

# **CHAPTER ONE**

## **INTRODUCTION**

### **1.0 Introduction**

This chapter serves as an introduction to the study, whose aim was to investigate the integration and frequency of environmental issues or topics in the pedagogic principles which constitute the structure of the Zambian mathematics curriculum. The study was motivated by the need to improve curriculum relevance in Lusaka urban district schools through contextualized teaching and learning based on environmental issues which affect our society today. For instance, issues to do with conservation, pollution, traffic jam, solid waste management, climate change, water, sanitation, beer drinking (tujilijili), HIV/AIDS, all warrant some educational attention since they constitute our environment. Environmental education (EE) if integrated into mathematics as a subject could facilitate the role of positive attitude formation in pupils towards the environment. The chapter provides a broad background of the study as well as the statement of the problem. It also introduces objectives of the study, and the study's major research questions. The chapter ends with the purpose and the significance of the study.

### **1.1 Background**

Education plays a major role in the lives of individuals, as its main purpose is to provide everybody in the community, private and government schools with quality and relevant education that would enable them acquire relevant skills, knowledge, attitudes and ideas to lead most fulfilling, productive and satisfying lives. Education is a right for each individual and it is also a means for enhancing the well being and quality of life for the entire society (MOE, 1996). Every government has, therefore, the responsibility to ensure that it provides an education of good quality to its people in all institutions.

Mathematics is one of the compulsory subjects in Zambian schools. It is taught in all grades as part of the curriculum and is practically applied in all spheres of our day-to-day existence. Mathematics as a subject is considered to be very necessary in areas such as environmental education, Information Communication Technology, banking and industries to mention a few. The world over, mathematics has contributed to the development of nations through technology. Since mathematics is about pattern and structure, and if integrated in different areas of science and technology, this pattern and structure can be used to explain and manage natural happenings and environmental problems

which have two distinct features; namely the quality and the quantity of environmental resources. Similar feelings are expressed by Porter (1996) who thinks that mathematics has a pervasive influence in our everyday life and contributes to the wealth of the country. Globally, the subject of mathematics has been and is the main driving force for economic development. It is because of this virtue that mathematics has been accorded great value.

The study of mathematics can satisfy a wide range of interest and abilities. It develops the mind, trains in clear and logical thought. Brenner (1984: 71) notes that:

Mathematics has a continuing drive to simplification, to finding the right concepts and methods to make difficult things easy to explain why a situation must be as it is. In doing so, it develops a range of languages and insights, which may then be applied to make a crucial contribution to our understanding and appreciation of the world and the ability to find and make our way in it.

Therefore, the study of mathematics provides a solid foundation to enable society make many aspects of daily life decisions.

Increased concern about the environment in recent decades has paralleled the development of environmental education and, in particular, has clarified its aims and purposes (Sterling 1995). The assertion above is supported by Namafe, 2006, who observes that the field of environmental education, which is relatively new in Zambia, attempts to mount programmes and resources to respond to each and every aspect of environmental complexity which warrant some educational attention. In this case, both school and family play important roles in the formation of children's positive attitudes towards the environment. Integration of environmental education in the Zambian education curricula may raise environmental literacy, and include knowledge that goes beyond an understanding of the environment. Environmental education should build concepts and awareness about the ways in which behaviour affects environmental literacy, knowledge and skills and a critical awareness of environmental action and skills.

The mathematics curriculum, together with other document-specific textbooks, are didactic tools that play an important role in environmental education because environmental problems involve not only the quality of air, land resources, material cycling, energy saving and other issues, but also their quantity. It is a known fact that pupils in Zambian mathematics classrooms, as they go higher in

their education, tend to show an increasingly negative attitude towards mathematics. One reason for this phenomenon is that these higher level classes contain an increasing number of abstract concepts. Another reason is that pupils think that these studies have nothing to do with everyday life, needs and problems. However, positive attitude towards Mathematics play an essential role in determining learners behaviour towards Mathematics. Oppenheim (1979: 105) defines attitudes as 'a state of readiness and tendency to act or react in a certain manner when confronted with certain stimuli.' In accordance with this definition, one could define attitude as a positive individual's behaviour towards Mathematics. The importance of attitude in the learning of Mathematics is further supported by Harlen (1997: 39), who stated that 'pupils' attitudes affect the willingness of individuals to take part in certain activities, and the way in which they respond to the person, the objects or situations. This shows that learners will only understand or be ready to learn new concepts in Mathematics if they are willing and are ready to learn. James et al. (2000) supported the above assertion and noted that positive attitudes towards courses in mathematics, science and technology help, pupils improve their conceptual skills. The above reasoning was also supported by Stipek et al (1991) who noted that Mathematics equips pupils with a uniquely powerful set of tools to understand and change the world. These tools include logical reasoning, problem solving skills and the ability to think in abstract ways. Pupils need these skills in order to fit in the challenging environment. Therefore, in the studies, where Mathematics, Science and other subjects are integrated, the effects of these on pupil success show that pupils who gain mathematical knowledge, also gain scientific knowledge that is based on mathematics and develop a preference for social-scientific activities.

Therefore, consideration is given to the fact that mathematics is based on environmental concepts and the ability to analyse and propose solutions to solve environmental problems encountered by pupils, influences the ways in which mathematical processes and abilities may affect success in science. It is from this background that this study will investigate the extent of integration of environmental education issues in the Zambian Mathematics Curriculum.

## **1.2 Statement of the problem**

Environmental education is conceptualised as an integral facet of education and there is consensus that education at all levels is central for giving impetus to sustainable development. Since 1996, there has been advocacy on the integration of environmental education in Zambia across the school curriculum. According to the ministry of education recommendation, environmental education should form an integral part of the curriculum. The relationship of environmental education and subject areas in the curriculum has been likened to that of flesh

and blood where one needs the other to give meaning to life. All the learning areas are about people and the environment and hence the need to see environmental learning as integral to the curriculum. As an example, the subject of social sciences is about society interacting with the environment and what it offers. Mathematics focuses on how to make calculations about human or natural phenomena, for example, population growth while natural sciences focus on how best to apply scientific approaches and skills in making a living out of the environment. The scientific knowledge collected from researchers and labourers add value to life in various ways. In short, environmental education can be linked to all facets of the curriculum.

The cross-curricular education perspective involves creating environmental learning opportunities in the existing mathematics school curriculum. This cross-curricular education approach is a way of giving a holistic type of education to learners who will have to shoulder responsibilities in society as respected citizens when they grow up. The earlier they are exposed to such a curricular perspective, the better for them to be made aware of the environmental issues and consequently to take appropriate action so as to help in the preservation of Mother Earth.

However, most of the ministry of education recommendations discussed above do not address themselves specifically to the issue of how environmental education should be provided to the learners of different subjects. For example, despite mathematics being a compulsory subject from grades 1-12, there has been little integration of EE in the subject. This integration has mainly been concentrated in subjects such as science and geography and this integration has been left, in most cases, to the schools and teachers in the classrooms themselves. It is against this background that this study attempts to investigate the integration of EE in the Zambian mathematics curriculum in order to understand better how teachers implement the new curriculum provisions in their classroom, since the subject area of mathematics, has no specific defined environmental learning content.

### **1.3 Purpose of the study**

The focus of the study was to investigate the integration of EE in the Zambian mathematics curriculum in selected Lusaka District schools and school teachers implement environmental education in the school curriculum.

#### 1.4 **Objectives of the study**

- (a) Find the kind of human resource basic and high schools rely on for teaching and learning of environmental education.
- (b) Determine the extent to which Lusaka urban schools integrate environmental education concepts in school programmes
- (c) Examine the extent to which environmental topics or concepts are found in the Mathematics syllabus for grades 1-12.
- (d) Identify the extent to which environmental topics or concepts are found in the Mathematics textbooks for grades 1-12.

#### 1.5 **Research questions**

- (a) What kind of human resource do basic and high schools rely on for teaching and learning of environmental education?
- (b) To what extent do Lusaka urban schools integrate environmental education concepts in school programmes?
- (c) To what extent are environmental topics or concepts found in Mathematics syllabus for grades 1-12?
- (d) Are environmental topics or concepts found in mathematics textbooks for grades 1-12?

#### 1.6 **Significance of the study**

The research results will raise environmental literacy by incorporating knowledge in mathematics that goes beyond an understanding of the environment. These include, relating mathematics to current critical environmental issues.

Furthermore, the findings will motivate government and the private sector to invest more in curriculum development, which will help to integrate environmental concerns into social, economic development and planning process of the country. In addition, the study will also contribute to the literature on environmental issues that are of current concern in Zambia.

## 1.7 Operational Definitions

<b>Biodiversity</b>	-	also biological diversity; relative number of species, diverse in form and function, at the genetic, organism, community and ecosystem level ( LEES, 2003:162).
<b>Carbon cycle</b>	-	the term used to describe the exchange of carbon between the atmosphere, ocean, terrestrial biosphere, and geological deposits (Lal, 2004: 22).
<b>Curriculum</b>	-	the sum total of planned teaching and learning experiences (CFD, 2000: 6).
<b>Cross cutting themes:</b>	-	Subject area theme, which cuts across all subjects or many subjects (curriculum Manual 2001: 69)
<b>Fauna:</b>	-	all the animals of an area or of a period of time (Curriculum Manual 2001: 70)
<b>Flora:</b>	-	plants; floors; vegetation; plant life (Curriculum Manual 2001: 70)
<b>Deforestation</b>	-	the destruction of vast areas of forest without Planting growth (Teacher's Curriculum Manual, 2001:69)
<b>Desertification</b>	-	the spread of desert-like conditions in arid or semi-arid, due to overgrazing, loss of agricultural productive soils, or climate changes (Spiropoulou 1997: 6)
<b>Ecosystems</b>	-	ecological units comprised of complex communities of organisms and their specific environments. (Curriculum Manual, 2001: 70)
<b>Effluents</b>	-	waste materials, such as smoke, sewage, or industrial waste which are released into the environment, subsequently polluting it.  (Sheldrick, 1991:26)

- Green house gas** - a gas that ‘traps’ infrared radiation in the lower atmosphere causing surface warming, water vapour, carbon dioxide, nitrous oxide, methane, hydro fluorocarbon, and ozone are the primary green house gases in the earth’s atmosphere. (Cherrett, 1989: 10)
- Ozone shield** - a lower of the atmosphere composed of ozone gas (O<sub>2</sub>) that resides approximately 40 Km above the earth’s surface and absorbs solar ultraviolet radiation that can be harmful to living organism. (Lal, 2004: 19)
- Pedagogical:** - relating to the Science and practice of teaching (Curriculum Manual, 2001: 71).
- Pollution** - the contamination of a healthy environment by man-made waste (Namafe, 2006: iv)
- Soil degradation** - damage to the land’s productive capacity because of poor agricultural practices such as the excessive use of pesticides or fertilizers, soil compaction from heavy equipment, or erosion of top soil, eventually resulting in reduced ability to produce agricultural products (Munson, 1994: 35)
- Soil erosion** - the removal of soil by the action of water or wind, compounded by poor agricultural practices, deforestation, overgrazing and desertification (Orr, 1992: 15)

## 1.8 Conclusion

This chapter provided an introduction to the study by giving a broad background of the study. It explained the role that education plays in the lives of individuals. It also explained the importance of mathematics in daily life decisions. The chapter further explained the importance of integration of environmental education in the Zambian education curricula. The chapter made statement of the problem and described the objectives as well as the major research questions of the study. Lastly, the chapter described the purpose of the study, and its significance.

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.0 Introduction**

In this section an attempt has been made what other scholars and researchers have written about on the same subject of an integration of environmental issues and the curriculum. The chapter also considers the general view of this integration from various types of literature including that which is suggested in the infusion approach of mathematics topic application to environmental issues.

#### **2.1 The importance of integration Environmental Education into the School Curriculum**

Educating our future (1996) emphasizes that every Zambian has a right to good quality education, relevant to the learner's needs and adapted to abilities of the learner. The policy document brings out the goals of the education system as concerned with positive attitudes, values and behaviour towards the promotion of environmental consciousness which must be rooted deeply into a formal education system. The National policy Education document emphasizes on the importance of producing a learner capable of participating in the preservation of ecosystem in one's immediate and distant environment as it is a well known fact that environmental problems world wide have been escalating at such a rapid rate in the last few decades.

The above statement is supported by Robinson and Wolfson (1982:5) who state that

The quality of the environment on earth has deteriorated to the point that continued existence of life is threatened. In order to reverse present destructive trends caused by people-related activities and styles of life, on environmental literacy and environmental ethic must become a basic objective of education at all levels, within the school system.....

Some scholars have viewed education as the salvation of pending environmental problems (Gayford 1986, Giglotti 1990). It is stated by Vullamy (1987) that after the publication of the World Conservation Strategy, with its main purpose being to 'persuade the nations of the world to adopt ecologically sound developmental practices' many nations have regarded the formal educational system as the most important system for influencing the behaviour of future generations.



According to Caduto (1984), if schools are to be successful in influencing learners to be socially and environmentally responsible people, governments will need to conceive, develop, and implement a comprehensive Environment Education programme as part of the general education curriculum.

The benefits and advantages of Environmental Education being incorporated into the curriculum would be that a cross-cutting curriculum that takes environmental issues into account will be drawn. Some of the benefits of such a step would be that:

1. the natural processes that shape habitats and the environment and that are fundamental to the ecology of the living world would be comprehend by the learners starting from a tender age.
2. the impact of human activities on ecological processes will also be understood by the stake holders.
3. the necessary use by man of renewable and non-renewable resource and the possibilities of sustainable development will be understood.

Thus learning becomes potentially more meaningful (UNESCO 1985).

Various scholars in Environmental Education for example Hurry (1984), Williams (1987), Kiroro (1987), Clacherty (1988), Giglotti (1990) agree that Environmental Education is not a subject in itself but an integral part of all courses such as Mathematics. Content should be drawn from across the whole of the curriculum (Williams 1998). Also there seems too little controversy over how to place Environmental Education in the school curriculum (Knamiller 1987). Environmental Education should be a dimension of all subjects and areas of education taking into account both the social and the natural aspects (UNESCO-UNEP 1987).

It is stated by Ballantyne and Tooth-Aston (1988) that curriculum planners often take for granted that educational structures such as the school allow the achievement of Environmental Education aims and objectives. But, according to Parry (1987), the development and integration of Environmental Education at the school level is complex. In spite of this, teachers play a central role in effective implementation of change in schools such as that brought about by Environmental Education (Stern and Wang 1988).

According to (LEESP 2003:106), Environmental Education can provide opportunities to use and apply mathematics to understand numbers and to use

number operations; to measure; to understand patterns and shapes and to collect, handle and interpret data. EE demonstrates the relevance of mathematics using problem solving strategies in realistic situations and fosters an appreciation of Mathematics components in the environment.

The environment provides a context for developing mathematical abilities such as investigation, representation, analysis and problem-solving. The environment provides a context in which mathematical abilities can be developed. In this way, it brings mathematics to the real life of the learners. It further encourages the development of the ability to critically analyse findings, and a commitment to apply mathematics for a wider social benefit (LEESP 2003).

It is further stated by (LEESP 2003), that learners develop necessary competences in environmental education, integrated with Mathematics and the following examples are learning outcomes:

- Demonstrate mathematical abilities appropriately to collect data for investigating and reporting environmental issues
- Apply mathematical abilities to analyse environmental issues where appropriate.
- Apply mathematical abilities to design solutions to environmental problems, where appropriate.
- Understand and value the way in which Mathematical skills can contribute to a better understanding of environmental issues.
- Demonstrate how the application of mathematics to environmental issues contributes to community and social life.
- Predict future status of environmental problems based on current ones.

## **2.2 Curriculum Integration in Schools**

Writers in the field of curriculum development, who have focused their concern on theoretical perspectives relating to curriculum integration, tend to agree that teachers who believe they are involved in curriculum development tend to show greater congruence between intended and actual use of a curriculum (Saylo et al (1981). It should however be borne in mind that although teachers may agree about the importance of curriculum development work, they are oriented towards instructional, not curricular development (Kimpston, 1985). Environmental Education in the formal sense in which it is understood today is a recent innovation into school curricula; (Ham et al1987), and since it is relatively new, teachers may raise questions about it.

It is acknowledged by many that a teacher is entitled to ask for a well-grounded assurance that new work in the curriculum is properly co-ordinated (Ham et al 1987). Also, since curriculum change does not take place in a vacuum, even insignificant change has implications for the total teaching process (Taylor 1975). Therefore, there needs to be clarity and agreement about aims and methods through which the new work is to be handled (Maclure 1967). This can only be achieved when consistent values throughout the process of integration are upheld, so as to avoid the confusion which often follows when people only partially understand and share the values which are implicit in what they are doing (Maclure 1967).

Taylor (1975) argues that one of the basic conditions needed is a climate within the school which is high in receptivity to new ideas. This is supported by Pannell and Alexander (1990: 40) as they state that “No worthy developmental situation should ignore the life culture of the school.” Schools, like all organizations are usually faced with continuing struggle to maintain stability and they tend to reinforce themselves by solidifying their belief in the “rightness” of their present practice (Maclure 1967). There are therefore implications for the incorporation of Environmental Education in Lusaka District Schools.

### **2.3 Impediments to Establishing Environmental Education in the School Curriculum**

There are conditions, existing within schools that are perceived as barriers to establishing and implementing a well developed Environmental Education Programme (Caduto 1984, Ham and Sawing 1988). It is through research that it may be possible to identify some of the major constraints which programmes for Environmental Education are experiencing, and it is through clear understanding of such constraints that appropriate interventions to overcome them can be adopted (Vulliamy 1987, UNESCO-UNEP 1987).

Vulliamy, (1987) argues that in the Third World, schools are regarded as structures that promote mobility out of the subsistence sector, to ‘white collar’ jobs through passing examinations and obtaining certificates. Therefore, any attempt at curriculum re-structuring must recognize that parents and pupils may reject any innovation which does not lead to recognition by a certificate. The school in this case is not perceived as an institution for learning but a vehicle to self-promotion to a high level in the society. In such circumstance, if Environmental Education as an approach is not perceived as a method to

improving performance to examinations, then it is likely to be rejected. As at now, the Ministry of Education in Zambia does not /or is yet to recognise teachers from University of Zambia, who have obtained Bachelor of Arts degrees in Environmental Education. Whenever they apply for employment they are rejected.

Also in these schools, teaching in the classroom is formalistic, stemming from the manner in which the teachers themselves were taught (Vulliamy 1987). In some cases teachers go through poor training and this leads to reluctance to venture away from the stipulations of the syllabus and textbooks. Such circumstances often result in considerable dampening of pupils' enthusiasm to question the subject matter yet this questioning is crucial for the realisation of Environmental Education objectives.

Teachers need to be trained through a curriculum that has Environmental Education as a component which can facilitate their teaching to promote Environmental Education (Vulliamy 1987). Kampston (1985:186) states that "Pedagogical innovations, usually not so clearly stated and demanding that teachers change their own behaviour, have less chance for across the board integration." Morris (1985) identified motivation leadership, and attitudes of participants, the structure and incentive system and resources of an organization, as some of the reasons that are used to explain why certain innovation are not implemented.

Among others, Havelock and Huberman (1978:227) identified two major factors that impede innovation: these are one "personality conflict and motivation-i.e. understanding others, lack of energy, rigidity, no openness to change, insufficient personal rewards" and two "underestimating the process (of innovating)-poor co-ordination and concession from political leaders, confusion and inadequate planning." In some instances teachers tend to integrate most effectively curricula which allow them use of methods with which they are already familiar. Also the nature of the relationship between attitudes and integration depends on the innovation itself (Kimpston 1985). If the innovation is seen as a learning process, it is likely to be successfully integrated (Dalton 1988).

An innovation assumes a different form in every situation and is interpreted differently by teachers and pupils. With reference to Environmental Education, Gayford (1986:147) states that "part of the problem of Environmental Education lies in initial confusion, even among advocates of Environmental Education, over its nature and identity and how it should relate to the curriculum." In the Zambian

situation, teachers and pupils do not believe that Environmental Education can be integrated into the Mathematics curriculum. Further, some of the reasons for these stems from the variety of sources from which Environmental Education has been developed. Environmental Education is often equated with outdoor education and in some cases perceived as a subject (Ham et al 1987).

According to Lahiry et al (1988) the development of Environment Education is yet to be completed and the methodological question remains to be elucidated. Essential to Environmental Education is the aspect relating to the effective nature of the subject. This often creates problems for those teaching within the formal curriculum where cognitive areas are the main consideration so as to meet examination requirements (Gayford 1986).

Caduto (1984) isolates other problems frequently encountered in Environmental Education as 'Lingering' doubts on the use of the classroom for Environmental Education by teachers, administrators, and parents, inadequate teacher training in

Environmental Education, exclusive concentration on subject matter and fear of community reaction to handling Environmental Education issues in the classroom. These persistent difficulties of a conceptual and structural nature within the education system prevent Environmental Education from being fully integrated (Lahiry et al 1988). A further challenge to actually getting Environmental Education operational in classrooms arises from the nature of the school itself and forces that determine what goes on inside "without a clear and realistic awareness of what motivates children to learn, teachers to teach, parents to accept education and education officials to encourage innovations in Environment Education are unlikely to take root and grow" (Knamiller 1987:72).

Following Hamilton (1982) the introduction of integrated studies is not merely equivalent to introducing a new syllabus but implies a radical change of emphasis in the organisational context and thinking. For Environmental Education to be fully incorporated and integrated with other disciplines or subjects, certain conditions need to be met. Hamilton (1982:180) identifies four conditions for integration of which three are discussed. First the integrated idea may only work where there is high ideological consensus among staff and wide spread agreement on its aims and objectives. Secondly, the linkage between the integrating idea and the knowledge to be co-ordinated must also be coherently spelt out. To retain the idea of integration, the various contributing subjects must be linked at a higher conceptual or cognitive level.

Thirdly, there should be close face to face discussion and feed-back between staff and pupils. This emphasises the issue of context. Consideration should be given to the context in which any innovation is attempted (Vulliamy 1987). Failure to do this often results in programmes and approaches becoming counter-productive. Many educational innovations rely on teacher education (Mac Donald et al 1985) and the effectiveness of any Environmental Education programme depends on quality of the teachers' training and experience (Kostova 1989).

UNESCO (1985) maintains that full incorporation of Environmental Education into the curriculum, teaching and learning process demands a realistic and practical renewal of an educational system to educate teacher-educators and teachers. Also the teachers must be involved in the conception, formulation and integration of the new innovations. Teachers themselves need to be well oriented and possess the knowledge and skills to cope with the integration process.

#### **2.4 The Zambian education system and environmental education**

Available literature review by MoE (2005), states that in Zambia, there is a nine year compulsory education system that is divided into four parts. Grades 1-4 are referred to as the Lower Basic School. Grades 5-7 as Middle Basic School and Grades 8-9 as Upper Basic School. Grades 10-12 are referred to as High School education system.

Currently, Zambia's formal education system has a 7-5-4 structure, with seven years of primary education (four years of lower and three year of upper primary), five years of secondary (two years of junior and three years of secondary) and four years of university to first degree level (MoE 2005). Transition from lower to higher educational level is determined by national competitive examinations at the end of grades 7, 9 and 12.

Until the early 2000s, environmental education had an informal place in Zambian schools (MoE, 2005). This simply means that education was conducted by teaching separate subjects in which environmental education was generally absent. Environmental education was usually conducted at club level such as Chongololo Club. However, since the late 2000, the system has improved slightly; environmental education has been institutionalized in the Zambian Education System of the curriculum framework document of 2000 (MoE 2001). However, environmental education in these schools does very

little formal instruction to help learners apply what they have learned in real life situation.

However, according to MoE, (2001), for environmental education to be reinforced in the Zambia education system it is suggested that a curriculum should be designed to develop three types of literacy associated with the environment: functional, cultural and critical. According to MoE (2001), functional environmental literacy is basically book knowledge related to environmental and scientific concepts; cultural environmental literacy explores the reasons that society values the environment; and critical literacy encourages learners to use functional and cultural environmental literacy to determine appropriate future action as citizens of the environments in which they live.

It is also important to consider and question which concepts pupils and other various stake holders envisage to be functionally and environmentally important. Cherreit (1989) has identified some important concepts such as ecosystem succession, energy flow, materials cycling, food webs, carrying capacity and species diversity. While Namafe (2006), has identified some environmental complexity in some Zambian societies such as beer drinking, conservation, declaration of Zambia as a Christian nation or water as some of the issues which warrant some education attention. However, in our Zambian situation, especially the case of Lusaka, it is important to consider environmental issues such as waste management and floods in our high density squatter settlements. Other environmental issues to be considered are quarrying, open burning, water and sanitation problem and addressing the deterioration of services and living conditions in the squatter settlements. Other researchers have found that both teachers and pupils bring many misconstrued or alternative conceptions to the science classroom and suggest that these need to be taken into account in curriculum design (Driver et al 1997). Teachers and pupils in school often confound the meaning of words, for example, weather and climate (Spiropulou et. Al., (1997), heat and temperature (Watts and Gilbert, 1985), words that are important in environmental education. Adults also have similar misconceptions about natural and environmental phenomena (Munson, 1994). However, Orr (1992) is concerned about the inaccuracies in teaching about the environment and the effect that these inaccuracies have on environment literacy. He makes the connection between literacy and behaviour when he talks about the impact that environmentally illiterate adults have on the world. However, because these adults, even if they wanted to improve the environment, might not know how to since they lack basic knowledge about how the environment functions. Therefore, the above

scenario may be the same true situation for pupils, due to the fact that teachers in our schools are failing to develop environmental literacy because they are not incorporating environmental concepts or ecological principles into the subjects they are teaching.

## **2.5. Curriculum Integration Models**

The concept of curriculum integration has been defined differently by different scholars and organizations such as UNESCO and UNEP. UNESCO/UNEP (1995) has defined curriculum integration as an interdisciplinary teaching in which two or more disciplines are expressed in terms of interrelationships, while Gehrke (1998) defines curriculum integration as a collective term for those forms of curriculum in which student learning activities are built, less with concern for disciplinary boundaries around kinds of learning and more notions of helping students recognize or create own learning. Ekpenyong (1997) defines the concept as the process when we begin to move from teaching isolated subjects to forging linkages with other subjects or knowledge areas. Beane (1995) takes a broader view of curriculum integration and defines it as the search for self and social meaning. Beane (1995) believes that only when knowledge is used without regard for its disciplinary origin does true integration takes place. Therefore, it is obvious from the above definition, that curriculum integration like many other terms associated with curriculum, has many facets. The above approaches to curriculum integration represent opposing ends of the curriculum integration interpretation spectrum with many others occupying the space in between. In the context, the concept of curriculum integration enjoys much attention from curriculum theorists and practitioners. This is especially so in the environmental education movement where this approach to curriculum is seen as most appropriate for addressing the multifaceted nature of environmental challenges and risks. While an integrationist approach to environmental education is now widely accepted, the debate over which forms of curriculum integration to adopt persists, although the cross-curricula approach seems to have received wider acceptance than other approaches (Lotz-Sisika 2002).

However, to help organize the different curriculum integration interpretations into a coherent framework, various categorizing schemes have been put forward by different writers. For example Gehrkes (1998) distinguishes two approaches to curriculum integration: those in which the various disciplines retain the integrity and from the organizational structure of the curriculum, and those which center around life experiences and learners' and societal needs. However, the author points out that integration approaches which are based on life experiences, learners' needs and so on represent a small fraction of the curriculum integration,



and are more difficult to understand and implement given the current school institutional structures.

However, an easier continuum to work with is that suggested by Kysilka (1998) which is based on only four integration models, namely the separate discipline approach, the discipline-based approach, the inter-disciplinary approach and the total integration approach. Kysilka (1998) bases her differentiation between the four models on the roles allocated to the disciplines or subject and to teachers during the curriculum development and implementation processes. The four models in more detail are as follows:

#### **2.5.1 Separate discipline approach**

According to Kysilka's (1998) curriculum integration model, is an approach which represents the traditional subject-based approach to curriculum. The subjects or disciplines are kept separate and the teacher is not obliged to forge links between them or and the world outside the school. If any integration occurs, it is unplanned for and is left to the learner to establish.

#### **2.5.2 Discipline-based approach**

Discipline-based approach is at the second stage on Kysilka's curriculum integration continuum. Although subjects or disciplines still form the basis of the curriculum, the teacher makes a concerted effort to relate to each other and to the outside world. This approach involves collaboration between different teachers as they identify natural connections between the different subjects around which learning activities can be planned.

#### **2.5.3 Inter-disciplinary approach**

The third stage of Kysilka's continuum is occupied by inter-disciplinary approach. In this approach, the artificial boundaries between subjects or disciplines are no longer recognized as natural relationships between them but are identified and used to make learning more meaningful and relevant for the learner. Skills, concepts, ideas and themes become the central foci around which the curriculum is structured. In addition, there is no specified content since this will depend on the themes, ideas and topics that are being studied.

#### **2.5.4 Total integration approach**

Total integration approach is the fourth and last stage of Kysilka's continuum. In this integration model, knowledge is treated as one entity since no subject divisions are recognized. Under the teacher's guidance, the learner has to identify the knowledge, activities and strategies necessary to study the chosen

topic, theme or concept. Therefore, the structural pillars of the curriculum are the ideas, themes or topics that the learner has chosen to study. All content knowledge is regarded as being useful depending on the topic, concept or idea that has been chosen. The teacher's role becomes that of a facilitator.

Having scrutinized the curriculum integration models from a continuum perspective, it has been observed that the models have their own problems. The approaches have been criticized by Venville et al. (2001) who noted that the approaches not only fail to capture the full complexity of what curriculum integration entails, but also for giving the wrong impression that the more the integration, the better the learning and teaching. Similar feelings are expressed by Kysilka (1998) who thinks that no curriculum integration model should be judged supreme over the rest. She believes the success of a particular integration model depends considerably on the context in which it is applied, especially the teacher's willingness and capacity to experiment with different models. However, the continuum approach serves to expose teachers to the range of curriculum integration models that are possible, and to help them identify the types that are best suited for the context in which they are working. Kysilka (1998) believes that the integration continuum helps teachers to reflect on their teaching approaches while at the same time providing them with guidelines on how they might improve them.

## **2.6 The Role of Mathematics in Environmental Education**

Environmental issues deal with government, economics, relations among nations and social classes, people's welfare and the preservation of natural and cultural resources. Mathematics is deeply involved with these issues because environmental problems have two distinct features: the quality and the quantity of environmental resources, which mathematicians and Mathematics educators cannot ignore (Spiropoulou (1997). D'Amboise (1998) notes that humanity is witnessing an environmental crisis that is to say; disruption of the economic system, institutional erosion, mounting social crises in just about every country and above all, the recent threat of climate change. This author also observed that it is clear that Mathematics is well integrated into the technological, industrial, military, economic, and political systems and that Mathematics has been relying on these systems for the material bases of its continuing progress. It is important to look into the role of Mathematicians and Mathematics educators in the evolution of mankind, especially because mathematics is recognized as the most universal mode of thought that can play an important role in the formation of learner's positive attitudes towards the environment.

However, the nature of mathematical behaviour is not yet clearly understood in the Zambian education system. A major problem area in mathematics in Zambia today is effective teaching. Generally, pupils in Zambia are poorly prepared in mathematics and have negative attitudes towards the subject. Every teacher of mathematics has probably heard pupils ask questions such as, "Why do I need to learn this mathematics?" "When will I ever use this material?" and "What connections are there between this Mathematics and life?" This view of relevance of mathematics to society is supported by Schwartz (1992) who maintains that lack of coherence between topics, the perceived irrelevance of the mathematics material and the scarcity of opportunities for pupils involvement often result in apathetic classes. In Zambian government schools, classes are typically large, due to inadequate class rooms compounding the problem. Since the pupils need the subject only to fulfil a graduation requirement and not as a prerequisite for any other subject such as environmental education, they usually try to obtain a satisfactory grade with a minimum of effort. As a result teachers are often reluctant to teach such subjects effectively. At the end of the course of study, the pupils negative attitudes towards the subject will have been reinforced with their negative feelings reinforced, thankful that they will never again be expected to do any mathematics (MoE, 2001).

From the historical view point, there is a need of a complete and structured view of the role of Zambian Mathematics Curriculum to stimulate interest in mathematics learners by building certain concerns and strengths in the learners in order to promote positive attitudes towards the environment. D'Ambrosio (2001) identifies Education as a strategy created by societies to promote creativity and citizenship. The author notes that to promote creativity implies helping people to fulfil their potentials to the maximum of their capability and to promote citizenship implies showing people their right and responsibilities in society. Educational systems throughout history and in every civilization have been focused on two issues: to transmit values from the past and to promote the future (D'Ambrosio 1998).

In other words, education aims equally at enhancing new creativity and the old societal value. This is the challenge faced by us educators, particularly as mathematics educators/environmentalists educators. The strategy of education systems to pursue these goals is the curriculum. Curriculum is usually organized in three strands: objectives, contents and methods. This Cartesian organization implies accepting the social aims of education systems, then identifying and developing methods to transmit those contents (D'Ambrosio 2001). Sterling (1995) notes that the concerns about the environment in recent decades have increased and have paralleled the development of environmental education and in

particular has clarified as aims and purposes. The author identifies integration of environmental education in mathematics curricula as a preferred way that may raise environmental literacy, and include knowledge that goes beyond an understanding of the environment. Therefore, infusion of environmental education into mathematics curriculum may build concepts and awareness about ways in which behaviour affects environmental literacy, knowledge and skills and a critical awareness of environmental action and skills.

## 2.7 Integration of Environmental Education into Mathematics Topics

In order to develop skills and attitudes necessary to understand and appreciate the interrelationships between humans, their culture and biophysical surroundings, it is important that environmental education programs are designed for either integration into existing curricula or the insertion of new courses into study (Heimlich 1992).

The following are some of the examples suggested in the infusion approach of mathematics topic application to environmental issues in some selected Zambian Mathematics text books.

- |                         |                                                                                                                                                                                                                                                                                                        |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Line Graphs:</b>     | Using the following abstract statistical data from Zambia Electrical Supply Corporation draw a line graph showing energy consumption in Zambia from 2000 to 2010.                                                                                                                                      |
| <b>Bar Charts:</b>      | Using abstract data from Electro Commission of Zambia (2011 elections), draw a bar chart showing per capital paper used. In such an exercise pupils will be able to calculate the consumption of paper and determine how such paper would be disposed and what effect it will have to the environment. |
| <b>Circle Diagrams:</b> | Circle diagrams can be drawn for contributions to global warming by human activity, Zambian household water use and solid waste generated in Lusaka Soweto city mark                                                                                                                                   |
| <b>Histograms:</b>      | An ecologist has developed an instrument to indicate average air pollution readings. Given the readings for 50 consecutive days, organize the data and draw a histogram.                                                                                                                               |
| <b>Scatter plots:</b>   | Using the scatter plot in mathematics plot a global survival graph showing the relationship between fat in the diet and prostate cancer deaths, and estimate                                                                                                                                           |

the number of lives that could be saved in a country with 13 million adults, if the fat consumption per person per day changed from 120 to 40.

- Sequences:** A natural resource (probably copper) is being depleted in Zambian mines at the rate of 4% per year. If there were 200 million tons of the resource in 2000, and there are no new discoveries, how much of the resource would be by the year 2030? Learners should discuss the effects of such a pattern of consumption to the environment.
- Averages:** Use data from a survey of teacher smokers at Chinika High School in Lusaka to find the mean, median and mode for the number of cigarettes per smoker. Learners must discuss the dangers of smoking to the environment.
- An elementary mathematics class might also calculate the average amount of solid waste that 40 pupils produce in a year. Learners must discuss disposal methods.
- Variability:** Given ten areas of pollution readings, find the range and the standard deviation. Learners can discuss the dangers of pollution to the environment.
- Probability:** If all women in a certain Zambian society had children until they had one son or a total of 6 children, what would be the mean number of children in that society? Here the learners should discuss issues of carrying capacity and consumption of resources and the impact on the environment.
- Normal curve:** If the average amount of daily garbage collected in Lusaka city is 300 tons, and the standard deviation is 20 tons, find the probability that the amount of garbage collected on a specified day will be more than 320 tons. Issues of waste management by learners can be discussed hence promoting Environment Education.

Of course, this is just a small sampling of environmentally related exercises that could be asked for these mathematics topics, in selected text books. Using sources such as those mentioned above, an extreme number of significant problems can be set up. Pupils should be encouraged, after solving each problem to ask questions related to the importance of the result with regard to

pollution, destruction of ecosystems, resource scarcities, and local, national and global environmental issues. For example, if the energy consumption of developing countries approached that of the United States, what would be the impact with regard to the environment, resource scarcities, and other quality of life issues? If the tropical rain forests continue to be destroyed to create pasture land for logging, what is the possible impact on the earth's climate and the potential for serious global warming?

## **2.8 Conclusion**

In general, the preparation of Zambian Basic and High School Environmental Education curriculum need special programmes that provide information about the obtainability of different Environmental Education resources, allows application of different methods and strategies with opportunities for practising and building confidence and provision of skills to overcome education and administrative constraints for the practice of new methodologies (UNESCO 1988). Also teachers may need to be trained to adapt to new conditions in which Environmental Education as a new approach may be integrated. The most effective means of improving learning experience for children is to improve the preparation of their teachers (Halverson 1982). In Southern Africa "the need for Environmental Education teacher training is identified as vital for the effective introduction of Environmental Education into schools" (Ballantyne and Tooth-Aston 1988).

## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.0 Introduction**

The purpose of this chapter is to show how the study was conducted and to describe various methods that were used to collect data for this research. The chapter discusses methods and research design. It looks at the sampling frame, sample size and sampling methods used. It also looks at the type of data collected, their sources and explains the analytical tools and procedures used to generate data on the integration of environmental education in the Zambian mathematics curriculum. The chapter also looks at data collection instruments used and methods of administration, analysis techniques used. It also looks at the limitations of the study. The phenomenon described during this study in the selected schools was the extent at which environmental topics or concepts are integrated within selected documents, school activities and practices. The chapter ends with a discussion of how research quality and ethical issues were addressed during the study.

#### **3.1 Research design**

According to Churchill (1987), a research design is simply the framework for a study used as a guide in collecting and analyzing data. It is a blue print that is critically followed in completing a study.

The study used partly quantitative and mainly qualitative research approach, because qualitative research approaches lend themselves to exploratory and inductive research (Trochim, 2001). This approach helped the researcher to understand the occurrence of events in their natural settings and how people at the study site (schools) in question defined these events from their own perspectives. Through this approach, the researcher explored how schools in Lusaka urban district were integrating environmental education into mathematics curriculum. More especially the researcher was able to examine the manner in which teachers provided environmental education as an integrated theme within other learning areas, such as clubs, surrounding environment as well as in their classrooms. The qualitative approach also facilitated the researcher understanding of the structure of teaching and learning of integrated mathematics with environmental education of the participating schools from the view points of an individual. Semi-structured interviews with teachers and learners were used. This involved direct observations of classroom lessons and also an analysis of documents, such as Mathematics textbooks, syllabuses, and other relevant environmental education documents used by the schools. The

analysis involved the interpretation of participants' explanations of the way they had integrated environmental education into the Zambian mathematics curriculum, as well as the kinds of resources the schools had for the teaching and learning of environmental education, with particular reference to the manner in which they were mobilised and employed.

### **3.2 Study Site**

The study was conducted in Lusaka District of Zambia, which is the capital city of the country. Lusaka district has ninety-six (96) basic schools and twenty-one (21) high schools. The target population of the study consisted of twenty-five (25) basic and fifteen (15) high schools. The study collected data from pupils, school managers, teachers of mathematics and mathematics specialists from Curriculum Development Centre (CDC).

### **3.3 Sample Size**

The precision of any study rests heavily on the sample size. This is usually based on pre-specified level of accuracy in order to accomplish the research objectives. In this research, this was somehow modified so that time and other resource hindrances were taken into account. The study used a sample of twenty-one (21) basic schools and eleven (11) high schools with each school providing, one grade for lesson observation in selected schools, one (1) class teacher grades from 1-7, one teacher of mathematics in grades 8-12, one school manager from each school and one (1) specialist from curriculum development centre(CDC).The total sample size for the study was ninety eight (98) respondents from schools and CDC.Sixty-five (65) teachers of mathematics were given questionnaires, thirty-two (32) school managers were interviewed and one (1) mathematics specialist from CDC was also interviewed.

### **3.4 Sampling Procedure**

The sample for this study was selected using two sampling techniques. The twenty-one (21) basic schools, eleven (11) high schools and basic school teachers were selected using the simple random sampling technique while mathematics specialist from CDC and teachers of mathematics from high school sectors were selected by purposive sampling technique.

Simple random technique is the process of selecting from the population in such a way that every sample of a given size has an equal probability of being selected (Ogula, 1998). In this study, Lusaka district had 96 basic schools and 21 high schools, and a list of both basic and high school of the district schools was made and a number was assigned to each respectively. Two boxes were



labelled respectively i.e. basic and high. Numbers were placed into respective boxes and then picked at random. The number corresponding to the schools picked were included in the sample and participated in the research. This is to say that, all school managers and teachers of Mathematics in high schools were automatically picked and participated in the research.

Classes to participate in lesson observation were also selected using the simple random sampling as most of these schools had more than one stream of grades. As a result, YES and NO responses were written on small pieces of paper and simple random technique was utilized. The small pieces of paper were put in a box and each class representative was requested to pick one paper. All those who picked papers with YES written on them participated in the research.

Purposive sampling technique was used to select mathematics specialists and teachers of Mathematics to participate in the study because this type of sampling allows a researcher to use cases that have the required information with respect to the objectives of the study. Cases of the study were therefore, handpicked because they were informative or they possessed the required characteristics. The technique was used because the researcher knew about the events and specific people who were likely to provide valuable information. The advantage of this technique is that it allowed the researcher to concentrate on those people and generate valuable data for the research. In support of purposive sampling, Cohen and Manion (2000) argue that this strategy can benefit the research because some of these key informants have special knowledge and perception that can add value to the research.

### **3.5 Data Collection Instruments**

The study employed triangulation. As Silverman (2000) observes, triangulation in data collection is the involving of two or more methods in the study, and it can help explain more fully the richness and complexity of data. Triangulation was initially used to refer to the use of more than one method in a given inquiry. This was to avoid a situation where research results are generated exclusively on one method. This is the view advanced by many researchers (Patton, 1990; Free body, 2003). The assumption is that some of the methods have weaknesses and exclusive reliance on one method could distort the research findings.

The study used triangulation in data collection by involving the use of, questionnaire, in-depth interviews, observations content analysis and focus group discussions. This was done by studying practices from more than one angle using multiple methods of data collection, each method reveal in different

aspects of empirical facts within the same site (Cohen and Marion, 1982; Yin, 1993)

### **3.5.1 Self Administered Questionnaires for teachers of mathematics**

Questionnaires were given to one hundred (100) teachers of mathematics to collect information about their personal/educational background and the extent to which they integrated environmental issues in their teaching of mathematics. However, the researcher only managed to collect sixty five (65) questionnaires because it was difficult to communicate with some of the respondents as indicated in the limitations.

### **3.5.2 Interviews**

Data was also collected in this study from school managers and some teachers of mathematics through interviewers from the thirty-two (32) schools. Interviews in this study were used as a method of data generation during the analysis of the school's activities and practices to determine the extent to which they integrate environmental education in the teaching of mathematics. In each school, the school manager and teachers of mathematics formed the respondents for the interviews. School managers were interviewed in order to gain insight into the extent of environmental issues integration within the selected school activities and practices from their perspectives. Teachers of mathematics in all the grades 1-12 were interviewed in order to obtain detailed information about their training, whether they had concepts on environmental issues and their teaching experiences especially with regard to environmental education.

This study used in-depth interviews. It has been argued that interviews are one of the most important sources of information for social research. Dexter (1970) reckons that interviews provide access to the content of a situation and make the researcher with deeper meaning about the reality being studied.

The interviews created an opportunity for the school Headteachers and the teachers to describe their feelings and experiences regarding the integration of environmental education using their own words. The interviews also allowed the researcher to cross-check data about the integration of environmental issues that were obtained from self administered questionnaires. Semi-structured interviews were conducted. Each series of interviews was conducted with the aid of an interview schedule which contained a few questions on the respondents' background, and a list of environmental education integration related issues that

the researcher wanted to talk about with the respondents. Using this type of interview, the researcher was able to change the order in which questions were asked in accordance to the emerging context of the interview. The researcher was also able to probe the responses from the interviewees, which helped to give the interviews more breadth and depth.

### 3.5.3 Observation

Observation was one of the methods of data collection that was used in this study. This method was used mainly to collect data on the extent of integration of environmental education during teachers Continuing Professional Development (CPD) meetings and in a sample of Mathematics lessons. The observation method was also used during the analysis of the school activities and practices, but mainly to cross-check the data that had been obtained from the interviews with various respondents.

Creswell (2003) describes observation as a method in which the researcher takes field notes on the behaviour and activities of individuals at the research site. Cohen et al (2007) refer to the data obtained through observation as 'live.' Similar views about the observation method are expressed in Jones et. al. (2006), who states that the method entails being present in a situation and making a record of one's impressions of what takes place. There were two major advantages of using the observation method in the study. The first was that the researcher was able to conduct the study in a natural school or classroom setting, without any deliberate manipulation of the natural environment. The second advantage was that the researcher was able to record the activities of the respondents as they related to the extent of environmental education integration into mathematics, instead of relying entirely on other sources such as interviews and self administered questionnaires.

There are several approaches to the use of observation as a research method, for example, unstructured, semi-structured and structured. Usher and Scott (1999) point out that the different approaches to observation reflect different theoretical assumptions about sociality and the generation of knowledge about it. According to these authors, unstructured observation involves detailed recording of all that is taking place, with no prior decision being made of what is to be recorded. This approach of observation was used for high school mathematics lessons attended by the researcher, who were involved in taking the field notes of everything the researcher saw and heard in these lessons. The aim was to use these first observations as a means of exploring the lessons with the

intention of identifying possible areas the researcher could focus on so as to make future amounts of data and its analysis more manageable. In most classroom observations the researcher relied on the semi-structured approach rather than the structured approach. The agenda of issues consisted of the following: topic of the lesson; oral questions asked; the teaching and learning materials used; notes written on the board; and assessment tasks set during the lesson. These issues helped to focus the observations, and to capture the lessons.

During the observations that were conducted in the study, the researcher assumed the role of observer as participant. In this approach to observation, the researcher participates in the activities of those they are observing to some extent (Jones et. al., 2006). While the researcher did not actively teach mathematics lessons, the extended period of engagement with the school Headteacher and teachers of mathematics created an opportunity for the researcher to engage and interact with them at a deeper level. The researcher was able to gain deep insight into their activities and practices regarding the extent of environmental education integration in mathematics lessons.

#### **3.5.4 Content analysis**

Content analysis is one method which was used in this study, which is sometimes referred to as document analysis (O'Leary, 2004), systematic content analysis or statement analysis (BOS et al 1999). Silverman (2004) notes that content is one of the major methods in qualitative research, although according to BOS et. al., (1999) its use is relatively marginalized compared to observations and interviews. According to O' Leary (2004), the method involves the collection, review, interrogation and analysis of various forms of text as a primary source of research data. The texts which the researcher analysed using this method were the various pedagogic texts produced by the Curriculum Development Centre (CDC) which relate to the teaching, learning and assessment of grades 1-12 mathematics as well as grades 1-12 mathematics textbooks which were in use at the schools order study. The researcher used this method to analyse various texts produced by teachers and learners during mathematics lessons.

According to Ahuvia (2001), content analysis proceeds in three main stages, which are: selection of focal texts; coding of the focal tests, and interpreting the results of the coding. In deciding to use this method, there were three major issues to contend with. The first issue was concerned with whether to use a quantitative or qualitative approach to the content analysis. Merriam (2005) note that some researchers take a positive approach to content analysis during which

they record the frequencies of certain items (for example, words, concepts, or themes) throughout the document. Berg (2004) sees such an approach as reductionist, and critiques it for focusing on only the surface meaning of the texts (manifest content), while ignoring its deeper meanings (latent content). Another researcher for whom the distinction between manifest and latent is crucial to the research process is Ahuvia (2001). Ahuvia maintains that manifest content analysis only looks 'at the most obvious and straightforward meaning of a text' (2001), and the coding of the texts follows strict rules in order to enhance inter-coder reliability. Ahuvia contends that manifest content analysis is appropriate for cases where there is general agreement on the meaning of the terms being coded, and on how to code them. This represents the traditional quantitative approach to content analysis.

For this study the researcher used both approaches to content analysis of the various documents that were investigated. In taking this decision, the researcher was heeding Berg's (2004), recommendation that both approaches be combined since whichever is appropriate depends on the unit of analysis under consideration. For example, in the grades 1-12 mathematics textbooks, the focus was on comparing the frequency of environmental concepts with that of concepts which are specific to mathematics in the books' indexes, which implied a quantitative approach to content analysis.

### **3.5.5 Focus Group Discussions**

Focus Group Discussions are known for a number of reasons as one of the good method to use in data collection. One of them is that they often bring out respondents' immediate reactions and ideas, making it possible to observe some group dynamics and organizational issues. For participants, the focus-group sessions made them feel at easy. Permission to use a tape recorder was sought from the group members. The setting in which the focus group discussions were done provided an encouraging environment for frank and open communication without any disturbances. This is also in line with the justifications given by Causley and Khumar (1988) on the purpose of focus group discussions in research studies, who argue that focus group discussions help assess needs, develop interventions, test new ideas or programmes, improve existing programmes and generate a range of ideas on a particular subject as background information for constructing more questionnaires or interviews.

Focus group discussions were conducted on three (3) groups of learners from three different basic schools, and three (3) groups of learners from three (3)

high schools. The names of learners were selected from the registers using random sampling. The schools to participate in the research were also selected using random sampling. Some pieces of paper bearing the names of schools were put in two separate boxes; one box for basic schools and the other for high schools. Some schools/participants which were picked participated in focus group discussion.

A pre-planned script of specific issues and set goals was followed to get the required type of information. During the focus group session, the researcher (moderator) had a responsibility of controlling the discussion without inhibiting the flow of ideas and comments. It was the job of the moderator to ensure that all group members contributed to the discussion and avoided letting one participant's opinions dominate. At the same time, the moderator avoided putting words into the mouth of group members by giving leading comments.

The researcher was conscious of the challenges cited in the use of focus group discussions by McNamara (1999) as that of sorting out what is important, decoding symbolism, unravelling complex situations, interpreting ambiguous behaviour, designing persuasion and predicting behaviour and developing strategies and new ideas. After the session, it was easy for the moderator to write a short report summing up the prevailing mood in the group, illustrated with a few personal quotes about the comments made by the respondents.

### **3.6 Data Analysis**

The quantitative data collected was analyzed and coded using the statistical package for Social Science (SPSS). Summaries of frequency distribution, percentages and tables have also been used. The qualitative data collected was manually analyzed, coded and processed using emerging themes. Lloyd and Blanc (1996) suggest that in analyzing qualitative data, the initial task is to find concepts that help make sense of what is going on. Patton (1990) seems to suggest that these concepts about data analysis start arising during data collection and that marks the beginning of the analysis. Patton (1990: 44) states that, "The strategy of inductive designs is to allow the important analysis dimensions to emerge from patterns in the cases under study without presupposing in advance what the important dimensions will be."

In this study, constructs, themes and patterns were identified from the interviews, observations, focus group discussions and review of documents with an aim to use them in the description of phenomenon that was being studied, "The role of

environmental education in Zambian Mathematics curriculum.”The understanding of the phenomenon under study and outcomes emerged from experience with the setting. What is happening in a setting is grounded in direct programme experience rather than imposed on the setting.

The procedure that was used to analyse the extent of environmental education integration in the various school documents, activities and practices formed the first step of the analysis procedure. The criteria were key features of a particular item which represented possible of suitable areas environmental integration. The final criteria identified for a particular item that was analysed depended on its structure, content and purpose. For example, during the analysis of the textbooks, the exercises illustrations, and examples were some of the criteria that were identified. During the analysis of mathematics lessons some of the criteria that were identified were: topic of the lesson; questions asked by the teacher; and writings on the board. Identification of criteria was necessary because it was assumed that not all parts of the item being analysed had the potential to integrate environmental education. It also facilitated the analysis process by breaking up the items into more manageable parts. The identification of criteria further helped to focus the analysis process to those key areas of the item which are relevant to the integration of environmental education in a particular item.

During the analysis of the mathematics textbooks, one of the criteria under which the analysis was conducted was the illustration of the textbooks. The indicator which was linked to these criteria was percentage of environmental concept in the illustrations. This value was calculated by comparing the total number of concepts listed in the illustrations to that of the environmental education concepts. The meaning of the concepts in the illustrations, were taken at their face value and no deep interpretations were involved.

Since there is always a large pool of potential indicators, it is necessary to come up with a selection process, therefore, the concept of SMART recommended by Tilbury, Janovsek and Bacha (2007) was used to facilitate the selection of suitable and relevant indicators. SMART is an acronym which stands for:

- Specificity i.e. indicators should closely measure what they are intended for,
- Measurable i.e. what indicators measure should be clear and concise,
- Attainable i.e. the required data should be obtained at a reasonable cost,

- Realistic i.e. targets set for indicator performance should be realistic and practically achievable, and
- Timely i.e. what the indicators measure can be assessed frequently enough to inform progress (Tilbury, Jonousek and Bacha 2007).

### **3.7 Ethical issues**

The first ethical issue was that of getting permission to conduct research at a public school. An introductory letter was obtained from the University of Zambia indicating the status of the researcher. Permission to carry out the research in Lusaka district was obtained from the District Education Board Secretary (DEBS) and from the thirty-two (32) school Headteachers. The second ethical issue concerned obtaining informed consent from the respondents. This was done by holding a meeting with the school Head teachers and teachers of mathematics in which they were informed about the purpose of the study, the methods to be used and what was expected of them. Respondents were informed of their right to withdraw from the study at any stage. In all cases, oral permission to conduct the research was granted. The third ethical issue was about respecting the respondents as human being. This was done by being sensitive to their cultural norms, respecting their space, and making sure that the study did not cause any physical or psychological harm to any respondent. The fourth and final ethical issue was about ensuring respondents' confidentiality. This was achieved by not mentioning names or those of their schools in the final research report.

### **3.8 Limitations of the study**

The scope of the investigation was limited by a number of factors. The researcher had an initial plan of covering more institutions as this was one way in which he could collect adequate data. However, due to lack of resources such as money and time only a limited number of schools were involved.

The study did not draw a large sample of teachers to solicit their views and the Ministry of Education was not consulted on policy issues regarding the integration of environmental issues in the mathematics curriculum grades 1-12, due to information which was collected from CDC specialist. Any generalizations of the findings of this study to schools should not therefore, ignore these limitations.



### 3.9 **Conclusion**

The chapter explained why methods such as self administered questionnaires, interviews, observations, content analysis and focus group discussions were used as the main methods of data collection. The chapter provided details on the procedures which were followed during the analysis of the different items, and described the construction and role of the different research instruments during the analysis. The chapter also described how various ethical issues were dealt with in the study ending with a description of how various limitations to the study were dealt with.

## **CHAPTER FOUR**

### **PRESENTATION OF RESULTS**

#### **4.0 Introduction**

This study investigated the integration of environmental education in the Zambian mathematics curriculum in Lusaka urban schools. The study sought to explore, among other issues, the availability of teachers who are qualified to integrate environmental Education into mathematics curriculum; determine the level of incorporation of environmental concepts found in the Mathematics syllabuses and textbooks. The findings presented in this chapter were from teachers of mathematics, school managers and mathematics curriculum specialists. A content analysis method was also used to ascertain pedagogic documents such as syllabuses and mathematics textbooks.

Guided by the research objectives, the findings of this study are presented under the following headings:

- Human resource
- Teacher professional development
- Environmental literacy among teachers of Mathematics
- Environmental topics found in the Mathematics textbooks
- Integration of environmental concepts
- The analysis of the Mathematics syllabuses
- The analysis of the Mathematics textbooks

#### **4.1 Human Resource**

This was an important issue to investigate in terms of the human resource with respect to teaching and learning of environmental issues. It also helped to determine the availability of teachers who had knowledge of Environmental Education. These respondents who participated in these questionnaires came from Lusaka urban schools and these comprised of 21 basic schools and 11 high schools.

**Table 1: Characteristics of the sample by gender**

			Type of schools respondents drawn from		Total
			Basic schools	High schools	
Gender of respondents	Female	Count	31	10	41
		Expected Count	26.5	14.5	41.0
		% within Gender of respondents	75.6%	24.4%	100.0%
		% within Type of schools respondents drawn from	73.8%	43.5%	63.1%
		% of Total	47.7%	15.4%	63.1%
	Male	Count	11	13	24
		Expected Count	15.5	8.5	24.0
		% within Gender of respondents	45.8%	54.2%	100.0%
		% within Type of schools respondents drawn from	26.2%	56.5%	36.9%
		% of Total	16.9%	20.0%	36.9%
Total		Count	42	23	65
		Expected Count	42.0	23.0	65.0
		% within Gender of respondents	64.6%	35.4%	100.0%
		% within Type of schools respondents drawn from	100.0%	100.0%	100.0%
		% of Total	64.6%	35.4%	100.0%

**Source: field Data (2011)**

Table 1 shows that from the 65 teachers of mathematics 31 (75.6%) were females from basic school while 10 (24.4%) females were drawn from high schools. From 65 teachers of Mathematics 11(15.5%) males who participated were drawn from basic schools and 13(54.27%) were drawn from high schools.

**Table 2: Type of schools where respondents were drawn from**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Basic schools	42	64.6	64.6	64.6
	High schools	23	35.4	35.4	100.0
	Total	65	100.0	100.0	

Source: field Data (2011)

Table 2 shows type of respondents who were drawn from schools. Forty two(64.6%) teachers of mathematics came from basic schools while 23 (35.4%) came from high schools.

**Table 3: Age of Teachers in years**

AGE (Years)		Frequency	Percent	Valid Percent	Cumulative Percent
VALID	23-27	4	6.0	6.2	6.2
	28-32	9	13.4	13.8	20.0
	33-37	20	29.9	30.8	50.8
	38-42	11	16.4	16.9	67.7
	43-47	10	14.9	15.4	83.1
	48-50	3	4.5	4.6	87.7
	51-55	8	11.9	12.3	100.0
	Total	65	97.0	100.0	
Total		65	100.0		

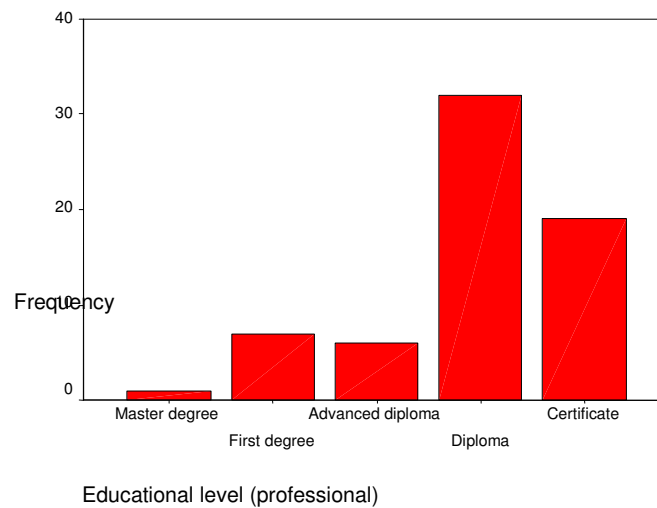
Source: field Data (2011)

Table 3: shows teacher respondents' ages ranging from 23 to 55 years. Four (6%) were aged between 23 and 27 years, nine (13.4%) were aged between 28 and 32 years, twenty (29.9%) were aged between 33 and 37 years, eleven (16.4%) were aged between 38 and 42 years, ten (14.9%) were aged between 43 and 47 years, 3 (4.5%) respondents were aged between 48 and 50 years and eight teachers were aged between 51 and 55 years.

#### **4.2 Teacher Professional Development**

Figure 1, shows professional education background of the teachers. Out of a total of 65 teachers of mathematics who participated in the study only one (1.5%) had a masters degree, seven (10.8%) were holders of first degree, six (9.2%) had advanced diploma. Thirty two (49.2%) had diplomas while 19 (29.2%) were certificate holders.

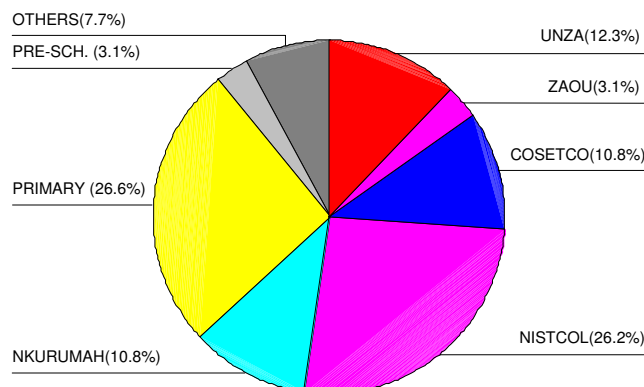
**Figure 1: Educational level of Teachers**



Source: Field Data (2011)

Figure 2 shows institutions of learning professional qualifications where obtained from. Eight (12.3%) teachers obtained their qualifications from the University of Zambia and only 2 (3.1%) respondents got their qualifications from Zambia Open University. Seven (10.8%) got their qualifications from Copperbelt Secondary Teachers' College. Seventeen (26.2%) obtained their qualifications from National In-Service College-Chalimbana. Seven (10.8%) respondents obtained their qualifications from Nkhrumah Teacher College. Seventeen (26.2%) respondents obtained their qualifications from various primary teachers colleges around the country. Two (3.1%) respondents got their qualifications from pre-school colleges and 5 (7.7%) obtained their qualifications from other private colleges.

**Figure 2: Institutions of learning**



Source: fields Data (2011)

#### **4.3 Environmental literacy among teachers of mathematics**

This indicator was used to determine the extent of environmental literacy among teachers of Mathematics who participated in the study. Concepts were listed down and teachers were asked to indicate by crossing the number of concepts they knew. Based on the like it scaling grid of this indicator (1) no idea (2) very slightly (3) slightly (4) knowledge (5) much knowledgeable (6) a great deal. Tables 4 to 11 show mathematics teachers concepts about some environmental issues:

## Teachers of Mathematics perception about environmental issues

**Table: 4 Teachers of mathematics knowledge about resource recycling**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No idea	10	15.4	15.4	15.4
	Very slightly	8	12.3	12.3	27.7
	Slightly	7	10.8	10.8	38.5
	Knowledgeable	11	16.9	16.9	55.4
	Much knowledgeable	16	24.6	24.6	80.0
	A great deal	13	20.0	20.0	100.0
	Total	65	100.0	100.0	

Table 4 revealed that only 16 (24.6%) of the respondents were much knowledgeable about resource recycling while 10 (15.4%) had completely no idea.

**Table: 5 Teachers of mathematics knowledge about water disposal**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No idea	4	6.2	6.2	6.2
	Very slightly	7	10.8	10.8	16.9
	Slightly	12	18.5	18.5	35.4
	Knowledgeable	14	21.5	21.5	56.9
	Much knowledgeable	19	29.2	29.2	86.2
	A great deal	9	13.8	13.8	100.0
	Total	65	100.0	100.0	

Table 5 revealed that 19 (29.2%) of respondents were much knowledgeable on water disposal while 4 (6.2%) had no idea.

**Table: 6 Teachers of mathematics concepts about energy shortage**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No idea	7	10.8	10.8	10.8
	Very slightly	8	12.3	12.3	23.1
	Slightly	13	20.0	20.0	43.1
	Knowledgeable	9	13.8	13.8	56.9
	Much knowledgeable	17	26.2	26.2	83.1
	A great deal	11	16.9	16.9	100.0
	Total	65	100.0	100.0	

About energy shortage 17 (26.2%) were much knowledgeable and 7 (10.8%) had no idea.

**Table: 7 Teachers of mathematics concepts about water pollution**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No idea	4	6.2	6.2	6.2
	Slightly	3	4.6	4.6	10.8
	Knowledgeable	14	21.5	21.5	32.3
	Much knowledgeable	16	24.6	24.6	56.9
	A great deal	28	43.1	43.1	100.0
	Total	65	100.0	100.0	

Table 7 revealed that teachers of mathematics concepts about water pollution at 28 (43.1%) while 4 (6.2%) had no idea.

**Table: 8 Teachers of mathematics knowledge about traffic jam**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No idea	5	7.7	7.7	7.7
	Very slightly	1	1.5	1.5	13.8
	Slightly	2	3.1	3.1	24.6
	Knowledgeable	7	10.8	10.8	46.2
	Much knowledgeable	27	41.5	41.5	75.4
	A great deal	23	35.4	35.4	100.0
	Total	65	100.0	100.0	

About traffic jam, Table 8 shows that 27 (41.5%) teachers of mathematics were much knowledgeable while 5 (7.7%) had no idea.

**Table: 9 Teachers of mathematics knowledge about Air pollution**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No idea	3	4.6	4.6	4.6
	Very slightly	2	3.1	3.1	7.7
	Slightly	4	6.2	6.2	13.8
	Knowledgeable	3	4.6	4.6	18.5
	Much knowledgeable	23	35.4	35.4	53.8
	A great deal	30	46.2	46.2	100.0
	Total	65	100.0	100.0	

About air pollution shown on Table 9, 30 (46.2%) of teachers of mathematics had a great deal of knowledge while 3 (4.6%) had no idea.



**Table: 10 Teachers of mathematics knowledge about climate change**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No idea	5	7.7	7.7	7.7
	Very slightly	4	6.2	6.2	13.8
	Slightly	7	10.8	10.8	24.6
	Knowledgeable	14	21.5	21.5	46.2
	Much knowledgeable	19	29.2	29.2	75.4
	A great deal	16	24.6	24.6	100.0
	Total	65	100.0	100.0	

About climate change shown on Table 10, 19 (29.2%) were much knowledgeable while 5 (7.7%) teacher had no idea.

**Table: 11 Teachers of mathematics knowledge about loss of natural resources**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No idea	5	7.7	7.7	7.7
	Very slightly	1	1.5	1.5	13.8
	Slightly	2	3.1	3.1	24.6
	Knowledgeable	7	10.8	10.8	46.2
	Much knowledgeable	27	41.5	41.5	75.4
	A great deal	23	35.4	35.4	100.0
	Total	65	100.0	100.0	

Source: field Data 2011

Table 11 shows the loss of natural resource teacher's concepts as well as deforestation. The table revealed that 31 (47.7% of these respondents had a great deal of knowledge while 4 (6.2%) had no idea.

#### 4.4 Environmental topics in the Mathematics textbooks

Table 12 gives a comparative analysis of both basic and high school teachers who found environmental topics in the Mathematics textbooks they were using during teaching. The findings revealed that 23 (22.6%) teachers from basic schools identified some environmental topics while 19 (19.4%) did not. In the high school section 12 (12.4%) teachers of Mathematics found some environmental topics while 11 (10.6%) did not find any.

**Table 12: Environmental topics found in some Selected Mathematics textbooks**

Type of schools respondents drawn from		Environmental concepts in mathematics practical exercises		Total
		YES	NO	
Basic schools	Count	23	19	42
	Expected Count	22.6	19.4	42.0
	% within Type of schools respondents drawn from	54.8%	45.2%	100.0%
	% within Environmental topics in mathematics textbooks	65.7%	63.3%	64.6%
	% of Total	35.4%	29.2%	64.6%
High schools	Count	12	11	23
	Expected Count	12.4	10.6	23.0
	% within Type of schools respondents drawn from	52.2%	47.8%	100.0%
	% within Identification of environmental topics in mathematics textbooks	34.3%	36.7%	35.4%
	% of Total	18.5%	16.9%	35.4%
Total	Count	35	30	65
	Expected Count	35.0	30.0	65.0
	% within Type of schools respondents drawn from	53.8%	46.2%	100.0%
	% within Identification of environmental topics in mathematics textbooks	100.0%	100.0%	100.0%
	% of Total	53.8%	46.2%	100.0%

Source: field Data (2011)

Table 13 shows data from both basic and high school teachers who found environmental concepts in mathematics practical exercises. The results revealed that 29 (31.7%) basic teachers found environmental concepts incorporated while 13 (10.3%) did not. In high schools, 20 (17.3%) found environmental concepts incorporated while 3 (5.7%) did not.

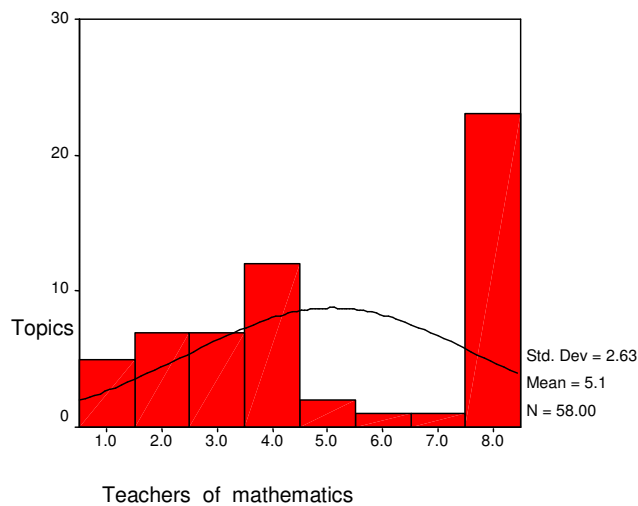
**Table 13: Environmental concepts in Mathematics practical exercises**

Type of schools respondents drawn from			Environmental concepts in mathematics practical exercises		Total
			YES	NO	
Basic schools	Count		29	13	42
	Expected Count		31.7	10.3	42.0
	% within Type of schools respondents drawn from		69.0%	31.0%	100.0%
	% within Environmental concepts in mathematics practical exercises		59.2%	81.3%	64.6%
	% of Total		44.6%	20.0%	64.6%
High schools	Count		20	3	23
	Expected Count		17.3	5.7	23.0
	% within Type of schools respondents drawn from		87.0%	13.0%	100.0%
	% within Environmental concepts in mathematics practical exercises		40.8%	18.8%	35.4%
	% of Total		30.8%	4.6%	35.4%
Total	Count		49	16	65
	Expected Count		49.0	16.0	65.0
	% within Type of schools respondents drawn from		75.4%	24.6%	100.0%
	% within Environmental concepts in mathematics practical exercises		100.0%	100.0%	100.0%
	% of Total		75.4%	24.6%	100.0%

Source: field Data (2011)

Figure 3, illustrates number of environmental topics found by teachers of mathematics in selected mathematics textbooks they used. According to respondents, 5 (7.7%) teachers identified one topic in the books they were using, 7 (10.8%) teachers found two topics each in the books they were using, 7 (10.8%) teachers found three topics each. Twelve (18.5%) teachers found four topics each in the books they were using while two teachers found seven and ten topics respectively in the books they were using. A total of 23 (35.4%) teachers did not find any environmental topic in the books they were using while 7 (10.8%) did not respond to the question.

**Figure 3: Number of environmental topics found in Mathematics textbooks**



Source: field Data (2011)

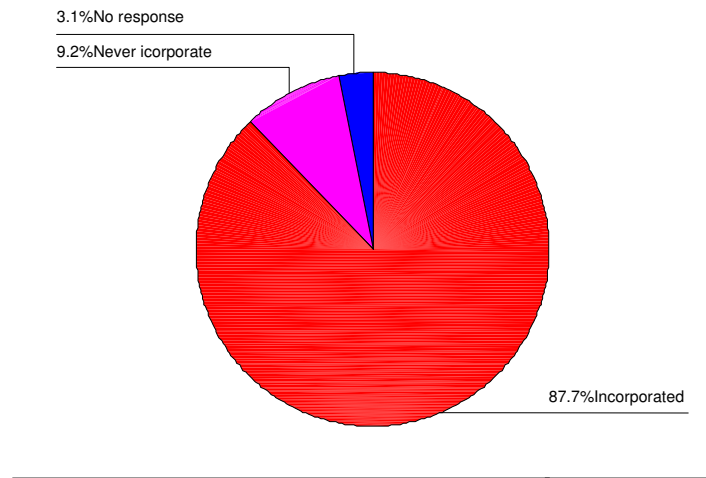
#### 4.5 Integration of Environmental Concepts in Schools

The results of the extent of integrating environmental education issues at each of the schools visited in Lusaka district are presented below. Since the results are very similar across all the schools involved in the study, to avoid unnecessary repetition, the results are presented per indicator, rather than per school. All the findings below came from teachers of mathematics and school managers who participated in the study from various schools.

##### 4.5.1 Teaching of Mathematics

Figure 4 shows respondents who claimed to incorporate environmental concepts or ecological principles into the teaching of Mathematics. What emerged from the study shows that 57 (87.77%) teachers of Mathematics incorporated environmental concepts in their teaching while 6 (9.2%) never incorporated any environmental concepts.

**Figure 4: Integration of environmental concepts in teaching**



Source: Field Data (2011)

#### **4.5.2 Lesson Observation**

A total of 12 mathematics lessons were observed during the study in order to investigate the extent of environmental concepts integration in the teaching. Prior arrangements were made with teachers before conducting class visits and only twelve teachers out of thirty (30) were ready to be observed. Of all the lessons observed only three (3) had reference to environmental education and this was only at two (2) basic schools and one high school. The rest of the schools registered weak extent of environmental education integration in the observed lessons although in figure four 10(87.7%) teachers of Mathematics claim to incorporate environmental concepts in their teaching while 9.2% never incorporated any environmental concepts.

#### **4.5.3 School Vision/Mission Statement**

One of the aims of Educating our Future (1996) is that schools could formulate their own vision and mission statements. These mission and vision statements provide information and guidance to teachers, learners and other key stakeholders on the core purpose of the school educational activities. This indicator was to determine the extent of environmental education issues integration in school Mathematics curriculum by considering the explicitness of

any reference made to environmental education issues in the vision and mission statement of all the schools that participated in the study.

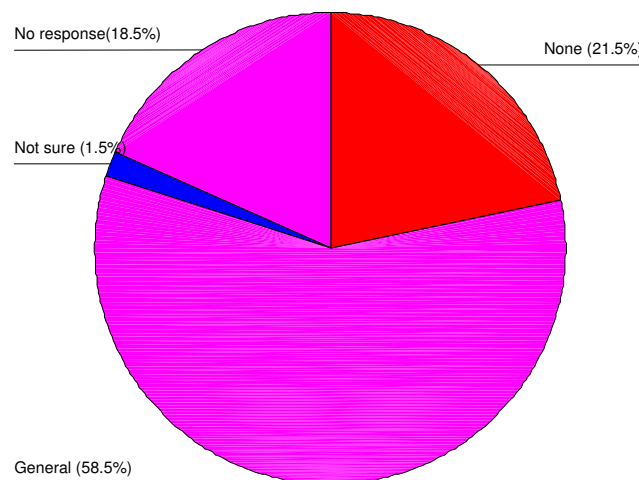
The findings revealed that almost all the schools that participated in the study had their vision and mission statements prominently displayed on school notice boards in the Headteacher's office. None of the vision and mission statements explicit or implicit mentioned environmental education issues. For example, the vision statement for one of the school was as follows:

“To offer Quality holistic Education to learners in order for them to address current cross-cutting issues by changing values, attitudes and behaviour through knowledge acquisition of skills.”

While the schools vision and mission statement lacked any explicit or implicit reference to environmental education issues, they contained references to concepts which are general to environmental issues.

Figure 5 shows the status of mission statements with regards to providing information and guidance to integration of environmental education to school activities such as teaching of mathematics.

**Figure 5: Status of mission statements in schools**



Source: field Data (2011)

Figure 5 showed that 38(58.5%) of the schools which participated in the study, contained references to concepts which were general to environmental issues, 14 (21.5%) of these schools had no mention of environmental education issues

while 12 (18.5%) did not have any mission statements and 1 (1.5%) school was not sure.

#### 4.5.4 Mathematics Clubs

Establishing school clubs or societies is a strategy that is often used by schools to enrich the curriculum on offer to learners. The existence of a particular club at a school and its membership can be used as a measure of the status accorded.

Table 14 shows the existence of clubs in schools that participated in the study. The findings revealed that 22 (37.9%) teachers of Mathematics acknowledged the learners participation in Mathematics clubs, while 36 (62.1%) did not witness any club activities with regards to environmental education and Mathematics.

**Table 14: Mathematics clubs in school**

SCHOOLS			Reponses of clubs in schools		Total
			existence	None	
Basic schools	Status of clubs in schools		17	21	38
	Respondents percentage		44.7%	55.3%	100.0%
	I				
	Total percentagel		29.3%	36.2%	65.5%
ools	Status of clubs in schools		5	15	20
	Respondents percentage		25.0%	75.0%	100.0%
	I				
	Total percentage		8.6%	25.9%	34.5%
Total	Status of clubs in schoolt		22	36	58
	Respondents percentage		37.9%	62.1%	100.0%
	I				
	TOTAL IN PERCENTAGE		37.9%	62.1%	100.0%

Source: field Data (2011)

#### 4.5.5 Environmental days

Zambia is found in the Global world which celebrates environmental days as a means of creating awareness around particular environmental issues. Examples of such days include Water Day (22<sup>nd</sup> March), Wetland Day (2<sup>nd</sup> February) World Health Day (7<sup>th</sup> April) Environmental Day (5<sup>th</sup> June) World Day to combat Desertification and Drought (17<sup>th</sup> June), Habitat Day (3<sup>rd</sup> October), World food Day (16<sup>th</sup> October), World Aids Day (1<sup>st</sup> December) and Tree planting Day (First Saturday of December). However, this indicator analysed the extent of environmental integration of these important days into Mathematics curriculum based on the number of environmental education related environmental days that are celebrated by the schools that participated in the study and the style in which they are celebrated. The assumption made is that the higher the number of environmental education related environmental days that are celebrated, and the more participatory the celebrations were, the more integrated environmental education issues in the schools' Mathematics curriculum and the higher role environmental education play in changing the attitudes of pupils in the schools. The findings revealed that none of the schools celebrated environmental days.

#### 4.5.6 Green Schools

Establishment or maintenance of Green schools was one of the indicators the researcher observed during the study. A school may establish a lawn or a special space within the school grounds or within its buildings that is devoted to the learning and teaching of a particular subject. A school garden and green lawns offer an excellent opportunity for environmental education based on learning and teaching. For example, school gardens can be used to help learners acquire knowledge and skills that are necessary for the cultivation of vegetables while good maintenance of green lawns can help learners acquire knowledge and skills of water and soil conservation during drought. Consequently, the learner learn to account for the quantity and quality of environmental resources by applying mathematical and scientific knowledge. Thus, this indicator analysed the extent of environmental education integration at school level based on the establishment and use of Green schools gardens for environmental education based teaching and learning.

The findings revealed that none of the schools established good green gardens that were devoted to the learning and teaching of environmental education.



## 4.6 The analysis of the Mathematics syllabuses

The result of the analysis of Mathematics syllabi are described and presented per category per grade.

### 4.6.1 Mathematics syllabus grades 1-7

#### Introduction

This was a 127 paged document, which was issued in 2003 by the Curriculum Development Centre (CDC). The new syllabi were developed in five learning areas. The learning areas were; Literacy and Languages, integrated Science, Creative and Technology Studies, Mathematics and Social and Development Studies. The aim of the syllabi was to provide clear guidance to teachers of grade 1-7 learning areas, while integrating cross-cutting issues and themes such as HIV/AIDS, Life skills, Gender, Human Rights, Reproductive Health, Good governance, Environmental education and water and sanitation across the curriculum to ensure holistic development of the learner. The Basic Education syllabi outcomes were based and focused on result rather than goals, aims and objectives. It placed emphasis on observable and measurable skills, knowledge and values to be acquired by learners at specified levels of their schooling.

In this document, pages 80-81 served as an introduction to section 'D' mathematics learning area. The introductory part contained general information regarding the curriculum framework, such as its principles and main design features.

The introductory parts pointed out that the aims of the syllabus was to enable the learners acquire mathematical knowledge and develop skills necessary for application in their everyday lives. It also defined mathematical skills to be developed in a learner, in order for the learner to raise environmental literacy and knowledge that goes beyond an understanding of the environment.

Analysis of the introductory part ends with the following general outcomes which are in line with environmental education which aims at building concepts and awareness in a learner about the ways in which behaviour affects environmental literacy, knowledge and skills and a critical awareness of environmental action and skills:

- Develop mathematical knowledge and skills
- Communicate mathematical ideas effectively-in the environment

- Develop skills for use in Social and Commercial Mathematics
- Develop and foster order, speed and accuracy in problem solving
- Develop interest in mathematical skills for everyday use
- Develop understanding of measurements and shapes
- Apply mathematical operations in problem solving

Grade one of section 'D' covered the following topics: Set, Numbers, Addition, Subtraction, Measurement and Arithmetic. The first grade syllabus contains the topics on sets which its presentation incorporated natural and environmental themes. The syllabus guided learners to sort out objects according to size, colour and shape, also matching sets into one-to-one correspondence. Under the topic "sets," a teacher was advised to use environmental photographs or pictures to state more members in a set.

Under the topic numbers and notation, teachers were encouraged to use environmental illustrations to help pupils qualify amounts of foods such as milk, oranges, eggs, sweets and sugar that were important in the diet. Under "Addition" teachers were advised to use pictures of trees, plants and health foods to help pupils counting with the help of environmental photographs and pictures.

Under the topic "Arithmetic," environmental topics were presented both in theory and practical exercises. The teacher and the class were advised to carry out simple practical shopping activities involving money with a view to achieving specific outcomes of vertical addition and subtraction of money. Here, the syllabus strongly advised teachers to use environmental materials such as health foods, and forest activities.

For the second grade up to fourth the grade syllabi, the learning outcomes were presented exactly as they appear in the first grade syllabi, and so it was decided not to analyse them again.

In the fifth up to seventh grade, the syllabi had pages from 90 to 97 with some pages containing relevant amounts of environmental materials. Most of the specific outcomes contained natural and environmental themes which had environmental interest, such as Health foods, animals, climate change, environment and technology, population density, plants and forests, water pollution, energy flow and Biological diversity. The document also provided a time frame for each knowledge area by grade.

#### 4.6.2 Mathematics syllabus grade 8-9

This was a 15 page document which was prepared by the commercial subjects' curriculum committee and published by the Curriculum Development Centre (CDC). The document was prepared against the background and needs of the Education Reform. The ultimate goals were to provide pupils with tools and means to tackle some challenges found in Mathematics and later on in life. The document was also intended to provide guidance to teachers in Basic Schools or at Basic School Level on how to plan and design learning programmes for mathematics and other cross cutting issues and themes such as environmental education, HIV/AIDS, Life skills and reproductive health. The intended result was to develop three types of literacy associated with the environment.

The first part of this document introduces the reader to the document and the emphasis in the syllabus was on essential knowledge and skills leading to self-reliance in the environment. In other words the basis of the mathematics curriculum was to strengthen the link between schooling and preparation for working life. The syllabus (or document) stressed the importance of integrating environment education in order for pupils not only to acquire mathematical knowledge and skills but also knowledge and skills that will enable them be self-reliant and form positive attitudes towards the environment by the end of grade 9.

The introductory part also described aims of the Basic Education (Grade 8-9) mathematics curriculum as follows:

- Equip the child to live effectively in this modern age of Science and Technology and enable him/her contribute to the social and economic development of Zambia.
- Simulate and encourage creativity and problem solving
- Develop the mathematical abilities of a child to his/her full potential and assist him/her study mathematics as a discipline and use it as a tool in various subject areas, such as environmental education.
- Assist the child understand mathematical concepts in order that he/she may better comprehend his/her environment.
- Develop in the child an appreciation of mathematics in the traditional environment.

The introductory section also defined objectives of Basic Education (Grades 8-9) Mathematics curriculum as a guide to a learning programme. As a learning programme it was a planning tool which ensured that teaching, learning and assessment were conducted in a sequenced and progressive manner across the different grades. It is a well known fact that carefully planned and crafted learning programmes help the teacher to ensure that the learning outcomes and Assessment standards in mathematics are realized in a coherent manner not only across the different grades, but also across the different knowledge areas and skills in order for the curriculum to develop three types of literacy associated with the environment: functional, cultural and critical.

Grade eight (8) and Nine (9) content in this document covered three (3) pages; under these grades, the following topics are found; Sets, Number and Numeration, Fractions, Ratios and Percentages, Arithmetic problems, Social and Commercial Arithmetic, Approximations, the basic processes of algebra, Angle properties of triangle and Statistics. A number of terminal objectives were given under content. The main purpose of this content was to provide guidance of what was expected to be taught in these grades to learners of mathematics. The document provided further elaboration of the contents through given terminal objectives of the main knowledge areas of mathematics by grade. The integration of environmental issues into the elaborated contents and terminal objectives of the knowledge areas were very much highlighted.

#### **4.6.3 Mathematics High School syllabus grades 10-12**

The High school Mathematics syllabus was reviewed because of the need to improve the quality of education at high school level as stipulated in the national policy document EoF1996. It is a 19 paged document and was intended to provide guidance to teachers to ensure that teaching, learning and assessment are conducted in a sequenced and progressive manner across different grades covered. The syllabus also addressed issues of national concern such as Environmental education, Gender and Equity, Health Education and HIV/AIDS, Family Life Education, Human Rights, Democracy, Reproductive Health, Population Education, Entrepreneurship and Vocation Skills, Life and Values Education.

The document was divided into four (4) parts. The first part covered the introduction while the three remaining parts covered grade 10, 11 and 12 contents respectively. The introductory part of this document introduced the reader to the document by highlighting its aims and objectives of teaching

mathematics at senior secondary school level. It described the general aims of teaching mathematics as follows:

- Provide the pupils, with Mathematics background necessary for terminal and further education.
- Develop logical and abstract thinking in the pupil
- Enable the pupil develop mathematical language and skills as a means of communication and investigation
- Develop the ability of the pupil to use Mathematics as a tool in the environment
- Provide pupils with mathematical skills to enable them perform adequately in other subject areas.
- Enable the pupil derive satisfaction and confidence from the understanding of mathematical concepts and mastery of mathematical skills.
- Stimulate and encourage creativity and a spirit of enquiry in the pupil.

The grade 10 section had five pages. The first part defines the learning areas of mathematics. In all the section has 18 topics, and outlined its scope, purposes and each topic had specific objectives. For instance, under the topic “Operations on Real Numbers,” the topic was consolidated with additional notes that suggested the inclusion of environmental education. For example; teachers and learners are encouraged to:

- Discuss whether planting the seed and improving the soil are commutative process.
- Discuss whether reducing poverty and improving the environment is commutative process etc.

Further the syllabus encourages teachers to give as many examples as possible from the environment when teaching sets. For examples, the teachers are to risk pupils/learners to mention sets that cause soil erosion or sets of natural calamities.

Grade 11 section covered pages from 6 to 13 and had 15 topics of which each topic had its specific objective. In this section, the example was on “Ratio, Proportion and Rate” and the specific objectives were devoted to discussing and

solving environmental problems involving ratio, proportion and rate, and some of environmental problems involving rate under this section included: rate of deforestation, rate of population growth and rate of human/ animal depletion. The Topic “Variation” in the syllabus could help solve environmental problems such as a number of people in a household and how long a bag of mealie meal could last or the price of electricity in relation to the number of people who could afford to pay. This could be done by distinguishing between inverse and direct variation or on direct and inverse variation.

The topic “Symmetry in two Dimensions” was another area which integrated environmental education. Photographs and pictures for symmetry inbuilt in the natural environment included the use of: insects, buildings, flowers and people, as learners identify symmetry. Furthermore, statistics was another interesting topic which integrated environmental education at a larger extent because the data to be used in mathematics practices could be from real life situations e.g. Something to do with electricity consumption or waste management statistics could be collected and classified from a real situation data which could be presented in form of tables, pie charts, bar graph, histogram and line graph, then interpreted environmentally.

Grade 12 sections contained 8 topics, which had specific objectives and additional notes for every topic in order to provide further elaboration of what was expected to be taught to grade 12 mathematics learners.

The first topic found in this grade 12 syllabus was on “Graphical Representation of inequalities.” The topic could help pupils apply the solution set of a system of linear in equations to solve linear programming problems of the environmental problems associated to linear in the environment which might include: planning, distribution of goods, economics and construction. All these environmental problems have two distinct mathematical features; the quality and the quantity of environmental resources arising from production and distribution of resources as well as construction.

The topic ‘vectors’ was found to have some environmental concepts in grade 12 syllabus. The concept of vector in different contexts could help the environment to explain transmission of communicable diseases such as TB, HIV etc.

“Earth Geometry” was another topic, which had some environmental concepts incorporated. It could help pupils identify parts of a sphere and locate points on the surface of the earth such as Amazon forests, which need to be protected. Also in the Zambian context, depletion of forests around the country could be an environmental topic to be incorporated.

The topic “Statistics” was another topic in the grade 12 syllabus that had infusion of environmental issues. Real statistics from ZESCO and water company providers could be used in order to determine the levels of power and water consumption with reference to pollution.

The topic “Probability” was the last topic found in grade 12 syllabuses which could help pupils form positive attitudes towards the environment because use of probabilities to monitor environmental resources could help pupils understand extinction of certain animals of the environment. Examples: problems such as the following can be given to pupils;

- If a dinosaurs is extinct, what is the probability of spotting it in a game park?

#### **4.7 The Analysis of the grades 1-12 Mathematics textbooks**

The aim of this section was to bring out the investigation on the implementation of environmental education as an integrated approach in selected Zambian Mathematics textbooks Grades 1-12. The textbooks in this study were used by grades 1- to 12 teachers from both basic and high schools and are referred to here as textbooks 1, 2 up to 12. All the textbooks used in this research were issued between 1995 and 2007 by three different textbooks publishers, all of them major players in Zambia’s textbooks publishing industry.

The criteria for analyzing the textbooks were arrived at through careful examination in order to ascertain their structure, format and contents. The textbooks used in this research had a number of similarities and also major differences. For this reason, a set of three common criteria for the analysis of all the textbooks was used. The following were criterion used for the analysis:

- Illustrations
- Examples
- Exercises

The next method involved in this analysis was formulation of indicators to describe the extent of environmental issues and their corresponding indicators that were used to analyse the extent environmental education integration in the nominated textbooks.

- Percentage of illustrations based on Environmental Education
- Percentage of Examples based on Environmental Education

- Percentage of Exercises based on Environmental Education

#### 4.7.1 Illustrations

##### Introduction

This indicator analysed the extent of environmental education integration in the textbooks based on the percentage of environmental- issues-based illustrations that they contain. The assumption underlying the use of this indicator was that the higher the number of environmental-issues- based illustrations in the textbooks, the stronger the extent of environmental education integration.

The relevant amount of environmental material illustrations in the nominated mathematics textbooks is presented in Table 9 to 12 according to the level of the resource.

##### (a) Lower Basic School Mathematics Textbooks

The first grade textbook given in Table 9, had 102 pages and had a total of 69 illustrations of which 51(50%) of these illustrations contain many photographs or pictures with natural and environmental themes such as health foods, flowers, birds, and forests. Most of the illustrations in the textbooks were presented in order to help pupils learn about the environment and to help them count environmental resources, while on the other hand they helped pupils calculate amounts of foods such as sugar, eggs and milk that were important in the diet.

**Table 15: Lower Basic relevant illustrations in the mathematics textbooks**

Grade	Number of pages		Total number of illustrations based on environmental topics	Percentage %
1 <sup>st</sup> Grade	102		51	50%
2 <sup>nd</sup> Grade	87		23	26.4%
3 <sup>rd</sup> Grade	92		10	10.9%
4 <sup>th</sup> Grade	108		22	20.4%

Furthermore, the first grade textbook, contain illustrations or pictures of people, vehicles and waste materials such as bottles and bottle tops. The pictures mentioned above helped pupils to count and classify sets but there was no



reference to either recycling process or carbon dioxide pollution due to emission from the vehicles.

The second grade textbook, given in Table 15 had a total number of 87 pages and a total number of 44 illustration of which 23 (26.4%) of the illustrations were based on environmental topics. Illustration such as sets of trees, birds, fish, frogs, grasshoppers and snakes were shown without reference to sustainable use of these natural resources. They instead helped pupils learn how to count and classify them accordingly. Pictures or photographs containing health foods as shown in grade one (1) textbook was another major illustration found in grade 2 textbook and health foods such as potatoes, pumpkins, cabbage, onion, lemon, maize, bread, oranges, flour, sugar, coffee, salt, apples and cold drinks were found to be an important health aspect in the diet.

The analysis of the third grade textbook, given in Table 15 indicates that the book had 92 pages and a total of 33 illustrations of which 10 (10.9%) of illustrations were based on environmental education. Most of the environmental education based on illustrations occurred in the knowledge of balanced diet. These were healthy foods which help pupils learn how to count and classify sets of fish, groundnuts pineapples, eggs, cabbages, bottles of milk, maize and bananas.

In the lower basic school textbooks, presented in Table 15, environmental illustrations in the fourth grade textbooks are more than those found in second and third grade. The textbook had 108 pages and a total of 52 illustrations of which 22 (20.4%) were environmentally based. The environmental based illustrations in the textbooks occurred as the knowledge of health foods, indiscriminate cutting of trees, waste management, open burning and HIV issues. Illustrations of pit latrines were shown in the textbooks to help pupils count the pit latrines without any reference to underground water pollutions. The textbook also had an illustration of a densely populated football stadium without any reference to hygiene. Technological illustration was another environmental issue, which the textbook contain. Machinery such as cars, buses, bicycles, boats and airplanes were shown in Venn diagrams to help pupils count and classify the given items without any reference to environmental interest. A beautiful landscape, mountains and a built up area was another environmental interest the textbook contain which helped pupils learn how to count trees of the forest.

#### **(b) Middle Basic School Mathematics Textbooks**

In the Middle Basic School textbooks, presented in Table 16, illustrations depicted specific pictures and diagrams or histograms, which had environmental interest, such as water pollution, population density, oil, and food supplies.

**Table 16: Middle Basic relevant illustrations in the Mathematics textbooks**

<b>Grade</b>	<b>Number of pages</b>		<b>Total number of illustrations based on environmental topics</b>	<b>Percentage %</b>
5 <sup>th</sup> Grade	140		17	12.1%
6 <sup>th</sup> Grade	140		10	7.1%
7 <sup>th</sup> Grade	184		12	16.9%

The fifth grade textbook, given in Table 16, had 140 pages with 17 (12.1%) illustrations based on environmental topics. These illustrations contained photographs or pictures and Venn diagrams with natural and environmental themes, such as health foods, animals, mountains and forests. The photographs helped pupils to use various set notations such as sets of birds and different animals to classify accordingly. In other cases, pupils were asked to classify in venn diagrams different names of diseases such as dysentery, diarrhoea, typhoid and cholera. The textbook also contains illustrations on measurement of mass of babies. The textbooks presented above also contained weather measurements with information such as temperature and rain statistics.

The sixth grade under the Middle basic category was a textbook with 140 pages and 10 (7.1%) of the illustrations were environmentally based. The textbook had fewer pages with environmental photographs or pictures, but a good number of venn diagrams and histograms of fruits such as mangoes, oranges, lemons and guavas were contained. The textbook also contained many photographs or pictures of different animals such as zebras, elephants and dogs. The textbook contained illustrations, which have environmental interest in mining of minerals such as copper, gold, coal and cobalt. Illustrations of different mode of transport facilities such as buses, aeroplanes, cars and bicycles with information such as fuel consumption and carbon oxide emission were contained.

The last grade in the Middle basic category was the seventh grade presented on Table 16. The textbook had 184 pages and only 12 (16.9%) illustrations were environmentally based. The environmentally based illustrations were not only in photographs but also in diagrams and histograms. Environmental based interest

illustrations such as HIV/AIDS, mining, food suppliers and pollution were presented in the textbook. The textbook contains, for example, one illustration, under the topic subtraction, showing miners digging copper ore in two different levels of a mine shaft 129,637 m and 2053488 m respectively. Pupils were then requested to find out the difference in levels with a view to bring out information such as land degradation and consumption of mineral resources.

### **(c) Upper Basic School Mathematics Textbooks**

In the Upper Basic textbooks, presented in Table 17, there were very few environmental illustrations despite the two selected mathematics textbooks with a huge volume of pages. A grade eight (8) mathematics textbook had 333 pages while the grade nine (9) one had 235 pages.

**Table 17: Upper Basic relevant illustrations in the Mathematics textbooks**

<b>Grade</b>	<b>Number of pages</b>		<b>Total number of illustrations based on environmental topics</b>	<b>Percentage %</b>
8 <sup>th</sup> Grade	333		08	2.9%
9 <sup>th</sup> Grade	235		02	0.9%

The grade 8 mathematics textbooks had a total of 35 illustrations, and only 8 (2.9%) of these illustrations were environmentally based. For example, one illustration in the textbook was on 'Number and Numeration.' The illustration helped pupils on how to keep a record of resources. It showed a man counting cows by picking up one stone for each cow. By keeping the stones in one place, he had a record of the number of the cows. The next time he wanted to count his cows, he simply removed one stone from the pile for each cow, in order to determine the use of his environmental resources such as the grazing land area, which must be equivalent to his animals. The Grade 8 textbook also contained pictographs consisting of environmental themes, of population. These illustrations showed small pictures, which made the environmentally based information more attractive and appealing to the learners. The textbook also showed some illustrations in the form of a pie chart, the mineral production of Zambia in tones without any reference to the consequences of mining in the long term.

The grade nine (9<sup>th</sup>) textbook had fewer pages with environmental illustrations. However, illustrations or pictures such as plants, trees, water resources, energy flow and technology were found.

#### **(d) High School Mathematics Textbooks**

In the Zambian education system, High School education covered grade 10 up to 12. The examination of all high school textbooks given in Table 18 revealed that there were no illustrations based on environmental topics on almost every page; despite large volumes in terms of pages. Grade 10 textbook had 389 pages with a total of 32 illustrations and no illustration based on any environmental topic. Grade 11 textbook had 372 pages and had 64 illustrations but no illustration based on environmental topic. For grade 12 textbook, 33 illustrations spread over 345 pages without a single illustration based on any environmental topic.

**Table 18: High School relevant illustrations in the Mathematics textbooks**

<b>Grade</b>	<b>Number of pages</b>	<b>Total number of illustrations based on environmental topics</b>	<b>Percentage %</b>
10 <sup>th</sup> Grade	389	Nil	Nil
11 <sup>th</sup> Grade	372	Nil	Nil
12 <sup>th</sup> Grade	345	Nil	Nil

#### **4.7.2 Examples:**

##### **Introduction**

This indicator analysed the extent of environmental education integration in the textbooks based on the percentage of examples that they contain. All the examples in the nominated mathematics textbooks were analysed. This involved careful reading and working out of each example to determine the levels of environmental integration. The total number of examples found in each selected mathematics textbook was summed up after counting while the total number of environmental based examples was identified and percentage calculated based on the number of pages each textbook contained.

The assumption underlying the use of this indicator was that the higher the number of environmentally based examples in the textbook, the stronger the

extent of environmental education integration and the higher the role it played in the formation of children's positive attitudes towards the environment.

The relevant amount of environmental materials in the examples of the selected textbooks is presented in tables 13 to 16.

**(a) Lower Basic School Mathematics textbooks**

A grade one textbook with 102 pages, had different topics such as Sets, Addition, Subtraction, Shapes and Time. The total number of environmentally based examples in this textbook was only 18 (17.6%) and occurred mostly under health foods, animals and plants. Examples of environmental based examples in the 1<sup>st</sup> grade textbook were:

- Sort into set by colour, size and shape
  - A set of pineapples
  - A set of pumpkins
  - A set of dogs
  - A set of flower

**Table 19: Lower Basic relevant environmentally based examples in the mathematics textbooks**

Grade	Number of pages		Total number of examples based on environmental topics	Percentage %
1 <sup>st</sup> Grade	102		18	17.6%
2 <sup>nd</sup> Grade	87		8	9.2%
3 <sup>rd</sup> Grade	92		4	4.3%
4 <sup>th</sup> Grade	108		9	8.3%

The second mathematics textbook was found to contain 87 pages and 8 (9.2%) examples were based on environmental education. The third grade mathematics textbook of the Lower Basic category had a total of 92 pages of which 4 (4.3%) examples were environmental education based. The last grade in the Lower Basic category was the fourth grade which had 108 pages and 9 (8.3%) was based on environmental education.

### **(b) Middle Basic School Mathematics textbooks**

Table 20 shows Middle Basic School relevant topics in the mathematics textbooks.

**Table 20: Middle Basic relevant examples in the mathematics textbooks**

<b>Grade</b>	<b>Number of pages</b>		<b>Total number of examples based on environmental topics</b>	<b>Percentage %</b>
5 <sup>th</sup> Grade	140		11	1.9%
6 <sup>th</sup> Grade	140		8	5.7%
7 <sup>th</sup> Grade	184		8	4.3%

A grade 5 mathematics textbook was found with 140 pages, (7.9%) were based on environmental education. A grade 6 mathematics textbook had 140 pages and 8 (5.7%) examples were based on environmental education. The last textbook in this category was a grade 7 mathematics textbook which had a total of 184 pages and of which 8 (4.3%) examples were based on environmental education.

### **Upper Basic School Mathematics textbooks**

The Upper Basic table 21 shown below covers two grades only i.e grades 8 and 9.

**Table 21: Upper Basic relevant examples in the mathematics textbooks.**

<b>Grade</b>	<b>Number of pages</b>		<b>Total number of examples based on environmental topics</b>	<b>Percentage %</b>
8 <sup>th</sup> Grade	333		9	2.7%
9 <sup>th</sup> Grade	235		8	3.4%

The Upper Basic mathematics textbooks contained large volumes of pages i.e grade 8 textbook had 333 pages of which 9 (2.7%) examples were based on environmental education. Grade 9 mathematics textbook had 235 pages and contain 8 (3.4%) examples were based on environmental education.

**Table 22: High School relevant examples in the mathematics textbooks**

<b>Grade</b>	<b>Number of pages</b>		<b>Total number of examples based on environmental topics</b>	<b>Percentage %</b>
10	389		Nil	Nil
11	372		Nil	Nil
12	345		Nil	Nil

In the high school mathematics textbooks shown in Table16, none of the examples were based on environmental topics. The grade 10 textbook had 389 pages, grade 11 had 372 pages of which none were based on environmental topic while the grade 12 textbook had 345 pages; no example were based on environmental issues.

#### **4.7.3 Exercises:**

##### **Introduction**

Exercises always appeared at the end of a sub-section, and varied in length. Some were generally longer, and all involved written work and calculations.

This indicator involved the procedure of careful scrutiny of the practical exercises items in order to determine which ones had environmental education concepts after which their percentage contribution was calculated. The use of this indicator was based on the assumption that the higher the number of environmental education concept in practical exercises tasks, the stronger the extent of environmental education integration in the textbook and consequently the higher role environmental education played in forming positive attitudes towards the environment.

The relevant amount of environmental based exercise of the selected textbooks are presented in Tables 17 to 20.

##### **(a) Lower Basic School mathematics textbooks**

In the Lower Basic textbooks, presented in Table 17, most of the exercises, contained

many photographs or pictures with natural and environmental themes, such as health foods, flowers, birds, pets and forests.

The grade one textbook with 102 pages, had 33 (32.4%) exercises based on environmental education. The highest number of exercises that were based on environmental education tested the learners' understanding and application of the main concepts of the sub-section.

The grade 2 textbook had 87 pages and contained 22 (32.4%) exercises based on environmental education. The grade three (3) textbook had 92 pages and contained only 8 exercises with environmental education concepts. The grade 4 textbook of lower basic category contained only 33 (30.6%) environmental education based exercises. Some of the examples of environmental education based questions in the textbook were as follows:

- A forest has 6725 trees. If people cut down 4351 of them how many trees remain?
- During an HIV test 1,235 people were tested, it was found that 367 were HIV-positive. How many people were HIV negative?
- Out of 4892 children, 3127 were immunized for polio. Find the number not immunized?

**Table 23: Lower Basic School relevant exercises in the mathematics textbooks**

Grade	Number of pages		Total number of exercises based on environmental topics	Percentage %
1 <sup>st</sup> Grade	102		33	32.4%
2 <sup>nd</sup> Grade	87		22	32.4%
3 <sup>rd</sup> Grade	92		8	8.7%
4 <sup>th</sup> Grade	108		33	30.6%

**(a) Middle Basic School Mathematics textbooks**



**Table 24: Middle Basic relevant exercises in the mathematics textbooks**

Grade	Number of pages		Total number of exercises based on environmental topics	Percentage %
5 <sup>th</sup> Grade	140		14	10%
6 <sup>th</sup> Grade	140		23	16.4%
7 <sup>th</sup> Grade	184		30	16.3%

Table 24 shows Middle basic school relevant topics in the mathematics textbooks.

The Grade 5 mathematics textbook in the middle basic section had a total number of 140 pages and only 14 (10%) exercises were environmental education based. The grade 6 textbook had 140 pages and only 23 (16.4%) exercises were environmental education based. The following were some of the environmental based question:

- The temperature one morning in Lusaka was 33°C. After it rained in the afternoon, the temperature dropped to 30.4°C. What was the difference in the temperature?
- The weather forecast in Antarctica shows that the temperature is expected to raise by 9°C from -9°C. What will the temperature be then?
- Mr. Juliamo had 110 litres of fuel in his car. If he used 80% of it when going to the Copperbelt, how many litres of fuel was used?

All the tabulated questions above were identified as being central to environmental education based and were specifically and explicitly under the two knowledge area i.e. climate change and fuel consumption which affects the environment.

A grade 7 mathematics textbook was found to have 184 pages of which 30 (16.3%) exercises were based on environmental education. Examples of environmental education based questions in a grade 7 textbook were:

- 850 Kg of pollutants are dumped in the Kafue River per minute. What is the total amount of pollutants which are dumped in the river in 1½ minutes?
- To stop desertification, 674 500 trees should be planted. If the local community has planted 398 725 trees. How many more trees are needed?

- Oxygen occupies about  $\frac{1}{5}$  of atmospheric air and the rest is taken up by other gases. What space do the other gases occupy?

In the grade 7 mathematics textbook the highest number of environmental education based questions occurred in the knowledge area of pollution, land degradation and climate change.

#### (b) Upper Basic school mathematics textbooks

The upper basic table 25 shown below covers only two grades

**Table 25: Upper Basic relevant exercises in the mathematics textbooks**

Grade	Number of pages		Total number of exercises based on environmental topics	Percentage %
8 <sup>th</sup> Grade	333		11	3.3%
9 <sup>th</sup> Grade	235		5	2.1%

In the upper basic section both grade 8 and 9 had huge volumes of page- 333 and 235 respectively. The grade 8 textbook had 11 (3.3%) exercises which were environmental education based. A grade 9 textbook had a total of 5 (2.1%) environmental education based exercises.

#### (d) High School mathematics textbooks

**Table 26: High School relevant exercises in the mathematics textbooks**

Grade	Number of pages		Total number of exercises based on environmental topics	Percentage %
10 <sup>th</sup> Grade	389		6	1.5%
11 <sup>th</sup> Grade	372		3	0.8%
12 <sup>th</sup> Grade	345		1	0.3%

In the high school mathematics textbooks shown in Table 26 , it was found that all the three nominated books had very few environmental based exercises despite large volumes of pages. A grade 10 textbook with 389 pages contained a total number of 6

(1.5%) exercises based on environmental education. The grade11 textbook had 372 pages and only 3 (0.8%) exercises were based on environmental education; the grade 12 textbook had 345 pages and contained a total of 45 exercises, of which only one (1) was environmentally based. This indicator revealed weak integration between environmental education and mathematics curriculum at high level in the exercises given.

## **CHAPTER FIVE**

### **DISCUSSION OF RESULTS**

#### **5.0 Introduction**

This chapter discusses the findings of the study. The discussion of the study covers the frequency and integration of environmental issues and topics in the Zambian Mathematics Curriculum. The main focus of the discussion is to find answers to the following questions:

- What kind of human resource do basic and high schools rely on for teaching and learning of environmental education?
- To what extent do Lusaka urban <sup>based</sup> schools integrate environmental issues into school programs?
- To what extent do grades 1-12 Mathematics syllabuses produced by the Curriculum Development Centre integrate environmental issues?
- How many environmental topics or concepts are found in the Mathematics' textbooks that are used by teachers and learners in Lusaka urban based schools?

The results of this study raise several implications as far as the role of environmental education in the Zambian Mathematics curriculum is concerned.

#### **5.1 Teachers of Mathematics and environmental education**

What emerged from this study is that teachers of Mathematics had different perceptions in the way they understood environmental concepts despite very high qualifications obtained from various universities and colleges. This is to say that a good number of teachers who participated in the study had misconceptions about natural and environmental phenomena. Some teachers from both basic and high schools lack basic knowledge about how the environment functions. Consequently, they fail to develop environmental literacy as they were not able to incorporate environmental concepts or ecological principles into mathematics they were teaching. These findings point to some revelations; either teachers did not receive adequate training in environmental education related issues or no training was offered in environmental education at all.

Teachers need to be trained through a curriculum that has EE as a component which can facilitate their teaching to promote EE (Vulliam 1987). This is supported by UNESCO (1995) who maintains that full incorporation of EE into the curriculum, teaching and learning process demands realistic and practical

renewal of an educational system to educate teacher-educators and teachers. Also the teachers must be involved in the conception, formulation and integration of the new innovations. Teachers themselves need to be well oriented and possess the knowledge and skills to cope with the integration process.

## 5.2 **Environmental Topics and Concepts in the Mathematics Textbooks**

Table 6 in chapter 4 revealed that 22.6% teachers of Mathematics from basic schools were able to identify some topics or concepts from Mathematics textbooks they were using while 19.4% were not. In the High school section, 12.4% of teachers identified topics or concepts on the environment while 10.6% were not able. The findings revealed that environmental education issues found by basic school teachers in the textbooks they were using, from the first up to the fourth grade, were mostly illustrations of environmental themes and phenomena such as health food, flowers, birds and forests. These illustrations helped pupils learn about the environment and calculate amounts of foods such as milk, beans, sugar and fruits that are important in the diet. Topics or concepts found by basic teachers in the fifth grade up to seventh grade include both theory and practical exercises. These can be picked from the context had environmental interest, such as population density, oil and food supplies, water pollution and traffic jam. Some topics found in grade 8-12 text books showed great diversity. Most beneficial topics in teaching and learning about environmental related issues such as plants, trees and forests, energy flow and recycling materials were found. The topics were presented together with pictures of deforestation, fruits and animals, examples of sustainable agriculture, water resources, and the consumption of energy.

The information in Figure 3 lists the environmental topics or concepts respondents found in the textbooks they were using. These were found in both theory and practical exercises as follows:

There were five respondents who found one topic each, seven respondents found 2 topics each- either in theory or practical exercises. Seven respondents found three topics each, twelve respondents found four topics, two respondents found 7 and 10 topics respectively. A total number of 23 (35.4%) respondents did not find any environmental topics in the textbooks they were using. This finding points to the fact that some teachers were either using outdated textbooks which did not have environmental related material or were not much knowledgeable about environmental issues as presented in the textbooks.

### 5.3 Integration of Environmental Topics and Concepts

What emerged from this study is that 87.7% teachers of Mathematics incorporated environmental concepts in their teaching while 9.2% did not incorporate any environmental concepts into the subject. This came about due to the textbooks used by these teachers in the primary section, as they contain many pictures with natural and environmental themes or environment materials.

The findings also revealed that almost all the schools that participated in the study had their vision or mission statements prominently displayed on school walls in order for the schools to provide information and guidance to teachers, learners and other key stakeholders on what has been decided upon as the core purpose of the schools educational activities. It is unfortunate that in none of the vision or mission statements was there explicit or implicit mention of environmental education issues. This is to say that all the mission statements lacked explicit or implicit reference to environmental education issues, but they contain references to concepts which are general to environmental issues. The implication to such a scenario in these schools is that, it is difficult or it may not be possible for schools to integrate environmental issues in the Mathematics curriculum due to lack of concepts which need to be taken into account in curriculum design by key stakeholders and teachers in these schools. This arises from the fact that these stakeholders have misconceptions about natural and environmental phenomena. Therefore, the implications of such misconceptions bring about inaccuracies in teaching and implementation of environmental issues and the effects of such inaccuracies lead to failure to integrate environmental issues in the subject. Consequently, such teachers and key stakeholders who are environmentally illiterate have an adverse impact on the school, because such people even if they want to improve the environment, may not know how to because they lack basic knowledge about how the environment functions.

Establishment of environmental clubs is a strategy that is often used by some schools to enrich the curriculum offered to learners. However, the findings revealed that 37.9% teachers of Mathematics acknowledged the learners participation in environmental education clubs, while 62.1% did not witness any club activities in their schools. This simply meant that there was very weak integration of environmental issues in the Mathematics curriculum in the school that participated in the study, especially that mathematics is a compulsory subject.

#### 5.4 **The Analysis of the Mathematics Syllabuses**

Several issues emerged from the findings on the extent of environmental education integration and frequency of topics in the syllabuses in conformity with textbooks and school programmes. Firstly a number of key criteria of environmental education integration and the frequency of topics in the syllabuses which were analysed for which there were no data on which to base the analysis. The disjuncture between the underlying messages carried by the syllabuses and the school recommended textbooks regarding the teaching and learning of environmental issues, and what was actually taking place both in the classroom situation and outside the classroom situation was totally different, although the findings revealed that grade 1-12 teachers of Mathematics had at their disposal syllabuses that were issued by the curriculum development centre. Although the teachers had these documents, the study revealed that some teachers did not understand what was contained in the documents while some did not even bother to read them or refer, to them when preparing schemes of work. However, the overall extent of environmental education integration was very strong in some of these documents although in some syllabuses environmental education was referred to as cross-cutting issues. The extent of environmental education integration was particularly strong in the grades 1 to 7 compared to syllabuses for grades 8-12 which generally reflected a relatively weaker overall extent of environmental integration.

Table 27 shows a sample of EE proposed integrated Basic and High school mathematics syllabus.

#### 5.5 **The Analysis of Mathematics textbooks**

The aim of analyzing mathematics textbooks was to investigate the implementation of environmental issues by finding out the frequency of environmental topics in these books.

Another major issue which emerged from the findings is that some textbooks used by teachers especially those in higher grades; (the overall extent of environmental education integration) was particularly weak due to textbook publishers who had no guidelines on expected textbook content for Mathematics and environmental education. Selection of Mathematics textbooks which integrated environmental issues was another issue which emerged from the findings. Teachers lacked knowledge and skills in the selection of correct textbooks which incorporated environmental issues. Teachers needed to be provided with more training in the selection and production of their own environmental education related pedagogic texts for use in class.

Another finding that emerged from the analysis of the grade 10-12 Mathematics textbooks was the disparity between the teachers in terms of the extent to which they integrated environmental issues. While the extent of environmental education integration in all Mathematics textbooks was comparable to most of the national syllabus texts, it was found that it was weaker in some textbooks. This finding points to a certain degree of inconsistency in the integration process between the syllabus and the textbook publishers regarding the status of environmental education within the Mathematics curriculum.

The purpose and practice of environmental education involves gaining appropriate knowledge as well as developing skills in decision-making and strategies for implementing change rather than taking action. In this regard environmental topics in Mathematics curriculum documents are able to provide pupils with the opportunity to heighten awareness about natural, social, technological and historical environmental issues. Moreover, if societal needs and values are seen to be changing, education must consider this fact and provide opportunities for pupils to investigate both the quality and the extent of environmental problems. This is supported by Mac Donald et al(1985) who states that many educational innovations rely on teachers education and the effectiveness of any EE programme depends on quality of the teachers' training and experience(Kostova 1989).

Finally, this study investigated the integration and frequency of environmental concepts in the Mathematics curriculum. The results showed that there were a number of environmental topics in the Mathematics curriculum documents, but the way they appeared in these documents and textbooks did not help pupils to develop positive attitudes towards the environment.

Teachers themselves need to be well oriented and possess the knowledge and skills to cope with the integration process as they play a central role in effective implementation of change in schools such as that brought about by EE.(Stern and Wang).





<b>Environmental Issue/Problem/Causes/ Basic solutions</b>		<b>Specific Objectives</b>	<b>Integrated EE competences: knowledge skills, values, attitudes. The learner will be able to:</b>	<b>Suggested activities and possible actions</b>
Environmental issue: Loss of biodiversity Theme: Plants and animals in our local areas	5.	<ul style="list-style-type: none"> <li>Identify and use effectively the relevant operations in everyday life</li> <li>Use data to solve problems</li> </ul>	Apply mathematical skills to analyse the state of biodiversity in the sample habitats.	Learners count all the plants and animals they identified in the different habitats and make a chart showing the differences in biodiversity (number of different plants or animals)
Environmental issue: Pollution Problem: land pollution Causes: <ul style="list-style-type: none"> <li>Improper disposal of waste</li> </ul> Possible solutions: <ul style="list-style-type: none"> <li>Waste management</li> <li>Reduce, reuse, recycle</li> <li>Landfills</li> </ul>	6.	<ul style="list-style-type: none"> <li>Measure mass in grams up to 1000 grams (1Kg)</li> <li>Measure land and calculate mass in grams and kilograms</li> </ul>	Apply mathematical skills to analyse environmental issues where appropriate	<ul style="list-style-type: none"> <li>Learners use scale to find the mass of different types of litter in their school.</li> <li>Learners compare mass of different types of litter and discuss how the amount of litter can be reduced.</li> </ul>
Environmental issue: Poverty Problem: <ul style="list-style-type: none"> <li>Hunger</li> <li>Ill-health and premature death</li> <li>Ignorance</li> <li>Discrimination and insecurity</li> <li>Lack of dignity and social status</li> </ul> Causes:	7.	Express a quantity as a percentage Specific objectives: <ul style="list-style-type: none"> <li>Identify and use effectively the relevant operations in everyday life.</li> <li>Identify and understand a problem.</li> <li>Use data to solve problems</li> </ul>	<ul style="list-style-type: none"> <li>Apply mathematical abilities to analyse the state of poverty in the local community.</li> <li>Apply mathematical abilities to design solutions to problems related to poverty</li> </ul>	<ul style="list-style-type: none"> <li>Learners calculate the percentage of people living below the poverty line in the area.</li> <li>Learners calculate the amount of food needed by average families and individuals.</li> <li>Learners calculate the daily costs to purchase</li> </ul>

<ul style="list-style-type: none"> <li>• Unequal distribution of land and other resource</li> <li>• Declining agricultural productivity and land degradation.</li> <li>• Unemployment</li> <li>• Overpopulation</li> <li>• Disrespect for the law and human rights.</li> </ul> <p>Possible solutions:</p> <ul style="list-style-type: none"> <li>• Access to basic services e.g. education, health, employment opportunities, and decent working conditions.</li> <li>• Investment in rural development programs</li> <li>• Law reforms to include formally disadvantaged groups e.g. women, children and people with disabilities.</li> </ul>				the necessary food.
<p>Environmental Issue: Population Growth Problems:</p> <ul style="list-style-type: none"> <li>• Poverty</li> <li>• Crime</li> <li>• Disease</li> <li>• Pollution</li> <li>• Resource exploitation</li> </ul>	8.			Much maize meal does an average family consume per month? How much will they need for the whole year? How many families need food? How much is produced in Zambia?

<p>Causes:</p> <ul style="list-style-type: none"> <li>• High birth rate</li> <li>• Rural-urban migration</li> <li>• Immigration</li> </ul> <p>Possible solutions:</p> <ul style="list-style-type: none"> <li>• Birth control</li> <li>• Access to basic services – education, health, etc</li> <li>• Investment in rural development programmes</li> </ul>				
<p>Environmental Issue: loss of biodiversity</p> <p>Problem: loss of indigenous species</p> <p>Causes:</p> <ul style="list-style-type: none"> <li>• Restruction of habitats and ecosystems.</li> <li>• Over-exploitation of biological resources.</li> <li>• Poor land use system</li> <li>• Alien species</li> </ul> <p>Possible solutions:</p> <ul style="list-style-type: none"> <li>• Environmental</li> <li>• Protected areas</li> <li>• Efforts to replant indigenous plants</li> <li>• Removal of alien species</li> <li>• Indigenous knowledge</li> </ul>	9.	<p>Have acquired skills to collect, represent and interpret data.</p> <ul style="list-style-type: none"> <li>• Use different ways of representing statistical data.</li> <li>• Use statistical data to make inferences</li> <li>• Express one quantity as a percentage</li> </ul>	<p>Obtain knowledge about the state of biodiversity loss in Zambia.</p> <p>Process and represent collected EE data to highlight the seriousness of EE problems.</p>	<p>Learners make e.g. posters, illustrating statistic using charts, diagrams etc. In order to clarify environmental problems.</p> <p>Learners make poster to illustrate and predict future possible developments. Differences shown in development related to appropriate action or no action taken to solve the identified problems.</p>

<p>Environmental Issue: Land degradation</p> <p>Problems:</p> <ul style="list-style-type: none"> <li>• Soil erosion</li> <li>• Desertification</li> <li>• Overgrazing</li> </ul> <p>Causes:</p> <ul style="list-style-type: none"> <li>• Deforestation</li> <li>• Bush fires</li> <li>• overgrazing</li> </ul> <p>Possible solutions:</p> <ul style="list-style-type: none"> <li>• Soil conservation</li> </ul>		<ul style="list-style-type: none"> <li>• Calculate the total surface area and volume of cuboids.</li> </ul>	<p>Apply mathematical abilities to analyse land degradation with regard to the mass of soil washed away in specific land formations (e.g. Kanyama) in their area.</p>	<p>Learners measure (find the volume of) a minor part of Kanyama in their local area to estimate the amount of soil lost from the area.</p>
---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--	-------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------

## **CHAPTER SIX**

### **CONCLUSIONS AND RECOMMENDATIONS**

#### **6.0 Conclusions**

This study investigated the integration of environmental issues in Mathematics curriculum and implementation of environmental concepts in Lusaka urban based schools. The major goal of this study was to analyse the frequency of environmental issues and the extent of environmental education integration in the different fields which constitute the pedagogic system. The results show that there are a number of environmental topics and concepts of different environmental fields which constitute the pedagogic system, but the way they appear does not help the pupil develop positive attitudes towards the environment.

However, the conclusion derived from the above information illustrates the existent preference for bio-diversity especially in low grade curriculum documents, since there are several concepts concerning the flora and fauna without, however, reference to the subject of animal and plant extinction. The findings that emerged from the textbooks show that many concepts concerning particular types of trees did not give sufficient attention to the dangers that forests face as ecosystems, such as deforestation and conflagration.

Furthermore, what emerged from the analysis of Mathematics textbooks are concepts concerning health foods such as vegetables and fruits, the availability and importance of drinkable water. However it is notable that there are no concepts with regard to waste management and recycling process. The Mathematics textbooks used by teachers and pupils had concepts on the consumption of petrol, and oil, for transportation and heating, but no concepts on ways of saving energy.

The findings in the study further showed that among the 33 schools that participated in the study, they had different Mathematics textbooks but of the same grade for the teaching and learning of Mathematics. The findings further suggested that some schools in Lusaka depended on donations of old and outdated textbooks which had no latest information with regard to environmental education integration, which was as a result of lack of funds to secure latest textbooks.

Another finding that emerged from the analysis of Mathematics textbooks and syllabuses was the disparity between the extents to which they integrated

environmental issues. While the extent of environmental education issues in the textbook recommendation was comparable to that in most of the national syllabus texts, which in the syllabuses was considerably weaker.

The above finding point to a certain degree of inconsistency in the integration process between the syllabus and the textbook publishers regarding the status of environmental education within the Mathematics curriculum.

The investigation of the Mathematics National syllabus revealed that the national syllabus was divided into three parts as follows: grade 1-7; grades 8-9 and grades 10-12. Grades 1-7 syllabus document had very strong environmental education issues integration while grade 8-12 was particularly weak of environmental education integration.

The dissemination of various syllabus documents to the 33 case study schools appears to be effective as all teachers claimed to have these documents in their possession. Nevertheless, what emerged from the findings showed that the majority Mathematics of lessons observed and other pedagogic text that were analysed either lacked or contained very little environmental issues content, which reflected either unwillingness or inability on the part of the teacher to engage with the environmental education discourse.

The study revealed that the extent of environmental education integration was particularly weak in the teacher professional programmes that are run by the provincial education office Professional Development (CPD).

In conclusion, the analysis of the extent of Environmental Education at school level in general, suggested very little integration of Environmental issues in all the 33 schools that were involved in the study, as the results show in chapter four (4) that there are a number of environmental topics and concepts in the Mathematics curriculum documents such as textbooks and syllabuses, but the way they appear did not help pupils to develop positive attitudes towards the environment. Therefore, the importance of integrating environmental concepts out of class activities, practices and other co-curriculum activities should not be underestimated as it can also serve as an entry point of environmental education into the school curriculum and eventually into the classroom, besides contributing to the quality of the learning experience offered by a school. In that way the school will play an important role in the formation of pupils' positive attitudes towards the environment. Consequently, the role of environmental education in

the Zambian Mathematics curriculum will be achieved as pupils will be helped to form positive attitudes towards the environment.

## **6.2 Recommendations**

- 6.2.1 It is recommended that the government increase funding to schools for the purchase of latest environmental related Mathematics textbooks and other materials.
- 6.2.2 Provide textbook publishers with environmental based guidelines on expected Mathematics textbooks.
- 6.2.3 Train teachers in textbook selection so that they are able to make informed textbook choices with regard to environmental issues. Also teachers should be given more training in the production of their own environmental education related pedagogic text for use in class.
- 6.2.4 School textbooks in the secondary section and other instruction materials be peer reviewed.
- 6.2.5 Educators, textbook writers and teachers should receive more substantive preparation in the Natural Sciences and Mathematics.
- 6.2.6 More environmental education related Mathematics textbooks be made available to schools to counteract the domination of textbook publishers with outdated materials.
- 6.2.7 To improve on the disparity, the syllabuses need to provide more guidance to the textbooks publishers about the teaching and learning of environmental education content within Mathematics curriculum. This may occur through further strengthening of the status of environmental education in the syllabus text, or through special guidelines and training session for the various textbook publishers in the country, in which environmental education is promoted.
- 6.2.8 There is a need for more standardization of the status of environmental education within the nationally produced documents. This can be achieved by making more explicit references to environmental education concepts.



- 6.2.9 Teachers of Mathematics need to form closer ties with NGOs and Organisations such as Zambia Environmental Management Agency (ZEMA) that promote environmental education and environmental conservation.
- 6.2.10 The Standards Officers in charge of teacher training and Mathematics should receive specialists training in Environmental Education especially in the production of education materials.
- 6.2.11 The C.P.D. co-ordinators at school level should work hand in hand with curriculum specialists to oversee environmental learning programmes within the Mathematics curriculum.
- 6.2.12 Mathematics clubs should be established at each school level to drive the environmental education integration agenda.

## REFERENCES

- Ahuvia, A. (2001). ***Traditional, interpretive and reception based content analysis:*** Improving the ability of content analysis to address issues of pragmatic and theoretical concerns  
Retrieved June 20, 2010, from  
[www.springerlink.com/content/q32062x4h78q52/full text. pdf](http://www.springerlink.com/content/q32062x4h78q52/fulltext.pdf)
- Beane, J.N (1995). ***Curriculum integration and the disciplines of Knowledge.***  
Phi, Delta. Kappan.76 (8), 616-626
- Berg, B.L (Ed.). (2004). ***Qualitative research method for the Social Sciences***  
(5<sup>th</sup> ed) Boston: Pearson
- Brenner, M.E (2001). ***Arithmetic Achievement: Results from Standardize Testing.***  
Centre for Development of Early Education: Honolulu.
- Bos, W. & Tarnai, C. (1999). Content analysis in empirical social research.  
***International Journal of Educational Research 31(8), 659-671.***
- Coduto, A.J. (1984). A Teacher Training Model and Educational Guidelines for Environmental values education.  
***Journal of Environmental Education. 16 (2) 30-34***
- Cherrett, J.M. (1989) Key concepts: The results of a survey of members' opinion. In J.M. Cherret (Ed.) ***Ecological Concepts.*** Oxford: Blackwell Scientific. Churchill (198
- Clacherty, A.J. (1988). Towards Environmental Education programme for the Training of primary school teachers. Unpublished M.A dissertation.  
University of Cape Town
- Cohen, L., Manion, L., and Morrison, K., (Eds.) (2007)). ***Research Methods in. Education*** (5<sup>th</sup> ed).London: Routledge Falmer.
- Dalton, T.H. (1988). ***The Challenge of curriculum Innovation: A study of ideology and practice.*** The Falmer Press: Philadelphia

- Creswell, J.W. (Ed.). (2003). Research ***design, qualitative, quantitative and method mixed approaches*** (2<sup>nd</sup> ed.). Thousand Oaks: Sage.
- Ekpenyoung, L.E (1970). Towards a systems approach to the integration of the Nigerian Junior Secondary School business studies curriculum. ***Journal of vocational Education and Training***. 49 (2), 267-281
- Gayford, C.G. (1986). Environmental Education and the Secondary Curriculum. ***Journal of curriculum studies***. 5 19-20
- James, K.R., Lamp, E.C., Bally, M., and Householder, D. (2000). ***Integrating Science, Mathematics and technology in middle school technology-rich environments***: A study of implementation and changed. School Science and Mathematics, 100, 27-35.
- Giglitt, L.M. (1990). Environmental Education: what went wrong? What can be done ***The Journal of Environment Education***. 22 (1) 9-12
- Jones, L. & Somekh B. (2006). Observations. In B. Somekh & C. Lewin (Eds.), ***Research methods in the Social Science*** (pp. 138-145). London: Sage.
- Ham, S.H., Mary, H., Relleargert-Taylor, H and Krumpe, E.E. (1987). Reducing Barriers to Environmental Education. The journal of ***Environmental Education***, 19 (2) 25-33.
- Hamilton, D. (1982). Handling Innovation in the classroom. Two Scottish examples. In Harton, T. (ed) 1982. ***Challenge and change in curriculum*** Hodder and Stoughton: Kent.
- Havelock, R.G. and Huberman, A.M. (1978). ***Solving Educational Problems: The Theory and Reality of Innovation in Developing countries***. Praeger Publishers: New York.
- Hurry, L.B. (1984). Directions in Environmental Education and their implications for the Training of primary school teachers in the Transvaal: A discussion of four B. Prim. Ed Programmes ***Southern African Journal of Environmental Education*** 1 10-12.

- Kimpston, D.R. (1985). Curriculum Fidelity and the Implementation Tasks Employed by Teachers: A Research Study. **Journal for curriculum studies** 17 (2) 185-195.
- Kariro, A.K. (1987). **Environmental Activities for School and Colleges** in Kenya. National Environment Secretariat Ministry of Environment and Natural Resources, Nairobi.
- Knamiller, G.W. (1987). Environmental Education in School. In Baez, A.V. (ed) 1987. **Science and Technology Education and Future Human Needs**: I.C.S.U. Press
- Kostova, Z. (1989). Environmental Education, Research and Practice, in Bulgavia. ***The Environmentalists***. 9 (2) 85-90
- Kysilka, M.L. (1998). Understanding integrated curriculum. ***The curriculum journal***, 9 (2), 192-209.
- Lahiry, D., Sinha, S. Gill, J.S., Mallik, U. and Mishra, A.K. (1988). ***Environmental Education: A Process for pre-service Teacher Training Curriculum Development***. UNESCO-UNEP International Environmental Education Programme Environmental Educator Series 26: New Delhi.
- Lal, D.S. (2004). ***Climatology***, Allahabad, Chaitanya Publishing base.
- Lotz-Sistka, H. (2004). ***Positioning Southern African environmental education in a changing content***. Howick, share-Net/SADC REEP.
- MacDonald, A.M. Gilmor, J.D., Moodie, P. (1985). Teacher Reaction to Innovation: A case study in a South African Setting. ***Journal of Education for Teachers***. 11 (3) 245-263.
- Maclure, S.J. (1987). **Curriculum Innovation**. Proceeding of the Third International curriculum conference, HMSO: Oxford.
- Merrian, S.B. (Ed.) (2005). ***Qualitative research and case study as application in education***. San Francisco: Jossey-Bass Publishers

- Ministry of Education, (1996). ***Educating our Future National Policy on Education***  
Lusaka. Government Printers
- Ministry of Education, (2003) ***Zambia Basic Education Syllabi 1-7***, Lusaka: CDC
- Ministry of Education (2001) ***Teacher's curriculum Manual***, Lusaka: Printpak
- Ministry of Education (2005) ***Basic Education Syllabus Grades 8-9***, Lusaka: CDC
- Ministry of Education (1997) ***Mathematics High School Syllabus Grades 10-12***,  
Lusaka: CDC.
- Mokotso, B. (2003). ***Environmental Education: A Teacher's Handbook for primary  
And secondary schools in Lesotho, Lesotho. LEESP.***
- Morris, P. (1985). Teachers' perceptions of the Barriers to the implementation of a  
Pedagogic innovation: A South East Asian case study.  
***International Review of Education.*** 31 3-18
- Munson, B.H (1994). Ecological misconceptions. ***The Journal of Environmental  
Education***, 25 (40), 30-34.
- Namafé, C.M. (2006), ***Environmental Education in Zambia: A critical Approach to  
change and Transformation***, Lusaka, New Horizon Printers.
- O'Donoghue, R. (2007). Environment and Sustainable development in a changing  
South Africa: A critical historical analysis of the outline of Schemes for  
defining and guiding learning outcomes. ***South African Journal of  
Environmental Education***, 24, 141-157.
- O'Leary, Z. (2004). ***The Essential guide to doing research.*** London: Pion.
- Orr, D.W (1992). ***Ecological literacy: Education and the Transition to a post  
modern world***: Albany, NY: Sunny Press.
- Parry, L. (1987). Environmental Education in Australia. Some recent Curriculum  
Developments. ***Environmental Education and Information.*** 6 (1) 10-16

- Silverman, D. (2004). ***Qualitative research: Theory, method and practice***. London: Sage
- Spiropoulou D., Kostopoulos D., and Jakobides C.P. (1997) Weather phenomena in the ***Greek national curriculum:an experiement in teaching meteorology. Weather***, 52 (9), 282-286.
- Stein, M.K. and Wang, M.C. (1988). Teacher Development and School Improvement: The process of teacher change. ***Teaching and Teacher Education***. 4 (2) 171-187
- Sterling, S. (1995). ***Towards a Sustainable Europe. Environmental Education***, 48, 6
- Taylor, P.H. 1975). ***Curriculum School and Society: An introduction to curriculum studies***. NFER Publishing Berks.
- Trochin WMK (2001. The Research Methods Knowledge Base: (2<sup>nd</sup> ed) cincinnat: Antomic Dog Publishing.
- UNESCO, (1985). ***A Comparative Survey of the Incorporation of Environmental Education into school curricula***. UNESCO-UNEP International. Environmental Educator Programme Environmental Education series 17: Germany.
- UNESCO-UNEP (1978). The Tbilisi Declaration, 3 (1). 1-7 ***connect***
- UNESCO-UNEP Congree, 1987. ***Environmental Education and Training. Moscow***.
- Usher, R. & Scott, D. (Eds.). (1999). ***Researching education: Data, methods and theory*** in education inquiry, London: Continuum.
- Venville G.J., Wallace, J.A. Rennie, L.L, and Malone, J.A. (2001). Curriculum integration: Eroding the high ground of Science as a school subject? A paper presented at the Annual Conference of the ***Australian Association for Research in Education***, Fremantle, Western Australia, December 2-6, 2001.
- Vulliamy, G. 1987. Environmental Education in Third World Schools: Rhotoric or Realism? ***The Environmentalist***. 7 (1) 11-19.

Watt, D.M. and Gilbert, J.K. (1985). ***Appraising the understanding of Science concepts***: Guildford: Department of Education Studies University of Survey.

Williams, R. 1987. Preparing Teachers for Environmental Education Across the curricula in One Earth Many Worlds. ww.F: (UK) London.

Yin R.K. (Ed) (2003). ***Case study research: Design and methods: Applied Social. research methods*** (3<sup>rd</sup> ed). Thousand Oaks: Sage.

## APPENDIX 1: QUESTIONNAIRE FOR TEACHERS

### THE UNIVERSITY OF ZAMBIA

#### DIRECTORATE OF RESEARCH AND GRADUATE STUDIES MASTER OF EDUCATION IN ENVIRONMENTAL EDUCATION

##### A Questionnaire on the role of environmental education in Zambian Mathematics curriculum.

Dear Respondent,

I am a postgraduate student at the University of Zambia. I am conducting a research on the role of environmental education in Zambian Mathematics curriculum. You have been purposefully chosen to participate in filling in the questionnaire. Please kindly answer the questions as honestly as possible and keep in mind that there are no 'right' or 'wrong' answers in this study. There are only your through responses that will make this study successful. Be assured that your response will be confidentially kept.

Thank you

- (a) Please answer the following questions by ticking [ ] the most appropriate one from your point of view.
- (b) Where not applicable indicate N/A
- (c) For open-ended questions, please write your response in the space provided.

##### **SECTION A:** General and personal information

- 1. Name of school.....
- 2. Your age.....
- 3. Your sex [ ] male [ ] female
- 4. What is your highest professional qualification?  
[ ] master degree holder [ ] First degree  
[ ] Advanced diploma [ ] Diploma [ ] certificate



5. Name of institution professional qualification obtained

.....

6. Do you belong to any environmental organization?

☐ Yes

☐ No

**SECTION B: Education of Mathematics/Environmental Education Curriculum**

7. Have you ever participated in any organized environmental activities (e.g. environmental education workshops, environmental conservation conferences, outdoor learning etc) either in or outside of school?

☐ Yes

☐ No

8. From the year you last obtained your higher qualification, have you ever attended any training course related to Mathematic/Environmental issues?

☐ Yes

☐ No

9. If 'Yes' briefly state the nature of the course attended, where the course was held and when?

(i) Nature of the course attended.....

(ii) Place where the course was held.....

(iii) Year the course was held.....

10. Have you ever been invited by the curriculum developers to review or integrate environmental education in the Mathematics syllabus?

☐ Yes

☐ No

11. Are there any environmental topics found in the mathematics textbook you are using?

☐ Yes

☐ No

12. If topics are found, how many are there?.....

13. Are there any practical exercises in the Mathematics textbook you are using, which bring out environmental issues? E.g. such exercise:-

- (i) If the average amount of daily garbage collected in Lusaka city is 300 tons, and the standard deviation is 20 tons, find the probability that the amount of garbage collected on a specified day will be more than 320 tons.
- (ii) Or any topics in the exercise which help pupils learn how to calculate or count amount of food.
- (iii) Or any diagrams in the exercise which have environmental interest, such as population density, food, trees, birds and water pollution.

☐ Yes                      ☐ No

14. As a teacher how innovative are you? Do you incorporate environmental ecological principles in your teaching?

☐ Yes                      ☐ No

15. What is the Mission Statement of your school?

.....  
 .....

16. As a school, do you celebrate environmental days?

☐ Yes                      ☐ No

17. Are there environmental clubs at the school?

☐ Yes                      ☐ No

### SECTION C: Concepts on environmental issues

Please read the following question and circle the one appropriate number that best reflects your perception on each item.

How much concepts do you feel you know about the following environmental issues?	NoneA great Deal					
18. Resource recycling.....	1	2	3	4	5	6
19. Water disposal.....	1	2	3	4	5	6
20. Energy shortage.....	1	2	3	4	5	6
21. Water pollution.....	1	2	3	4	5	6
22. Traffic jam.....	1	2	3	4	5	6
23. Air pollution.....	1	2	3	4	5	6
24. Climate change.....	1	2	3	4	5	6
25. Loss of natural resources (e.g. Deforestation, loss of biodiversity And habitats).....	1	2	3	4	5	6

Thank you for sparing you precious time and for your willing co-operation to participate in this research.

## **APPENDIX 2: INTERVIEW SCHEDULE FOR HEADTEACHERS**

### **UNIVERSITY OF ZAMBIA**

#### **DIRECTORATE OF RESEARCH AND GRADUATE STUDIES**

#### **MASTER OF EDUCATION IN ENVIRONMENTAL EDUCATION**

### **AN INTERVIEW GUIDE FOR HEADTEACHERS**

I am a student at the University of Zambia currently studying for a Masters Degree in Environmental Education. I am researching on the role of environmental education in the Zambian Mathematics curriculum. Whatever information that I shall collect will be treated with the highest level of confidentiality.

#### **1. PROFILE OF THE SCHOOL**

- History
- Enrolment
- Pass rates
- Funding
- Major challenges
- 

#### **2. PROFILE OF THE INTERVIEWEE**

- Educational background
- Training in environmental education
- Experience in teaching environmental education

#### **3. ENVIRONMENTAL LEARNING AT THE SCHOOL**

- Vision and Mission Statements
- School's environmental policy
- Purchase and of environment education resources
- Use of school time a space for environmental activities
  - school garden
  - participation in the Eco-school programme
  - celebration of environmental days
  - environmental clubs at the school

### APPENDIX 3

#### CLASSROOM OBSERVATION SCHEDULE

NAME OF SCHOOL..... GRADE..... DATE.....

NUMBER OF LEARNERS: ..... TIME: .....

CRITERIA	OBSERVATION
1. Lesson topics	
2. Lesson objective	
3. Questions asked by the teacher	
4. Environmental concepts mentioned by teacher	
5. Types of resources used during lesson	
6. Drawings written on board	
7. Notes written on board	
8. Assessment questions set.	