USE OF THE PROCESS SKILLS APPROACH BY ZATEC STUDENT TEACHERS: THE CASE OF SELECTED BASIC SCHOOLS OF KITWE DISTRICT IN ZAMBIA

By

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DECLARATION

I......EMMANUEL MUSESHI........................, hereby declare that this dissertation is my own work and that it has not been previously submitted for a degree at this or any other university.

CERTIFICATE OF APPROVAL

This dissertation by Emmanuel Mweshi is approved as a fulfillment of the award of the degree of Master of Education in Science education by the University of Zambia

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ABSTRACT

The purpose of this study was to investigate the use of process skills approach by student teachers from Kitwe College of Education who were on school experience in basic schools of Kitwe district. The objectives of the study were to: establish the student teachers understanding of the process skills approach, the extent to which they used the approach, and determine the constraints the student teachers faced in implementing the process skills approach.

The research design was primarily a descriptive survey. The study employed the following data collecting instruments: self administered questionnaires for student teachers, observation schedule and semi-structured interview schedules for school mentors and lecturers. The target population was student teachers from Kitwe College of Teacher Education who were on school experience in 2005 in Kitwe district. The sample size was 45, of which 30 were student teachers on school experience, 10 mentors and 5 lecturers.

The study found out that student teachers from Kitwe College of Education were inadequately prepared to use the process skills approach in teaching Integrated Science. They failed to translate the theoretical knowledge they acquired about the approach into practical lessons. The observed lessons revealed that much of the teaching and learning of Integrated Science focused heavily on the acquisition and reproduction of scientific knowledge. Some of the identified constraints to the use of the process skills approach were inadequate knowledge of the process skills approach by the student teachers, lack of learning and teaching materials in basic schools, large class sizes, over-loaded Integrated Science syllabus and inadequate knowledge on process skills by the mentors.

The following recommendations are being made:

- The government should improve on the supply of science learning and teaching materials to basic schools.
- Government should limit the enrollment level in each class.
- Teacher Education and Specialized Services should increase the duration of the ZATEC course from a two year certificate programme to a three year diploma course. The Mathematics and Science Education study area should have two components namely background and methodology.
- The Curriculum Development Center should include objectives in Integrated Science documents that should state clearly the process skills to be developed in each topic or suggested activities.

I dedicate this work to my mother, Ann Chakulimba Mweshi, her life always inspires me to do greater things, thank you mum you are my hero.

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LIST OF ABBREVIATIONS

CDC - Curriculum Development Centre

CPD - Continuous Professional Development

KCE - Kitwe College of Education

MARK- Mathematics Rainbow Kit

MOE - Ministry of Education

NEDCOZ- National Education Distribution Company of Zambia

NOS - Nature of Science.

PRP - Primary Reading Programme

SAPA - Science A- Process Approach

ZASE - Zambia Association of Science Education

ZATEC - Zambia Teacher Education Course

ZBEC - Zambia Basic Education Course

ZPC - Zambia Primary Course

CHAPTER ONE: INTRODUCTION

1.1 Introduction

Integrated Science is one of the subjects taught in lower and middle (primary) basic schools in Zambia. The general outcome of Integrated Science is to help children develop scientific skills, knowledge and attitudes. The syllabus for Integrated Science dictates teachers to use activity-based approaches that enhance pupils' creativity, analysis and problem solving in and outside the classroom (Curriculum Development Centre, 2003; Ministry of Education, 2000). Thus, the teaching of this subject requires a person to be trained to teach it to have an adequate understanding of how to engage children in scientific activities. It's through well planned and conducted science activities that pupils acquire the scientific skills and attitudes essential for conceptual understanding of scientific knowledge and for long life learning. The science teacher is, therefore, not only entrusted with the responsibility of transmitting of scientific knowledge but, more importantly, that of helping children of the lower and middle basic grades to acquire scientific skills and attitudes. These dimensions of science which have not been emphasised by the previous syllabi namely General Science and Environmental Science, help children to explore and understand their immediate environment and the world at large (CDC, 2003).

1.2 Background to Primary Science Teaching Approaches in Zambia

There have been three different primary science syllabi in Zambia since 1966: General Science, Environmental Science and the present, Integrated Science. Each syllabus was designed to respond to the objectives of the national education policy documents of its own time. In order to meet the goals of these syllabi, three different primary teachers' training courses have been designed since 1966. These programmes trained teachers in different approaches in the teaching of primary science.

The first primary training course was referred to as the 'Zambia Primary Course' (ZPC). This course started from 1966 and ended in 1973.The course viewed teachers as transmitters of factual scientific knowledge; hence teachers were trained in expository teaching approaches. The course was teacher-centred, content focused and highly prescriptive in nature. The teachers were trained in this way because they were being prepared to teach General Science which was principally concerned with the teaching of the content of science and excluded other dimensions of science. Teachers used content oriented approaches which stressed the passive role of pupils as the recipients of factual scientific knowledge transmitted by the teacher (MOE 1992). However, this model of science curriculum was discredited by many scholars both local and abroad, because it failed to equip the learner with the ability to cope with his or her immediate environment (Haambokoma et al, 2002, Jerry, 1989, Fraser et al, 1993).

In 1974 a second primary teachers' course called 'Zambia Basic Education Course (ZBEC) was introduced in all primary teachers training colleges in Zambia and it ran up to 1997 in Kitwe, Mufurila and Solwezi teacher training colleges. While in the following colleges; Kasama, Mansa, Mongu Macom Moffat and David Livingstone, it continued up to 1999. In ZBEC, the focus in primary science education was similar to ZPC in that both programmes put more emphasis on teaching of scientific content than other dimensions of science, like process skills. However, this course was a bit liberal than ZPC, it had both features of teacher-centred and pupil- centred approaches. Under this programme, teachers were trained to put the learner at the center of the learning process. This was the focus in the 'Environmental Science,' the primary science syllabus at that time. This changed the role of teachers in the learning process; teachers were viewed as facilitators and were expected to be more creative than before in order to involve the pupils in the learning of Environmental Science. However, the learner-centredness was still in the context of scientific knowledge acquisition as opposed to processes of science. Thus, the pupil-centred approach in the teaching of Environmental Science under ZBEC was still content oriented and failed to equip the learner with science process skills needed to explore and understand his or her immediate environment.

In 1996, the Zambian government came up with a new policy on education "Educating Our Future," in which it refocused the goals of teaching Science at lower and middle basic schools from the acquisition of scientific knowledge to the development of processes of science in children. The policy asserts that;

> The primary goal for teaching science at that level should be to help develop science processes of scientific thinking in children... From the curriculum point of view, there is need to balance content of what pupils learn with the process by which they learn. It also implies an enhanced role for guided discovery, teaching-learning approaches that will enable pupils to use their ideas use their hands and conduct their own investigations however simple (MOE, 1996: 35).

In trying to achieve the above prime goal, the Ministry of Education came up with a new teacher education programme for lower and middle basic (primary) teachers called Zambia Teacher Education Course (ZATEC) in 1997. From 1997 to 1999, the programme was piloted at Kitwe, Mufurila and Solwezi Colleges of Teacher Education and in 2000 it was extended to all government and grant-aided Primary Colleges of Teacher Education. During this period, the Ministry also started developing a new science syllabus, the 'Integrated Science' for lower and middle basic Grades. The teaching of the new syllabus started in 2003. The prime goal of Integrated Science is to develop science processes of scientific thinking in children. It means that teachers are suppose to employ activity-based approaches that allow pupils to use and develop the process skills which are very important tools for conceptual understanding of the scientific knowledge (CDC, 2003).

In order to prepare the college students for the above responsibility, the ZATEC programme gives much more importance to school experience, active participation and reflection of the learning process by the students, and the integration of tradition subjects into study areas (MOE, 2001). Mathematics and Science Education (MSE) is one of the study areas under this programme. The MSE study area equips students with the pedagogical content knowledge in Mathematics and Science. Unlike the previous primary teacher training progremmes, the MSE study area has included 'Nature of Science' (NOS) as an introductory topic to the course (see appendix 5A).

The topic helps students to understand that school science does not only constitute the products of science which is the scientific knowledge, but also the science process skills (MOE, 2000). The term 'science process skills,' refers to a set of broadly transferable abilities appropriate to many science disciplines and reflective of the behavior of scientists (Padilla, 1990; CDC, 1981; Young 1990; Ostlund, 1998). Science-A Process Approach (SAPA) grouped process skills into basic and integrated skills. The basic process skills are observation, inference, measurement, communication, classification and prediction. These skills provide a foundation for learning the following integrated skills such as; controlling variables, defining operationally, formulating hypotheses, and interpreting data, experimenting and formulating models (Padilla, 1990). The science curriculum for lower and middle basic schools in Zambia stresses the development of the following process skills: classification, measuring, communication, prediction, inference, hypothesis and experimenting (MOE, 2000; CDC, 2001; CDC, 2003). Thus, the focus of the study was to establish how the student teachers used the process skills approach to teach these skills in Integrated Science lessons.

Under ZATEC, science teacher educators are expected to use the activity-based teaching by giving students opportunities to learn science through hands-on science activities. Through these activities students are expected to acquire the pedagogical knowledge on how to teach process skills so that when they go on school experience (teaching practice), and finally when they complete their training and assigned to teach, will use the same activity-based approach to teach the Integrated Science (MOE, 2000). This means that student teachers are not expected to teach Integrated Science exclusively as a body of knowledge for solving text book and examination questions but to develop children's ideas, attitudes and acquiring thinking tools for solving problems. The process skills approach implies that the teaching of science should embody the specific characteristics of the discipline it represents. It should reflect the nature of science, as scientists know it. Student teachers were expected to understand that science constitutes science process skills (syntactical structure) and scientific knowledge (substantive structure) and the two have an interactive relationship and these dimensions of science should be taught.

After spending one year in college, students are sent to schools where they try various educational theories and approaches in practice for one year, under the supervision of school mentors. The students are visited by the lecturers once per term for monitoring exercises as part of their job description. After one year of school experience, the students report back to their respective colleges for the rap up exercise for a week.

1.3 Statement of the Problem

The ZATEC programme has been running for five years now, from the time it was introduced in all Colleges of Teacher Education in Zambia. However, very little is known about how student teachers try to put into practice the acquired pedagogical content knowledge in the teaching of Science in basic schools in Zambia. No study has been done to establish the use of the process skills approach in the teaching of Integrated Science in lower and upper basic schools in Zambia. There was an information gap, which this study sought to bridge.

1.4 Purpose of the Study

This study sought to investigate the use of the process skills approach by ZATEC student teachers from Kitwe College of Education in teaching Integrated Science in basic schools of Kitwe district during their school experience.

1.5 Objectives

The specific objectives of this study were:

1.5.1 to establish the student teachers' understanding of the process skills approach;

1.5.2 to establish the extent to which the student teachers used the process skills approach;

1.5.3 to determine the constraints the student teachers faced in implementing the process kills approach.

1.6 Research Questions

The study addressed the following questions:

1.6.1 What was the ZATEC student teachers' understanding of the process skills approach?

1.6.2 To what extent did ZATEC student teachers use the process skills approach in the teaching of Integrated Science?

1.6.3 What constraints did the student teachers face in implementing the process skills approach?

1.7 Significance of the Study

The current trend in the teaching of Science in basic schools in Zambia is towards the process skills approach. Therefore, this study was important in that it intended to establish if student teachers had the adequate knowledge about the process skills approach, the extent to which they used the approach and identify what problems if any, student teachers faced when using the process skills approach. It was hoped that the information generated by this study, may be used by college lecturers, standards officers, In-service Education Training (INSET) providers and other stakeholders in ensuring that student teachers and teachers use process skills approach when teaching science. The study also adds more knowledge and literature to this area.

1.8 Limitations of the Study

Due to insufficient funds and time, the study was limited to the ZATEC students from one Teacher Education College in the Copperbelt, those who were doing their school experience in Kitwe district. Thus, the results of this study cannot be a representative of all the ZATEC students from other colleges or from Kitwe College of Teacher Education who were doing their school experience in other districts

1. 8 Definition of Key Terms

The following are the definitions of terms used in this study.

1.8.1 **Activity- Based Methods:** Teaching methods that actively involves the leaner in hands- on activities

1.8.2 **Constructivism:** The cognitive developmental processes by which individuals abstract conceptual understanding from experience.

1.8.3 **Drawings:** Refers to graphs, tables and diagrams produced by pupils or used by the pupils during hands – on activities.

1.8.4 **Epistemology:** Refers to the theory of knowledge or philosophical study of scientific knowledge, how it is constructed and acquired.

1.8.5 **Hands-on Activities:** Refers to all science practical activities in which learners are actively involved in construction of their scientific ideas using manipulative and process skills.

1.8.6 **Lower Basic School Level:** Refers to lower primary school Grades 1 to 4.

1.8.7 **Mentor:** Refers to serving teachers who have been trained to supervise and guide student teachers on school experience on all professional aspects of teaching

1.8.8 **Middle Basic School Level:** Refers to upper primary school Grades 5 to 6.

1.8.9 **Pedagogical Content Knowledge**: The knowledge formed by the synthesis of three knowledge base subject matter knowledge, pedagogical knowledge, and knowledge of context.

1.8.10 **Process Skills Approach:** Refers to activity- based teaching that emphasizes the development of an enquiry mind and the skills for exploring and interpreting the immediate environment

1.8.11 **School Experience:** Refers to students' practical teaching experience in basic schools under the supervision of the school mentors.

1.9.12 **Scientific Literacy:** Refers to the understanding of scientific concepts and having the knowledge of the processes that create the concepts.

1.9.13 **Student Teachers**: Refers to students under the Zambia Teacher Education Course (ZATEC), on school experience for the final year of their programme.

1.9.14 **Study Area:** Integration of traditional subjects with clearly definable relationships among them into one area of study.

CHAPTER TWO: LITERATURE REVIEW

2.1 Preview

This chapter examined the evolution of the process skills (inquiry) approach in teaching of school science, discussed the use of science process skills approach, its strength and the criticisms labeled against it, and finally reviewed related studies done on science process skills approach.

2.2 Conceptual Framework

2.2.1 *Evolution of the Process Skills Approach in Teaching Science*

Early in the 19^{th} century when science education was still in infancy, the objective was simply to present theories, along with their proof to successive generation of pupils as effectively as possible. The scientific knowledge was considered to be the intellectual heritage of our children (Solomon, 1995). The preoccupation was to fill the child with the scientific facts; the child's mind was considered as empty jag and it was the duty of a teacher to fill it with scientific knowledge (Gott and Mashiter, 1994). Although practical activities were conducted in school science, they took the form of teacher demonstrations to verify facts and theories, which were explicitly presented (Bennett, 2003). As Solomon (1995: 8) puts it "a theory was announced and then practical illustrations were paraded in its honors." Pupils were introduced to topics via practical work in which they made neutral observations, the aim of the practicals was just to illustrate concepts so that pupils could 'see' them in action, it did not lie in the discovery process but in understanding the basic concepts (Millar, 1995). The consequence of this approach, in terms of pupils' learning, has been that pupils acquire fragments of knowledge which they recalled only in the context in which they were taught and reinforced. According to Gott and Mashiter (1994: 179) "opportunities to put science to use in relevant situations were limited since the practical work was so tightly defined and often used purpose-built and 'pupil-proof' (in theory) apparatus."

Later, in the 1920s, the above approach to practical activities in school science was critisised by Armstrong and the naturalist movement in education spearheaded by

Froebel, the originator of kindergarten education (Bennett, 2003; Driver, 1988; Solomon, 1995).

Armstrong was attempting to instill the spirit of initiative and self-reliance, which Baden Powell was trying to stimulate in boys scouts, into the conduct of school experiment (Solomon, 1995; Praag, 1973). Armstrong's argument was that demonstrations or verifications performed in school science were different from experiments, just as trial is very different from execution (Solomon, 1995). He argued that experiments involve prolonged mental activity while demonstrations involve mere mechanical obedience. His appeal was to seek a new dimension to science education in which experiments could be reinvested with all their original excitement and uncertainty. Thus Armstrong supported the heuristic approach in which pupils were trained to find things out for themselves (discovery learning) (Bennett, 2003; Solomon, 1995). Armstrong also urged his pupils not to depend on text books and lectures as these would destroy their power to find things on their own (Solomon, 1995; Praag, 1973).

Armstrong's heuristic approach was very much influenced by the empiricist view of scientific enterprise which holds that all scientific knowledge is reached by a process of induction from the facts of sense data. This view of science suggests that observations, are objective and facts are immutable (Driver, 1988, Solomon, 1995). Thus the approach's assumption was that pupils can only acquire scientific knowledge by being left alone to discover things on their own through objective observations during experiments. Urging children to form conclusions from the results of their experiments appeared to be both an ideal education process and also the likeness to science. The heuristic approach gained support from Froebel and his mentor Pestalozzi who had worked and written about new liberal methods of teaching early in the nineteenth century. According to them, what children most needed was simply the freedom to cultivate their own individuality and exercise their capacity to discover. Naturalists like Leo Tolstoy, went so far along this path that it became hard to see much point in the continued existence of the teachers at all (Solomon, 1995).

However, the Armstrong's method began to fall from favor by 1925. There were many criticisms labeled against the discovery approach and some of them are particularly interesting in light of present arguments about the teaching of science.

To start with, many educators and scientists had problems with this empiricist view of science as epistemological basis for practical work and education in the natural science. Smolicz and Nunan (1975) felt that this stereotype of science and scientists had a very little likeliness to the actual functioning of science and those science curricula were a 'pernicious transfiguration' of what scientists actually do. A number of concerns were raised about the value of pupils finding things for themselves (Driver, 1988). The concerns were raised about the artificial and constrained nature of much of the classroom practical activities. Questions were raised on the legitimacy of encouraging pupils to "be scientists" whilst engaging them in activities which aimed at pre-determined answers. Driver (1988: 3) refers to this as "the intellectual dishonesty of the approach." Moreover it was found that the concept demand of the courses that emphasized discovery learning was proving to be well beyond the ability of the average learner (Bennett, 2003). Pupils failed to discover what was intended, and this was one of the practical difficulties which the approach posed for teachers. This problem did not stem from the competences on the part of the teachers but the fallacies in the assumptions underlying the approach (Millar, 1995). The approach was also criticised that it was too slow to cover the syllabus (Solomon, 1995).

During this same period philosophers of science and scientists realized that the inductivist view of science upon which heuristic approach was based was faulty. The inductivist position had ignored the role that imagination and theory play in the construction of scientific knowledge, in that it considered observations in scientific investigation to objective and not theory dependent. Thus a 'new' constructivist or hypothetico-deductive view of science, identified with the views of Popper and Kuhn, was developed and accepted. This view, asserts that "... theories are not related by induction to sense data, but are construction of the human mind whose link with the world of experiences comes through the processes by which they are tested and evaluated" (Driver, 1988:4). In support of this view Hodson (1986) argues that, there is no such a thing as brute facts, let alone the observation of absolute facts; all observations are theory dependent. Theory does not only determine how the scientists observe but also what the scientists observe. Scientists observe selectively and the tool of this selection is the theory. It tells the scientist what to observe as well as how to describe what is observed (Kirschner, 1992; Ayayee and McCarthy, 1996).

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This view has implications for school science, for pupils, too, should be allowed to observe the world through their 'conceptual spectacles'. Pupils should be allowed to use hypothetico-deductive nature of scientific enquiries, not from observation to generation, but being initiated by hypotheses which are driven by pupils' alternative frameworks (Driver, 1988). Pupils' alternative frameworks (preconceptions), just like conversational theories, don't only determine how pupils observe, but also their acquisition and retention of subject matter knowledge. These pupils' ideas may be poorly articulated but they provide the base on which enquiry activities and formal learning can be built (ibid).

The other reason why science educators started looking for other approaches other than the heuristic approach in the teaching of science was due to the development of the constructivist theory and new understanding of the nature of the children's learning spearheaded by Jean Piaget (Solomon, 1995). The constructivism and Piaget's theory of cognitive development had an impact on the direction of science education reforms. The two theories posed a very big challenge to educators to look for approaches in science teaching that will allow pupils to construct their own knowledge from rich and stimulating learning experiences.

The above developments in theories of learning and the philosophy of science, and the concerns raised on the heuristic approach, lead to the formation of new movements in Britain and the United States of America in the 1950s, which resulted in the formulation of the science syllabuses. The most famous ones were; Physical Science Study curriculum (PSSC) and the Biological Science Curriculum Study (BSCS) in the United States of America, and the Nuffield Science Project in England (Solomon, 1995; Imenda, 1984). At the same time there was a process of change in the approach to science teaching which was to give discovery the pride place. In the Nuffield scheme the emphasis was learning with understanding. They supported this view by quoting the Chinese proverb, 'I hear and I forget, I see and I remember, I do and I understand.' At this time even the long neglected teachings of Armstrong had been incorporated in the new approach, but the true value of the experiments/ practical work in science curriculum lied in the spirit of enquiry, enthusiasm and individually created understanding (Solomon, 1995).

The enquiry approach, with English spelling and meaning, under the Nuffield project encouraged pupils to raise questions about phenomena and work independently to find answers (Harlen, 1997). This approach seemed to be successful at secondary school level where pupils had a good knowledge of a range of phenomena to which the outcome of new, well-designed, enquiries can be linked (ibid). However, during practice, it was found that the main purpose of the Nuffield was still to teach the concepts of scientific knowledge. The practical activities in this project were relatively controlled (guided-discovery) and the 'right answer' often apparent, and the science curriculum of the Nuffield project was examination oriented (Gott and Duggan, 1995; Solomon, 1995). Thus the spirit of imaginative thinking was lost and pupils failed to acquire scientific attitudes and process skills, which was the original aim of the project. Moreover, the strength of the enquiry approach was considered to be a weakness with younger children whose results from their enquiry could be a set of isolated 'islands' of ideas not linked to each other nor indicating any progression in development (Harlen, 1997).

In 1967, a scheme arose in the United States of America called Science-A process Approach (SAPA). It stemmed from the study of the procedures used by the scientists in their investigations (Gott and Duggan, 1995). SAPA placed a firm emphasis on the scientific method or processes as opposed to 'substantive' concepts of science that is facts, laws, theories and principles. Other process oriented schemes which emerged later in the United States of America were: Elementary Science Study (ESS) and Science Curriculum Improvement Study (SCIS) (Wilson and Chalmers-Neubauer, 1990; Ostlund, 1998). The main purpose of these process oriented schemes was to develop the intellectual processes that enable one to attain and use knowledge in a meaningful way (Gallagher and Hurd, 1968). Thus these schemes supported the use of process-oriented approach that encouraged pupil – centred inquiry through well planned hands-on activities. The inquiry approach, with American sense, meant any learning which involved children learning actively through hands-on activities, and took into account the children's previous experiences and ideas (Harlen, 1997). The process skills approach is identified with this approach. In the spirit of inquiry the process skills approach put much emphasis on what scientist do rather than facts and principles of science (Bennett, 2003). The basic mission of scientists is to construct knowledge about how the world works, so that they can explain, predict and control phenomena. Science process skills are the means by which scientists seek data and construct knowledge. The approach proposes that a similar outlook works in science teaching, by regarding the science process skills as tools that enable children to gather and reason about data to make sense of their world (Gega, 1994). After all, if pupils are to construct their scientific knowledge they should be equipped with the intellectual tools to do so.

This alternative approach to science curriculum focuses on the qualities of science education which Millar (1995) termed "the primary or generic qualities" which are of value when facts are outdated or forgotten, in that they remain and are transferable. After all the net result of education is a trained mind, and education is what is left when all that has been learnt in school has been forgotten

2.2.2 *Theoretical Framework Underpinning the Process Skills Approach*

More than any other theoretical development, constructivism has been used to justify the current reforms in science education. In general, constructivism is defined as a collection of theoretical approaches sharing the idea that knowledge, beliefs, values, and meaningful behaviors are constructed in experience (Eisenhart et al, 1996).

Constructivism as a conceptual framework tends to have many different perspectives. For the purpose of this study, the following paradigms of constructivism will be considered; cognitive (Piagetian) and social constructivism. Each of these paradigms tends to look at teaching and learning from a different perspective.

Cognitive constructivism focuses on the cognitive developmental processes by which individuals abstract conceptual understanding from experience. It takes the position that conceptual development occurs through individual mental adaptation, that is, as emergent ideas are tested and found to work and to make sense of one's surroundings (John, 1994). Teaching from this perspective requires the use of approaches that emphasize the need for the learners to be actively involved in the learning process. To have experience with observing, hypothesizing, predicting, manipulating objects, posing questions, researching answers, imagining, and inventing, in order for new constructions to be developed (Fosnot, 1989). Process skills approach is very well justified by this position of the constructivism theory.

The cognitive constructivism has been accused of ignoring the role of the society in ones construction of knowledge. In their work Nicholls et al (1990) with eight and nine-year olds suggested that construction of knowledge by individuals is very much influenced by others. This is in support of Dewey who sees education as a process in which learners co- exist in a democratic manner and in a group effort in problem solving is appreciated. Because of the limited view of the cognitive constructivism on how knowledge is constructed, the study saw the need to consider a much more inclusive perspective of constructivism, the social-constructivism, in justification of the theory underpinning the process skills approach.

In social- constructivism there is an assumed shift from a sole (individual) to a learner located in a social context (group). This paradigm of constructivism states that meanings stem from the consensual domains of individuals (Wheatley, 1991). Supporting this paradigm, Bauersfeld states that "Learning is characterized by the subjective reconstruction of societal means and models through the negotiation of meaning in social interaction" (1988:39). In a science class it is important therefore for teachers to allow pupils in group activities to share their scientific ideas however simple they may be. This provides opportunities for meaning to be negotiated and consensus reached. In this perspective of constructivism, a teacher plays a role of a facilitator, he/she engages with the meanings of learners in their construction of knowledge.

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simple they may be. This provides opportunities for meaning to be negotiated and consensus reached. In this perspective of constructivism, a teacher plays a role of a facilitator, he/she engages with the meanings of learners in their construction of knowledge.

The constructivism approach represents a shift from product (content) oriented science curriculum to a process-oriented one in most of the countries in the world to day, Zambia inclusive. The goals of instructions under process oriented curriculum focus on the development of science process skills that enable learners to attain and use knowledge in a meaningful way (Gagne, 1966).

2.2.3 *Policy Perspectives on the Use of Process Skills Approach in Zambia.*

Zambia has not come up with a specific science curriculum like Science-A Process Approach (SAPA) of the United States of America, to champion the reviewing of the science curriculum with a view of refocusing its emphasis from content oriented to a process oriented curriculum. However, the government intensions on science curriculum especially for basic schools have been greatly influenced by constructivist perspective of how knowledge is constructed.

Previously, the primary science curriculum under the ZPC and ZBEC as pointed out in chapter one, were content oriented. The focus was on the acquisition of factual verifiable bits of scientific knowledge (MOE, 1992). The pupils were considered as passive recipients of scientific knowledge transmitted by the teacher. Commenting on the same, Hayward (1978: 10) pointed out that "... pupils are not taught science in schools, they are only taught about science. Most science syllabi concentrate on a small selection of the basic facts and concepts of science. They ignore its essential nature." This approach to the teaching of science has been cited by many scholars locally as one of the major factors contributing to low achievements by pupils in Zambia (Hayward, 1978, Kelly and Kanyika, 2000). For example the study by Haambokoma (2004) revealed that pupils at grade six level in selected basic schools of Monze district in Zambia, performed poorly in science because they were not given opportunities to participate in the learning process. Seventy six percent of the observed lessons in this study showed that teacher centred approach was dominant.

After reviewing the above concerns and shortcomings of the previous science curriculum, the new education policy "Educating Our Future" realized that science occupies a very important place in primary curriculum and in the attainment of scientific literacy of the majority of the Zambian citizen. Scientific literacy is key in the development of Zambia's economy and way of life of almost every citizen. The policy acknowledges in strongest terms that, "...the ability to think scientifically and to understand scientific processes is becoming a condition for survival" (MOE, 1996: 35). This became the underlying principle in the revision and development of a new science curriculum for basic education. Developing processes of scientific thinking in children has become the focus of the teaching approaches used by the teachers trained under the ZATEC programme to teach the Integrated Science.

It has been 10 years since the new policy was put in place. During this period the Ministry of Education has tried to interpret the policy by putting a new teacher training programme ZATEC and the revised science syllabus, for lower and middle basic Grades, called the Integrated Science in place. It is one thing to make pronouncements in the policy and curriculum documents and implementation is another thing. At this point in time Zambian scholars and science educators in particular should seek answers to the following questions: (a) Are the products of the ZATEC programme well trained to implement the process oriented science curriculum? (b) To what extent are they using the process skills approach in teaching Integrated Science in basic schools? (c) Has the Ministry of Education initiated and influenced supportive and favorable changes in basic schools where the actual implementation of the government policy takes place to warrant the use of process skills approach? (d) What are the major constraints to the use of this approach?

These are some of the pertinent questions which this study sought answers to. Although the findings of this study was restricted to the student teachers form Kitwe College of Teacher Education who were doing their school experience in Kitwe district, this study, being the first, opens more doors for further research in Zambia on process skills approach. It's through research that the above raised concerns and questions can be understood and answered.

This shift in the approach to school science does not entail that process skills should be taught directly but rather through children's experiences in coping with problems in class that give rise to the development of the skills. Gega (1994: 71) points out that "the processes are most productive when guided by a valid conceptual framework." In other words, quality process thinking and accurate knowledge of subject matter are interactive-one helps, and also depends on the other. The SAPA scheme sparked a lot of research projects in the USA and in other countries, which focused on teaching and acquisition of basic and integrated skills, which were reviewed later in this chapter.

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2.2.4 *The Process Skills Approach in the Teaching of Elementary Science.*

The most important and pervasive goal of schooling is to help children to learn how to think, and science contributes its unique skills to this goal, with its emphasis on hypothesizing, manipulating the physical world and reasoning from data (Padilla, 1990). Thus science teaching should not focus on facts only but also on thinking tools that are key to scientific literacy and the technological advancement of any country.

Psychology informs us that for children to grow in their thinking, they need to explore many objects and events and share their experiences. Gega (1994: 71) points out that "...most important, children need to perform mental operations as they do these things." Science process skills are the means by which our children's thinking can be improved because they help in the development of the concrete operative structures, as they explore concrete objects and events in early grades. The development of concrete operative structures forms the foundation for the formal operative structures that facilitates the acquisition and organisation of verbal and complex information without concrete reference later in life (Raven and Calvey, 1977).

In order to learn process skills pupils should work with raw data through the hands-on, open-ended investigation under the guidance of a knowledgeable teacher. The teacher should always make sure that a valid conceptual framework guides these investigations in order to help the pupils to use the process skills to develop their scientific ideas through experience (Gega, 1994). The teacher should have a correct view of science, because how we teach science is related to how we understand what science is (Harlen and Jelly, 1998; Naidoo and Savage, 2004). That is, it affects how teachers manage the learning process, learning/ teaching materials and the class as whole. If a teacher has a view of science as being concerned with established facts, would tend to lead the teacher wanting to ensure that the knowledge of past generations is passed on as accurately as possible to the new generation. Science should be seen as being the creation of human minds and actions, from which comes ideas and relationships that are regarded as always open to challenge and change in the light of future evidence (Harlen and Jelly, 1998; Harlen, 1997). This means that pupils should be involved in the creation of their scientific ideas and relationships through their actions as they use the science process skills in their investigations under the guidance of a teacher. Children always have some ideas or concepts which they bring to a new experience in trying to understand it, and the process skills help them to obtain evidence which help them to change and develop their initial, limited ideas into more widely applicable and helpful ones.

The process skills are the learner's cognitive activity of creating meaning and structure from new information and experience (Mikalsen and Oyunniyi, 2004). From the teaching point of view, they are building blocks from which suitable science tasks are constructed). The skills should therefore be emphasised in science activities in which the following scientific attitudes, curiosity, respect for evidence, flexibility and critical reflection, which control the use of process skills are fostered (Harlen and Jelly, 1998).

Various scholars have advocated the development of children's thinking process by putting much emphasis on the following scientific skills: observation, classification, communication, measuring, inference, prediction, experimenting, interpreting, manipulating and controlling of variables in different activities. In practice these process skills are overlapping and interconnected, they are only separated for convenience (Harlen, 1997; Young, 1990). It should be pointed out that as children attempt to use and test ideas in relation to new experiences, mental and physical skills and scientific attitudes are involved. According to Harlen,

> The development of ideas and understanding goes hand in hand with the development of process skills and scientific attitudes.... Learning with understanding involves the development of ideas through the learners' own thinking and actions and in science this means that process skills are used and developed in a wide range of experiences since there is no way of teaching attitudes directly (1997: 66).

The above claims have been supported by the constructivist theory, which has its roots in cognitive psychology; it proposes that children learn as a result of their personal generation of meaning from experience. This is also in line with the new philosophy of science which views science as " being a creation of human mind and actions from which come ideas and relationships that are regarded as always open to challenge and change in the light of future evidence" (Harlen and Jelly, 1998: 67). The fundamental role of science teachers is therefore to help children to generate connections between what is to be learned and what the children already know (Abruscato, 1996). Developing children's thinking process skills, through different activities could mean anything; it is better to pin it down to how this can be done by discussing the teacher's role in developing these aspects.

2.2.5 *Supporting Development of Process Skills in Children*

Activity-oriented science programme usually gives a teacher a chance to teach a variety of science process skills and foster the scientific attitudes. In these activities, children should be provided with experiences that will help them use and develop the thinking skills and acquire the process skills. The teacher may provide a variety of experiences by:

- Providing opportunities for the exploration of materials and phenomena at first hand.
- Ask open-ended questions which are deliberately phrased to ask for the children's ideas.
- Ask children to draw or write about what they think is happening or predict what will happen as they perform the activities.
- Providing opportunities for discussion in small groups and as a whole class.
- Listening to their talk and studying their products to find out the processes, which have been used in forming their ideas.
- Encouraging critical review of how activities have been carried out.
- Providing access to the techniques needed for advancing thinking skills (Gega, 1994; Harlen, 1997; Young, 1990; Wilson and Chalmers-Neubauer, 1990).

It should be noted that, good questioning techniques by teachers are key in initiating and guiding the use of process skills by pupils as they perform science activities. Children are challenged to further action by questions, which open up avenues for investigation. The student teachers were expected to play the above roles in their teaching strategies in order to develop the following process skills: observation, classification, communication, measuring, prediction, inference, hypotheses and experimenting. The student teachers were supposed to be creative in designing activities that involve children in testing their ideas through their own experiences as they use these process skills to manipulate objects and events. Children's ideas may be limited by their experiences and science activities challenge their views based on restricted evidence. The teacher's role is therefore a: motivator, provider, guide, questioner, listener and instructor (CDC, 1981, Naidoo and Savage, 2004). The process skills could mean anything in other disciplines; this chapter therefore, briefly explains the meaning of each of the above targeted skills in science.

Observing

Observing means using the senses to obtain information, or data about objects and events (Abruscato, 1996; CDC, 1981). It is important that pupils themselves make the observations, gather the data and think about relationships. Science begins with observations of objects and events; this skill is very crucial to the 'method' of science. The teachers should therefore, plan hand-on activities, which allow children to explore materials and phenomena at first hand. They should use their senses to gather and select information (Harlen, 1998; Ostlund, 1998). Observation has two aspects; the ability to notice as much detail as possible and the ability to distinguish between what is relevant to a particular problem and what is not. At primary level, these aspects of observation are guided by the teacher's questions, which help the children to notice important details. The teacher should start with broader questions and later narrow the questions to specific and relevant details to guide learning in observing (Gega, 1994). It is the duty of the teacher to help children use all of their senses to notice how things may be alike or different and become aware of the changes. Acquiring the ability to make careful observations creates a foundation for making inference, hypothesis and prediction, and leads to exploration that require several of other processes, such as classifying and communication (Abruscato, 1996; Gega, 1998; Young, 1990).

The uses of observation skills by pupils in various activities help them to acquire scientific attitudes like curiosity which in turn controls how the children use the observation skill and other skills. Curiosity is the willingness to question and the eagerness to explore the objects and events. This attitude can only be fostered through the use of the process skills.

Classifying

Classifying is the basic process skill, which scientists use to impose order on collection of objects or events. "Classifying is organizing observations, ideas or events so that patterns and relationships can be detected" (CDC, 1981: 15). Children should be given an opportunity to observe objects or events in order to identify their similarities, differences and inter relationships (Abruscato, 1996; CDC, 1981; Young, 1990). The teacher should organize activities that allow children to construct a simple classification scheme and use it to classify objects and organisms in class. Children should be guided by the teacher's questions in focusing the properties or characteristics, such as color, shape, size and characteristics, being used for grouping objects or events (Gega, 1994).

Communicating

In science, communicating means putting the information obtained from observation and investigation into some form so that another person can understand it. Children should be helped to develop this skill by encouraging them to draw and discuss their observation and findings (Abruscato, 1996; Young, 1990). The teacher should design tasks that require children to share ideas, they should listen to others, to explain and defend their ideas. These tasks don't only help children to use and develop the communication skill but also to foster flexibility, which is the willingness to change ideas in the light of evidence. They should be helped to spontaneously seek other ideas which may fit the evidence rather than accepting and keeping to themselves their ideas which seem to fit (Harlen and Jelly, 1998). At later stages pupils should be encouraged to define terms in the context of their own experiences. This is referred to as defining operationally, which is an integrated process skill and it is introduced after primary school.

Measuring

In science activities pupils should be encouraged to make their observations more precise, and this is achieved by measuring. This is the process of comparing things and events with the standard units of measuring (CDC, 1981; Young, 1990). Pupils should measure using both unconventional and conventional units, and use the measurements in making the comparisons, so that by the end of primary school, they will be able to use the following units: seconds, minutes, hour, week, month, year; millimetre, centimetre, metre; gram, kilogram; millilitre, litre; square centimetre, square metre, hectare; cubic centimetre, cubic metre; degrees of the circle; degrees Celsius. These units will help them to make precise measurements of length, area, volume, mass, temperature, time, distance, and distance time-relationship (CDC, 1981). The development of this skill necessitates the basic schools to be equipped with measuring instruments. If the instruments are not adequately available in our basic schools this could be a potential constraint to the development of this skill, which is what this study sought to find out.

Inference

An inference is a tentative conclusion deduced from observations or recorded data (CDC, 1981). It is the process of interpreting observations or data. Children should be encouraged to state their interpretations of the observed phenomena or data in tentative terms, usually as a cautious 'open' sentence, often prefaced by: 'It seems that...,' 'I think...,' 'The evidence suggests that...' They should be encouraged to make as many inferences as possible and then proceed to test each one of them. These statements form the basis investigations in early grades at primary level.

Predicting

A prediction is a specific forecast of what a future observation or event would be. It is the teacher's job to design tasks, which encourage pupils to make predictions based on observations, measurements and inferences about relationships between observed variables (Abruscato, 1994). A prediction that is not based on observation is only a guess. Children should be encouraged to make prediction early in the science curriculum from very simple sets of data and graphs, later on they can make predictions on the basis of opinion surveys and other sources of data. Prediction helps to encourage positive attitudes towards science activities as they work anxiously towards the verification of their predictions.

Hypothesising

Harlen (1998: 76) defines hypothesis as "an attempt to explain some observation, happening or relationship." Formulating hypotheses is an integrated skill, though complex, it has to be introduced as early as possible in that, it guides the use of other process skills like: experimenting, planning, interpretation of data and even controlling of variables. Children can be introduced to this process by first learning to distinguish between hypotheses and observation and later to distinguish hypotheses from inference and prediction (Abruscato, 1994). The teacher can help the pupils to develop confidence in ability to suggest explanations by asking for several possible alternatives in situations where there is not necessarily an obvious answer to a problem (Harlen, 1998). The art of questioning is key in stimulating the generation of explanations based on the children's ideas. Children should know that their suggested explanations (ideas) are tentative which have to be checked against evidence through investigations.

This skill provides the teacher with an opportunity to access the children's existing ideas as stated earlier. It also fosters scientific attitudes like, respect for evidence, pupils develop the willingness to collect and use evidence to check their explanations through investigations.

Experimenting

Although this is a complex skill, pupils as early as Grades 6 and 7 should be encouraged to test their hypotheses, answer questions, verify or demonstrate known facts or principles by conducting simple scientific activities. Since there are many different types of questions and problems, each with suitable methods of solutions, children will need many experiences guided and supported by the teacher before they can recognize and select suitable methods. However at elementary level an experiment may involve the following steps:

1. Observation of the phenomena.
2. Problem identification.
3. State a hypothesis, making a generalization from a set of observations,

inferences or data.

4. Identification of variables which could affect the out come.
5. Devising and carrying out activities which test an hypothesis, answer a question, or verify previous results.
6. Reject or modify an hypothesis in the face of inconclusive or contrary evidence.

(CDC, 1981; Young, 1990).

These steps are illustrated in an example of an experiment on magnetism see Appendix 6.

Teacher should always remember that knowledge gained in a scientific investigation may be used to predict what might happen in a related situation. Frequently during experimentation new problems and questions will arise. This skill may involve all the other process skills. If well planned for in any science activities, process skills help children to verify and develop their scientific ideas. They are the means through which they attain and use knowledge in a meaningful way.

The activity- based approaches that focus the above skills seem to be the only answer to low achievements by pupils in science in our basic schools, but what was worrying was that we seemed not to know the extent to which this approach was being implemented in basic schools. Hence there was need for the researcher to carry out this study.

Although the process skills approach has been haled as the best approach in teaching school science, it has some shortcomings which have been highlighted by many scholars, and they are discussed below.

2.2.6 *Criticisms against Use of Science Process Skills Approach*

Most of the criticisms against the process skill (inquiry) approach stems from the assumptions for the major shift of emphasis away from the teaching of science as body of knowledge towards increasingly emphasising on experience of processes and procedures of science. One of the assumptions for the shift is that scientific knowledge is best learned through experiences based on the procedures of science. Kirschner (1992) argues that the basic error here is in assuming that pedagogical content of the learning experiences is identical to syntactical structure of the discipline that is being studied. Syntactical structure is the pathway of inquiry that scientists use, it is concerned with ways in which new substantive concepts are formed and the ways in which different kinds of scientific knowledge is validated (ibid).

The above assumption that teaching science using science process skills approach is identical to the syntactical structure of science has led to failure by educators and curriculum developers to distinguish between teaching/learning science and doing science. Consequently they are uncertain as to distinguish between the epistemological and psychological basis for teaching science (ibid). It has been argued that the aims of teaching /learning science should not coincide with the aims of sciences which the process skills approach seems to propose. Hodson (1990) points out that the mistake lies in overlooking that pupils do not practice science, but are learning about science and learning to practice science and it is the job of the teacher to teach science and how to do science. Children are not scientists but learners of science. Ausubel (1964) states that a scientist is engaged in a full- time search for new, general or applied principles in a field whereas a pupil is engaged in learning the basic subject matter of science which the scientists learned in his/her pupil days plus the way in which the scientist practices.

Teaching of science should therefore be concerned with introducing pupils to a body of knowledge (substantive structure of science) and familiarising them with the way a problem–solving scientist works (syntactical structure of science). The substantive structure of science (body of knowledge) is a vehicle in aiding understanding and enjoyment of science while the syntactical structure of science (the habits and skills of those who practice science) is a vehicle in helping pupils to develop attitudes and to use them. Both of these aspects should be emphasised in the teaching of science.

The other area of debate has been on the assumption that syntactical structure of science enhances the learning of scientific knowledge. It has been argued that although one of the original purposes of practical activities was to help develop understanding, an aim that was identified by the proponents of the process skills approach, there is a surprising lack of evidence to support this claim (Bennett, 2003). Most studies suggest that science-specific skills are the only things pupils learn better through actually doing practical activities for themselves, and that practical activities have little impact on the development of understanding, though they motivate pupils in lessons (Yager et al, 1969).

The proponents of the above assumption tend to believe in the old saying, 'if you – do-it yourself it sticks'. Tamir (1976) pointed out that the problem here was that pupils often were unable to explain what they did or why they did it even immediately after performing the activity. The other reason for the proponents of practical activities as the means for meaningful learning is based on the belief that discovery learning is synonymous with and is thus the only way to achieve meaningful learning (Kirschner, 1992). Hodson (1986) pointed out that this characterized a wide spread adoptions of the epistemologically weak and pedagogically inappropriate discovery learning and process approach, that deliberately avoided giving the learner a prior theoretical understanding of the context of the practical activity. It should be noted that theory and practical activities have an interdependent and interactive relationship, practical activities assist theory building and in turn theory determines the kinds of practical activities to be carried out and their interpretations (Kirschner, 1992). This just shows that without a good conceptual framework meaningful observation cannot take place. Meaningfulness of an event (an experience with sensory data) depends upon on the kind of relevant information the learner already posses in that, what the learner knows determines what the learner sees (Suchman, 1966). Existing knowledge is critically important for learning science in that this knowledge consists of integrated structures of conceptions (organised units of substantive knowledge) and procedures for using the structures (syntactical knowledge), which are used to make sense of new phenomena, construct more appropriate concepts and solve problems (Hewson, 1980).

The other criticisms labeled against the process skills approach are that, the approach presents a distorted and oversimplified view of science and it lacks clarity over the meaning of the terms 'process' and 'process skills.' The word 'skills' has been used in the context of practical work in a variety of different ways. Hodson (1990) distinguishes between skills which are science-specific or what he terms craft skills, which are necessary for future scientist and technicians, and skills that are more general such as measuring.

The claim that process skills have special link to science has also been questioned, because they are simply convenient labels for general approaches which we use all the time in making sense of the world (Millar, 1995). They are common to systematic thought in all formal discipline and why should we claim to teach them? Children, for example, are encouraged to observe in science lessons, to pay attention to detail or make relevant observation. Millar (1995: 168) argues that the problem here is "... how will pupils know what is relevant and what details to pay attention to without some kind of hypothesis or prior expectations?" Pupils need the background knowledge about what they are looking at and guide the process of selection; this agrees with the accepted view that observation is theory laden (Hanson, 1958). It has been argued that the notion presented by the approach that science processes can be seen as something separate from the content and context in which the processes are being developed is a fallacy (Millar, 1995). They have also questioned the extent to which it is possible to break down aspects of scientific inquiry into a hierarchy of discrete processes and the validity of the claims that processes such as observation can be taught. Millar (1995) points out that although it has been argued that the process approach seeks to involve pupils more actively in science than the content dominated transmission of science, it confuses the means and ends. It fails to see that active learning approaches are the means of engaging pupils' attention and interest in science lessons' but are not themselves the ends or goals of the instructions.

2.2.7 *The Way Forward*

The above criticisms against the approach are remainders to science teacher educators, curriculum developers and teachers that the science curricula should help children to use and develop science process skills whilst enhancing the learning of scientific knowledge without divorcing the two. It's true that process skills are not separated from content when problems are encountered in real situations. However, in classroom context, it is often convenient and helpful to isolate the processes so that activities can be planned to provide pupils with intensive practice on the skills (Tobin, 1984). It should be emphasized however, that teachers should always make sure that a valid conceptual framework guides pupils' activities that enable them to use and develop science process skills, and they should bear in mind that pupils are not scientists but they are learning about science and how to do science, thus a knowledgeable teacher should guide them through the process of inquiry.

One of the outstanding strength of the process skills approach is that it remains the best approach for skills and attitudes development, and it motivates the pupils more than content oriented approaches (Padilla, 1990; Ostlund, 1998). Motivation is key to learning process, it determines what, how and how much a child learns, according to behaviorists theory of learning, what a child does and consequently what a child learns depends on the child's behavior during the process of learning (Abruscato, 1996). Thus the approach ensures the maximum participation of the learner. The process skills approach reflects the nature of science, as scientists know it. Content alone does not represent science. Teaching of science should therefore embody the specific characteristics of the discipline it represents.

Gott and Mashiter (1994: 185) point out that "the way forward is to construct a curriculum around a series of tasks that have within them the elements of motivation that stem from confidence in the sense of ownership of the activity by the pupils." This approach to the curriculum is represented in figure 1 as outlined by Gott and Mashiter (ibid) on the next page.

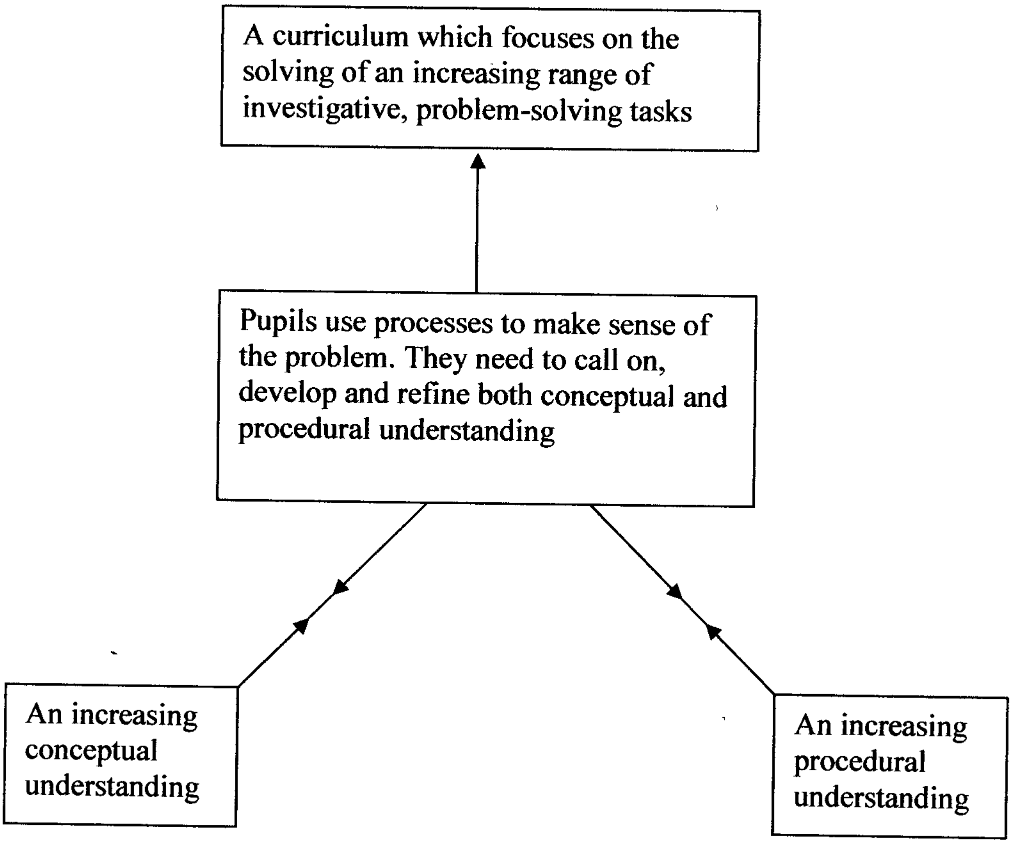

Figure 1. Processes mediate procedural and conceptual understanding in the solution of a task

Source: Gott and Mashiter, 1994: 185

This approach means that science can become a more exciting and relevant school subject for learners but also place considerable demands on teachers (Dekkers, 2002). This makes science relevant, real, meaningful, exciting and accessible to every one and not just to those who can succeed in absorbing a multitude of facts and abstract relationships (Harlen and Jelly, 1998). The approach provides pupils with thinking tools that are not only applicable in the context of 'school science,' but to life in general (Harlen and Jelly, 1998; Gallagher and Hurd, 1968). In this way, science will contribute its unique skills to one of the most important goals of schooling, that is, to teach the pupils to think (Padilla, 1990).

The above discussion points only to one thing, that the science process skills approach is the only means by which primary science curriculum can help children how to think and develop scientific ideas and attitudes.

2.3 Review of Related Studies on Process Skills Approach

The studies reviewed in this section focused on the following: use of process skills in teaching and learning science, mobilisation of the skills in performing cognitive tasks and impact of science process skills on the pupils' performance.

Science curricula in many countries have claimed to have shifted from knowledge transmission model to science process skills. Zambia and other neighboring countries like Zimbabwe have not been left behind in the curriculum reforms in science education. In Zimbabwe, Moyo and Nyikahadzoyi (2005) carried a descriptive survey in Masvingo district. The purpose of the study was to determine if primary teachers and pupils in this district made adequate use of science process skills in teaching, learning and assessing science. They found out that theoretically more than 90 percent of the teachers in Masvingo district were prepared to teach science using discovery-teaching approaches. They acknowledged that discovery-teaching methods are more effective, more enjoyable and exciting to pupils than expository teaching. The pedagogical instruments prepared by the teachers also showed that teachers had clear intension of using science process skills in teaching and learning of science.

However, in practice teachers never used science process skills in their science lessons. They emphassised the acquisition and production of science content rather than on the use, acquisition and development of science process skills. The findings of their study, Moyo and Nyikahadzoyi (2005), resonates with other results obtained in other countries like South Africa (Ogunniyi, 1986), and China (Yu and Bethel, 1991). The study by Moyo and Nyikahadzoyi (2005), just confirms two important points that, teachers do not always put into practice the acquired pedagogical knowledge, and how teachers translate the theoretical knowledge into practical lessons is very much influenced by the context. In this study, the teachers confirmed that they could not use science process skills because of lack of teaching and learning resources in primary schools. It's therefore, not enough to just make declarations in education policies and other pedagogical documents of what we expect science syllabuses should be, how it should be implemented and what outcomes are supposed to be met, without creating a supportive environment in schools. This seems to be the case in Zambia because the picture that emerged from the research on assessment and learning in Zambia was that many teachers in basic schools were struggling with crowded classrooms and poor resources (Kelly and Kanyika, 2000; Haambokoma et al, 2002).

Thus, the researcher was interested to find out what was happening to the student teachers who were practicing to teach the new Integrated Science syllabi using the inquiry approach that balances content of what pupils learn in science with the processes by which they learn (MOE, 1996), by conducting a similar study in Zambia.

Other studies have focused on the pupils' use of ideas about certain topics and the process skills they used to perform the tasks on those topics. Mikalsen and Ogunniyi (2004) carried out a study whose purpose was to determine the ideas and process skills used by South African and Norwegian pupils to perform cognitive tasks on acids, bases and magnetism. They used two assessment instruments namely; 'My ideas about acids and bases' (MIAB) and 'My ideas about magnetism' (MIM). The assumption of the study was that when a pupil for one reason or another could not perform the cognitive tasks, he/she lacked the necessary understanding of the concepts and consequently the ability to mobilise appropriate process skills. Each of the two assessment instruments had 7 questions and pupils were asked to perform cognitive tasks using process skills, which were grouped into two major categories: classification/conception process skills, and application and decision-making process skills. Question 1 of the MIAB, for example, displayed 11 pictures of labeled household items: vinegar, cement, sunlight bath soap, coca cola drink and others familiar to the pupils. This question required the pupils to classify these items into acids and bases using the classification/ conception process skills of the assessment framework. The result showed that only 54 percent of the South Africans and 29 percent of the Norwegian pupils were able to group the substances into appropriate categories.

The overall results on various questions on the MIAB and MIM revealed that the two groups hold the same valid ideas about acids, bases, and magnetism. However, they were not able to mobilise necessary classification/conceptual and application decision-making process skills to perform cognitive tasks. Instead of using the scientific conceptions to perform cognitive tasks on MIAB and MIM, they relied on their alternative conceptions (commonsense notions) to perform such tasks. In other words they lacked the understanding of the concepts, which serve as the context for mobilization of the process skills needed to perform the task. This study agreed with the argument put across by many scholars, already discussed in this chapter that content should not be isolated from the process skills, because performing any activity involves the interaction of the two (ibid).

Many studies have been done on science process skills especially in the United States of America by the following projects: Elementary Science Study (ESS), Science Curriculum Improvement Study (SCIS), and Science-A process Approach (SAPA). The results from these projects indicate that process approach programmes are more effective in raising pupils' performance and attitudes than traditional content-based programmes (Ostlund, 1998). They also indicate that elementary pupils, if taught process skills, do not only learn to use these processes, but also retain them for future use (Padilla, 1990). Results from meta-analyses by Shymansky et al. (1983) on pupils' performance under the activity-based programme, in terms of achievements, perceptions, and performance on process skills out performed their counterparts under the traditional elementary school programme. The hands-on activity oriented approaches are more effective in enhancing pupils' achievements and problem-solving skills than expository approaches.

Other studies have explored the relationship between the use of process approach in elementary schools and the development of formal thinking abilities described by Piaget. In their study entitled, 'Achievement on a test of Piaget's Operative Comprehension as a function of a process-Oriented Elementary School Science Programme', Raven and Calvey (1977) found that one of the major benefits that is accrued from concrete referenced, activity-oriented programmes is the development of a concrete foundation for thinking and operative comprehension that later can be used as a basis for more abstract thinking that uses information which is not concrete referenced. This study used experimental design, the experimental schools used the Science-A-Process Approach programme from kindergarten through the sixth grade and the control group used a traditional text-oriented programme. The Science-A-Process Approach provided pupils with experiences in organizing concrete objects and natural phenomena in a variety of ways. The process of organizing concrete objects and events uses the operative structures that provide a solid referential background for more abstract situation such as reading (ibid). The following tests were administered to both groups, the Raven Test of Logical Operation (RTLO) and the Raven Content Comprehension Test (RCCT). The RTLO is composed of pictorial problems while the RCCT is composed of 12 paragraphs and each paragraph was followed by two questions. Each test employed the following operations, classification, seriation, logical multiplication, proportionality, compensation, probability, and correlation.

The results of the study showed no differences in scores in RTLO and RCCT tests at both sixth and eighth grades while at eighth grade those who underwent through the SAPA performed better on RCCT than the control group. The results show that the SAPA programme had produced a foundation for concrete thinking, which was later, used as a basis for formal and abstract thought. At this stage pupils are able to comprehend information by using logic operations to structure or reorganize verbal information. Piaget calls this process 'operative comprehension.' (ibid)

The liability and the validity of this study are subject to question. In that the results obtained in the quasi-experimental design cannot always be attributed to the treatment alone. There are always other variables, which are beyond the control of the researcher, variables like the pupils and teachers' ability and their responses to the expectations of the introduced treatment (Cohen et al, 2002). The fact that the experimental group is given special treatment, they are bound to perform better than the control group. The study also skipped one of the crucial steps in quasi-experimental design, the pre-test, to test the performance of the two groups before the treatment was introduced to the experimental group, so that the outcome could be attributed to a new programme introduced to the experimental group.

2.4 Summary of the Literature Review

Most of the reviewed literature in this chapter stressed the need for reform in primary science teaching from content oriented approaches to process kills approach so that pupils could learn science in a more authentic manner and acquire process skills for transforming, organising, storing, and using information useful in problem solving. In conclusion the reviewed literature points out that:

- Activity oriented approaches that involve pupils in the learning process, have a more holistic approach in enhancing the development of skills, attitude and scientific ideas in children than knowledge transmission models.
- Teachers in countries where research has been done failed to use the process skills approach because they did not have adequate knowledge on how to use the approach, time, and learning and teaching resources.
- Process skills can not be separated from content, the two are interdependent. For pupils to use the process skills effectively in performing tasks in science they need to have adequate knowledge on the topic.
- Process skills if taught, remain even when the facts are forgotten and are transferable to other situation in life.
- Process skills refine conceptual understanding hence they enhance pupils performance, though this has been questioned by many scholars as the basis for practical work in school science.
- Under the process skills approach a teacher is seen as a: motivator, provider, guide, questioner, listener and instructor.

However, the literature reviewed said nothing about how ZATEC student teachers in Zambia use the approach. Hence this study sought to investigate and contribute to what is already known about the use of process skills in teaching and learning of primary science.

CHAPTER THREE: METHODOLOGY

3.1 Overview

This chapter outlines the methods used to collect and analyse data. It gives a description of the research design, study population, sample size, sampling procedures, research instruments, data collection procedures and data analysis. Before the actual study was conducted, a pilot study was done on selected student teachers who were in the target study population but not in the study sample. The purpose of conducting the pilot study was to remove ambiguity in the instruments and to sharpen them so as to answer the research questions more effectively. It was also meant to determine whether the research design was appropriate or not.

3.2 Research Design

This study used a descriptive survey design. This design was chosen because it is economical and efficient in that, it gathers data in one- shot basis (Cohen et al, 2002). A descriptive survey has several characteristics, and some of them are reflected in this study:

- Using of the same instruments and questions for all the participants in order to gather standard information.
- Capturing of data from multiple choice, closed and open-ended questions, and observation schedules.
- Using of sampling techniques in order to represent a target population
- Gathering of numerical data.
- Provision of descriptive, inferential and explanatory information

(Cohen et al, 2002; Kulbir, 2003; Struwig and Stead, 2001).

In order to obtain comprehensive results both qualitative and quantitative research methodologies were used. In most cases the two techniques compliment each other, in that qualitative research dwells on quantitative techniques and vice-versa.
The qualitative research methodology was used because the research questions were open-ended. Thus the study's main objective was not so much to disprove a

hypothesis or theory but to seek a new understanding of how student teachers were trying to implement the process skills approach. The research also demanded that the field of study was in the natural setting of the student teachers engaged in their normal everyday teaching activity, meaning no experimentation was needed (ibid). Thus the study used observation and semi- structured interviews which are the most effective procedures of collecting qualitative data. Lesson observations and semi-structured interviews for mentors and lecturers provided the study with the multiple angles of understanding the problem as an internal method of triangulation by way of validation (Kulbir, 2003; Struwig and Stead, 2001).

The study also employed quantitative research methodology in that a numerical method of describing observations was needed to produce quantifiable and, if possible, generalisable conclusions on the use of process skills by the student teachers (Best and Kahn, 1986; Kulbir, 2003). The closed questions in the self – administered questionnaire for student teachers, semi- structured interviews for mentors, and the observation schedule provided the quantitative data.

3.3 Target Population

The targeted study population was the student teachers on school experience from Kitwe College of Education who were teaching in government basic schools of Kitwe district. The students were chosen for this study because they were easier to be accessed in a study like this one (Cohen and Manion, 2000), than their counter parts, the graduates who had been posted all over the country. Kitwe district was specifically chosen because it had a large concentration of student teachers; the district hosted 100 student teachers during 2005 / 2006 academic year. In order to get more comprehensive results, the study included all the mentors in basic schools and lecturers in Mathematics and Science Education section at Kitwe College of Education.

3.4 Sample Size

The sample size of this study was 45, which comprised 30 student teachers who were selected using systematic sampling technique, Five (5) science lecturers in Mathematics and Science Section at Kitwe College of Education and 10 mentors who were supervising the sampled student teachers were purposively sampled. This sample was representative enough considering the nature and the purpose of this study. The study needed a relatively small sample size in that, it required the use of triangulation in data collection instruments; questionnaires, structured interviews and non-participant observation (Cohen et al, 2002; Best and Kahn, 1986). If a larger sample were picked, it would be very difficult to triangulate the data collecting methods especially lesson observation which required a lot of time.

3.4.1 Characteristics of Sample

(i) *Student teachers*

These were school leavers with Grade twelve certificates with at least three credits in 'O' level subjects. The students had finished their first year of the ZATEC programme in college. At the time of data collection, they were in their final term of the school-based programme, as such, they had acquired enough pedagogical content knowledge and school experience, to give their own version of what teaching of science was about.

(ii) *Mentors*

These were senior teachers in basic schools who had been in the teaching service for not less than 10years, with a certificate either in Zambia Primary Teaching Course (ZPC) or Zambia Basic Teaching Course (ZBEC). All of the interviewed mentors were trained at Kitwe College of Teacher Education in the supervision of the student teachers

(iii) *Lecturers*

All the five (5) interviewed lecturers were tutors in Science Education, a component of Mathematics and Science study area, of which two were diploma holders, two were Bachelors' degree holders and one had a Masters degree. Out of the five lecturers, only one had served less than five years, and the rest had been lecturers for ten years and above

3.5 Sampling Procedures

The study sample was selected from the study population using the following sampling techniques briefly described later in this chapter; systematic and purposive sampling. The selection of a subset to represent the entire study population was done because of the following reasons:

- It saved a lot of time, energy and money in carrying out the study; it was economical in terms of costs in that data was collected only from a fraction of the population. Sampling was also less time consuming than the census technique.
- It made the study manageable hence it was possible to collect intensive and extensive data.
- It reduced the volume of work, therefore careful execution of field work and data processing was possible (Kulbir, 2003: 256).

In Kitwe district, schools were grouped in three zones, A, B and C. Zone A covered schools in the northern part of the district, starting from Kitwe Central Hospital up to Hybrid area. Zone B covered all the schools in Kitwe Central, Parklands, Nkana East and West up to the show grounds area. While Zone C of the district went up to Kanfinsa area. The number of students posted to Zone A, B and C was 54, 20 and 26 respectively. In order to get a representative sample, student teachers were selected from each zone using systematic sampling technique. The number of student teachers selected from each zone was determined by the proportions of the population of each zone to the study population (Cohen et al, 2002; Best and Kahn, 1986). Systematic sampling is one of the probability sampling techniques. It involves selecting an initial point on the list of names of the target population by random process and then every n^{th} number on the list is selected (Struwig and Stead, 2001). In this study a list for each zone was prepared and the sampling frame table 3.1 was used to systematically select the participants in each zone.

Table 3.1 Sampling Frame

Zones	A	B	C	TOTALS
Number of student teachers (N)	54	20	26	100
Proportions to the study population	0.54	0.20	0.26	1
Samples (sn)	16	6	8	30
Number of schools	5	3	2	10

To systematically select the samples from each zone, the following formula was used
f = N/sn where f = the frequency interval

N = the total number of the wider population,

sn = the required number in the study sample (Cohen et al, 2002; 100)

For example Zone A had 54 (N) student teachers and the required number in the sample (sn) was 16, this meant that every third person on the list of students for zone A was selected. Systematic sampling was used so that each student teacher in each zone had an equal chance of being selected, and as such the total sample picked was a representative of the study population. After the students were sampled, mentors and lecturers were selected using purposive sampling technique. One mentor in each of the ten schools where the selected were teaching was purposively selected. The mentor who was directly in charge of the sampled student teachers in each school was selected to take part in the study. All the 5 science lecturers in Mathematics and Science section at Kitwe College of Education were selected. The purposive sampling technique was used in selecting the mentors and lecturers in that it enabled the researcher to have complete control in selecting information- rich participants to meet the objectives of the study (Struwig and Stead, 2001; Kulbir, 2003). The mentors and the lecturers were key stakeholders in the ZATEC programme as such they were in a better position to provide vital information to this study.

3.6 Data Collection Instruments

The following instruments were used;

(i) *Questionnaires*

This was a self-administered instrument for student teachers only. The instrument was developed by the researcher. It comprised mainly of Likert scale-type items, dichotomous and open ended questions. (see appendix 1). The Likert scale- type items were adapted from science teaching activities evaluation checklists in Trowbridge and Bybee (1996),

(ii) *Semi-structured interview schedules*

Two different interview schedules were used. These were targeted at the science lecturers in Mathematics and Science section at Kitwe College of Teacher Education and mentors supervising the student teachers in basic schools. The questions in the interview schedule for lecturers focused on the student teachers understanding of science process skills approach and the constraints which might have stemmed from the course. The instrument for mentors focused on the student teachers' use of process skills approach and the constraints, if any, in the use of the approach encountered by the student teachers in various schools. The instruments were developed by the researcher.

(iii) *Observation schedule*

This instrument focused mainly on the second and third objectives. It was used to confirm and counter check the information collected by the questionnaires. It focused on the information that could not be captured by other instruments. Its main focus was to examine the following aspects of the lesson; lesson objectives, teaching methods, type of the science activities and the learning/ teaching materials student teachers used in science lessons. (See appendix 4). The instrument was adopted from one of the lesson observation instrument used by the department of Mathematics and Science Education of the University of Zambia. A few modifications were made to the instrument to suit the study. The issue of internal validity was taken care of through audit- trail and chain of evidence. That is each section of the observation schedule was followed by clear description of what was observed in form of comments.

3.7 Data Collection Procedures

The data collecting process was carried out after the instruments were piloted to check for clarity, meaningfulness and gaps in the questions. The actual data collection was conducted in the first term of 2006 academic year from 10th February to 31st March. During this time student teachers were in their third and final term of their school experience programme. Data collection took eight weeks. The questionnaires were distributed by the researcher himself, to the sampled student teachers in Zones A, B and C in that order.

To gain access to the respondents in basic schools, the researcher reported to Head Teachers or Deputy Heads who introduced him to the mentors and student teachers. Interview and observation appointments with the mentors and student teachers were made respectively during the distribution of the questionnaires. One mentor was interviewed at each school; the interviews were tape recorded and later transcribed in the spaces provided in the interview schedule. After the mentors were interviewed, student teachers were observed according to the observation time table agreed upon by the researcher and the student teachers with the knowledge of the mentors. The observations were recorded using an observation schedule. The researcher also examined the work in pupils' exercise books and took some observation notes on the type of work given to pupils. The researcher had a brief discussion with each participant just after observing his/her lesson to find out if they were aware of the process (investigative) skills which they were supposed to teach in the observed lesson, and if they were able to identify the process skills at planning stage of the science lesson and reflected them in the objectives.

The lecturers were the last participants to be interviewed. The researcher reported to the principal who introduced him to the head of Mathematics and Science Education section. The Head of the section called the science lecturers and asked each of them to indicate when they could have an interview with the researcher. The interviews were tape recorded and later transcribed in the spaces under each question in the interview schedule. The participants in the study were identified by codes. ST was used for student teachers followed by the student's questionnaire number. For example, the respondent number 23 was "ST23." L and M were used for lecturers and mentors respectively.

3.8 Data Analysis.

The quantitative data was subjected to computer generated frequencies and percentages as well as cross tabulations using the Statistical Package for Social Sciences (SPSS) software. While qualitative data was subjected to coding of themes, categorization and re-categorizing of themes until the most significant ones emerged. This information is presented in form of charts and tables in the next chapter.

3.9 Data Interpretation

After data was put into groups according to strata of respondents and objectives, comparisons and interpretations were made. Then conclusions were made concerning the student teachers' understanding of the process skills approach, the extent to which they used the approach and the constraints they faced in using it.

3.10 Ethical considerations

The researcher respected the participants' decision whether or not to get involved in the study. Since the study used interview schedules as one of the instruments in data collection, it took care of sensitive questions that would have evaded the respondents' privacy and most of all the respondents' confidentiality, anonymity and non-traceability of the information they provided to the study guaranteed in all data collecting procedures.

CHAPTER FOUR: FINDINGS

4.1 Preview

This chapter presents the findings according to the objectives of the study.
The frequency tables, graphs and percentages were used in the presentation of quantitative data, while themes were used for qualitative data.

4.2 Student Teachers' Understanding of the Process Skills Approach

To establish the students' teachers' understanding of the approach, the study looked at the following: student teachers' own definition of process skills approach, identification of aspects of science teaching that constitute the approach, their appreciation of the relevance of the approach in teaching Integrated Science and their knowledge on process skills approach.

4.2.1 *Student Teachers' Definition of the Process Skills Approach*

Regarding student teachers' definition of the process skills approach, the following definitions stood out;

(i) Teaching process skills used by the scientists during their investigations. Some of the examples of the definitions given by the student teachers were: " *process skills approach is the teaching of skills like observation, hypotheses, communication and others which are used by the scientists,* " ST05. Respondent ST11 defined the approach as "... *the teaching of skills used by the scientists when solving scientific problems.* " Most of the responses 19(63.3 percent), fell under this definition. The definitions did not indicate how the process skills are taught.

(ii) Activity – based teaching approach in which pupils use the procedures of science. There were 7(23.3 percent) of the respondents who indicated that the approach was activity- based. For example, respondents ST01 and ST20 defined process skills approach as "... *teaching of science where the teacher uses group activities in which pupils use the procedures of science to solve problems,*" and " *activity based teaching approach where pupils are left alone to solve problems using scientific method,* " *respectively.*

(iii) Teaching of science through experiments which allows pupils to acquire scientific knowledge and investigative skills such as, classification, observation, measuring and others. Only 4(13.3 percent) of the responses fell under this definition. ST03 for example, defined process skills approach as, *"the use of experiments in science lessons in order for pupils to observe, measure, make predictions, etc, as they learn scientific concepts."*

The above results show that, the majority 63.3 percent of the student teachers understood that the approach emphasised the teaching of process skills but they failed to indicate how the process skills were taught. While 36.7 percent of respondents indicated that the skills are taught through hands- on activities.

4.2.2 *Identification of the Aspects of the Process Skills Approach*

The student teachers were provided a variety of science teaching practices in item 1(b) of the Appendix 1. The respondents were asked to identify the teaching practices that fell under the process skills approach. See the results in table 4.1 on the next page.

The findings in table 4.1 on page 48 revealed that all the 30 (100 percent) respondents believed that teaching practice that focused on the development of an enquiry mind and skills so that children could explore and interpret their immediate environment as an aspect of the process skills approach. Encouraging pupils to organise observations, ideas or events in order to detect patterns and relationships (classification) in science lessons, was identified by 29 (96.7 percent) of the respondents as an aspect of the approach and was ranked second. Twenty seven (90 percent) of the student teachers indicated that science teaching that encourages pupils to use reliable observations, to tell what is going to happen in the future (prediction) was an aspect of the process skills approach. Teaching practice that encourages pupils to test their ideas or verify known facts by conducting experiments, was ranked fourth.

Table 4.1. Identification of science teaching practices that are aspects the process skills approach by the student teachers

Science teaching practices	Frequency	%	Rank
Development of an enquiry mind and the skills for exploring and Interpreting the immediate environment	30	100.0	1
Pupils organizing observations, ideas or events in order to detect patterns and relationships	29	96.7	2
Encouraging pupils to use reliable observations, tell what is likely to happen in future	27	90.0	3
Encouraging pupils conducting activities to test their explanations for a set of observations answer questions or verify known facts.	26	86.7	4
Encouraging pupils to gather and select data using their senses	24	80.0	5
Pupils giving possible explanations for a set of observations	21	70.0	6
Pupils comparing objects and duration of events with standard units in order to make their observations more precise	20	66.7	7
Pupils writing filling in the blanks exercises from the pupils' book	19	63.3	8
Pupils receiving scientific facts on a given topic from a knowledgeable Teacher	17	56.7	9
Pupils copying graphs, diagrams and charts from the chalk board	16	53.3	10
Emphasis on the ability to recall scientific knowledge	12	40.0	11

The findings also reveal that 24(80 percent) of the respondents acknowledged that encouraging pupils to gather and select data using their senses was an aspect of the process skills approach in the teaching of Integrated Science. In general, table 4.1 shows that more than 65 percent of the respondents identified all the teaching practices that were activity- based and child centred as aspects of the process skills approach.

The research also revealed that although the following teaching practices that encourage pupils to; write filling in the blanks exercises from text books, receive scientific facts from a knowledgeable teacher and copy graphs, diagrams and charts from the chalk, are associated with knowledge transmission approaches, were identified by between 53.3 to 63.3 percent of the respondents as aspects of the process skills approach. While the science teaching practice that emphasizes on the ability to recall scientific knowledge was identified by only12 (40 percent) of the student teachers and was ranked the least as an aspect of the approach. These findings gave an indication that the majority of the respondents identified the science teaching practices that are associated with the process skills approach

4.2.3 *Student teachers' Knowledge on Process Skills Approach*

The respondents were asked to indicate if they had enough knowledge on how to plan and implement the process skills approach. Table 4.2 below shows the student teachers' response.

Table 4.2. Student teachers' knowledge on process skills approach

Level	Frequency	Percentages
Adequate	6	20.0
Not adequate	23	76.7
Not sure	1	3.3
Total	30	100

Key to understanding of level of knowledge on process skills approach

Criteria	Response	level
To have knowledge on how to plan and implement the process skills approach	Yes	Adequate
	No	Not adequate
	Not sure	Not Sure

The research revealed that only 6(20 percent) of the student teachers affirmed that their knowledge on process skills was adequate, while 23(76.7 percent) indicated that they didn't the knowledge on how to plan and implement the approach . When the 23 respondents were asked to state what was missing, they said that they lacked both theoretical knowledge and practical experience on how to identify and teach the process skills. Respondent ST19 for example, said that, "*I know the process skills but I find it difficult to tell that in this topic, I should teach these skills.*" For respondent ST30, identifying process skills in a given topic was not a problem, "*I'm able to identify the skills in a given topic. For example, if I'm teaching types of flowers, I know that observation and classification skills are involved but how to teach them is* *a problem.*" Analysis of the responses reveals that the majority of the student teachers had inadequate knowledge on process skills approach.

The student teachers' responses were in unison with the lecturers' responses to questions 3, 5 and 6 which required them to state the extent to which student teachers were equipped with the theoretical knowledge and practical experience on how to teach process skills. The lecturers admitted that 'Science Process Skills' was one of the first topics they taught in Mathematics and Science Education (MSE) when the students came into college (see appendix 5 A). Respondent L4 for example said that, "*we teach them how to plan for process skills by reflecting them in lesson objectives.*" On practical experience, the same respondent went on to say, "*yes we give them the practical experience by allowing them to do their own experiments in groups, but the programme is too short. Most of the lecturers don't have time to involve the students while in college to do a lot of practical work.*" Appendix 5C shows an example of the practical work sheet student teachers were supposed to use while in college. While L2's response was, "*we cover how to teach the skills, but we often find that this knowledge is more of theory than practical and I don't think student teachers have the practical knowledge on how to teach basic skills.*" Then respondent L1 went further to point out that:

> "*Although the course puts so much emphasis on student teachers acquiring pedagogical knowledge on process skills approach, we are not making head way... the problem here in the college is that we assume that these students come with subject content knowledge from high schools, but experience has shown us that students come with very little basic knowledge about science, and the kind of teaching that goes on in high schools does not emphasise the acquisition of process skills. Lack of content which we don't emphasise here in college affects the student teachers ability to identify and teach these science process skills in any given topic*"

These findings indicate that student teachers were not ready to use the process skills approach, because the course failed to equip the student teachers with adequate knowledge on how to use the approach.

4.2.4 *Student Teachers' Views about the Relevance of the Process Skills Approach*

The student teachers were asked to state their appreciation of the process skills approach in the teaching of Integrated Science in basic schools. Table 4.3 below shows how respondents' appreciations of the approach were ranked into levels of relevance of the approach.

Table 4.3. Student teachers' views about the relevance of the process skills approach

Level	Frequency	Percentages
Very relevant	1	3.3
Quite relevant	11	36.7
Relevant	12	40.0
Not relevant	2	6.7
Not sure	4	13.3
Total	30	100

Key to understanding of the relevance of the process skills approach

Appreciation of the approach	Level
It's the means of acquiring process skills that enable children to attain scientific knowledge in a meaningful way	Very relevant
It's the only means through which children acquire process Skills and attitudes	Quite relevant
It's the most effective way of motivating children	Relevant
Children can still acquire scientific knowledge in a meaning Way through expository approaches	Not relevant
Not sure of its relevance to the teaching of Integrated Science	Not Sure

The results above reveal that only 1(3.3 percent) respondent felt that the approach was very relevant because it enabled the pupils to acquire the process skills which in turn helped the learner to attain scientific knowledge in a meaningful way. Eleven (36.7 percent) respondents said that the process was quite relevant to the teaching of Integrated Science especially in the acquisition of process skills and scientific attitude. Twelve (40 percent) of the student teachers felt that the approach only helped to motivate the pupils in science lessons. Two (6.6 percent) of the student teachers indicated that it was not relevant as children could still learn science in a meaningful way using expository teaching methods. While 4 (13.3 percent) of the student teachers were not sure of the relevance of the approach in the teaching of Integrated Science.

The distribution of responses in table 4.3 indicates that the majority 23(76.7 percent) of the respondents felt that the process skills approach was not very relevant in the acquisition of scientific knowledge, it was just a means through which pupils got motivated and acquired the scientific process skills and attitudes. There are many factors that could have affected the student teachers appreciation of the approach. One of the factors could be their level of knowledge on the approach. The study examined this relationship by cross tabulating the student teachers' level of knowledge on how to implement the process skills approach and their appreciation of it. The results are shown in the table 4.4 below.

Table 4.4 Student teachers' knowledge on process skills approach against their views about the relevance of the approach

Parameters	Relevance of process skills approach						
Knowledge on process skills approach	Levels	Very relevant	Quite relevant	Relevant	Not relevant	Not sure	TOTAL
	Adequate	1(3.3%)	3(10.0%)	2(6.7%)	0(0.0%)	0(0.0%)	**6(20.0%)**
	Not adequate	0(0.0%)	8(26.7%)	9(30.0%)	2(6.7%)	2(6.7%)	**23(76.7%)**
	Not sure	0(0.0%)	0(0.0%)	1(3.3%)	0(0.0%)	0(0.0%)	**1(3.3%)**
	TOTAL	**1(3.3%)**	**11(36.7%)**	**12(37%)**	**2(6.7%)**	**2(6.7%)**	**30(100%)**

The distribution of responses in table 4.4 shows that 6 (20 percent) student teachers who said that their knowledge on process skills approach was adequate, acknowledged that the approach was relevant in the teaching of Integrated Science. One (3.3 percent) of the respondents said that it was very relevant, 3(10 percent) indicated that it was quite relevant and 2(6.7 percent) said it was relevant. However, it seems that among the 23(76.7 percent) respondents whose knowledge on the approach was not adequate, 17(73.9 percent) of them said the approach was relevant. It was surprising that despite their inadequate knowledge on the process skills approach, they still appreciated it. On the other hand, the results show that 2(6.7

percent) respondents who said that the approach was not relevant and the 4 (13.3 percent) who were not sure of the relevance of the approach, had inadequate knowledge on process skills approach.

Despite the unexpected responses of the 17 (73.9 percent) student teachers, there was a close relationship between the respondents' level of knowledge on the approach and their appreciation of the approach. This is because all the student teachers who acknowledged the relevance of the approach had adequate knowledge on the approach and all those who did not appreciate the approach had inadequate knowledge on process skills approach.

4.3 Extent of Use of the Process Skills Approach by the Student Teachers

In order to establish the extent to which student teachers used the approach, the study focused on the following aspects: how often they used the approach, process skills mostly taught at lower and middle basic level, and the methods/activities most often used. The study also looked at student teachers' level of difficulty in using the approach, teaching the specific process skills and in using various methods/activities. The sources of the above data were the student teachers' questionnaires, mentors and lecturers interview schedules, and the lesson observation schedule.

4.3.1 *Frequency of Use of the Process Skills Approach by the Student Teachers*

The frequency in this study was measured by taking into consideration the number of periods for Integrated Science per week. In most basic schools in Kitwe district on average, the maximum number of Integrated Science lessons per week was four (4). Each level of frequency was determined by looking at the number of lessons per week in which process skills approach was used. The results are shown in table 4.5 on the next page.

Table 4.5. Frequency of use of the process skills approach by student teachers during Integrated Science lessons per week

Level	Frequency	Percentage
Very often	0	0.0
Often	1	3.3
Sometimes	28	93.4
Not used	1	3.3
Total	30	100

Key to understanding of the frequency of use of process skills approach

Frequency	Level
In 4-3 lessons per week	Very often
In 2-1 lessons per week	Often
In 1-0 lessons every two weeks	Sometimes
Not used at all in any lesson	Not used

Table 4.5 shows that, 28(93.4 percent) of the respondents indicated that they sometimes used the process skills approach and only 1 (3.3 percent) respondent often used the approach. It means that the majority of the student teachers used the approach in one Integrated Science lesson in every two weeks. This frequency of use of the approach by the majority of the student teachers was not enough to have the desired skills imparted in the children. Theoretically, though in practice, there could be other factors at play, the knowledge one has on something affects the way and how often he or she uses that thing. Below is the cross tabulation table to find out if there was any relationship between the student teachers' level of knowledge on the process skills approach and the frequency of use of the approach.

Table 4.6. Student teachers' knowledge on process skills approach against the frequency of use of the approach

Parameters	Frequency of use of process skills approach					
Knowledge on process skills approach	**Levels**	Not used	Sometimes	Often	Very often	TOTAL
	Adequate	0(0.0%)	5(16.7%)	1(3.3%)	0(0.0%)	**6(20.0%)**
	Not adequate	2(6.7%)	21(70.0%)	0(0.0%)	0(0.0%)	**23(76.7%)**
	Not sure	0(0.0%)	1(3.3%)	0(0.0%)	0(0.0%)	**1(3.3%)**
	TOTAL	**2(6.7%)**	**27(90.0%)**	**1(3.3%)**	**0(0.0%)**	**30(100%)**

Table 4.6 shows that all the 6(20 percent) respondents who said that their knowledge on the approach was adequate used the approach sometimes. This suggests that their frequency of use of the approach might have been affected by other constraints which will be discussed later in this chapter. However, the relationship between student teachers' level of knowledge and the frequency of use of the approach is clear. The majority of the respondents, 21(91.3 percent) of the 23 who said that their knowledge was inadequate, used the approach in one Integrated Science lesson in two weeks. The table also revealed that that the respondent, who did not use the approach, had little knowledge on the approach. The cross tabulation of results show that lack of adequate knowledge on process skills approach affected the extent to which the approach was used by the student teachers.

4.3.2 *Student Teachers' Perception of Difficulty in Using the Process Skills Approach*

The study also collected data on the views of the student teachers regarding the level of difficulty in using the approach to teach Integrated Science in basic schools. The perceptions are shown in the table below.

Table 4.7. Student teachers' perceptions of difficulty in using the process skills approach

Level of difficulty	Frequency	Percentage
Very difficult	1	3.3
Difficulty	19	63.3
Easy	10	33.3
Very easy	0	0.0
Total	30	100

Key to understanding of each level of difficulty in using the process skills approach

Difficulty	Level
Hard to plan and implement in all the topics	Very difficult
Easy to plan but hard to implement in all the topics	Difficult
Easy to plan and implement in some topics	Easy
Easy to plan and implement in all the lessons	Very easy

Table 4.7 shows that, a total of 20(66.7 percent) respondents found it difficult to use the process skills approach. It means that the majority of the student teachers found it hard to plan and implement the approach in all the topics in Integrated Science lessons. While 10(33.3 percent) of the respondents said that they found it easy to plan and implement the approach in some Integrated Science topics. It is evident that the majority of the student teachers found it hard to plan and implement the approach. There could be different factors which made it difficult for the respondents not to use the approach in the teaching of Integrated Science in basic schools. The study therefore, went further to check if there was a relationship between student teachers' level of knowledge on process skills approach and their perception of the approach. The results of the cross tabulation are shown in table 4.8 below.

Table 4.8. Student teachers' knowledge on process skill approach against their perceptions of difficulty in using the approach.

Parameters	Difficulty in using process skills approach					
Knowledge on process Skills approach	**Levels**	Very difficult	Difficult	Easy	Very easy	**TOTAL**
	Adequate	0(0.0%)	1(3.3%)	5(16.7%)	0(0.0%)	**6(20.0%)**
	Not adequate	1(3.3%)	18(60.0%)	4(13.3%)	0(0.0%)	**23(76.7%)**
	Not sure	0(0.0%)	0(0.0%)	1(3.3%)	0(0.0%)	**1(3.3%)**
	TOTAL	**1(3.3%)**	**19(63.3%)**	**10(33.3%)**	**0(0.0%)**	**30(100%)**

The majority, 19(82.6 percent) of the twenty three (23) respondents who said that their knowledge on the approach was inadequate found, it difficult to plan and implement the approach in some topics in Integrated Science. While 5 (83.3 percent) of the 6 student teachers who indicated that their knowledge on process skills approach was adequate found it easy to use the approach in the teaching. From the distribution of responses in table 4.8 above, it can be deduced that lack of adequate knowledge on process skills approach was one of the reasons why student teachers perceived the approach as difficult to use.

The study also did a cross tabulation of the student teachers' perception of difficulty in using the approach against the frequency of use of the process skills approach. This was done in order to find if their perceptions affected the frequency at which they used the approach. The results are presented in table 4.9.

Table 4.9. Student teachers' perceptions of difficulty in using process skills approach against the frequency of use of the approach

Parameters	Frequency of use of process skills approach					
Difficulty in using process skills approach	**Levels**	Not used	Sometimes	Often	Very often	**TOTAL**
	Very difficulty	1(3.3%)	0(0.0%)	0(0.0%)	0(0.0%)	**1(3.3%)**
	Difficulty	0(0.0%)	18(60.0%)	1(3.3%)	0(0.0%)	**19(63.3%)**
	Easy	0(0.0%)	10(33.3%)	0(0.0%)	0(0.0%)	**10(33.3%)**
	Very easy	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)	**0(0.0%)**
	TOTAL	**1(3.3%)**	**28(93.3%)**	**1(3.3%)**	**0(0.0%)**	**30(100%)**

Table 4.9 shows that the majority of the respondents (eighteen (18) out of nineteen (19)) who said that they found the approach difficult to use, did not use the approach often. However, the distribution of the responses shows the unexpected relationship. All the ten (10) student teachers who said that they found it easy to use the approach indicated that they used the process skills approach in one science lesson in two weeks.

These findings suggest that there other factors other than the respondents' perception and their knowledge on the approach that affected the extent of use of the approach in terms of frequency. Some of these factors are discussed as constraints later in this chapter.

4.3.3 *The Possibility of Using the Process Skills Approach in Teaching all the Topics in Integrated Science*

The extent of use of the approach in terms of frequency was also determined by looking at whether or not the student teachers felt it was possible to use the approach to teach all the topics in Integrated Science. The results are shown in the table below.

Table 4.10. The possibility of using the process skills approach in teaching all the topics in Integrated Science

Responses	Frequency	Percentage
Yes	4	13.3
No	23	76.7
I don't know	3	10.0
Total	30	100

The results above show that the majority of the student teachers 23(76.7 percent) indicated that it was not possible to use the approach in teaching all the topics. They cited "Solar system," "Body systems" and "Animals," the topics they felt it were not possible to use the process skills approach. Student teachers were likely to use other approaches when teaching the cited topics, and pupils were denied the opportunity to acquire the skills which they were supposed to develop. The respondents said that it was very difficult to plan and implement hands-on activities in the cited topics. *" It is difficult to organise some activities when you are teaching 'Digestive system' for a example and what skills can you teach under this topic?"* pointed out by ST4. This kind of response just shows that the majority of the respondents did not have adequate knowledge on the approach. This affected their creativity, hence they found it difficult to plan and implement activities in these topics.

4.3.4 *Process Skills Often Taught by the Student Teachers.*

Although the number and the particular skills to be taught in any science lessons depend on the topic, it was necessary to find out how often different skills were taught in Integrated Science lessons per week (see figure 2). These helped the study to establish the extent to which the approach was being used.

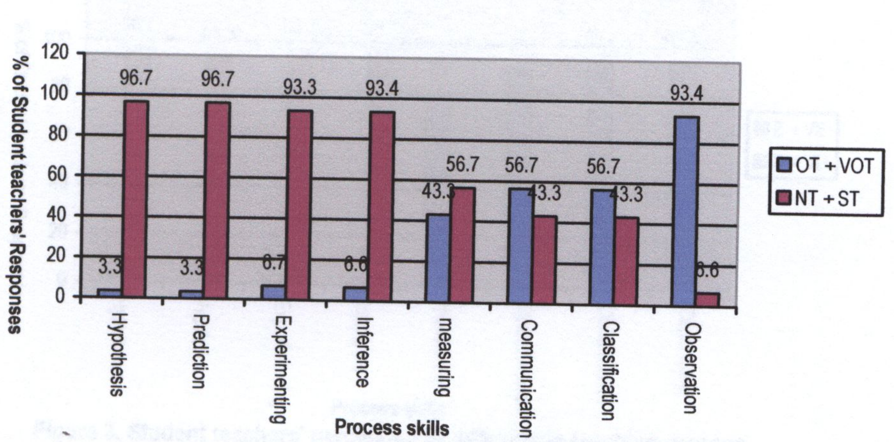

Figure 2. Process skills often taught by the student teachers

Key to understanding of the frequency of teaching process skills

Frequency	Level
In 4-3 lessons per week	Very often **(VOT)**
In 2-1 lessons per week	Often **(OT)**
In 1-0 lessons every two weeks	Sometimes **(ST)**
Not taught at all in any lessons	Not taught **(NT)**

Figure 2 shows that only 4(50 percent) out of the eight (8) process skills which were supposed to be taught at middle basic level in Integrated Science were taught: observation, classification, communication and measuring. Twenty eight (93.4 percent) of the respondents indicated that they taught observation skill in at least two (2) lessons per week. About 56.7 percent of the student teachers said that they taught classification and communication. The least taught process skill was measuring which was taught by 43.3 percent of the respondents. While the following skills were not taught: inference, experimenting, prediction and hypothesis

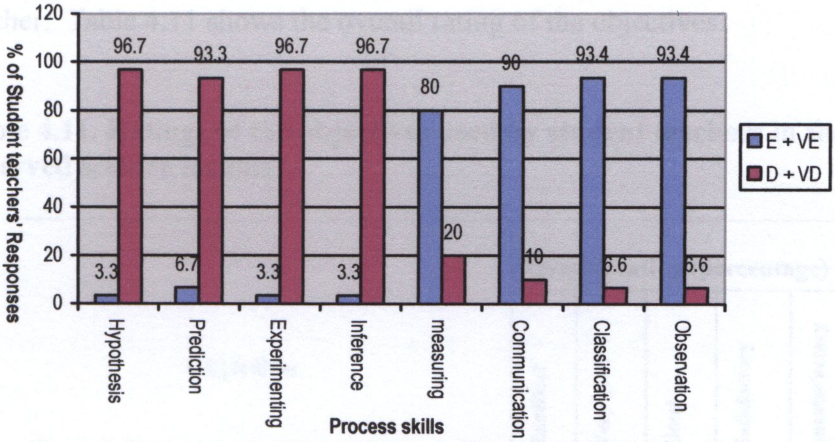

Figure 3. Student teachers' perception of difficulty in teaching process skills

Key to understanding of difficulty in teaching process skills

Difficulty	Level
Hard to identify, plan and implement in all the topics	Very difficult (VD)
Easy to identify but hard to plan and implement in all the topics	Difficult (D)
Easy to identify, plan and implement in some topics	Easy (E)
Easy to identify, plan and implement in all the lessons	Very easy (VE)

The findings reveal that nearly all the respondents indicated that they found it difficult to teach the following skills: hypothesis, prediction, experimenting and inference. On the other hand they said that observation, classification, communication and measuring were easy process skills to teach. The relationship in the pattern of responses in figure 2 and 3 suggests that student teachers taught the process skills which they perceived to be easy to teach. While the difficult ones were not taught. The student teachers attributed the difficulties in teaching these skills to the following factors; lack of learning and teaching materials, lack of adequate knowledge on process skills approach and large size classes. These factors will be looked at in more detail later in this chapter.

In order to confirm the student teachers' claims of teaching the identified process skills, lesson objectives were examined during lesson observations to see if they reflected process skills. Objectives are the best indicators of the desirable behavior a teacher would like his or her pupils to exhibit after learning experiences in any science lesson. They also give a clue of the approach likely to be used by the teacher. Table 4.11 shows the overall rating of the objectives.

Table 4.11. Ratings of the objectives used by student teachers in the observed science lessons

Objectives	Overall rating (percentage)					
	Excellent	Very good	Good	Satisfactory	unsatisfactory	Absent
Were they clear and specific?	6.7	43.3	30.0	16.7	3.3	0.0
Were they attainable in the time available?	0.0	36.7	43.3	13.3	6.7	0.0
Were they measurable?	0.0	10.0	43.3	33.3	13.3	0.0
Did they reflect process skills?	0.0	0.0	10.0	10.0	36.7	43.3
Did they reflect knowledge?	0.0	50.0	23.3	26.7	0.0	0.0
Did they reflect attitudes?	0.0	0.0	0.0	13.3	20.0	66.7

Key to understanding of rating

Score	5	4	3	2	1	0
Meaning	Excellent	Very good	Good	Satisfactory	Unsatisfactory	Absent

Table 4.11 shows that most of the objectives formulated by the student teachers were very clear and specific, attainable and measurable. However, most of them were in cognitive domain as they only reflected scientific knowledge. Attitudes and the process skills were either not well reflected (36.7 percent) or completely absent in most (43.3 percent) of the objectives. The emphasis of most of the lesson objectives formulated by the student teachers was the scientific knowledge. Pupils were expected to; label, state and define the scientific concepts. These imply that the focus of most (73.3 percent; very good + good ratings) of the observed lessons was scientific knowledge not the process skills development.

4.3.5 *Teaching Methods/Activities Used by the Student Teachers*

Teaching methods/ activities used by a teacher tell us more about the teachers' role and focus of a lesson. They give us an indication of the approach a teacher intends to use in his or her science lesson. This is why the study collected data on the teaching methods/ activities used by the student teachers in order to establish the extent to which they used the process skills approach. The data was collected by asking the mentors, lecturers and the student teachers to indicate the methods/ activities student teachers often used in teaching Integrated Science in basic school. The same key used to understanding the frequency of use of process skills approach and of teaching process skills, was also used to indicate how often each of the teaching method/ activities was used in Integrated Science lessons per week. Figure 4 shows the distribution of the Lecturers', mentors' and student teachers' responses.

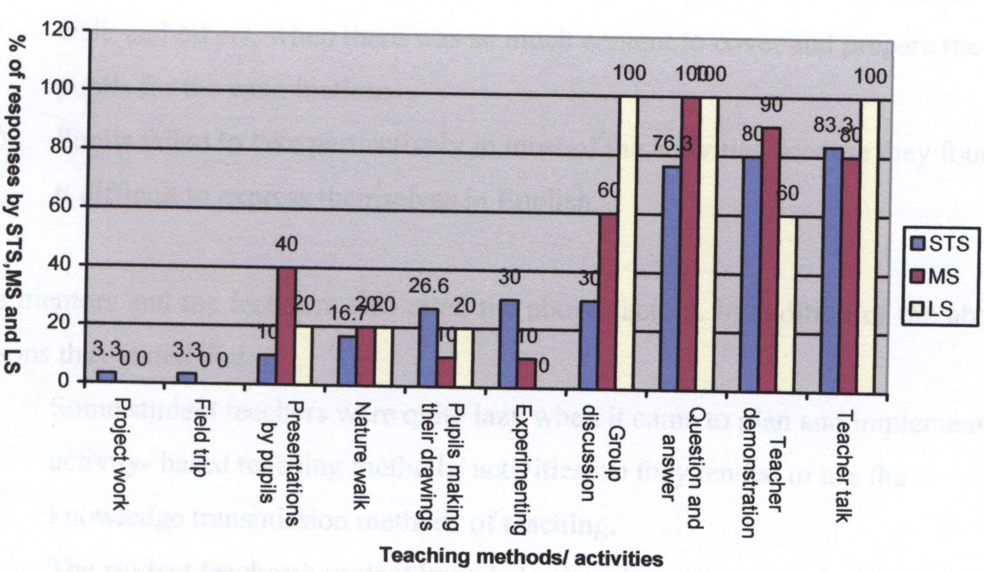

Figure 4. Teaching methods/activities often used by the student teachers in teaching Integrated Science.

Key

STS- Student teachers **MS**- Mentors **LS**- Lecturers

Figure 5.0 shows that more than 90 percent of the respondents found it easy to use teacher talk, teacher demonstration, question and answer, nature walk. Although the distribution of responses in figure 4 revealed that student teachers did not use nature walk, pupils making their own drawing and pupils making presentations, the respondents perceived these teaching methods/ activities easy to plan and implement. The respondents viewed these methods/ activities to be easy to plan and implement when teaching various topics in Integrated Science, but in practice. The results also show that the respondents found it difficult to plan and execute experiments, group discussion, project work and field trip. Student teachers gave the following reasons for finding it hard to plan and implement these teaching methods/ activities:

(i) There were no learning and teaching materials in basic schools.
(ii) The classes were too big to conduct hands on activities in groups.
(iv) Basic schools didn't have transport to enable the teachers organise field trips.
(v) Time was not enough to be spent on other activities like field trip, nature walk and others, when there was so much content to cover and prepare the pupils for the examinations.
(vi) Pupils failed to take part actively in most of the activities because they found it difficult to express themselves in English.

The mentors and the lecturers also cited the above factors. In addition of the above reasons they stated that:

(i) Some student teachers were quite lazy when it came to plan and implement activity- based teaching methods/ activities, so they tended to use the knowledge transmission methods of teaching.
(ii) The student teachers' content knowledge in science was not adequate hence it affected their creativity and improvisation.
(iii) Use of the activity- based teaching approaches required a lot of time. The Integrated Science syllabus is still examination oriented and so student teachers resorted to use content oriented teaching approaches to cover as many topics as possible and drill the pupils for the examinations.
(iv) The Curriculum Development Centre doesn't collaraborate with the colleges

when effecting the curriculum changes and innovations in basic schools. There were more changes in basic schools than in colleges in terms of teaching approaches. This confused the student teachers on school experience.

To establish the teaching methods/ activities student teachers used in practice, lesson observations were conducted. The rating of the aspects of the lesson implementation shown in table 4.12 were used to find out the teaching approaches used by the student teachers and consequently determine the extent to which they tried to teach the process skills in the observed Integrated Science lessons.

Table 4.12 Ratings of the methods used by student teachers in the observed science lesson

Aspects of the lesson implementation	Overall rating(percentage)					
	Excellent	Very good	Good	Satisfactory	Unsatisfactory	Absent
Were the methods used suitable to achieve the stated objectives?	3.3	3.3	43.3	36.7	13.3	0.0
How well did the student teacher demonstrate the knowledge of the subject?	0.0	3.3	10.0	60.0	26.7	0.0
Did the activities allow pupils to learn the process skills?	0.0	0.0	6.7	13.3	26.7	53.3
How do you rate the pupils' participation in practical activities?	0.0	3.3	30.0	30.0	33.3	3.3
How did she/he guide the pupils to check and verify their scientific ideas?	0.0	0.0	6.7	13.3	40.0	40.0
Identification of process skills on a topic being taught?	0.0	0.0	6.7	13.3	20.0	60.0
Did the teacher questioning techniques lead the pupils to use the identified process skills?	0.0	13.3	36.7	30.0	20.0	0.0
How was the general class management?	0.0	13.3	36.7	30.0	20.0	0.0

Key to understanding of rating

Score	5	4	3	2	1	0
Meaning	Excellent	Very good	Good	Satisfactory	Unsatisfactory	Absent

It was observed that, most student teachers used teacher exposition, question and answer and teacher demonstration. These methods were suitable to achieve the objectives in cognitive domain which were formulated in most of the observed lesson. The majority of the student teachers did have adequate knowledge in the subject they were teaching. The subject knowledge for the majority (60 percent) of the student teachers was just satisfactory and 26.6 percent was unsatisfactory. No process skills were identified during the lesson implementation in most (60 percent) of the observed lessons. Most of the practical activities in the observed lessons were teacher demonstrations whose emphasis was to verify scientific concepts. Pupils did not take part actively in practical activities so they were denied the chance of acquiring process skills. Pupils mostly used observation skill when they were asked to state what they were observing, and this skill was limited only to the sense of sight. Pupils were not guided by the student teachers to check and verify their scientific ideas about the observed phenomena. For example participant ST12, was teaching 'Flowering and non flowering plants' to a Grade 6 class. The student teacher brought different plants in class quite alright and distributed them to pupils in groups. Instead of guiding the pupils in the observation process in order for them to detect differences and similarities among those plants, he identified and explained the differences and similarities himself. While ST22 tried to encourage the pupils to use process skills in her lesson 'Soil drainage'. The student teacher took the pupils in groups outside the classroom to collect sandy, clay and loam soil. Each group put the three soil types in three different improvised transparent containers, poured the water on top of each container at a time and one pupil started counting from one and stopped immediately the water reached the bottom of each container and recorded the results in the table, see appendix 7.

After the activity was completed, each group presented their findings under the guidance of the teacher. In this Integrated Science lesson, the student teacher reflected the following process skills; observation, measurement and communication in her lesson plan, which she focused during the hands-on activity performed by pupils in groups.

During the lesson observation process the researcher also examined the work in pupils' exercise books. The written work in pupils' exercise books comprised of notes which took the form of simple filling in the blanks exercises. These were of low cognitive nature such as "A flower is a...part of a plant." There were a number of diagrams in the pupils' books which gave an impression that pupils did a lot of hands- on activities and communicated their findings through those tables, graphs and drawings. However, discussions with most of the student teachers about those diagrams revealed that these diagrams were not produced after practical work, but given to pupils as part of the notes.

Analysis of results obtained on the teaching methods/ activities, shows that the student teachers used expository teaching approaches in teaching Integrated Science. The process skills approach was used to a very small extent.

4.4 Constraints in the Use of the Process Skills Approach

The study identified ten constraints shown in table 4.13. Most of them were attributed to earlier by the student teachers as some of the reasons why they found difficult to implementing the process skills approach in basic schools

Table 4.13. Constraints identified by the student teachers in the use of process skills approach

Constraints	Frequency	%	Rank
Lack of learning/ teaching materials in basic schools	30	100.0	1
Integrated Science syllabus has a lot of topics to cover	29	96.7	2
There are a lot of changes in basic schools in terms of teaching method	28	93.3	3
Lack of teachers' guide with tips on how to implement science process skills approach	26	86.7	4
Learners inability to communicate in English effectively	23	76.7	5
Lack of pupil's text books for Integrated Science	22	73.3	6
Big class sizes in basic schools	20	66.7	7
Mentors' inadequate knowledge on use of process skills approach	17	56.7	8
Inadequate knowledge on process skills approach by the student teachers	15	50.0	9
Inadequate knowledge of the subject by the student teachers	14	46.7	10

The findings reveal that lack of leaning/ teaching materials, and unfavorable classroom dynamics were the major constraints in the use of the process skills approach. The results also show that 15 (50 percent) of the student teachers acknowledged that the difficulties they faced in implementing the approach were due to their inadequate knowledge on the use of the process skills approach. And only 14 (46.7 percent) of the respondents considered their inadequate knowledge of the subject matter as a hindrance to the use of the process skills approach.

In order to get more information about the nature of the above constraints, data was collected on some of them, and the results are presented below.

4.4.1 *Lack of Learning/ Teaching Materials*

The study sought to establish the availability of learning/ teaching materials to support the use of process skills approach in basic schools in Kitwe district. To estimate the level of availability of essential materials the following criteria were used: If the quantity of materials was sufficient to carry hand-on activities in groups of not more than 6 pupils, they were considered to be adequate. If the quantity of materials was enough to be used only for demonstrations they were considered to be inadequate. In practice a chart or model is usually considered to be enough to be used by the whole class, but in this study charts and models were considered to be adequate if they were enough to be used in groups to guide and enhance pupils' participation in group activities. The results on the availability of various learning/ teaching materials to support the use of the process skills approach are shown in table 4.14 on the next page.

The findings in table 4.14 on page 70 show that more than 60 percent of the respondents indicated that there where no learning/ teaching materials enough to support the use of process skills approach, especially in topics under the following units: Materials and Energy, Environment and Health. While more than 50 percent of the respondents indicated that learning/ teaching materials under the unit Plants and Animals were available but not enough.

Table 4.14 Availability of teaching/ learning materials

Type of materials	No Response	Not Available	Availability	
			Not Adequate	Adequate
Materials & Energy				
Bar magnets	3.3	83.3	13.3	0.0
Iron filings	6.7	76.7	10.0	6.6
Connecting wires	10.0	60.0	13.3	16.7
Dry cells (batteries)	6.7	73.3	16.7	3.3
1.5V bulbs	6.7	73.3	16.7	3.3
Switch boards	3.3	73.3	16.7	6.7
Mirrors	3.3	56.7	30.3	6.7
Compass	0.0	83.3	13.3	3.4
Measuring tapes	0.0	83.3	16.7	0.0
Metre rulers	0.0	30.0	70.0	0.0
Stop watches	0.0	90.0	10.0	0.0
Plants & Animals Charts of: -				
- Amphibians	0.0	40.0	53.3	6.7
-Reptiles	0.0	40.0	53.3	6.7
-Mammals	0.0	40.0	53.3	6.7
-Insects	0.0	40.0	50.0	10.0
-Insect & wind pollinated flowers	0.0	50.0	40.0	10.0
- Seed & vegetative propagated plants	3.3	56.7	36.7	3.3
The Environment Models of;-				
- Wind vane	0.0	93.3	3.3	3.3
- Anemometer	0.0	93.3	3.3	3.4
Thermometers	0.0	80.0	13.3	6.7
Charts of different types of pollution	0.0	86.7	3.3	10.0
Health Charts of;-				
-Different types of diseases	0.0	40.0	46.7	13.3
-Different types of abused drugs	0.0	46.7	43.3	10.0
First Aid Kit	6.7	53.3	26.7	10.3
HIV/AIDS resource materials	6.7	16.7	40.0	36.6

4.4.2 *Lack of Teachers' Guides for Integrated Science*

The teachers' guides are important in the teaching of any subject because they highlight the general objectives and give tips on how best those objectives could be achieved. Student teachers they did not have enough experience in teaching, they needed to be guided by the teachers' guides on how to implement the process skills approach. One of the general objectives of the Integrated Science is to equip learners with investigative (process) skills. The study therefore, sought to find out if basic schools had teacher handbooks in Integrated Science syllabi with tips on how to teach process skills. Results are shown in table 4.15.

Table 4. 15. The availability of Teachers' Guides

Available	Frequency	Percentage
Yes	8	26.7
No	20	66.7
No response	2	6.6
Total	30	100

The results revealed that 20 (66.7 percent) of the respondents indicated that such books were not available in basic schools. Only 8 (26.7 percent) of the student teachers indicated that they had the Teacher's Guides. However, they pointed out that the Integrated Science Teacher's Guide did not give clear-cut tips on how to teach process skills. The Guides gave only suggestions on how a given topic should be approached with some suggested activities. Process skills were just implied in the suggested activities. It was up to the student teacher to identify the process skills to focus on in the suggested activities. The absence of Integrated Science Teachers' Guides with tips on how to teach the process skills was a constraint in it self in the use of the process skills approach on the part of student teachers.

4.4.3 *Lack of Text Books for Integrated Science*

No matter how actively the learners are involved in science practical activities in class, they need books to read. The books help the pupils get more detailed information on their own complement and exploit the knowledge acquired through the activities. More importantly, they acquire different ways of communicating scientifically by studying various diagrams and graphs by which scientific information is presented in the books. Student teachers were asked to indicate the percentage of pupils in their class having Integrated Science text books. The results are presented in table 4.16.

Table 4.16. Availability of text books for Integrated Science

Percentage of pupils in class having text books	Response	
	Frequency	Percentages
0-25	24	80.0
26-50	3	10.0
51-75	0	0.0
76-100	3	10.0
Total	30	100

The table shows that 80 percent of the participants indicated that only between 0-25 percent of pupils had books in their classes. It meant that on average one Integrated Science text book was being shared among four pupils.

When mentors were asked to comment on the non availability of the text books and teachers' guides, they were quick to confirm that those text books were not yet in schools. The Ministry of Education did not supply those text books to basic schools, instead the Ministry has entered into an agreement with Macmillan Zambia Limited to produce the books, and then basic schools were supposed to buy from them. Most basic schools found it difficult to procure the books, because basic schools find it extremely difficult to source the funds they need to buy text books, because pupils at lower and middle basic level do not pay user fees. At the time of this study, most schools had only managed to procure a few pupils text books for lower basic grades.

4.4.4 *Large Class Sizes*

Class size has a bearing on the choice and implementation of any teaching approach, process skills approach included. The respondents identified large class sizes as one of the constraints that made the use of process skills approach very difficult. The table below shows the class sizes handled by the student teachers who took part in the study.

Table 4.17. Class sizes handled by the student teachers

Number of pupils	Responses	
	Frequency	Percentage
20-35	4	13.3
36-45	2	6.7
46-55	9	30.0
56-65	8	26.7
66-75	5	16.7
76-85	2	6.7
Total	30	100

From the data presented in table 4.17, we can clearly see that only 6(20 percent) of the student teachers taught 'normal' classes in terms of class size of about 20 to 45. It is inconceivable to see that some respondents handled about 65 to 85 children in one class, and they were expected to use the process skills approach. Even a well experienced teacher would find it extremely difficult to engage such number of pupils in practical activities in groups. Commenting on the class sizes, mentors pointed out that the situation was like that because of the government's policy is not to deny any eligible child access to basic education. This is one of the ways the government is trying to achieve the millennium development goals of 2015. School heads had been strongly advised to enroll as many pupils as possible so long as there was space in classrooms.

After indicating the availability of learning/ teaching materials; the number of pupils in the classes, and the percentage of pupils who had text books in their classes, the participants were asked to state if the schools had enough learning and teaching aids to support the teaching of Integrated Science using the activity based approaches. The majority 26 (86.7 percent) of the participants indicated that their respective schools did not have enough learning/ teaching aids. Then 15 (56 percent) of the 26 respondents, were holding the view that schools should provide all the learning/ teaching aids they needed to teach all the topics in Integrated Science effectively. Such attitude by the student teachers shows that most of them were not creative. This was evident by the results obtained in table 4.18 below during the lesson observations on the provision and utilizations of learning/ teaching aids during the lesson observation.

Table 4.18. Use of learning/ teaching materials by the student teachers during science lessons

Aspects of the use of learning/ teaching materials	Overall ranting (percentages)					
	Excellent	Very good	Good	Satisfactory	Unsatisfactory	Absent
Improvisation of learning/ teaching materials	0.0	3.3	10.0	13.3	10.0	63.3
The use of local environment	0.0	3.3	13.3	6.7	6.7	70.0
The use of charts/graphs/pictures and models.	0.0	3.3	3.3	13.3	26.7	53.3
Were the learning/ teaching materials appropriate and adequate?	0.0	3.3	3.3	13.3	30.0	50.0
Did the learning/ teaching materials enhance the use and development of the identified process skills in that lesson?	0.0	3.3	6.7	10.0	26.7	53.3
Did the learning and teaching enhance the participation of pupils in the hands-on activities?	0.0	3.3	0.0	16.7	20.0	60.0

Table 4.18 shows that the majority 19 (63.3 percent) of the student teachers were not creative in the preparation of the learning/ teaching materials, and improvisation was absent. The majority 23 (76.7 percent) did not take the advantage of the local environment. Even those who were teaching about plants did not take the pupils around the school environment to observe different plants in their natural setting. They were confined to illustrations of plants in pupils' text books. Most of the charts which were used by the student teachers were of poor quality and not appropriate. Since most of the lessons were content oriented, the use of materials was either unsatisfactory (26.7 percent) or absent (53.3 percent) in the observed lessons. Lack of learning/ teaching materials and the student teachers' lack of creativity were evident to be some of the major constraints in the use of process skills approach.

4.4.5 *Inadequate Knowledge on Process Skills Approach by the Student Teachers*

Results in table 4.2, have already shown that the majority of the respondents' knowledge on the process skills approach was inadequate. The student teachers were able to identify the aspects of the approach but they indicated that they found it very difficult to plan and implement the process skills approach. This meant that student teachers were not adequately prepared to use the process skills approach and as such they found it difficult to use it.

4.4.6 ***Inadequate Knowledge on Process Skills Approach by Mentors***

When mentors were asked to state which investigative (process) skills were supposed to be developed in pupils, they seemed not to know what science process skills were. Some were so frank as to indicate that they knew nothing about process skills. Mentor 7 (M7) for example just said, "*No idea.*" While others gave completely wrong answers, like mentor 9 (M9) who said that, "*teachers should teach writing, reading and listening skills.*" Those who seemed to have some knowledge on process skills said that, pupils should do practical work and left alone to discover things on their own. This shows that mentors who were supposed to help and guide the student teachers on how best they should teach the investigative skills, did very little or nothing to assist the student teachers teach the skills. This was supported by L3 who said that, "*... the problem is that these student teachers are not being helped by the mentors, they are not making a point that student teachers emphasis this component of science.*" Student teachers look up to their mentors for help when they are in the field. But mentors failed to help them to achieve the objectives the Integrated Science because mentors knew very little about the process skills then we should not expect the students to use the approach.

4.4.7 ***Inadequate Subject Knowledge by the Student Teachers***

The knowledge of the subject matter is key in the teaching of any subject. If not adequate, it may adversely affect the teachers' confidence, interest and consequently methodology. Although the respondents ranked their inadequate science subject knowledge, as the least constraint to the use of process skills approach, mentors and lecturers said that this was one of the major problems when it came to the student teachers' ability to use activity based approaches. For example M5 said:

"The major problem is the caliber of our student teachers is questionable, some of them they even fail to teach grade six science...Most of these students did not do well in science at grade twelve (12) level even when they come to teach science, the problems which they had in science in high schools still comes back on the ground. They literally hate the subject and they have no interest. They don't have enough subject knowledge, that's why they fail to teach Integrated Science."

This shows that the student teachers were struggling to teach Integrated Science because of their weak background in science. Commenting on the same, L1 said, *"their own subject content knowledge is not enough and it affects their creativity, improvisation and consequently the use of activity based teaching like process skills approach when they go in the field to teach."* This was evident during lesson observations where 26.7 percent did not demonstrate to have the command of the knowledge on the topic they were teaching, while only 60 percent was just satisfactory.

4.4.8 *Too Many Topics in Integrated Science*

When the student teachers were asked to give the reasons why they did not use the activity based methods like project, experiment, nature walk, pupils making their own drawing and field trips, they said that they did not have time to spend on these activities. They were expected to cover a lot of topics which meant that the knowledge transmission teaching strategies were used more often in order to finish the overloaded syllabus in time. Thus, the Integrated Science syllabus by design was still concerned with the acquisition of content knowledge rather than other dimensions of science like process skills.

4.4.9 *A lot of Changes in terms of Teaching Methods in Basic Schools*

The student teachers pointed out that when they reported in schools; they were introduced to new methods, which they did not come across while in college. When their mentors attended the workshops, they came back with new methods which they encouraged the trainee teachers to use other than the methods student teachers acquired while in college. Mentors also acknowledged this as one of the constraints in the use of process skills approach. Mentor 4 (M4) said,

> *"These student teachers spend only one year in the college and are sent to schools without being adequately prepared. When they come in the field they have more to learn than to teach, and they became confused in that there are so many changes in schools in terms of teaching methods."*

This shows that, the changes that go on in the basic schools disadvantages the trainee teachers to put into practice what they acquired while in college.

4.4.10 *Inability by the Pupils to Communicate Effectively in English*

The ability of the class in terms of communication using English language was cited by lecturers and student teachers to be one of the hindrances in the use of the process skills approach. The student teachers pointed out it was very difficult to involve pupils in hand- on activities because pupils found it difficult to take part actively in these practical activities because they could not express themselves in English. The language as a media of communication became a barrier to their participation, hence making it difficult for student teachers to teach process skills which could only be taught through practical activities.

4.5 Summary of the Findings

This chapter has shown that:

4.5.1 *Student Teachers Understanding of the Process Skills Approach*

- The majority of the student teachers viewed the approach as an activity based teaching that enables pupils to use and develop science process skills as they perform various activities in a science class.
- The ranking of the teaching practices identified as aspects of the process skills approach indicated that the majority of the student

teachers had an understanding of what process skills approach emphasis on.

- However, the majority (76.7 percent) of the student teachers indicated that their knowledge on the process skills approach was not adequate. They acknowledged that they understood what process skills were, but the knowledge on how to identify and teach these skills using various science activities was missing.
- Lecturers indicated that student teachers were not adequately prepared to use the process skills approach.

4.5.2 *Extent of Use of the Process Skills Approach by the Student Teachers*

- The majority (93.4 percent) of the student teachers indicated that they used the process skills approach, usually in one science lesson in two weeks.
- The majority of the respondents (76.7 percent) who indicated that their knowledge of process skills was inadequate; they found it difficult to use the approach. They also said that it was not possible to use the approach in all the topics in Integrated Science.
- Student teachers found it easy to teach observation, classification and communication and consequently these were the only basic process skills they claimed to teach often.
- Most of the lesson objectives formulated by the student teachers did not reflect science process skills. They only reflected knowledge.
- The majority of the student teachers found it easy to use teacher exposition, teacher demonstrations and question and answer. These were the only teaching methods which they used. What they taught were products of science and not the basic process skills.

These results indicate that the process skills approach was used to lesser extent in terms of frequency of use, the number of basic process skills taught and by the number of the student teachers who used the approach in teaching Integrated Science.

4.5.3 *Identified Constraints in the Use of Process Skills Approach*

The following constraints were identified:

- Lack of learning and teaching materials in basic schools.
- The new Integrated Science syllabus is still content oriented, and it is overloaded with topics. Process skills did not come out clearly in teachers' guides instead they were just implied. These leave the student teachers with no option but to use expository teaching approaches and drill the pupils for the examinations.
- Inadequate knowledge on process skills approach by the student teachers. The lecturers acknowledged that students were inadequately prepared to teach Integrated Science using the process skills approach. The time spent in college was not enough for them to acquire practical experience on how to use the approach and this shortcoming of the programme was compounded with students' poor background in science.
- Large class sizes in basic schools, mostly handled by the student teachers, had more than fifty (50) pupils. The majority of the pupils in those overcrowded class rooms found it very difficult to communicate effectively in English
- Inadequate knowledge on process skills approach by the school mentors. The majority of them were well vested with 'new' teaching strategies acquired in Continuous Profession Development (CPD) workshops than the process skills approach.

The above mentioned constraints made it very difficult for the student teachers to use the activity –based teaching methods that enabled learners to use and acquire the basic process skills in Integrated Science. Because of the gravity of the constraints the student teachers were left with no choice but to resort to teaching practices that suited the context of the school situation.

CHAPTER FIVE: DISCUSSION OF THE FINDINGS

5.1 Preview

This chapter discusses the results according to the following main themes of the study; student teachers' perceptions of the process skills approach, the extent to which student teachers used the process skills approach, and the constraints faced by the student teachers in using the process skills in basic schools of Kitwe district.

5.2. Student Teachers' Understanding of the Process Skills Approach.

The research showed that, theoretically the student teachers had an understanding of what the process skills approach was. They indicated that the approach was activity-based and focused on the development of process skills. They knew that hands-on activities gave the pupils opportunities to use and acquire various process skills. This was evident when they identify the teaching practices that emphasized the development of the basic process skills as the aspects of the process skills approach.

All the respondents (100 percent) acknowledged that the main focus of the process skills approach is to develop an enquiry mind and skills for exploring and interpreting the pupils' immediate environment. The fact that the respondents were able to identify those aspects of the approach meant that the student teachers understood what the process skills approach meant. However, their knowledge on process skills approach was very much limited to the theoretical meaning not the practical implication of the approach in the teaching of integrated Science. The majority 23 (76.7 percent) of the respondents acknowledged that they did not have enough knowledge and practical experience of how to plan and implement the approach. It meant that while in college, the student teachers were not given enough practical experience on how to use the approach.

The student teachers were supposed to conduct practical activities in groups and report their findings while in college. They were expected to make reports of their finding (see appendix 5C), in which they were required to identify and state the process skills used in every activity they conducted in various topics. However, the lecturers in MSE study area from Kitwe College of Education (KCE) confirmed that, they tutored students how to teach process skills, but this knowledge was more of theory than practical. Hence, the students finished the college based instructions and were sent to basic schools without being adequately prepared to use the process skills approach.

Although the majority of the respondents 23 (76.7 percent) did not have adequate knowledge on how to implement the process skills approach, they did appreciate its role in the motivation of pupils and the development of the scientific process skills and attitudes. Table 4.4 shows that, those 2(6.7 percent) respondents who did not appreciate the approach and the 4(13.3 percent) who were not sure of its relevance to the teaching of Integrated Science, did not have the adequate knowledge on the approach. This meant that the respondents' appreciation of the approach was to some extent affected by their level of understanding of the process skills approach. That's why only one (3.3 percent) of the respondents was able to see that the approach was not only a means of acquiring process skills and attitudes but also a means of acquiring scientific knowledge in a meaningful way.

These findings resonate to some extent with the results obtained by Moyo and Nyikahadzoyi (2005). In their study they also found out that more than 90 percent of the teachers in Masvingo district of Zimbabwe, theoretically, understood the process skills approach. However, the pedagogical instruments prepared by the teachers in Masvingo district showed that they were more prepared to use the approach then the student teachers from Kitwe College of Education.

The above discussion shows that student teachers' understanding of the process skills approach was inadequate because they lacked the pedagogical knowledge on how to develop the process skills in pupils. They knew what the approach was, but they didn't know how to use the approach which was crucial in achieving the objectives of the Integrated Science

5.3 Extent Use of the Process Skills Approach by the Student Teachers

The research shows that the majority (93.4 percent) of the respondents used the approach only from time to time. That is, they used it at least in one (1) Integrated Science lesson fortnightly. Only one student teacher acknowledged using the process skills approach in at least two (2) lessons in a week. In terms of the extent of the use of the approach, the number of the student teachers who claimed to use the approach and the frequency at which the majority of the student teachers used the approach implied that the approach was used to a very limited extent. It meant that the respondents used other teaching approaches in teaching the four lessons in a week. One of the reasons why the majority of the respondents did not often use the approach was that they were unable to plan and implement the approach. Majority, 21(70.0 percent) out of the twenty eight (28), respondents who indicated that they sometimes used the approach, had inadequate knowledge on the approach.

However, the results in the same table seems to contradict the above argument, it shows that even the majority, 5 out of the 6, respondents who had adequate knowledge on the approach also indicated that they did not use it often as expected. This result suggests that having knowledge on a given approach does not necessarily mean that one will always use that approach to teach. This is because there are always gaps between theory and practice. In practice, there are always factors that hinder teachers from implementing what they know. This argument is supported by Moyo and Nyikahadzoyi (2005). In their study they found out that although more than 90 percent of the teachers in Masvingo district in Zimbabwe were prepared theoretically to use science using process skills approach, but failed to use the approach due to various contextual factors. The gaps will be explained by other factors apart from the student teachers level of knowledge on the approach. These factors are referred to as constraints in this study and will be discussed later in this chapter.

This study also found out that the majority (70 percent) of the respondents perceived the use of the process skills approach in the teaching of Integrated Science as difficult. Only 30.0 percent of the respondents said they found it easy to use. They attributed the difficulties in using the approach to lack of learning/ teaching materials, overcrowded classes, lack of time to cover the syllabus and lack of adequate knowledge on the approach. From the results in table 4.8, it is clear that the respondents' level of knowledge on the process skills approach also affected the way they perceived the approach.

The results show that 5 out of 6 of the student teachers who indicated that their knowledge on the approach was adequate perceived it to be easy to plan and implement in most of the topics in Integrated Science. While the majority, 18 out of the 19, of the respondents who perceived the approach to be difficult to use, indicated that their level of knowledge on process skills approach was inadequate. The student teachers' level of knowledge affected their perception of the approach. Their perception in-turn, affected their frequency of use of the process skills approach, hence it adversely affected the extent to which the student teachers used the approach.

The frequency of use of the process skills approach was also affected by the view of the majority (76.6 percent) of the respondents that it was not possible to use the approach to teach all the topics in Integrated Science. They cited the following topics: "Body systems," "Solar systems" and "Animals." This could be 'true' to a certain extent in that, the topic to be taught also had an influence on the choice of the approach by a teacher. For example if a teacher is teaching "Prevention of HIV/AIDS" it could have been very difficult to use hands-on activities because of the risks and moral issues involved. However, the student teachers cited the topics in which one could easily plan and implement the hands-on activities. For example, if one was teaching the "Circulatory system" in a grade 7 class, pupils could be given an activity in groups to find out what happens to the pulse rate when a person is doing the following activities; sitting, walking and running. In this activity, pupils will be able to use the sense of feeling to observe different pulse rates as pupils perform different activities, and they will be able to measure the pulse rate and communicate their results in table form. For many student teachers, it seemed hands- on activities meant the use of laboratory apparatus/ equipment and chemicals.

This restrictive view of the hands-on activities adversely affected the respondents' creativity and because of this, they denied the pupils the chance in the construction of their knowledge through simple activities like the one illustrated above.

Since the Integrated Science syllabus focuses on the development of the following skills: observation, classification, measuring, inference, hypothesis, prediction, communication and experiment, it was important for the study to establish the extent to which the process skills were used by finding out whether the number of the above process skills were taught by the student teachers. Figure 2 reveals that only 4 process skills out of 8 were taught. These were classification, measuring, observation and communication. And the student teachers claimed that they found it easy to identify, plan and teach these skills when teaching topics in Integrated Science (see figure 3).

Although the student teachers claimed to teach certain skills and exclude others completely, this is not possible in practice because process skills are interrelated and not disjointed dimensions of science. The use one process skills opens avenues to use other skills. Take observation skill for example, if the majority of the student teachers taught this skill during hands – on activities not demonstrations, it would have lead to the teaching of other skills like hypothesis, inference and experimenting. . The claim by the respondents to teach certain skills was also undermined by the responses given in table 4.5 which indicates that the majority (93.4 percent) of the student teachers used the approach only from time to time. Thus it was not possible for them to teach the identified skills when they only used the approach in one science lesson in two weeks.

In order to deal with the above inconsistencies, the study made a follow up by examining the lesson objectives and the teaching methods used by the student teachers in Integrated Science lessons. The inspection of the lesson objectives used by the respondents revealed that most (80 percent) of the objectives did not reflect any of the process skills they claimed to have taught. This just showed that although they claimed to teach certain skills, they did not actually plan and teach these skills in practice; if they did, then the process skills were just implied and poorly taught. The emphasis of the lesson objectives formulated by the student teachers was the scientific knowledge and as such the majority of them used expository teaching methods/ activities to transmit scientific facts and concepts to pupils.

This was evident by the responses of the mentors, lecturers and the student teachers in figure 4, that student teachers used teacher talk, teacher demonstration and question and answer. Although the majority of the lecturers (60 percent) and the mentors (100 percent) said that student teachers often used group discussion, the majority (60 percent) of the student teachers indicated that they did not use the approach often. The results in figure 5 show that student teachers perceived the methods they often used to be easy to plan and implement in the teaching of Integrated Science in basic schools. The distribution of responses in figure 5 also revealed that, although the respondents did not use nature walk, pupils making their own drawings and presentation by pupils in their teaching of science, the majority of them perceived these teaching activities easy to use. These results show that the majority of the student teachers used expository teaching methods more than activity-based inquiry approaches that focused on the attainment of scientific knowledge through the use of processes of science. Pupils were denied opportunities to use and develop process skills by not engaging them in simple investigations (experiments), nature walks, field trips, project work and in making their own presentations of findings using simple graphs, tables, and diagrams.

The observed lessons confirmed that the student teachers used mostly teacher talk and question and answer as methods of instruction in Integrated Science. Thus, Integrated Science teaching, learning and assessment focused heavily on the acquisition and reproduction of scientific content. This was evident by the type of class exercises which were given to pupils; which were at the low levels of cognitive domain. This shows that Integrated Science teaching by the student teachers was teacher centred and content oriented. Most of the lessons were 100 percent theoretical and text book driven. These results resonate with the findings of other studies such as Ogunniyi (1986) in South Africa and Moyo and Nyikahadzoyi (2005) in Zimbabwe.

The above discussion dispels the claim made by the student teachers that they taught the process skills identified in figure 2. It also shows that although the student teachers seemed to have acquired the language of activity-based science teaching did not seem to translate that language into practical lessons. Much of their teaching of Integrated Science remained focused heavily on the transmission of scientific knowledge rather than the use, acquisition and development of science process skills. Thus, the approach was used to a very lesser extent to develop the process skills in children.

5.3 Constraints in the Use of Process Skills Approach

There were many constraints identified in this study, and in this chapter they are going to be discussed in the following broad themes:

- Lack of learning - teaching materials in basic schools to support the use of the process skills approach.
- Large class sizes.
- Inadequate knowledge on process skills approach by the student teachers
- Inadequate knowledge on process skills approach by the mentors.

5.3.1 *Lack of Learning/ Teaching Materials in Basic Schools*

The results show that although the Ministry of Education has made pronouncements in basic schools' science curriculum documents to refocus the teaching approaches from content to process oriented ones, very little has been done in basic schools in terms of provision of learning/ teaching materials for Integrated Science. The findings revealed that all (100 percent) respondents stated that this was one of the major constraints in the use of the activity based approach in Integrated Science, and this was also expressed by the mentors and lecturers

To start with government has lamentably failed to provide Integrated Science pupils' text books and teachers' guide in basic schools in Kitwe district. Instead of supplying these books free of charge, the Ministry has given the mandate to Macmillan of

Zambia to supply these books to basic schools at a cost. This is a contradiction in the implementation of the education policy in that the same government is offering free basic education from grade 1 to 7, and it expects the already constrained basic schools to source for funds to buy these materials. This has undermined the implementation of the Integrated Science syllabus. Eighty percent of the classes handled by the student teachers had inadequate number of text books, and only 25 percent of pupils had books in those classes. This meant that one book was shared among four pupils. Thus, pupils were denied a chance of getting more detailed information on their own and have a strong conceptual framework of the scientific knowledge which is key in their mobilization and use of process skills in science activities. Since the pupils had no other source of information on Integrated Science topics, they depended very much on the student teachers as sole providers of the scientific knowledge. This left the student teachers with no other choice but to focus more on the transmission of scientific content rather than process skills through hands on activities. They did this by writing some passages from text books on the chalk board for pupils to copy in their exercise books as notes. These took the form of class exercises and they were mostly filling in the blanks type. This is one of the reasons why most of the observed lessons were text book driven.

To make matters worse, the student teachers had no instructional manuals on the teaching of process skills. Sixty six percent of the respondents indicated that they did not have Integrated Science Teachers' Guides. A brief discussion with those who had them revealed that the Integrated Science Teachers' Guides had no clear cut tips on how to teach processes. This dimension of science was just implied in the suggested activities in each topic. Everything was left to the individual student teachers to either identify the skills or not. If these process skills have to be taught, teachers' guides should clearly emphasise this dimension of science by clearly bringing them out in the suggested activities, and give tips on how they can be taught. Lack of guidance on how to teach process skills by instructional materials in form of teachers' guides, made it very hard for the student teachers to identify, plan and teach the skills. Most of science activities which they conducted in Integrated

Science lesson focused on the confirmation and demonstration of scientific facts rather than the use and development of process skills.

The above discussion shows that the Integrated Science syllabus was still content oriented. It put more emphasis on the acquisition of scientific content than process skills. The syllabus was overloaded with topics whose objectives focused on the lower level of cognitive domain. The student teacher attributed their failure to use activity - based approach to this problem. They said that they did not have enough time to spend on hands-on activities when they had so many topics to teach in a term. Thus their main focus was to drill pupils for examinations.

The research revealed that basic schools in Kitwe district did not have the materials to support the use of process skills in teaching Integrated Science. Unlike the first world countries which did not experience problems in providing facilities and curriculum materials and equipment to support the implementation of process skills approach, in Africa this has been the problem in using the approach in schools. In third world countries like Zambia, this problem has been left to be solved by individual teachers through improvising and the use of no- cost or low cost materials. However, the study found out that student teachers found it difficult to improvise or take advantage of the materials in the local environments. Lack of the readily available materials in schools made it very difficult for the respondents to conduct hands-on activities. In cases where the student teachers tried to improvise, the learning and teaching materials were of poor quality and they failed to enhance the use and development of process skills. In most cases, these were drawn charts which only served the purpose of illustrating scientific concepts and facts.

No matter how brilliant the intensions on basic school science curriculum by the Zambian Ministry of Education might be, it will always be like a chase after the wind if the government can't invest heavily in the provision of learning and teaching materials in basic schools. There are some very important materials in science which cannot be improvised. Take for example cells, thermometers, compass and others. It is very impossible to substitute these resources and they are very expensive for teachers to afford from their meager salaries. The Ministry of Education should provide favorable conditions in basic schools to support the implementations of the much talked about 'activity- based approaches,' in policy and curriculum documents.

5.3.2 ***Large Class Sizes***

The study identified large class sizes as one of the major constraints in the use of the process skills approach. Out of 30 respondents only 6(20 percent) of the student teachers taught normal classes in terms of class size i.e. 20 to 45 pupils. The majority of the respondents handled very big classes of about 65 to 85 pupils. Although there is no one class organisation of children that fits all science activities, class size has a bearing on the choice and implementation of any teaching approach. It also influences the teacher's organisation of children in a science lesson to suit the approach being used. The children may be organized in the following ways: as a whole class, in groups, in pairs and individually. There is work appropriate for each class organisation. This is summerised in the table 5.1

Table 5.1. Different types of class organisation for various science activities

Class organisation	Where most appropriate
Whole class	• Teacher introducing a topic; giving a motivating demonstration; giving information about available materials, resources and points of safety; showing how a technique that may be useful.
Group work (Ideally groups of 4, but 5 and 6 for older children)	• Exploration and investigation where genuine collaborative tasks can be set (each child has a role in the combined effort and all are aware of this). • Brain storming about how events might be explained (hypothesis), or what results mean. • Discussion of idea and findings with the teacher. • Teacher suggesting further experiences or ideas to try.
Pairs	• Planning and carrying out investigations where close observation is needed and collaborative larger group work is not possible.
Individual	• Children expressing their own ideas; recording their work; finding information from books; practicing new technique; gathering evidence to pool later in group or whole class.

The table above suggests that the appropriate number of children to perform a task in a science class is between 4 and 6. It also shows that group work gives children more opportunities to use and acquire process skills as they actively take part in the explorative and investigative tasks. However, looking at the number of children in the classes taught by the student teachers, it was extremely difficult for them to plan and manage the group work. Firstly, the classes were just too big and secondly, there were no resources in basic schools for pupils to use in groups. For example, a class of 70 pupils meant that the student teacher was supposed to manage and plan for 14 groups of 5 pupils each. This was beyond their class management abilities, even the most experienced teacher would find it very difficult.

Group work requires pupils to actively be involved in the construction of their own knowledge in a social context (a group). It follows then that the smaller the groups the more each pupil participates and contributes to the outcome of the task. Due to large classes student teachers who tried to use group work, ended up with very big groups, of 10 to 12 pupils each. These groups were too big to give each child an opportunity to use and acquire process skills, and actively contribute to the outcome of the task. The participation of the pupils was not only affected by the size of the groups but also by their inability to communicate their ideas in English. This was one of the constraints cited by both the student teachers and lecturers in the use of activity based approaches. The only class organisation which seemed appropriate for student teachers to use in this context was whole class and as a result they used teacher talk, question and answer and teacher demonstration as these are the most effective teaching strategies in this type of class organisation.

5.3.3 *Inadequate Knowledge on Process Skills Approach by the Student Teachers*

Adequate level of preparation of teachers is central in the implementation of any curriculum. From the comments by the lecturers from Kitwe College of Teacher Education, the student teachers were not adequately prepared to teach Integrated Science using process skills approach. This is why the study could not find the envisaged change in terms of the use of teaching approach by the student teachers in basic schools in Kitwe district. The knowledge student teachers acquired from the college about the process skills approach was more of theory, than practical. While at college the student teachers did not have enough practical experience on the approach as outlined by the MSE study area. They were supposed to acquire practical experience by performing various practical science activities while in college (see appendix 5 C). This made it very difficult for the student teachers to use the approach during their school experience. They knew what process skills were, and what process skills approach was but the student teachers did not have knowledge on how to plan and implement it. That is why they found it difficult to identify and plan for the process skills which were supposed to be taught in various topics in Integrated Science through hands-on activities.

The above student teachers' problem was compounded by their poor background in science. The student teachers' science content knowledge was very weak and as such it affected their ability to identify and teach science process skills. This study confirms the findings of Mikalsen and Ogunniyi (2004) that understanding of scientific concepts served as a context for mobilization of the process skills needed to perform a task. It meant that, student teachers could not identify process skills involved in teaching topics in Integrated Science because their content knowledge for mobilization of process skills was inadequate. Weak subject content knowledge hindered both the understanding of pedagogical knowledge on process skills and its implementation.

5.3.4 *Inadequate Knowledge on Process Skills Approach by the Mentors*

Mentors are very important stakeholders in the ZATEC programme, in that they provide profession support to the student teachers. Mentors practically train student teachers how to teach. They help them to plan and in the actual teaching of Integrated Science lessons. However, the mentors who took part

in this study seemed to have no idea of what it meant to teach Integrated Science using process skills approach. This in itself was one of the major constraints to the use of the approach. The mentors were pre-occupied with the introduction of student teachers to new teaching methods based on Primary Reading Programme (PRP), such as Mathematical Rainbow Kit (MARK). These methods are learned through meetings and workshops under Continuous Professional Development (CPD) programme, and these methods were completely new to the student teachers. These changes in methodologies in basic schools confused the student teachers. It was difficult for them to really implement what they had learned in college. The situation for the student teachers was like finding the direction when the ground is moving.

The above discussion on the constraints show that there was no harmony between the three knowledge bases acquired by the student teachers to enable them use process skills approach in teaching Integrated Science in basic schools. These three knowledge bases are; subject matter knowledge, pedagogical knowledge and knowledge of the context, this weakened their pedagogical content knowledge in science. Hence, it was extremely difficult for them to use the process skills approach.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

The conclusion of this study was done according to the following objectives:

- Student teachers understanding of process skills approach
- Extent of use of process skills approach by the student teachers.
- Constraints to the use of process skills approach.

6.1.1 *Student Teachers' Understanding of Process Skills Approach*

The research revealed that student teachers did not have adequate understanding of the science process skills approach. Theoretically, they knew that the approach involved the use of hands-on activities that focused on the development of process skills, and they appreciated the relevance of the approach to the teaching of Integrated Science. However, they lacked practical experience of how to plan and implement the approach.

6.1.2 *Extent of Use of Process Skills Approach by the Student Teachers*

The research revealed that the majority (93.4 percent) of the student teachers used the approach in one science lesson every two weeks. Their inadequate knowledge on the approach prevented them from using the process skills approach in all Integrated Science lessons per week. This frequent use of the approach showed that the approach was used to a very small extent. The study also revealed that although student teachers claimed to teach some of the process skills, this was not the case in practice. The lesson observations revealed that the student teachers used expository teaching methods/ activities which emphasised more on the acquisition of scientific knowledge than process skills. The lesson objectives did not reflect the process skills they claimed to teach. In some lessons pupils used observation, communication, measurements and classification. However, theses process skills were not planned for by the student teachers and as a result, they were not used for their sake as tools for children to construct their scientific ideas. Observation for example, was restricted to the sense of sight, and pupils were asked to pay attention and see the demonstrations by the student teachers, it was not used as a means of gathering information through experience. Among the observed lessons, only one student teacher gave pupils an opportunity to use process skills during a practical activity on soil drainage. This showed that the student teachers used the approach to a very lesser extent to be noticed as being used in the teaching of Integrated Science in basic schools.

6.1.3 *Constraints in the Use of Process Skills Approach*

The study identified the following factors as constraints to the use of the process skills by the student teachers in basic schools in Kitwe district.

1. Lack of learning/ teaching materials to enable student teachers plan and conduct hands-on activities which were the means through which pupils were supposed to use to acquire process skills.

2. Inadequate knowledge on the process skills approach by the student teachers. They did not have adequate pedagogical knowledge on how to identify process skills, plan for them and teach them through activities.

3. Inadequate subject knowledge by the student teachers: Their weak back ground in science hindered their ability to identify process skills in a given topic in Integrated Science.

4. Inadequate knowledge on process skills approach by the mentors: This was a draw back on the part of the student teachers in that they did not have the much needed professional guidance based on the real context on how process skills can be taught in Integrated Science.

5. Large class sizes: Research shows that student teachers taught very large classes of about 65 pupils on average; hence they found it extremely difficult to use the activity based teaching methods.

6. Content oriented science curriculum: The Integrated Science syllabus was still content oriented in that it was overloaded with topics. These left student teachers with no option but to use the knowledge transmission models of teaching which are more effective in covering a lot work. The syllabus objectives focus mainly on the cognitive domain learning outcomes.

7. There were a lot of changes in terms of teaching methods in basic schools: the changes confused student teachers, they did not know what approaches to use between the ones they leant while in college and the ones they found in the field. In some cases student teachers were even forced by the mentors to abandon the approaches they learnt in colleges so as to conform to new approaches acquired through Continuous Profession Development (CPD) programmes.

8. Inability by the pupils to communicate in English: The ability by the pupils to communicate in a language of instruction is key in the implementation of group activities in science. However, the majority of the pupils in basic schools in Kitwe district could not express their 'scientific' ideas in English. This made it difficult for student teachers to actively involve the pupils in hands-on activities.

6.2 Recommendations

In light of the findings of the study the following recommendations are made to the following stakeholders in the provision of education in Zambia:

6.2.1 *Policy Makers*

Since middle basic education is free, the government through the Ministry of Education should provide free teaching and learning resources in basic schools. The government should re- introduce a company like National Education Distribution Company of Zambia (NEDCOZ) to produce and distribute free education material to basic schools. If the government is providing free education at that level it should play a bigger role at every step of basic education delivery. The Ministry of

Education should also limit the enrollment level in each class like it was some time back. Forty five (45) was the maximum number of pupils in each class.

6.2.2 *Curriculum Development Centre.*

The CDC should always rehearse with the Colleges of Teacher Education when they are developing new science curriculum in basic schools so that these institutions can make necessary changes in their teacher training curriculum and meet the needs of the science curriculum in basic schools. The center should also revisit the objectives stated in teachers' guides and the Integrated Science syllabus itself. The objectives of the suggested activities and each topic should be explicit on the development of process skills. The process skills to be developed in every suggested activity and in every topic in the syllabus should be stated clearly. This will constantly guide and remind teachers to teach this dimension of science.

6.2.3 *Teacher Education and Specialised Services Department*

This department should seriously consider the extension of the duration of the ZATEC programme from the current one year in colleges to two years, and school experience should remain one year. The duration of the whole programme should be three years and graduates should be awarded with a diploma in primary school teaching methods. This means that students are going to have enough contact time with the lecturers to acquire both science subject matter and pedagogical knowledge. Each study area should have two components background and methodology and they should be offered separately.

6.2.4 *Teacher Educators (Mathematics and Science Section)*

In order to adequately prepare students to use the activity based approach in the teaching of Integrated Science, the teacher educators should give enough practical experience in planning and implementation of hands-on activities that focus on the development of process skills. This can be done once every week using the same outline of an activity report shown in appendix 5C. These activities should be marked and they should contribute to marks in continuous assessment. The lesson plan should also have a column under lesson development/ presentation in which the process skills to taught during the learning/ teaching activities should be indicated. Lecturers should also lobby for funds to conduct research on various teaching methods in science, because they are in a better position to advice government on how best it should go on to implement its intensions on science education at that level. Teacher educators and mentors should also hold Continuous Professional Development meetings regularly in order to brace themselves with the new methods in the teaching of science.

6.2.5 *The Basic School Head Teachers*

The Head Teachers identify teachers who have interest in science and support them materially to make simple and cheap learning and teaching aids. They can be supported to raise some bit of money to buy cells (batteries), 1.5V bulbs, thermometers, stop watches and other materials which teachers can't improvise. These materials should be kept in one of the senior teachers' office or a class room reserved for science activities only.

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APPENDICES

APPENDIX 1

QUESTIONNAIRE FOR ZATEC STUDENT TEACHES

QUESTIONNAIRE NO. | | |

Dear Respondent:

The purpose of this questionnaire is to collect data related to the teaching of Integrated Science in basic schools.
Please feel free and be as **honest** as possible as they are no **right** or **wrong** answers in responding to this questionnaire.

True and frank responses will help to provide vital information which college lecturers, standard officers, INSET providers and other stakeholders may use in designing programme that will meet the needs of student teachers and teachers in using process skills approach. **Your responses will be treated with confidence, and will only be used for the purpose of this study.**

Yours, Mr. Mweshi E: Student Master of Education in Mathematics and Science Education

THANK YOU IN ADVANCE FOR YOUR PARTICIPATION.

PART ONE IDENTIFICATION OF DATA

Official use

School:.....................................

Grade:......................................

A. STUDENT TEACHERS UNDERSTANDING OF PROCESS SKILLS APPROACH

1 (a) What do think science process skills approach is?

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(b) **Tick (√)** the teaching practices which you think are aspects of the process skills approach

Item Number	Teaching practices	Tick (√)
1	Emphasis on the ability to recall scientific knowledge	
2	Emphasis on the development of an enquiry mind and the skills for exploring and Interpreting the immediate environment	
3	Encouraging pupils copying graphs, diagrams and charts from the chalk board	
4	Encouraging pupils to give possible explanations for set of observation	
5	Encouraging pupils to gather and select data using their senses	
6	Giving pupils filling in the blanks exercises from the pupils' book	
7	Pupils organizing observations, ideas or events in order to detect patterns and relationships	
8	Encouraging pupils to use reliable observations, tell what is likely to happen in future	
9	Pupils receiving scientific facts on a given topic from knowledgeable teacher	
10	Pupils conducting activities to test their explanations for a set of observation answer questions or verify known facts.	
11	Pupils comparing objects and duration of events with standard units in order to make their observations more precise	

Official use

(c) How do you appreciate the use of the process skills approach in teaching Integrated Science?

1. It is the means through which children acquire process skills that enable them to attain scientific knowledge in a meaningful way
2. It is the only means through which children acquire science process skills and attitudes
3. It is the most effective way of motivating pupils
3. Pupils can still acquire scientific knowledge in a meaning way using other approaches
4. Not sure of it's value to the teaching of Integrated Science

(d) Do you have enough knowledge on how to plan and implement the process skills approach in Integrated Science lesson?

1. Yes   2. No   3. Not sure

(e) If '**No**,' what is missing?

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B. EXTENT OF USE OF PROCESS SKILLS APPROACH

2. (a) How often do you use process skills approach in Integrated Science lessons per week?

1. In 4-3 lesson per week
2. In 2-1 lessons per week
3. In 1-0 lesson every two weeks
4. Not used at all

(b) How do you find using process skills approach in teaching Integrated Science?

Official use

1. Hard to plan and implement in all the topics ☐
2. Easy to plan but hard to implement in all the topics ☐
3. Easy to plan and implement in some topics ☐
4. Easy to plan and implement in all the topics ☐

(c) Is it possible to use the process skills approach to teach all the topics in Integrated Science?

1. Yes ☐ 2. No ☐ 3. I don't know ☐

(d) If '**Not**,' state the topics where you think it is not possible to use the process skills approach.

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(e) State the reason(s) why you think is not possible to use the approach in the identified topic(s).

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3. (a) Do the Integrated Science syllabi have Teachers' Guides Which give tips on how to teach pupils process (investigative) skills?

1. Yes ☐ 2. No ☐

Official use

(b) If 'Not' how has it affected your teaching of science process skills?

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4. (a) One of the general out comes of each unit of Integrated Science syllabi, is to develop investigative (process) skills in learners. Indicate by **ticking (√)** how frequent you teach each the following process skills?

Frequency of teaching process skills				
Process skills	**Frequency**			
	1	**2**	**3**	**4**
1. Observation				
2. Classification				
3. Inference				
4. Measuring				
5. Hypothesis				
6. Communication				
7. Experiment				
8. Prediction				

Key

1. In 4-3 lessons per week
2. In 2-1 lessons per week
3 In 1-0 lessons every two weeks
4 Not taught at all

(b) State the reasons (if any) why the identified process skills are only taught once in every two weeks or not taught at all

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Official use

5. (a) How do you find teaching each of the following process skills? Indicate your response by **ticking (√)**

Difficulty in teaching process skills.				
	Level of difficulty			
Process skills	**1**	**2**	**3**	**4**
1. Observation				
2. Classification				
3. Inference				
4. Measuring				
5. Hypothesis				
6. Communication				
7. Experiment				
8. Prediction				

Key

1. **Hard to identify, plan and teach in all the topics**
2. **Easy to identify, but hard to plan and teach in all the topics**
3. **Easy to identify, plan and teach in some topics**
4. **Easy to identify, plan and teach in all the topics**

(b) State the reasons (if any) why you find it hard to identify, plan and teach the process skills identified above

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6. (a) How often do you use the following teaching methods/activities when teaching Integrated Science per week. Indicate your response by **ticking (√)**

Official use

Frequency of use of various teaching methods/activities				
Teaching methods/activities	**Frequency**			
	1	**2**	**3**	**4**
1. Teacher demonstrations				
2. Pupils listen to the teacher (teacher talk)				
3. Pupils experimenting				
4. Class goes outside to learn(Nature walk)				
5. Pupils discussing in groups				
6. Pupils making their own drawing				
7.Project work				
8. Pupils making presentations				
9.Field trip				
10. Question and answer				

Key

1. In 4-3 lessons per week
2. In 2-1 lessons per week
3 In 1-0 lesson every two weeks
4 Not used at all

(b) State the reasons (if any) for rarely or not using the methods/ activities identified above

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7. (a) How do you find using each of the methods/ activities listed below? Indicate your response by **ticking (√)**

Official use

Difficulty in using various teaching methods/activities				
	Frequency			
Teaching methods/activities	1	2	3	4
1. Teacher demonstrations				
2. Pupils listen to the teacher (teacher talk)				
3. Pupils experimenting				
4. Class goes outside to learn(Nature walk)				
5. Pupils discussing in groups				
6. Pupils making their own drawing				
7.Project work				
8. Pupils making presentations				
9.Field trip				
10. Question and answer				

Key

1. **Hard to identify, plan and teach in all the topics**
2. **Easy to identify, but hard to plan and teach in all the topics**
3. **Easy to identify, plan and teach in some topics**
4. **Easy to identify, plan and teach in all the topics**

(b) State the reasons (if any) why you find it hard to identify, plan and teach the process skills identified above

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D. SUPORTING LEARNING/ TEACHING MATERIALS TO PROCESS SKILLS APPROACH

Official use

8. Indicate by **ticking** (√) the availability of the following learning/ teaching materials in your school

Key
1. Not there
2. Available but not enough to be used in group activities
3. Available and enough for group activities

Availability of Learning /teaching materials.			
Types of materials	**Availability**		
	1	**2**	**3**
Materials & Energy			
Bar magnets			
Iron filings			
Connecting wires			
Dry cells (batteries)			
1.5V bulbs			
Switch boards			
Mirrors			
Compass			
Measuring tapes			
Metre rulers			
Stop watches			
Plants & Animals Charts of: -			
- Amphibians			
-Reptiles			
-Mammals			
-Insects			
-Insect & wind pollinated flowers			
- Seed & vegetative propagated plants			
The Environment Models of;-			
- Wind vane			
- Anemometer			
Thermometers			
Charts of different types Of pollution			
Health Charts of;-			
-Different types of diseases			
-Different types of abused drugs			
First Aid Kit			
HIV/AIDS resource materials			

Official use

9. How many pupils are there in your class? **Tick (√)** your response.

1	2	3	4	5	6
20 - 35	36 - 45	46 - 55	56 - 65	66 - 75	76 - 85

10. What percentage of pupils in your class has pupils' books for Integrated Science? **Tick (√)** your response

1	2	3	4
0 - 25%	26 - 50%	51 - 75%	76 - 100%

11. After completing items **8, 9** and **10,** could you say that your school has enough learning/ teaching materials?

1. Yes ☐ 2. No ☐

12. If your response to item 13 is '**No,**' how does the non-availability of learning/ teaching materials affect your teaching methods?
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13. Do you think the school should provide all the learning/ teaching materials for you to teach all the topics effectively?

1. Yes ☐ 2. No ☐

14. If 'No,' to item 14, list the topics where you can easily improvise learning/ teaching materials and teach the topic effectively.
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E. CONSTRAINTS TO PROCESS SKILLS APPROACH

Official use

15. (a) In your own experience of teaching science so for, could you consider the following to be the major constraints to the teaching of science process skills? **Tick (√)** your response.

Item Number	Perceived Constraints	Tick (√)
1	Lack of learning/ teaching materials in basic schools	
2	Lack of teachers' guides with tips on how to teach science process skills	
3	Inadequate knowledge on process skills approach by the Students	
4	Big class sizes in basic schools	
5	Integrated Science syllabus has a lot of subjects to cover	
6	Learners inability to communicate effectively in English language	
7	Lack of pupils books for Integrated Science	
8	There are a lot of changes in basic schools in terms of teaching methods	
9	Inadequate science subject matter knowledge by the student teachers	
10	Inadequate knowledge on science process skills by the mentors	

(b) How best can the identified constraints be resolved?

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THE END

APPENDIX 2

SEMI-STRUCTURED INTERVIEW SCHEDULE FOR THE LECTURERS IN MATHEMATICS AND SCIENCE DEPARTMENT OF KITWE COLLEGE OF EDUCATION

QUESTIONNAIRE NO. | | |

INDENTIFICATION OF DATA

Title of respondent..
Date of interview...

Dear interviewee:

The purpose of this interview is to collect data related to the use of process skills approach by the ZATEC student teachers on school experience in Kitwe district. Feel free and be as honest as possible in responding to the questions. True and frank responses will help to provide vital information which college lecturers, standard officers, INSET providers and other stakeholders may use in designing programme that will meet the needs of student teachers and teachers in using process skills approach

Your responses will be treated with the strict confidence, and will only be used for the purpose of this study.

Yours, Mweshi E: Student Master of Education in Mathematics and Science Education

THANK YOU SO VERY MUCH FOR YOUR CO-OPERATION

PART ONE: BACKGROUND DATA

Official use

Qualification

1. Certificate ☐
2. Diploma ☐
3. Advanced Diploma ☐
4. Bachelors Degree ☐
5. Masters ☐

2. Work experience in the present position

1. 0 – 5 years ☐
2. 6 - 10 years ☐
3. 11- 15 years ☐
4. 16 – 20 years ☐
5. 20 years and above ☐

PART TWO: OBJECTIVES

SECTION A

Lecturers views on Student teachers understanding of process skills approach

3. Could you outline the scope of the coverage of the process skills as stipulated by Mathematics and Science study area syllabus?

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Official use

4. State the process skills student teachers are suppose to teach in Integrated Science at lower and middle basic schools level.

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5. To what extent were student teachers equipped with theoretical knowledge to identify these skills as they teach Integrated Science?

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6. How does the mode of teaching in Mathematics and Science Education study area provide students with practical experience to teach science process skills when they are out on school experience?

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SECTION B

Methods used by ZATEC students during school experience

Official use

7. From your own experience during the monitoring exercise, how often do the ZATEC students currently on school experience use the following teaching method/ activities?

Frequency of use of various teaching methods/activities				
	Frequency			
Teaching methods/activities	**1**	**2**	**3**	**4**
1. Teacher demonstrations				
2. Pupils listen to the teacher (teacher talk)				
3. Pupils experimenting				
4. Class goes outside to learn(Nature walk)				
5. Pupils discussing in groups				
6. Pupils making their own drawing				
7.Project work				
8. Pupils making presentations				
9.Field trip				
10.-Question and answer				

Key

1. In 4-3 lessons per week
2. In 2-1 lessons per week
3. In 1-0 lesson every two weeks
4. Not used at all

8. What do you consider as the major constraints student teachers face in teaching integrated science in basic schools using the activity-based approach?

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Official use

9. What do you think should be done to remove the constraints you Have identified?

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APPENDIX 3

SEMI-STRUCTURED INTERVIEW SCHEDULE (SSI) FOR MENTORS

QUESTIONNAIRE NO. | | |

INDENTIFICATION OF DATA

School..
Date of interview..

Dear interviewee:

The purpose of this interview is to collect data related to the use of process skills approach by the ZATEC student teachers on school experience in Kitwe district. Feel free and be as honest as possible in responding to the questions. True and frank responses will help to provide vital information which college lecturers, standard officers, INSET providers and other stakeholders may use in designing programme that will meet the needs of student teachers and teachers in using process skills approach

Your responses will be treated with the strict confidence, and will only be used for the purpose of this study.

Yours, Mr. Mweshi E: Student Master of Education in Mathematics and Science Education

THANK YOU VERY MUCH FOR YOUR CO- OPPERATION

PART ONE: BACKGROUND DATA

Official use

1. How long have you been teaching?

   1. 0 – 5 years ☐
   2. 6 – 10 years ☐
   3. 11 – 15 years ☐
   4. 16- 20 years ☐
   5. 20 above years ☐

2. How long have you been a mentor?

   1 year ☐

   2 years ☐

   3 years ☐

   4 years ☐

   5 years ☐

3. Are you a trained mentor?

   1. Yes ☐ 2. No ☐

4. If not trained how you did become a mentor?

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5. As a mentor, are you familiar with the ZATEC programme?

   1. Yes ☐ 2. No ☐

PART TWO: OBJECTIVES **Official use**

SECTION A
Student teachers use of the Process Skills Approach

According to the Integrated Science syllabi learners are expected to conduct experiments, study tours, fieldwork and project work in order to develop investigative (scientific process) skills.

6. State the investigative (process) skills student teachers are Suppose to teach in Integrated Science. [ ]
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7. Do the Integrated Science syllabi have teachers' guides which clearly guide the teachers on how to teach process skills? [ ]

   1. Yes [ ] 2. No [ ]

8. If '**Yes**' to what extent do they guide the teachers? [ ]
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Official use

9. If '**No**' to item 7, how has it affected the student teachers choice of activities so as to help children use and develop the investigative (process) skills?

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10. From your own experience, as a mentor, do you think that the student teachers are teaching the investigative (process) skills?

1. Yes ☐ 2. No ☐ 3. Not sure ☐

11. If '**Yes**' which process skills are mostly taught?

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12. If '**No**' to 10, what would you consider to be the major constraints for not teaching process skills?

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SECTION B
Teaching Methods used by student teachers

Official use

13. How often do the student teachers use the each of the following teaching methods/ activities in Integrated Science lessons per week?

Frequency of use of various teaching methods/activities				
	Frequency			
Teaching methods/activities	**1**	**2**	**3**	**4**
1. Teacher demonstrations				
2. Pupils listen to the teacher (teacher talk)				
3. Pupils experimenting				
4. Class goes outside to learn(Nature walk)				
5. Pupils discussing in groups				
6. Pupils making their own drawing				
7.Project work				
8. Pupils making presentations				
9.Field trip				
10. Question and answer				

Key
1. **In 4-3 lessons per week**
2. **In 2-1 lessons per week**
3. **In 1-0 lesson every two weeks**
4. **Not used at all**

(b) State the reasons (if any) for not using the methods/activities Identified above
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THE END

APPENDIX 4

THE USE OF PROCESS SKILLS APPROACH IN TEACHING INTEGRATED SCIENCE BY STUDENT TEACHERS

LESSON OBSERVATION SCHEME

A. GENERAL INFORMATION

STUDENT NO.......................................SCHOOL...........................

CLASS.................... NO. OF PUPILS...

TOPIC...

B. LESSON OBJECTIVES

Objectives	Ratings					
	5	4	3	2	1	0
1. Were they clear and specific?						
2. were they attainable in the time available?						
3. Were they measurable?						
4. Did they reflect process skills?						
5. Did they reflect knowledge?						
6. Did they reflect attitudes?						

General
comments...
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C. TEACHING METHODS

Lesson implementation	Ratings					
	5	4	3	2	1	0
7. Were the methods used suitable to achieve the stated objectives?						
8. How well did the student teacher demonstrate the knowledge of the subject?						
9. Did the activities allow pupils to learn the process skills?						
10. How do you rate the pupils' participation in practical activities?						
11. How did she/he guide the pupils to check and verify their scientific ideas?						
12. Identification of process skills on a topic being taught?						
13. Did the teacher questioning techniques lead the pupils to use the identified process skills?						
14. How was the general class management?						

General comments...
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D.LEARNING AND TEACHING AIDS

Use of resources	Rating					
	5	4	3	2	1	0
15. Improvisation of learning/ teaching materials						
16. The use of local environment						
17. The use of charts/graphs/pictures, models were they clear?						
18. Were the learning/ teaching materials appropriate and adequate?						
19. Did the learning and teaching materials enhance the use and development of the identified process skills in that lesson?						
20. Did the learning and teaching enhance the participation of pupils in the hands-on activities?						

General comments..
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KEY TO UNDERSTANDING OF RATING

Rating	5	4	3	2	1	0
Meaning	Excellent	Very good	Good	Satisfactory	Unsatisfactory	Absent

APPENDIX 5A

KITWE TEACHERS' COLLEGE BOARD MATHEMATICS AND SCIENCE EDUCATION TERM ONE SCHEME OF WORK

WEEK	CONTENT	COMPETENCIES	METHODS	REFERENCE
1-2	Induction to MSE	• A secure knowledge and understanding of MSE	• Seminar • Group Work	• Educating the Future • ZATEC Document
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 Theories of learning	• A Secure knowledge of the differences 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 work	• Teaching Primary Science • Teaching Primary mathematics • A Teacher handbook for Primary Science. • Primary Science-making it work

APPENDIX 5 B

A LAYOUT OF A LESSON PLAN USED IN INTEGRATED SCIENCE

Name:	Subject:	Time:
School:	Topic:	
Grade:	Sub Topic:	Duration:

Teaching/learning aids
i) Materials: ....
ii) Apparatus: ....

Problem under investigation: ....

Pre-requisite: (Knowledge pupils should have in order to proceed with the new lesson). Teaching from known to unknown

Behavioural Objective:

- These must be specific, a variety and related reflecting process skills. Knowledge and attitude.
- Avoid using un-measurable verbs e.g. tell, know and understand

INTRODUCTION

This can be in form of a song, story, puzzle, revision questions, etc. It must bridge the previous lesson to the current one. It must create curiosity in the minds of the learners. This must be in short and motivating. It should capture the interest of the learners. It must be more than 5 minutes.

DEVELOPMENT/PRESENTATION

Topic/Content	Teaching/Learning Activities	Class Organisation	Method	Time

PUPIL'S ACTIVITIES (EXERCISE)

Don't give raw notes instead a simple exercise must be given, fill in the blanks, simple response question, drawing a diagram labelling a diagram.

APPENDIX 5 C

A SAMPLE OF A LABORATORY REPORT USED IN MATHEMATICS AND SCIENCE EDUCATION

MEASUREMENT

In everyday life we make measurements. Measurements are of the greatest importance to Scientists and Engineers. Many kinds of measuring instruments have been designed. The instrument panel of a car contains quite a variety. As well as the speedometer and the distance instrument panel, there is the petrol gauge, the oil-gauge, and a thermometer to give the temperature of cooling water.

AIM To measure length, mass, volume and time.

TERM Standard units of measurement, mass, volume, time, distance and derived units (e.g. density).

MATERIALS Measuring cylinder, beam balance, stop watch, stone, and a stirring

PROCEDURE

(i) Measure your height to the nearest centimetre and from the result for the whole class make a histogram by drawing blocks so that the top of each block shows the number of pupils whose heights are between certain values (number of pupils on y-axis and height in centimetres on the x-axis).

(ii) Half fill a measuring cylinder with water and read the volume. Lower the object so that it is all in the water and read the new volume.

OBSERVATION

Write the observations made in this practical

(i) ....

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CONCLUSION

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EXERCISE

(a) (i) Which process skills did you use in conducting this experiment?

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(ii) Which scientific attitudes have you learnt from this work?

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(b) Complete the table below

INSTRUMENT	SI UNIT OF MEASUREMENT	WHAT IT MEASURES
Meter rule		
Watch		
Beam balance		
Druddle wheel		
Measuring Cylinder		
Thermometer		

(c) How many millimetres are there in?

(i) 3cm: ....

(ii) 5cm: ....

(d) What are these lengths in meters?

(i) 750cm ....

(ii) 1,200cm..

(e) Calculate the density of an object with a mass of 10g and $30cm^3$ as its volume.

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APPENDIX 6

A SAMPLE AN EXPERIMENT IN ELEMENTARY SCIENCE ON MAGNETS

1. Observations: A magnet attracted some objects but not others. Objects attracted by the magnet were made of metal. Not all metal objects were attracted by the magnet.

2. Problem: Which metals are attracted by a magnet?

3. Hypothesis: Some metals are attracted to a magnet because they contain iron or steel.

4. Variables: Properties of metals

5. Experiment: Metallic materials are brought close to a magnet to see if they are attracted by it.

6. Data: A table is made listing the objects attracted and not attracted by the magnet.

7. Answer to the problem: Metals containing iron or steel are attracted by a magnet

8. New problem: It was noted after the experiment that a piece of rock was attracted by a magnet. This led to the new problem. Does this piece of rock contain iron, or must we revise our hypothesis?

Source; Curriculum Development Centre, 198

APPENDIX 7

A SAMPLE OF DATA COLLECTION ON SOIL DRAINAGE BY GROUP B: GRADE 6 C CLASS

GROUP B

SOIL DRANAGE OF DIFFERENT TYPE OF SOIL

SOIL TYPE	NUMBER OF COUNTS	SECONDS	MINUTES	COMMENTS
SAND	154	154 sec	2 minutes 34 seconds	very good
CLAY	672	672 sec	11 minutes 12 seconds	Poor
LOAN	248	248 sec	4 minutes 8 seconds	Good