of experiments, field trips and project work in their classroom practice even though the topic they were teaching had provided some opportunities to build their teaching around the above named physical activities. 'Hands-on' activities such as finding out if soil contained air, determining the pH of the soil and soil profile, in the view of the researcher could have been done practically because these activities required only very basic science apparatus, which was readily available in the college.

5.7.2 Time and Syllabus as variables in the use of Activity-based Teaching

Time as a variable in activity-based teaching, was another contextual factor brought out by the respondents in this study. In the minds of the respondents, there was too much work to cover within a time frame of one year. As a result of this, one would perhaps have to make a decision as to whether he/she would teach science through activity-based and remain
teaching style that was less time consuming than activity-based teaching. In the view of
the researcher, the ‘conflict’ in choosing the way to go by the respondents in teaching
science could perhaps, be resolved by making the necessary adjustments in the science
curriculum that would possibly address important issues such as time-related variables and
large classes, which surrounded the implementation of activity-based teaching at KCE.

5.7.3 Respondents’ Mindset in Relation to the use of Activity-Based Teaching of
Science at KCE

From the analysis of the factors that science educators claimed to negatively impact on
their teaching of science through activities, one may find it hard to read their minds, but
may attempt to consider other reasons that were only implied rather than stated. In the
opinion of the researcher, another factor that could have hindered their teaching of science
process skills could have been their ‘mindset’ towards the philosophy and teaching style
involved in the activity-based teaching of science. This is due to the point that attitudes of
respondents could have a cognitive basis as well as an affective one (Gagne, 1965). In
view of this, it would be desirable to deepen the interest and morale of respondents of this
study by powers that be at local, regional and national levels to enable (respondents) them
to go ‘an extra mile’ in the teaching of science through practical activities. To highlight
this point, Abbott (1980) claims that the way a teacher ‘... actually behaves will depend on
his attitudes.’ In other words there was a relationship between the attitudes of respondents
and their classroom practice employed. This could perhaps have been part of the reason
why (GRZ and DANIDA, 1997) felt that some teacher educators could still be ‘haunted’
by their attitudes that they themselves had learnt during their practice of ZBEC. As earlier
indicated, ZATEC demanded a drastic shift for a science teacher educator from organizing
teacher-centred lessons to learner-based ones (GRZ and DANIDA 1997). Peter (1982,
p.38) however, noted ‘... that a sudden major change in teaching style could be an
unsettling experience.’ This can offer some clue as to why the respondents could not
translate their head knowledge of activity-based teaching into their classroom practice. As
stated earlier on in this report, majority of the respondents had experienced ZBEC prior to
ZATEC. Therefore, it can be stated that majority of the respondents had already formed
many of their attitudes that were enduring up to date. As a result of this, some respondents
were apparently still being ‘haunted’ by ZBEC methodology of the teaching of science.
According to Brimer and Pauli (1971, p. 92) they claim that ‘attitudes as established as
this are difficult to change...’ Furthermore, some educationists have indicated that learner-based and activity-based teaching is a challenge on the part of the science teacher educator because its organization is labour-intensive and a drain on one’s time (Asiedu-Akofi, 1981). A further point to note is that as a teaching style, activity-based teaching at the time of this study required a particular mind set and readiness in order to be appreciated by its implementers (GRZ and DANIDA, 1997). Lesson observations conducted during this study revealed that respondents were, generally, set mentally not to include physical activities such as experiments in their classroom practice. That is, regardless of the availability of teaching and learning materials that were noticed to be present in the college area, the respondents of this study still presented their lessons mainly through group discussions and lectures. Under these circumstances the respondents could have easily organised practical tasks for their students to do. This inability demonstrated by respondents of this study to rise to the challenge of teaching science process skills in a practically based manner when teaching and learning resources are readily available in the environment could be worrisome particularly, to science educationists that advocate for the use of activity-based teaching of science. The break noticed in the verbal interpretation of activity-based teaching by respondents at KCE and their classroom practice could be attributed to some degree to the nature of training these same respondents under went in the course of becoming teachers. This is due to the point that majority of them (respondents) were trained as teachers during the ‘content era’ as opposed to a ‘process’ one under which ZATEC falls. In view of this, some respondents might have been unable to make sufficient adjustments in ‘switching’ from the principles of the ‘content era’ to those of the ‘process’ one. According to Brimer and Pauli (1971, p. 85)

*It is useless to tell teachers over and over again that they should be guides and advisers ...unless, in the course of their training, they have themselves taken part in a community experiment in an atmosphere which gives them an idea of what the atmosphere of a class should be.*

The respondents’ apparent preference of teaching science through content-led approach at KCE as opposed to a process-based could also be linked to their reluctance to ‘switch’ onto the learner-based from the ‘traditional’ teacher centred one. According to Alexander (1974, p.37, 38) ‘...teachers normally react more quickly to changes of content than they do to changes of approach ... and ... can only become secure after a great deal of hard
work, of challenge and criticism…” Peter (1982, p.34,35) also claims that ‘teachers generally find it easier not to change their styles of teaching, which they have probably developed over a period of increasingly successful years in a school.’ The Brimer and Pauli’s (1971), Alexander’s (1974, p.37,38) and Peter’s (1982, p.34,35) points noted above could be part of the reason for the respondents of this study for not using ‘hands-on’ approach in teaching science.

The respondents’ mindset in relation to the use of activity-based teaching at KCE has, therefore, implicitly indicated that teacher characteristics can be important in either enhancing or inhibiting activity-based teaching of science. It is important to note here, that teachers in their individual capacities as subject specialists have, however, from time to time always adjusted their teaching styles especially when their students appear not to be learning enough science (Peter,1982). For instance, if there was massive failing in the previous final examinations, a particular teacher might consider changing his/her teaching style to address any shortfalls in his/her previous teaching pattern (Peter,1982). This change in one’s teaching style alluded to above is internally motivated. That is, a teacher makes a decision freely and ‘happily’ with a sole intention of improving his/her own classroom practice. As regards to the activity-based teaching style that came up with ZATEC, these respondents were asked by MOE (1999) to make a drastic shift from ‘traditional content-led approach’ to the ‘contemporary process-based approach’ irrespective of their readiness to undertake this challenge of teaching a new course, which had emphasized the use of activity-based teaching in science lessons. The practicing science teacher educators were not given a chance to either accept or reject the apparent ‘new’ teaching style (MOE,1999). In other words, ZATEC was ‘imposed’ on to the science educators (MOE,1999). In part, the above account seems to explain the respondents’ non-application of activity-based teaching of science at KCE. On the other hand, it appears to the researcher that while large sums of money and many man-hours of work have been ploughed into developing of new courses such as ZATEC, the readiness of practicing science teacher educators regarding the adoption or acceptance of such a new syllabus by the same practicing teacher educators has received little or no attention from the Ministry of Education (Peter, 1982). In this view, it is important for MOE officials charged with the responsibility of syllabus design to incorporate the end-users of the said document at various stages of its development. This, in the view of this researcher, can help in creating the much needed right mindset in the actual implementation of the said syllabus.
5.8 Research Findings in Relation to the Literature Reviewed

The research findings of this study were found to be similar to those of Haambokoma et al (2002) in Zambia, Asheena (2004) in South Africa and those of Kasanda et al (2005) report of a research conducted in Zimbabwe. The above named studies, also regrettably noted that even though the conception of activity-based teaching of science was appropriately articulated by respondents of these studies, the classroom practice of these same respondents, sadly, did not match with their conception of the above named teaching style. This study has, therefore, shown that the gap that existed in the respondents at KCE regarding their conception of activity-based teaching of science and their actual classroom practice was not only a ‘KCE problem’, but a national one as being reflected in Haambokoma et al’s (2002) study which covered the whole country, Zambia. Similar results on the use of ‘hands-on’ activities obtained in Zimbabwe (Kasanda et al, 2005)) and from South Africa by Asheena (2004) confirms the point that the above noted problem of non-application of ‘hands-on’ activities in teaching of science by the respondents was also an international problem that cuts across the boundaries of Zambia. It should, however, be noted that caution has to be exercised when comparing data from the above named sources. This is due to the point that the above named studies from outside Zambia were conducted under different education systems of the above stated countries. Furthermore, the contextual factors that influenced activity-based teaching in Zimbabwe and South Africa at the time of those studies might not have been necessarily the same or uniform as those that had prevailed at KCE.

The research findings further showed that the respondents’ ‘verbal’ interpretation of activity-based teaching was associated with practical-based teaching. The verbal interpretation of activity-based teaching by the respondents of this study was, however, at variance with their classroom practice. This study showed that the break between the respondents’ verbal interpretation of activity-based teaching at KCE and their actual teaching of science was as a result of the contextual factors among other factors that prevailed at KCE at the time of this study. These being, large classes, lack of time and shortage or lack of teaching materials. The above mentioned contextual factors were the major ones. As for the minor ones the following were mentioned, namely, non-availability of specialized science rooms (labs), student characteristics, methodology used
shortage or lack of teaching materials. The above mentioned contextual factors were the major ones. As for the minor ones the following were mentioned, namely, non-availability of specialized science rooms (labs), student characteristics, methodology used by the science teacher educators, and language problem. These findings, noted above, were similar to those obtained by Haambokoma et al (2002) in Zambia, Asheena (2004) in South Africa and Kasanda et al (2005) in Zimbabwe.

The findings of this study were similar to the research findings of Kasanda et al (2005) and Haambokoma et al (2002) in many aspects. For instance, Haambokoma et al’s (2002) study revealed that despite respondents of that study knowing the importance of ‘hands-on’ experiences in teaching of science, teaching of science was generally content-focused and teacher-centred. Unlike this study, Kasanda et al (2005) and Haambokoma et al (2002) used larger sample than the sample that was used in this study. Nevertheless, the general finding of those studies was that respondents could not translate their head knowledge of teaching science process skills into a practically-oriented manner. Furthermore, this study also revealed a huge gap between what the respondents could tell ‘verbally’ regarding their perceptions on teaching methods of science and how they constructed their classroom practice. To highlight this point, Haambokoma et al, 2002, p.133) lamented that

    instead teachers presented facts to pupils in the way as teachers taught subjects such as History, English and pupils took notes. Learners on their part complained that they were not exposed to laboratory apparatus, and there had been no practical work done in the course of the year.

The research findings of this study were also very similar to those of Asheena’s (2004) findings. The only apparent differences were that those studies used different samples and dealt with different levels of education from this study. In addition to this, the Asheena’s (2004) study and Kasanda et al’s (2005) study were carried out outside Zambia. Perhaps, the question one would ask is: is there a uniform internationally agreed interpretation of activity based teaching to determine as to whether literature regarding this study from Zambia and outside Zambia would be worth comparing?

The contemporary interpretation of activity-based teaching of science according to the literature reviewed was associated with the use of ‘hands-on’ and ‘minds-on’ activities in
educationalists (Fraser et al. 1993; Haambokoma et al., 2002; Peter, 1982). However, their implementation of activity-based teaching was basically, 'looped-sided; only 'minds-on' activities were conducted in their teaching mainly through group discussion. No physical activities were used in their teaching of science even though these same respondents had earlier on made some claims in the interviews, of them to be focusing their science teaching on the following science process skills, namely, measurement, communication, observation, inference and experiments. Their claim was, therefore, found by this study to be an 'empty' one due to the point that it was not backed up by their classroom practice. The non-use of science process skills in their teaching perhaps reflected among other things, the version of activity-based teaching that was actually being practised at KCE as opposed to their 'head knowledge' of the afore-mentioned term.

The research findings presented by Kasanda et al. (2005) from a study that was conducted in Zimbabwe 'on the use of science process skills in primary schools' indicated that the respondents' conception of practical work was congruent with the current belief of activity-based teaching in science education. Amongst the major reasons the study came up with for respondents of that study not teaching science process skills through 'hands-on' approach were as follows: lack of time, lack of teaching and learning resources, syllabus examination-based and lack of knowledge on the part of the respondents. The research findings of that study were similar to the general findings of this report, particularly, the contextual factors that surrounded the application of activity-based teaching of science process skills using the laboratory method. One of the major differences between the two studies was that the causes for the non-application of activity-based teaching by respondents at KCE in their actual teaching of science had nothing to do with their conception of the above stated teaching style. The respondents of this study, unlike Kasanda et al.'s (2005) study were thoroughly grounded in the theory of activity-based teaching. However, the two studies indicated that the respondents in each of these studies taught science without using physical practical activities.

As noted earlier in chapter two of this study, outcomes-based education was rooted in a learner-centred and activity-based teaching of science. In regard to the theory underpinning outcomes based education, of which activity-based teaching forms a pillar among others, the study observed that respondents had the 'head knowledge' of outcomes based
outcomes based education, of which activity-based teaching forms a pillar among others. The study observed that respondents had the ‘head knowledge’ of outcomes based education, but the same respondents could not use their ‘head knowledge’ in effecting activity-based lessons in their actual teaching of science (Kasanda et al., 2005).

The above account indicates that respondents in each of the studies noted above were unable to teach science process skills to their learners using physical practical activities such as experiments, field trips among other ‘hands-on’ activities. The research findings of this study tallies quite well with the above literature reviewed. The literature noted has shown that science teaching was generally content-focused. In view of this, teaching science through ‘hands-on’ approach poses a very big challenge at KCE. The same scenario has been noted in literature arising from outside Zambia. This merely indicates, once again, that the problem of non-application of physical activities in science teaching is not, merely a ‘KCE problem’ but a national one as well as international.

The relevance of this study was, therefore, that it established the interpretation of activity-based teaching of science at KCE as one that involved the use of ‘hands-on’ activities (for the development of manipulative skills) and ‘minds-on’ activities (cognitive skills) in one’s classroom practice. The difference that this study made, unlike some other similar studies such as the Asheena’s (2004) and Hambokoma et al.’s (2002) regarding activity-based teaching under constructivism paradigm and outcomes-based teaching was that whereas those other studies dealt with some different aspects of learning, this study specifically investigated some aspect of teaching noted in the previous chapters.

5.9 Challenges Facing Respondents in Implementing Activity-Based Teaching

The location of challenges faced by science teacher educators at KCE in their use of activity-based teaching style in their classroom practice was quite an important step to be undertaken if the appropriate remedial actions were to follow. In this study, two kinds of factors were isolated as being hindrances towards the implementation of activity-based teaching. The following were the factors, namely, external factors and internal factors.
5.9.1 External Factors

The external factors in this study were referred to as contextual factors. According to Department of Education (DoE), 2003, in Asheena (2004, p.53) contextual factors were referred to as ‘factors that influence the teachers’ practice within a learning environment and that the factors are beyond the control of teachers.’ The study revealed the following as major contextual factors in the teaching of science process skills: shortage or lack of teaching materials, large classes, and lack of time.

Time, as a constraint in the implementation of activity-based teaching, scored the highest percentage response (jointly with shortage of teaching materials and large classes). The respondents who subscribed to the above stated constraint, in the view of the researcher, seemed to indicate that the time to cover ZATEC syllabus sufficiently well especially if one had to employ physical activities such as experiments in his/her teaching was inadequate. Kasanda et al (2005, p.506) revealed that ‘42.1 percent of the teachers found science practical work to be extremely time consuming.’ It should be remembered again that the ZATEC syllabus was bloated, and was examination - driven. In other words, the syllabus was quite long and was therefore, extremely ‘taxing’ in terms of effort to deal with it both in ‘breath and depth’ within a time space of one year. In the same study being referred to above (ibid) the respondents blamed their non-use of science process-skills in their teaching on the ‘bloated’ science syllabus which was content-laden. Worse still, the non-academic activities during the time of the research were quite a big drain on the much needed time: the college had a sports’ week and a week-long monitoring of second year students in the field. Added to this, was the induction of students for two weeks. In all the stated activities, the respondents were required to take an active role. Against this background, the respondents were apparently left with relatively fewer working days in which to work on the syllabus. This and many other reasons, could have had impacted negatively on the use of science process skills in their teaching.

Another major contextual factor that was brought out by the respondents was associated with lack of science teaching-learning materials. Lack of materials as a contextual factor manifested itself in form of inadequate science laboratory spaces, in general and science equipment in particular, at the time of study. Lack of relevant teaching materials in science, in the eyes of the respondents, were part of the reason for ‘turning their backs’ on
the use of science process skills in their teaching of science. Similar findings were obtained by Kasanda et al (2005). In this study, however, it cannot be said that the necessary resources for use in experiments, field trips and project work were lacking. At the time of the study, the basic science apparatus were readily available at KCE for respondents’ purpose of conducting experiments on many aspects of the soil in their teaching. In this respect, the availability of science resources was, therefore, not an issue, and one would have expected the respondents to cover that topic by employing both ‘hands-on’ and ‘minds-on’ tasks rather than exclusively teaching it theoretically.

The respondents also brought large classes forth as a challenge in using activity-based teaching. During science lesson observations, it was noted that some classes actually had been fused into one. So in the view of the researcher, when the respondents mentioned large classes as a hindrances to their implementation of activity-based teaching, they seemed to suggest that the ‘excess’ number of students tended to reduce the science educator to students ratio making it somehow extremely difficult to use a learner-centred and activity-based teaching approach in their classroom practice.

As a result of this, the respondents appeared to have been overburdened by large classes to the point of sideling the use of activity-based teaching in their classroom practice. Assuming that all the stated contextual factors were removed, one would perhaps ask: would it be ‘plain sailing’ for the respondents to maximally employ activity-based teaching in their classes at KCE?

5.9.2 Internal Factors

The internal factors were not explicitly stated by the respondents but their behaviour regarding the way they constructed their classroom practice revealed that there were some other reasons other than the contextual factors that could have impacted negatively over their use of activity-based teaching. Amongst the prominent ones were the apparent inertia and diminished desire to employ science process-skills in their teaching.

As a reminder, the study revealed that despite having sufficient science teaching resources in place, the respondents still preferred to teach all aspects of soil theoretically without exposing their students to ‘hands-on’ activities. The study also showed that the
respondents focused their teaching on content even after, as earlier stated, attending some in-house workshop(s) concerning the use of activity-based teaching in their classroom practice. The above account seemed to suggest that the respondents had no major problems regarding content but seemed not to have made sufficient adjustments concerning the actual application of activity based teaching style to their classroom practice. According to Alexander (1974, p. 37) ‘... teachers normally react more quickly to changes of content than they do to changes of approach...’. In the view of the researcher, for one to take on activity-based approach as a teaching style, a suitable mindset, perhaps, needed to be established. It appeared like the respondents’ attitude toward the philosophy of activity-based teaching somehow impacted negatively towards its implementation. As a result of this, the respondents appeared not to have enough thrust to work hard in organizing practical tasks such as experiments for their students. It was, therefore, implicitly noted that laziness and seemingly negative attitudes on the part of the respondents could have played some role in their non-use of science process skills in their classroom practice.

5.10 Implications of the Study

This study has clarified the version of activity-based teaching used at KCE. Areas within our education system that needed appropriate action regarding the interpretation and perhaps, implementation of activity-based teaching were established. In view of this, the following could be said to be the implications of the study.

The interpretation of activity-based teaching may have substantive effects upon practicing teachers in primary schools and science teacher educators at KCE concerning their classroom practice. Findings regarding the relationship between science teacher educators’ conception of activity-based teaching and their classroom practice at KCE indicated that the conception of activity-based teaching was related to the following: the methods of teaching employed in the teaching of science, the mode of assessment used, students’ participation in the teaching/learning experiences availed to them by these same science teacher educators and the teaching/learning resources used in their teaching. As already established by this study, science teacher educators with correct interpretation of activity-based teaching are at an advantage of passing on the correct version of this same teaching style stated above to their students as they teach them science. In this way, KCE students
upon completing ZATEC are expected to teach science using activity-based teaching in a manner similar to the way they were taught science when they were being trained to become teachers at the college. Fraser et al (1993, p.51) have highlighted this point by saying that ‘teachers should be taught in the manner in which they will be expected to teach’. It should, however, be noted that science teacher educators can only apply activity-based teaching correctly in a classroom situation if they have a comprehensive knowledge, among other things, of activity-based teaching of science. In view of this, one can infer to say that interpretation of activity-based teaching of science precedes its actualization in a classroom situation at KCE. This, therefore, means that the interpretation of activity-based teaching is the first step in the realization of activity-based teaching of science.

The interpretation of activity-based teaching of science by policy makers at both the national and the college levels, and the curriculum designers may affect operations and management of the teaching of science at KCE. Correct interpretation of activity-based teaching by the MOE headquarters would, for instance, be translated into either the expansion or doubling of the laboratory space at KCE that would enable science teacher educators to teach science process skills using a scientific method. In addition, the same MOE headquarters would be expected to allocate sufficient funds for the procurement of science equipment and chemicals that are required for science lessons at KCE. Furthermore, the correct interpretation of activity-based teaching of science by the curriculum designers may make these same designers consider shortening the ZATEC syllabus in a bid to remove time-related variables that are known to impact negatively on the implementation of activity-based teaching of science at KCE. In the same vein the setters of ZATEC examinations at the Examination Council of Zambia (ECZ), are expected to include questions in science that are process-oriented so that science process skills are covered at both the implementational stage (classroom practice) and assessment stage of teaching science.
CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.0 Introduction

This chapter contains conclusions and recommendations arising from findings of this study.

6.1 Conclusions

The study revealed that science teacher educators at KCE had grasped the theoretical aspects of activity-based teaching of science in general, and ‘hands-on’ activity, in particular. However, the same respondents could not translate their head knowledge into the practical teaching of science. This study noted that respondents had placed particular emphasis on covering content in the syllabus rather than teaching science process skills. The respondents preferred to teach science theoretically even when the opportunity to expose their learners to ‘hands-on’ activities prevailed in the college. This finding implied that the interpretation of activity-based teaching that was present in the minds of respondents at the time of this study, did not influence their (respondents’) classroom practice. From this study, it is clear that respondents’ interpretation of activity-based teaching at KCE was at variance with their actual classroom practice. That is to say, the respondents’ theoretical knowledge and actualization of activity-based teaching of science at KCE were ‘poles apart’ despite their ‘verbal’ interpretation of the above stated teaching style being congruent to that of the contemporary science educationists. In view of this, this study has, therefore, argued the need for the respondents to ‘marry’ their ‘verbal’ interpretation of activity-based teaching of science with their actual classroom practice.

The above account leads one to agree that the respondents at KCE had not achieved activity-based teaching of science. They were frequently teaching science through discussion and lecture methods. Regrettably, it was noticed that no form of physical science activity such as field trips and experiments were done physically by the students. This implies that no science process skills were taught using ‘hands-on’ activities though the topic they were teaching, namely, ‘The Soil’ offered ‘excellent’ opportunities for them
to teach through the use of ‘hands-on’ activities such as experiments and field trips. Furthermore, respondents could not improvise teaching and learning resources or make use of the local environment to bring about concrete experience in teaching and learning of science.

The respondents blamed their non-application of activity-based teaching of science to their classroom situations on contextual factors, namely, time, bloated classes, lack of laboratory space and long ZATEC syllabus. It was however, observed that even when such constraints were not crucial to the implementation of activity-based teaching of science, such as the use of field work concerning some aspects of soil erosion, the respondents still chose to cover the above stated sub-topic using either group discussion or lecture method. This finding implies that other than contextual factors that surrounded the implementation of activity-based teaching of science at KCE such as lack of time, large classes, lack of laboratory spaces, and long ZATEC science syllabus there were some ‘hidden’ factors such as negative attitude that also impacted negatively on actualisation of activity-based teaching. In short, ‘resistance to ‘abandon’ teaching science through process-led approach at KCE by respondents was a complex issue at the time of this study which, as the study noticed, could not be attributed merely to contextual factors alone.

This study has shown that the respondents’ conception of activity-based teaching of science did not influence their own (respondents) classroom practice. This result, therefore, indicates that having theoretical knowledge on activity-based teaching of science was one thing and putting those same ideas in the head into practice was another thing. Since the respondents’ conception of activity-based teaching of science were ‘poles apart’ from their actual classroom practice the study came to a conclusion that the respondents at KCE had ‘solidly’ remained adhered to the old ‘traditional’ classroom practices of teaching science to their learners. In view of this, this study has suggested that some ‘new’ and meaningful teacher education in-service training programme in science teaching using ‘hands-on’ or ‘material-centred’ activities be designed and conducted at KCE. The challenge to MOE, in general, and in-service providers of further training in science education, in particular, is therefore, to lobby for funding required to hold workshops and seminars for the respondents concerning the implementation of ‘hands-on’ teaching of science.
This study further revealed that respondents' conception of activity-based teaching of science was related to the following classroom practices: methods of teaching one employed (in the teaching of science), mode of assessment employed, extent of student participation in the lesson, teaching material employed in teaching and the respondents' construction of their practice. In view of this, one would probably say that this study was important in establishing 'focal points' in the respondents' interpretation of activity-based teaching of science at KCE so that areas that needed improvement regarding their classroom practice with respect to 'hands-on' teaching were identified. The identification of gaps in the respondents' conception of activity-based teaching, in the opinion of this researcher would, therefore, be important, if not necessary for in-service training in the area of activity-based teaching.

One positive aspect of this study was that the conception of activity-based teaching of science by respondents was congruent to that of contemporary science educationists. In view of this, this study notices that such 'appropriate verbal' interpretation of the above mentioned teaching style demonstrated by respondents could serve as a springboard from which appropriate correctional measures can be launched. In the mind of the researcher, it was felt that having a correct interpretation of activity-based teaching of science by respondents was a better development than having a wrong one or none at all in as far as providing correctional measures was concerned. This study, therefore, argues the need to bridge the gap observed in respondents at KCE regarding their 'head knowledge' of activity-based teaching of science and their classroom practice. This study, therefore, expresses the view that until the respondents are able to 'marry' their 'head knowledge' of activity-based teaching of science with their classroom practice, will they be able to interpret activity-based teaching, both in deed and in practice as expected of them by those who advocate for the use of activity-based teaching of science.

6.2 Recommendations

The recommendations arising from this study are three fold: firstly, recommendations to policy makers. Secondly, recommendations for future research work concerning the interpretation of activity-based teaching at KCE and thirdly, recommendations for teacher education in science at KCE.
6.2.1 Recommendations for Policy

The curriculum designers, CDC, should re-visit the ZATEC syllabus and consider removing areas in the syllabus document that had impacted negatively on the implementation of activity-based teaching of science at KCE. Variables such as shortage of time and lack of adequate teaching materials, which formed some of the major contextual factors, should be resolved in the syllabus. Items, which, for instance, are not crucial to the teaching of science through practical activities should be ‘weeded out’ from the syllabus in an effort to create sufficient room for its implementation. After all, activity-based teaching, at the time of this study formed one of the pillars surrounding the implementation of the ZATEC science curriculum. In addition to this, the syllabus should deliberately include clear assessment procedures of physical activities in both the formative and summative assignments. Added to this is that ECZ should consider very seriously the inclusion of practical component in ZATEC science final examination in which the competence of students in the intended and planned science process skills would be assessed. Once such adjustments to the syllabus have been made, one would hope that science teaching at KCE would shift from being largely content-based to one that would be process-based. The above account would obviously call for CDC to liaise with the ECZ so that major curricular issues regarding the teaching of science process skills and their assessment procedures are harmonized. As Brimer and Pauli (1971) have rightly observed ‘...curricular, methods and evaluation are closely interdependent...’ Therefore, introduction of a practical-based examination by ECZ based on ZATEC syllabus designed by CDC would obviously make the respondents of this study to start teaching science process skills using ‘hands-on’ activities.

Furthermore, the study advises MSE Head of Section, who is a member of the KCE management team, to advocate for the formulation of a policy by the college that would make the use of ‘hands-on’ activities in the teaching of science at KCE a priority. That is, putting in place a working policy that would, for instance, require respondents to conduct a minimum number of practical tasks per term. Once such a policy framework is put in place, there would be a number of changes that would necessitate physical application of science concepts to the respondents’ classroom practice. To solve the problem of insufficient laboratory space, a rotational timetable regarding the use of the laboratory room for the purpose of exposing students to ‘hands-on’ activities at KCE by the
the respondents would be made. As for large classes, the study saw the need to split them, for practical reasons, into two or three groups so that laboratory tasks could be done in turns.

6.2.2 Recommendations for Further Research.

Because of the vast nature of the topic studied one can not hope to deal exhaustively with it in a single study such as this. As a result of this, many aspects of activity-based teaching were not fully covered. In view of this, the following aspects of activity-based teaching are suggested for future studies:

- Scholars in the field of science education should conduct a study that would explore the relationship between the use of activity-based teaching and retention of the learnt material by ZATEC students at KCE.
- A study on the relationship between the use of activity-based teaching of science and the acquisition of science process skills by ZATEC students at KCE.

6.2.3 Recommendations for College Management

Another recommendation arising from this study is that the college administration of KCE through TESS, should organize in-service training programmes designed to create a 'new' positive 'mindset' in science teacher educators that would enable them to begin actualizing their head knowledge of activity-based teaching in their classroom practice. This would involve translating theoretical knowledge on the stated teaching style into practical lessons in their teaching. While the college is drawing plans to orient its science teacher educators in creating a 'new mindset' concerning the use of science process skills in their teaching, MOE should provide sufficient financial support and set the necessary structures for sustainable science teacher educators' professional development.

Since the study has noted the need to develop respondents of this study further regarding the much needed shift in their interpretation of activity-based teaching of science, that is, from verbal interpretation to physical application of the same mentioned teaching style to their classroom practice. This study, recommends that the respondents at KCE should sit down with all stakeholders in the MOE such as ECZ and CDC, and map up a strategy that
would enable these same respondents to develop an interest in using the teaching strategy noted above. This recommendation requires ECZ as well as CDC to have a clear understanding of the principle of ‘activity-based teaching’ of science so that there is unity of purpose and unwavering commitment towards its implementation at all levels, KCE inclusive.

This study further recommends that KCE should procure various types of teaching and learning resources for use by respondents of this study. Since this study at KCE noticed that theoretical conception of activity-based teaching of science that respondents had in their minds, did not influence their classroom practice, this study recommends to KCE to expose the respondents of this study to materials such as books, videos, journals, and other relevant material resources that would provide a ‘new’ and perhaps an enduring experience to the respondents in forming or changing attitudes that might inspire them to incorporate ‘hands-on’ activities in their teaching of science. This study hopes that such teacher education programme which would contain items as stated above could make the respondents of this study start to embrace activity-based teaching of science using ‘hands-on’ and ‘minds-on’ activities.
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APPENDICES

APPENDIX A: DEKKER’S AND MABOYI’S QUESTIONNAIRE

Appendix: questionnaire: Teacher’s purposes for doing practical work in the teaching of natural sciences.

This questionnaire has been designed to explore your purposes for doing practical work in the teaching of sciences. The results of this survey are expected to have a positive impact on the ACE programme. Please note that your names will remain anonymous and the information that you will provide will be treated as confidential. Kindly fill in the information required as it forms part of the study.

<table>
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<tr>
<th>Sex (put a cross)</th>
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<td>Age</td>
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<tr>
<td>Professional teaching qualification(s)</td>
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<td>Highest academic qualification (e.g. less than std 10, std 10, 1st year university degree, 2nd year university, BA etc)</td>
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<tr>
<td>Teaching experience in science (in years)</td>
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<tr>
<td>Science subject(s) you are currently teaching and the respective grades</td>
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Please answer the following questions with regard to practical work.

1. Can you describe in your own words what practical work means to you?
2. Do you ever conduct practical work?
3. How often do you carry out practical work in grades 7-9 (or the grades in which you teach)?
4. When did you last do practical work in grade 9 (or the grade that you teach)? What was it about?
5.1 If you do not conduct practical work do you use activities that are similar to practical work when teaching?
5.2 If so, can you give examples of such activities?
5.3 Why this activities instead of practical work?

NB: If you never do practical work, and only similar activities, answer question 11-15.

6.1 Do you ever like doing practical work? Please explain.
6.2 What do you like about it?
6.3 What do you dislike about it?
7. Why do you include practical work in your teaching?
8.1 Do your learners learn something from practical work?
8.2 Can you give examples of the things they learn?
8.3 How can you be sure that they learn this from practical work?
8.4 How do you assess practical work?
9.1 How do you organise practical work?
9.2 How do you prepare learners for practical work?
9.3 What instructions do you give learners during practical work?
9.4 How do you avoid that learners create a mess during practical work?
10. What, in your view are the most important problems when doing practical work?

If you use practical work in teaching and learning you do not have to answer questions 11-15.

11.1 Do you like activities similar to practical work? Please explain.
11.2 What do you like about the activities?
12. Why do you include activities similar to practical work in your teaching?
13. Do your learners learn something from those activities similar to practical work?
13.1 Can you give examples of the things they learn?
13.2 How can you be sure that they learn this from the activities?
13.3 How do you assess those activities?
14.1 How do you organise those activities similar to practical work?
14.2 How do you prepare learners for those activities?
14.3 What instructions do you give learners during those activities?
14.4 How do you avoid that learners create a mess during those activities?
15. What, in your view are the most important problems when doing the activities similar to practical work?
APPENDIX B : OPEN-ENDED QUESTIONNAIRE

THE UNIVERSITY OF ZAMBIA
SCHOOL OF EDUCATION
MATHEMATICS AND SCIENCE EDUCATION DEPARTMENT

This questionnaire attempts to explore Science Educators’ Interpretation of activity – based teaching at Kitwe College of Education (KCE). The information obtained in the survey is for academic purposes only and will be treated confidential. Against this background, your personal details will remain anonymous. Kindly fill in the information required as truthfully as you can. The return date of duly completed questionnaires will be the 28th February, 2006.

Personal details

1. sex □
2. Age □
3. Number of years as Science educator at
   (i) Primary school
   ..................................................................................................................
   (ii)Secondary school
   ..................................................................................................................
   (iii)College
   ..................................................................................................................

4. Science subject (s) you specialized in during your training as a teacher
   ..................................................................................................................
   ..................................................................................................................

5. Highest academic qualification(s) attained
   ..................................................................................................................
   ..................................................................................................................

6. In – service training done
   ..................................................................................................................
   ..................................................................................................................

Section A

1.  

104
(a) What does process skill mean?

(b) What does process approach of teaching science mean?

2. Which intellectual science process skills do you focus on as you teach science?

3. What difficulties do you normally experience in teaching science process skills named (2)?

4. Describe the extent of coverage of the process skills as stipulated in the ZATEC science syllabus.

Section B
1. Can you explain what activity-based teaching means to you?
2. How is your version of activity – based teaching different from that employed in other Study Areas such as Literacy and Language Study Area?

3. In your own view, what is the ultimate value of activity – based teaching?

4. When you give a science activity to your students, do your students have a prescribed way of doing the task?
   (a) If so, describe how this is done

   (b) If not, briefly indicate how students work through the activity

5. Why is it necessary for you to remain in the 'background' as your students interact on a given task?
Section C

1. How do you implement your version of activity-based teaching in your science class?

2. Which teaching methods do you employ in the teaching of
   (i) Practical ‘hands-on’ activities to your students?
   (ii) Practical ‘minds-on’ activities to your students?

3. What follow-up activities do you give students after doing practical ‘hands-on’ activity? Give reasons for your answer

4. Explain why your conception of activity-based teaching of science will determine whether your students will ‘do’ science or know about science.

End of the questionnaire

THANK YOU FOR YOUR CO-OPERATION
APPENDIX C : KAMPAMBA'S INTERVIEW SCHEDULE

1. Gender: F/M

2. Teaching experience: A. 0-1   B. 2-5   C. 5-10   D. 10-15   E. 15-off

3. Do you teach another subject apart from science? If so, which one?

4. Why have you made science subject compulsory?

5. Have you achieved the national aims of teaching science?

Over the years, the learning of science is relying more and more on the evidence from experimental designs and inferential reasoning practices. The process engages students in sustained and frequent conversations.

6. What factors do you think need to be present in the class to engage the students in conversations and thus, promote reasoning?
7. Are there any hindrances during thinking science activities?

8. How do you encourage the use of scientific language in the students?
APPENDIX D: OPEN-ENDED INTERVIEW SCHEDULE

THE UNIVERSITY OF ZAMBIA
SCHOOL OF EDUCATION
MATHEMATICS AND SCIENCE EDUCATION DEPARTMENT

This interview aims at collecting data on Science Teacher Educators' interpretation of activity-based teaching at Kitwe College of Education. Your input in this interview will highly be appreciated.

Q1. Describe in your own words what activity-based teaching means to you.

Q2. Why do you think teaching through activities is important in the teaching of science?

Q3. State the factors that can promote student participation in an activity as you are teaching Science.

In the current education policy, 'Educating Our Future (1996)', there has been great emphasis on the use of a learner-centred and activity-based teaching approach rather than the traditional teacher-centred teaching approach.

Q4. In your own words, describe in outline how you can go about implementing activity-based teaching given a sub-topic of 'separation of a mixture of iron filings and sulphur'.
Q5. What would be the follow-up science activities to the above mentioned task? Referring to Q6.

Q6. How would you ensure that there is nothing more than the 'working noise' during the Activity if it was organised in groups?

Q7. State any hindrances in the teaching of intellectual science process skills in the above mentioned activity. Referring to Q6.

*Thank you very much for taking part in this interview. Good day and God bless you!*
### APPENDIX E: A SCIENCE TEACHING OBSERVATION SCHEDULE

**UNIVERSITY OF ZAMBIA**

Name of Science Teacher Educator: ____________________________ Date of observation: ____________________________

Class: ____________________________ Venue: ____________________________

**Topic:** An exploration science teacher educator’s interpretation of activity based teaching at Kitwe college of Education

**AIM:** To categorise science teacher educator’s behaviour by observing some intellectual transactions which take place in science lessons so that it would be possible to establish a typology of teaching styles. (That is to assign science teacher educators to categories according to observed features of the intellectual transactions taking place between them).

1. **TEACHER TALK**

   1a. Teacher asks questions (or invites comments) which are answered by:
   - a1 recalling facts and principles to problems solving
   - a2 applying facts and principles
   - a3 making hypothesis or speculation
   - a4 designing of experimental procedure
   - a5 direct observation
   - a6 interpretation of observed or recorded data
   - a7 making inferences from observations or data

<table>
<thead>
<tr>
<th>0</th>
<th>3</th>
<th>6</th>
<th>9</th>
<th>12</th>
<th>15</th>
<th>18</th>
<th>21</th>
<th>24</th>
<th>27</th>
<th>30</th>
<th>31</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>a1</td>
<td>a2</td>
<td>a3</td>
<td>a4</td>
<td>a5</td>
<td>a6</td>
<td>a7</td>
<td></td>
</tr>
</tbody>
</table>

   b1. of fact and principle
   b2. Teacher makes statements:
   - b1
   - b2
   - b3
   - b4

   1c. Teacher directs pupils of information for the purpose of:
   - c1 acquiring or confirming facts or principles
   - c2 identifying or solving problems
   - c3 making inference, formulating or testing hypotheses
   - c4 seeking guidance one experimental procedure

   2. **TALK AND ACTIVITY INITIATED AND/OR MAINTAINED BY PUPILS**

   2d. Pupils seek, information or consult for the purpose of:
   - d1 acquiring or confirming facts or principles
   - d2 identifying or solving problems
   - d3 making inferences, formulating or testing hypotheses
   - d4 seeking guidance on experimental procedure

   1e. Pupils refer to teacher for the purpose of:
   - e1 acquiring or confirming facts or principles
   - e2 seeking guidance when identifying or solving problems
   - e3 seeking guidance when making inference, formulating or testing hypotheses
   - e4 seeking guidance on experimental procedure

<table>
<thead>
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<th>3</th>
<th>6</th>
<th>9</th>
<th>12</th>
<th>15</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>e1</td>
<td>e2</td>
<td>e3</td>
<td>e4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## OPEN-ENDED INTERVIEW RESULTS FREQUENCY TABLE

1. What does activity-based teaching mean?

<table>
<thead>
<tr>
<th>Description</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learners are active during teaching</td>
<td>1</td>
</tr>
<tr>
<td>Teachers give practical work to students</td>
<td>1</td>
</tr>
<tr>
<td>Teaching in which students find out on their own</td>
<td>1</td>
</tr>
<tr>
<td>Students learn by doing</td>
<td>2</td>
</tr>
</tbody>
</table>

2. Why teaching through activities is important

<table>
<thead>
<tr>
<th>Description</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learners learn better if they do things on their own</td>
<td>1</td>
</tr>
<tr>
<td>Its learner-centred and practical oriented</td>
<td>3</td>
</tr>
<tr>
<td>Activities motivate learners to learn</td>
<td>1</td>
</tr>
<tr>
<td>Retention of material is high</td>
<td>1</td>
</tr>
</tbody>
</table>

3. Factors that promote student participation in activity-based teaching

<table>
<thead>
<tr>
<th>Description</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of resources</td>
<td>6</td>
</tr>
<tr>
<td>Time availability</td>
<td>2</td>
</tr>
<tr>
<td>Good tutor-student relationship</td>
<td>1</td>
</tr>
<tr>
<td>Adequate preparations</td>
<td>1</td>
</tr>
<tr>
<td>Teacher educator characteristics</td>
<td>2</td>
</tr>
<tr>
<td>The policy of MOE</td>
<td>1</td>
</tr>
<tr>
<td>Nature of examinations</td>
<td>1</td>
</tr>
<tr>
<td>Nature of topics</td>
<td>1</td>
</tr>
<tr>
<td>Clear instructions from teacher educator</td>
<td>1</td>
</tr>
<tr>
<td>Outline of separation of iron filings and sulphur using activity-based teaching</td>
<td>Frequency</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Students do practical work themselves</td>
<td>4</td>
</tr>
<tr>
<td>Teacher demonstration, then students repeat the practical work themselves</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Follow-up activities</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discussions of other separation techniques in real life situations, followed by reports</td>
<td>3</td>
</tr>
<tr>
<td>Extension activity given on separation techniques</td>
<td>3</td>
</tr>
<tr>
<td>Assessing students on separation techniques</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How to ensure nothing more than the ‘working noise’ in a group work activity</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students to be focused on the task at hand</td>
<td>3</td>
</tr>
<tr>
<td>Ensure orderly student participation in group work</td>
<td>1</td>
</tr>
<tr>
<td>Provide enough apparatus to each group</td>
<td>1</td>
</tr>
<tr>
<td>Teacher to be available during group work</td>
<td>1</td>
</tr>
<tr>
<td>Work or task should be challenging</td>
<td>1</td>
</tr>
<tr>
<td>Each student to have a role in the group</td>
<td>1</td>
</tr>
<tr>
<td>Hindrances in teaching of science process skills</td>
<td>Frequency</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Shortage or lack of material</td>
<td>5</td>
</tr>
<tr>
<td>Large classes and lack of time</td>
<td>5</td>
</tr>
<tr>
<td>Non-availability of specialised rooms (labs)</td>
<td>1</td>
</tr>
<tr>
<td>Students characteristics</td>
<td>1</td>
</tr>
<tr>
<td>Methodology used by STE</td>
<td>1</td>
</tr>
<tr>
<td>Lack of quick feedback</td>
<td>1</td>
</tr>
<tr>
<td>If the task is not properly stated</td>
<td>1</td>
</tr>
<tr>
<td>Language effect</td>
<td>1</td>
</tr>
</tbody>
</table>
**APPENDIX F2**

**OPEN-ENDED QUESTIONNAIRES’ RESULTS FREQUENCY TABLE**

### A1(a)

<table>
<thead>
<tr>
<th>Meaning of process skills</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure of acquiring knowledge</td>
<td>4</td>
</tr>
<tr>
<td>Thinking tools</td>
<td>2</td>
</tr>
<tr>
<td>Problem solving skills</td>
<td>2</td>
</tr>
<tr>
<td>Not sure</td>
<td>1</td>
</tr>
</tbody>
</table>

### A1(b)

<table>
<thead>
<tr>
<th>Meaning of process approach</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inquiry-based approach</td>
<td>1</td>
</tr>
<tr>
<td>Process skill-focused teaching</td>
<td>2</td>
</tr>
<tr>
<td>Practical-based teaching</td>
<td>6</td>
</tr>
</tbody>
</table>

### A2.

**Intellectual science process skills being focused when teaching**

<table>
<thead>
<tr>
<th>Skill</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring</td>
<td>1</td>
</tr>
<tr>
<td>Communicating</td>
<td>1</td>
</tr>
<tr>
<td>Observing</td>
<td>2</td>
</tr>
<tr>
<td>Inferring</td>
<td>2</td>
</tr>
<tr>
<td>Experimenting</td>
<td>9</td>
</tr>
</tbody>
</table>

### A3.

**Difficulties experienced in teaching science process skills**

<table>
<thead>
<tr>
<th>Difficulty</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor background in science</td>
<td>2</td>
</tr>
<tr>
<td>Lack of interest in laboratory work</td>
<td>3</td>
</tr>
<tr>
<td>Lack of apparatus</td>
<td>6</td>
</tr>
<tr>
<td>Limited time</td>
<td>8</td>
</tr>
</tbody>
</table>
A4.

<table>
<thead>
<tr>
<th>Extent of coverage of process skills in the syllabus</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>More basic process skills covered</td>
<td>7</td>
</tr>
<tr>
<td>Less integrated process skills covered</td>
<td>3</td>
</tr>
<tr>
<td>Not sure</td>
<td>2</td>
</tr>
</tbody>
</table>

B1

<table>
<thead>
<tr>
<th>Meaning of activity-based teaching</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hands-on activity</td>
<td>1</td>
</tr>
<tr>
<td>Minds-on activity</td>
<td>1</td>
</tr>
<tr>
<td>Practical-based teaching</td>
<td>7</td>
</tr>
</tbody>
</table>

B2

<table>
<thead>
<tr>
<th>Difference in science activity-based teaching version from those in other study areas</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>More practical in science</td>
<td>8</td>
</tr>
<tr>
<td>Same in all study areas</td>
<td>1</td>
</tr>
</tbody>
</table>

B3

<table>
<thead>
<tr>
<th>Ultimate value of activity-based teaching</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhances the learning process</td>
<td>5</td>
</tr>
<tr>
<td>Increases participation of students</td>
<td>1</td>
</tr>
<tr>
<td>Learning by doing is fun</td>
<td>4</td>
</tr>
<tr>
<td>Easy retention of material learnt</td>
<td>3</td>
</tr>
</tbody>
</table>

B4

<table>
<thead>
<tr>
<th>54.5% YES</th>
<th>27.27% NO</th>
<th>9.09% YES &amp; NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guided investigations in groups</td>
<td>Unguided investigations in groups</td>
<td>Both guided and unguided investigations in groups...depending on the nature of activity</td>
</tr>
</tbody>
</table>

117
<table>
<thead>
<tr>
<th>Reasons to remain in the background as students do a task</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tutor is facilitator</td>
<td>3</td>
</tr>
<tr>
<td>To allow students to explore as much as they can</td>
<td>4</td>
</tr>
<tr>
<td>To avoid spoon feeding</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How is activity-based teaching implemented</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giving learners-centred practical work</td>
<td>9</td>
</tr>
<tr>
<td>Using a worksheet for the activity</td>
<td>1</td>
</tr>
<tr>
<td>Through guided investigations</td>
<td>3</td>
</tr>
<tr>
<td>Group work</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching methods used in the teaching of practical ‘Hands-on’ activities</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory method</td>
<td>9</td>
</tr>
<tr>
<td>Project method</td>
<td>2</td>
</tr>
<tr>
<td>Discovery method</td>
<td>3</td>
</tr>
<tr>
<td>Field trip</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching methods used in teaching of practical ‘minds-on’ activities</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question and answer method</td>
<td>1</td>
</tr>
<tr>
<td>Discussion method</td>
<td>3</td>
</tr>
<tr>
<td>Inquiry method</td>
<td>7</td>
</tr>
<tr>
<td>Laboratory method</td>
<td>2</td>
</tr>
</tbody>
</table>
### C3

<table>
<thead>
<tr>
<th>Follow-up activities to reinforce ‘hands-on’ activities</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group discussions</td>
<td>5</td>
</tr>
<tr>
<td>Writing notes</td>
<td>1</td>
</tr>
<tr>
<td>Class exercise (Laboratory reports)</td>
<td>6</td>
</tr>
<tr>
<td>Use of worksheets</td>
<td>3</td>
</tr>
</tbody>
</table>

### C4

<table>
<thead>
<tr>
<th>Why conception of activity-based teaching will determine whether your students ‘do’ science or ‘know about’ science.</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conception is related to practice</td>
<td>6</td>
</tr>
<tr>
<td>Conception will determine student participation</td>
<td>2</td>
</tr>
<tr>
<td>Conception is related to mode of assessment</td>
<td>2</td>
</tr>
</tbody>
</table>
Focus Group Discussion

Good afternoon gentlemen.

I would like to thank you most sincerely for making it to this focus group interview/discussion. This interview will take about 30 minutes.

This is a follow up discussion to the issues arising from the analysis of the open-ended questionnaires, which I distributed to you and later on collected.

The questionnaire looked at three issues namely:

(i) Intellectual science process skills Science Teacher Educators focus on as they employ their version of activity – based teaching.

(ii) Science teacher educator’s conception of activity-based teaching at Kitwe College of Education.

(iii) How science teacher educator’s conception of activity-based teaching influences their own classroom practice?

The purpose of this interview ladies and gentlemen is to share and clarify certain information obtained from the analysis of the responses obtained from the open-ended questionnaires.

This afternoon, I wish to share with you some data obtained from the open-ended questionnaire that, 78% science teacher educators indicated that activity based teaching was the teaching that is practical-based. With respect to the intellectual science process skills, science teacher educators employ in their version of activity based teaching, 60% indicated experimental skills. As regards to how science teacher educator’s conception of activity-based teaching influences their classroom practice, 75% suggested that the use of inquiry-based teaching.
Against this background, I would like to get some clarification on the above raised responses and some other patterns of responses that emerged during the analysis of the questionnaire.

Now from what you responded before, can we get some clarity on the meaning of practical based teaching?

STE 1: Er...practical based teaching basically will involve the learners themselves in carrying out an activity and coming up with a solution. The teacher or facilitator has very little to do because mainly a large portion of it is done by the learner.

  Mum: Thank you so much. What is your feeling STE 2:

STE 2: Thank you very much ba Mr. Mum. Er ... I perceive practical based teaching as a kind of teaching which forces a learner to use hands-on. The facilitator only arranges. In other words, he arranges the activities may be through questionnaire or may be through work cards and so on. And then the learner himself or herself does the practice. So in other words it's an activity based using hands.

  Mum: Thank you so much. STE 3:

STE 3: Activity based teaching is whereby like in science, you do something practical, for example, like an experiment, you give instructions how to go about the experiment and they do it or you demonstrate and then the learners do the experiment and checking what they are doing.

  Mum: Thank you so much. STE 4: do you have anything to add on?

STE 4: Yes, as the name implies practical based teaching is the teaching that will involve mostly concrete objects, as opposed to abstract teaching. You, the teacher will have to provide the materials, the resources er ... we are talking about the apparatus and the children as alluded to earlier on will have to manipulate the objects ... That is, hands-on activity. And er... the children will have to make discoveries at the end of it all.
Mum: Thank you so much. We have looked at practical teaching as some kind of teaching, which is hands-on. Does it really involve minds-on. STE 1:

STE 1: Er ... I would say yes, because one er... in order to use hands automatically the intellectual part of it should be involved otherwise one would be doing things not in line with the question. Aam....he really has to use the brain. First, it might be... First he uses the brain, then the hands. Then the brains in the analyses, in the... where he has to now analyse what he has ... the activity he has been doing. The reasoning is actually there.

Mum: Thank you for clarifying that issue. Er...secondly, we er....the people who developed ZATEC curriculum proposed that the college science should be taught according to the process approach. Why do we think that teaching students how to learn, involving an emphasis on process rather than product in learning is important. STE 1:

STE 1: Mum ... Thank you so much. Er... I feel the process should be involved because once this process is acquired a learner will transfer that knowledge to a certain situation. It might be outside the classroom or in our daily activities. If only we based on the... or the emphasis was on the product, it would be mechanical sort of thing, but if the process is involved, it sinks and you may use the same knowledge somewhere else.

Mum: Thank you so much. STE 2:

STE 2: Yah. thanks so much Mr. Mum. Er ... we emphasize process based teaching... more especially in the sense that we also have to make allowance for the learner to construct his or her own learning. So, through the process, that process can be replicated anywhere in any situation, so hence I think the teaching of science, even mathematics also... is important that a process is emphasized.

Mum: Thank you so much. STE 3:
STE 3: A process based teaching is important because the learners need to have certain skills in order to do a science work. These skills assist the learners to do science work using the process.

Mum: Thank you so much. STE 4, anything else?

STE 4: Everything has been highlighted. I don’t need to amplify more than that which has been amplified.

Mum: Now, having said this, which of the processes do you employ in your teaching of science. STE 2?

STE 5: Ok, I will try. Since I am a process based ... but I will try. Er ... I think there are several processes. I think among others, which can, come off the hook ... are the process of observation. I am, am ... I am quite sure most concepts in ... in the ... in science actually also make use of observation where learners are supposed to observe what they are doing and of course go ahead. Sir let me...

Mum: Oh, thank you so much. So one of the processes that has been mentioned is observation. How about you STE 3, which processes do you use in the teaching of science?

STE 3: Er ... In the teaching of science we use processes such as classification, measurement, formulation of hypotheses, we, we do experiments er ... Concluding, predicting er ... May be others could add on.

Mum: You are right that others could add on. STE 4:

STE 4: I think what has been left out er ... Observation and everything to do with observation. And we also do the inferring. Basically, I think that's what we do.

Mum: Thank you so much a STE I

STE 1: Er ... I ... I think I can't add any more. I think they are almost there.
Mum: Thank you so much. Now, a very important pattern that emerged from the responses of the questionnaires is that 75% of us indicated that the concept of activity-based teaching will influence some one to be employing inquiry based teaching as a classroom practice. Why do we think inquiry – based teaching is so crucial in activity – based teaching. STE 1

STE 1: Inquiry er... is very crucial. Er... did you say in regards to what?

Mum: To activity – based teaching.

STE 1: Ok, activity - based. Yees er.... When you talk of inquiry. You are actually trying now to get the actual results. You collect data through asking ... the oral method. But as opposed to the activity based... The activity based is like we alluded earlier on is actually where your use hands. Now to harmonize the two, you have a very tough time and er...using our... our activity based as we normally... that’s the one we are using, you find that it will superceed the inquiry method because the inquiry method will be limited. You might, you might not have or might ask people who might not have the actual knowledge... The actual er... knowledge. I think that’s what I can say about that.

Mum: So STE 1, you are saying that the basic knowledge or pre-requisite knowledge is important in achieving inquiry based teaching. Is that your line of...?

STE 1: In other word, exactly that’s what I mean.

Mum: Thank you. STE 2

STE 2: Yaa. basically I think my first presenter alluded to er... very well. He made a distinction there between inquiry based teaching and activity – based teaching. But all the same even when you are emphasizing on activity based teaching there is an element of inquiry as well because for some one to be able to carry out an activity. Firs. may be ....within that person’s thinking he has to inquiere exactly what is it that he is supposed to do in that particular activity. So, in a nutshell I would say
side by side inquiry based and activity based should go hand in hand if we have to...to achieve meaningful results in our teaching.

Mum: Thank you so much. STE 3 do you have anything to say?

STE 3: Er...er inquiry based teaching? This is whereby a teacher asks, finding out what the learners know rather then telling them. So, I think what is can...

Mum: Thank you so much. STE 4

STE 4: Yes, although much of it has been said but there is also the aspect of the child asking himself or herself as to why certain things happen the way they happen. Er...that is on the hypothesizing...hypotheses stage. And as the practical part is being undertaken the child again will be asking why the result has come out the way it is. Er...that is on the part of inquiry. But we don't leave out the aspect of the teacher setting out certain questions as a guide to what the children ought to discover in the end.

Mum: Thank you so much.

STE 1: May be, let me also add something on inquiry. Like my...the other speaker said, you see, we see inquiry being very crucial in teaching science. This is basically, the learner is actually...has limited knowledge on certain science skills...basic skills. As such it is not easy for a learner to supply the correct answer over a certain phenomenon which he might have limited knowledge...knowledge over that so he, he...activity – based will be better because you will be guiding, there you...there will be actually telling or supplying the answers from their experiences other than. Probably you would ask a question from a...a teacher would ask a question to pupils outside their experience and it would be very, very difficult for learners actually to supply answers. I think that's what I can add...on that.

Mum: Thank you. STE 3 would you also like to add on something.
STE 3: In inquiry-based teaching of science, the pupil...the learners follow a method which follows laid out...laid down steps whereby they start with observation and there is a problem, they hypothesize, then they experiment - just trying to see if the hypothesis is true or not. Then they collect data and then conclude. So they follow that...those steps...like that. So that's why its very important.

Mum: Mum: Thanks very much STE 3. Er...let me acknowledge the presence of Mr. STE 5 who has just arrived to join us.

STE 5: You are welcome. We were looking at inquiry-based teaching as a classroom practice. Why do you think inquiry based teaching is so crucial in activity-based teaching?

STE 5: (The first part was very, very faint. The part which was slightly audible reads)...but the emphasis is on learner-centred activities. The inquiry is important in that respect. Er...learners should be able to investigate...through er...may be through research; book research or experimental research and be able to find out the information that the teacher is trying er...to make them discover. I think it's crucial in that aspect. It will help them discover knowledge. These are my few wards.

Mum: Thank very much STE 5. Your, your few words are actually important STE 5. Er...finally, there was another pattern that emerged. ...was that of the issue of teaching experimental skills in our version of activity-based teaching. 75% er...78% of us focus on this skill when teaching science. Why do you think teaching science through experiments is vital especially at Basic School College's level.

STE 1: Sir.

STE 1: Em...this method of teaching is very vital. Indeed we acknowledge that it's very vital, because it's not very far from that we er...we said earlier on...the activity based. Actually, experiment will constitute...experimentation will constitute activity-based type of method. When a learners are involved in the experiment, there are...they, they, they hypothesize and again they will even give...supply answers according to their observation. The, the process skills actually are at play.
In this case when they are using experimentation method. So, its very, very vital because it will sink in their heads. Its easy to assimilate. The learners are ...assimilate easily other than if it is taught using other methods, although I am not saying; this is the best. There could be other methods that could also be of help depending on what type of topic you are actually tackling. But basically, what I am saying is experiments in, in ...in the teaching of er ...at basic school level are actually very important and learners are able to remember and er ...recall. the retention is er ... they can retain or recall that knowledge easily if they use that method. Thank you.

Mum: Thank you so much STE 2:

STE 2: Yaa, thank very much Mr. Mum. Er...yes, I would say em...the use of experiments more especially at basic college school levels in terms of teaching is very vital. One, I would say through experiments the learners are able to sort of verify certain, certain er ...can I say generalizations which come up, for example, if you are teaching on “air has got pressure” so, they would want to see it practically whether that saying er....holds through an experiment. So, through experiments actually learners actually are forced to think like the original thinkers of that particular concept that they are talking about. So, I would concur with my, my er...the first speaker that experiments, though not the...on their own can constituent ...a...a...best method, but they are a very important component in the process skill.

Mum: Thank you so much. STE 3 do you have anything to add on?

STE 3: em ...when the learners do experiments, what happens is they get information first hand, not second hand, from a teacher. They learn better like that because they are discovering on their own.

Mum: Ok. STE 3 your answers are very interesting. In fact, you may give even er...further er...more answers...you are coming in at a later stage er ...

STE 3: I will add on something. Can I pass...
Mum: Yes...

STE 5: Yes, it's vital because experiments help to prove certain laws and principle. have been taught...the laws and principles...have been taught are true or not. So, its important to do experiments. They will be able to prove, and even verify the, laws, principals and other theories. So, I think as lecturers we need to...to....allow the students to perform experiments, although time may not be there. But, I think we need to create time for them to do the experiments. They will help them prove certain things ...certain facts and generalizations ... Thank you.

Mum: Thank you so much STE 4 anything else?

STE 4: At basic school college level, it's very vital because they are setting a standard from the first stage. I think when people get used to doing experiments at a tender age it will be instilled in them that they, they ought to continue even at a later stage. Then, the skill will be reinforced as they grow up in their older stages. So, it's very, very important.

Mum: Thank you so much. Er...what has come out very clearly regarding the question here was that er...experiments are actually very important because through experiments we can prove, verify, and then there is also the learning of process skills: that the process skills are actually at play when we are teaching through experiments. These are very interesting answers, but does it mean that when we are teaching through activities ...does teaching through activities ensure effective learning. STE 1

STE 1: Er ... If you remember I said there is no best method. Er....experimentation or rather activity based, it applies very well in certain...when you are actually teaching certain topics. Equally other methods could also be quite effective. So, its all about what type of topic are you teaching and what type of learners are you teaching and because in some cases a method would apply in a certain area or classroom or a group whereas the same... If I try to apply the same method elsewhere it might not work as effective as it had worked in the previous one. Basically here, what we are saying is the experimentation is quite good but the
other methods can also reinforce or help actually to...to...to...to... it perfects the activity – based. In short what I am saying experimentation ... I would for... zero in for or I would settle for activity based and use the other method to actually reinforce what I am teaching.

Mum: Thank you, Thank you so much. Do we have anything to say? The rest of us...

STE 2: Er... I mean, mean it has already been said. There is no one clear-cut to say this is the best method that one can approach. But all the same, all these methods actually because they should be used in combination. We only vary depending on the level of difficulty of the topic that we are...and also the level of the learners themselves. The kind of er...the type of learners that we are actually teaching. So, we can’t draw to say, say no this is the best method...its better than this one. To me, I think it is just a combination of them all. I think that’s what I can say.

Mum: Thank you very much  STE 3

STE 3: In addition er... I feel if the pupils do something on their own they...they learn better like that. They, they, they discover so...so many things if they do something own their own. Like that rather than it being done for them or just...they are seated back, they are observing. I think they learn more if they do ... they do it on their own.

Mum: STE 5

STE 5 (Quite faint).  The reason why this one should be emphasized so much is that our learners here are students who should go and teach children; so therefore, when they develop the spirit of experimenting and doing activities, they will apply the same to the children who should also be coached in the same direction of implementing and experimenting... that is why it is important that these activities are promoted.

Mum: Yes, STE 4
STE 4: Ya, with regards to effectiveness of the method, I would say to a certain degree. It is because, earlier on you said it is both hands - on and minds – on. When something is so exciting the children will be able to remember all the aspects that they were doing in that experiment and bearing in mind that most of the principles and laws in science were derived from practical experiments and then finally summarized as a law. So, one would start from experience and practice, it will be very...they would be able to learn more than when it is just done in abstract. So, to a certain degree it is quite an effective method, though it will be complemented by other methods as well.

Mum: Finally, gentlemen, I would like to thank you for making an appearance to this focus group interview. It has been a pleasure having you. Thank you so much.
## APPENDIX H: SCHEMES OF WORK

### KITWE TEACHERS COLLEGE BOARD

### MATHEMATICS AND SCIENCE EDUCATION

### TERM ONE SCHEMES OF WORK 2006

<table>
<thead>
<tr>
<th>WEEK</th>
<th>WORK TO BE COVERED</th>
<th>COMPETENCIES Students should demonstrate</th>
<th>SUGGESTED METHOD</th>
<th>REFERENCE</th>
</tr>
</thead>
</table>
| 1 - 2 | Induction to MSE  | * A secure knowledge and understanding of MSE | * Seminar  
* Group work | * Educating our future  
* ZATTC documents |
| 3-4 | * What is Maths/Science education?  
* Nature of science – scientific method  
* Scientific/process skills  
* Causes and remedies to pupils poor performance in MSE  
* Gender and SEN issues in MSE & Maths/science | * A secure knowledge of the difference between maths/science and maths/science Education Respectively.  
* Ability to use scientific skills and method in solving their problems and teaching maths/science at primary school level.  
* Ability to identify and help pupils with learning difficulties in Maths/science.  
* Understanding gender in relation to pupil’s performance in Maths and science at lower and middle basic schools. | * Lectures  
* Investigations  
* Group work  
* Field trips | * Teaching primary science  
* Teaching primary mathematics  
* A teacher handbooks primary science.  
* Primary science-making it work |
| 5 - 6 | * Maths/science syllabuses and general aims of teaching MS at lower and middle basics school.  
* Strategies/approaches/methods used in teaching M/S  
* Classroom management  
* Theories of learning | * Production of teaching and learning aids.  
* Measures | * Demonstration  
* Peer teaching  
* Lectures | * GCSE Biology  
* Primary science-making it work  
* Teaching primary maths  
* O level physics  
* Farrant |
<table>
<thead>
<tr>
<th>Week</th>
<th>Planning:</th>
<th>*Crop production</th>
<th>*Ability to apply appropriate teaching/learning strategies/approaches/methods</th>
<th>*Demonstrations</th>
<th>*GCE Biology</th>
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<tr>
<td>7-8</td>
<td>*Schemes of work</td>
<td>*Social arithmetic</td>
<td>*Ability to plan, implement and evaluate lessons of stated topics</td>
<td>*Peer teaching</td>
<td>*Primary science-making it work</td>
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<td>*Weekly forecast</td>
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<td>*Ability to make and use TLA effectively</td>
<td>*Lectures</td>
<td>*Teaching primary maths</td>
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<td>*Lesson plans/mark</td>
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<td>*Serial school visits</td>
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<td>Application of methods and planning in:</td>
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<td>*Farrant</td>
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<td>*Number and numeration</td>
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<td>*The four operations</td>
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<td>9-10</td>
<td>Application of methods and in:</td>
<td>*Pressure</td>
<td>*Ability to apply appropriate teaching/learning strategies/approaches/methods</td>
<td>*Demonstrations</td>
<td>*GCE Biology</td>
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<td></td>
<td>*Plants</td>
<td>*Equations</td>
<td>*Ability to plan, implement and evaluate lessons of stated topics</td>
<td>*Peer teaching</td>
<td>*Primary science-making it work</td>
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<td>*Human body</td>
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<td>*The four operations</td>
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<td>*Farrant</td>
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<td>11-12</td>
<td>Application of methods and planning in:</td>
<td>*Shapes and symmetry</td>
<td>*Ability to apply appropriate teaching/learning strategies/approaches/methods</td>
<td>*Demonstrations</td>
<td>*GCE Biology</td>
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<td>*Plant</td>
<td>*Energy</td>
<td>*Ability to plan, implement and evaluate lessons of stated topics</td>
<td>*Peer teaching</td>
<td>*Primary science-making it work</td>
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<td>*Ecosystems</td>
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<td>*Ability to make and use TLA effectively</td>
<td>*Lectures</td>
<td>*Teaching primary maths</td>
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<td>*Balance of nature</td>
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<td>13</td>
<td>Revision and formative assessments</td>
<td>*Revisions</td>
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<td>*Group work</td>
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* Research and consultation worksheets; these must be given to students in time to enable them answer, prepare and present work in time to their class members.
* In topics where students have poor background knowledge, worksheets should prepare and given to students to work on their own, lecturers should concentrate on planning and methods.
APPENDIX I: MAJOR ASSIGNMENT, COLLEGE BASED YEAR, 2006

KITWE COLLEGE OF EDUCATION

MATHEMATICS AND SCIENCE EDUCATION

MAJOR ASSIGNMENT
COLLEGE BASED YEAR, 2006

Instructions for term one assignment
• This assignment is 1 x 2000 words or equivalent
• Marks will be awarded depending on the research done, professional arguments put up, mathematical and scientific competencies exhibited, flow of the language and grammar and logical presentation of work.
• Presentation, acknowledge, introduction, conclusion and bibliography [16marks]

Term 1 assignment
Teaching and learning is an on going process, learning only stops when a person ceases to live. Many people think that anyone can teach, but the biggest problem they face is how to teach. You are required in this assignment to:

a. Define a concept in four different ways as done by different authors and authorities. [12 marks]
b. Define Abstraction and Classification. [10 marks]
c. Mathematics and science as disciplines of knowledge, classify concepts in four different ways. State and explain each of the four classes of concepts. [12 marks]
d. Man uses several methods to extend the boundaries of his/her knowledge. State and explain the two main methods man uses in extending mathematical an scientific knowledge. [10 Marks]
e. Using ONE example from mathematics and ONE example from science, explain the meaning of each of the following terms.
   - Facts
   - Skills
   - Generalization [10 marks]
f. i Concepts are often not separated from their names. How does this arise? [10 marks]
   ii Teaching of definitions in any subject is one important element but, usually, we encounter a problem of circularity. With reference to ONE concept in mathematics and, ONE concept in Science, explain the meaning of a circular definition. [10 marks]
   iii How is circularity avoided in Mathematics and Science? [10 marks]

DUE ON 03/04/06
CURRICULUM COVERAGE

RECORD OF WORK, 2006

TERM ........................................................................................................................................
CLASSES ....................................................................................................................................

<table>
<thead>
<tr>
<th>DATE</th>
<th>WORK COVERED</th>
<th>TUTOR'S REFLECTIONS</th>
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SUPERVISOR'S REMARKS

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