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JAPAN
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STRENGTHENING OF MATHEMATICS AND SCIENCE EDUCATION IN ZAMBIAN SECONDARY SCHOOLS

BASELINE STUDY REPORT

Prepared for
Ministry of Education, Zambia
And
Japan International Co-operation Agency

by

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LIST OF ABBREVIATIONS

AIEMS	-	Action to Improve English, Mathematics and Science
BEDMAS	-	Bachelor of Education Degree in Mathematics and Science
BPAZ	-	Book Publishers Association of Zambia
CDC	-	Curriculum Development Centre
CEs	-	Colleges of Education
COSETCO	-	Copperbelt Secondary Teachers' College
CPD	-	Continuing Professional Development
DANIDA	-	Danish International Development Agency
DEO	-	District Education Officer
DFID	-	Department for International Development
DIP	-	District In-Service Provider
DT	-	Diploma in Teaching
ECZ	-	Examinations Council of Zambia
EEC	-	European Economic Commission
FAWEZA	-	Forum for African Women Educationists in Zambia
GRZ	-	Government of the Republic of Zambia
HOD	-	Head of Department
HQ	-	Headquarters
INSET	-	In-Service Education and Training
ISTT	-	In-Service Training Trust
ITE	-	Initial Teacher Education
JETS	-	Junior Engineers, Technicians and Scientists
JICA	-	Japan International Cooperation Agency
MOE	-	Ministry of Education
MSE	-	Department of Mathematics and Science Education
MSTVT-		Ministry of Science, Technology and Vocational Training
NGO	-	Non-Governmental Organisation
NIP	-	National In-Service Provider
NISTCOL	-	National In-Service Teachers' College
NRDC	-	Natural Resources Development College
NSC	-	National Science Centre
ODA	-	Overseas Development Administration (UK)
PEO	-	Provincial Education Officer
PIP	-	Provincial In-Service Provider
PTA	-	Parents' - Teachers' Association
PTCs	-	Primary Teachers' Colleges
SESTUZ	-	Secondary School Teachers' Union of Zambia
SIP	-	School In-Service Provider
SMASE	-	Strengthening of Mathematics and Science Education
SPRINT	-	School Programme of In-Service for the Term
STCs	-	Secondary Teachers' Colleges
SWOT	-	Strengths, Weaknesses, Opportunities and Threats
TED	-	Teacher Education Department
TG	-	Teachers' Group
TRC	-	Teachers' Resource Centre
TTCs	-	Teachers' Training Colleges
UNDP	-	United Nations Development Programme
UNESCO	-	United Nations Educational, Scientific and Cultural Organisation

UNZA	-	University of Zambia
VSO	-	Volunteer Services Organisation
VVOB	-	Flemish Office for International Cooperation and Technical Assistance
ZAME	-	Zambia Association for Mathematics Education
ZAMSTEP	-	Zambia Mathematics and Science Teachers Education Programme
ZASE	-	Zambia Association for Science Education
ZATEC	-	Zambia Teacher Education Course
ZEPH	-	Zambia Educational Publishing House
ZIP	-	Zone In-Service Provider
ZPC	-	Zambia Primary Certificate
ZIATEA	-	Zambia Industrial Arts Teacher Education Association

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Chapter Six: Environmental Science

EXECUTIVE SUMMARY

Background

Low learning achievement in mathematics and science subjects among secondary school pupils as revealed by public examination results has been a source of concern among stakeholders. At the same time many educators were not satisfied that existing (Government/Donor led) teacher Continuing Professional Development (CPD) initiatives in Mathematics and Science Education (MSE) had the desired effect, that is, not only increasing teacher effectiveness but also inculcating in teachers a realisation that participation in CPD was a personal responsibility, undertaken solely for purposes of improving one's professional skills.

In view of this, in 2001 concerned stakeholders, mainly Mathematics and Science Education practitioners from schools, colleges/universities, Teacher Education Department (TED), Zambia Association for Mathematics Education (ZAME), Junior Engineers, Technicians and Scientists (JETS) and the Zambia Association for Science Education (ZASE), formed a task force to explore ways of promoting teachers' CPD in MSE, particularly at secondary school level. The task force team came up with the idea of a programme to be called "Strengthening of Mathematics and Science in Education" (SMASE), a teacher driven (bottom-up) CPD initiative intended to be implemented through activities of subject Associations (i.e. those of ZAME and ZASE).

The Department of Mathematics and Science Education (MSE) in the School of Education, University of Zambia was tasked to carry out a Baseline study to generate information on the basis of which the programme could be designed. MSE sub contracted the In-Service Training Trust to conduct the Stakeholder analysis component of the study.

Objectives of the study

The baseline study sought to:

- determine and evaluate the effectiveness of past and present teacher development activities in Zambia related to Mathematics and Science Education.
- establish the demographic characteristics of teachers of Mathematics, Biology, Chemistry, Environmental Science and Physics.
- determine topics which teachers find difficult to teach in Junior mathematics, senior mathematics, biology, chemistry, environmental science and physics.
- establish teaching trends in mathematics and various science subjects.
- determine teachers' views on aspects of mathematics and science teaching and on continuing professional development.
- find out topics which pupils find difficult to learn in mathematics and sciences (biology, chemistry, environmental science, and physics) and their opinions on teachers' teaching styles.
- identify potential stakeholders and their potential roles and responsibilities in SMASE.
- make recommendations on the teacher - led CPD through ZAME/ZASE activities.

Methodology

The study was divided into 3 components namely: situation analysis on teacher development in Zambia; survey on teaching and learning of mathematics and science at secondary school and stakeholder analysis.

For the situation analysis of teacher development, a desk/library research approach was used. This involved analysis of various documents such as research reports, policy documents, project reports etc. The survey on teaching and learning of mathematics and science in secondary schools covered all the nine provinces of Zambia. The number of secondary schools which participated was 65. They were of various types (government, grant-aided, established, emerging, rural, urban, technical and private). Data were obtained from a total of 599 teachers, 92 Heads of Department (both mathematics and science) and 1,862 pupils. The required information was obtained by means of questionnaires, interview and lesson observation schedules as well as reviewing documents. For the stakeholder analysis, a workshop approach was used to gather data from 30 participants drawn from various identified stakeholder institutions (see appendix 7).

Main Findings

Situation Analysis of Teacher Education

The situation analysis of teacher education showed that since the 1980s there had been several government/donor led Continuing Professional Development initiatives in Mathematics and Science Education (MSE). Although these initiatives had resulted in some improvement in teacher effectiveness in MSE, being Government-led they had failed to inculcate in teachers a realisation that participation in CPD was a personal responsibility undertaken solely for improvement of one's professional skills, which is one important ingredient for sustainability of CPD progrmammes.

Demographic characteristics of teachers

With regard to demographic characteristics of teachers of mathematics and science the study found that most of the teachers were young males and had diploma qualifications with little teaching experience. The majority of them were not members of ZAME/ZASE and those who claimed to be members in most cases had not paid membership fees for a number of years.

Topics which teachers found difficult to teach

Biology: In biology, topics teachers/HoDs found difficult to teach included: genetics, diversity of organisms, co-ordination and response as well as parasitism. In biology practicals, some of the areas mentioned were food test, preparation of solutions and making biological drawings including magnification.

Chemistry: In chemistry, some of the topics teachers/HoDs indicated as being difficult were organic chemistry, electricity and chemistry; stoichiometry and the mole concept as well as energy changes. In practical work, some of the topics mentioned were: titration, identification of ions and preparation of standard solutions.
Environmental Science: In Environmental science, some of the topics teachers/HoDs thought were difficult to teach were: the universe; mammals; electricity; energy and its sources; transpiration; intervention of human beings on nature; reflection; refraction as well as communication (Radio/TV).

Junior Mathematics: In Junior mathematics, some of the topics teachers/HoDs indicated as being difficult to teach were: social and commercial arithmetic; shapes and symmetry; construction; equations and inequations; measurements; numbers and numeration.

Senior Mathematics: In senior mathematics, some of the topics teachers/HoDs indicated as being difficult to teach were: transformation; probability; locus and constructions as well as trigonometrical problems in three dimensions.

Physics: In physics, some of the topics teachers/HoDs thought were difficult to teach were: electronics (Cathode Ray Oscilloscope); logic gates; action and use of circuit component; static electricity as well as radioactivity.

Prevailing Teaching Trends

With regard to prevailing teaching trends, the study found that most teachers of mathematics and science used lecture method, question and answer, as well as demonstration. Teachers were more active than pupils who took the passive roles of listening and observing.

Teachers' perceptions on some aspects of teaching

On teachers' perceptions/views on some aspects of teaching mathematics and science, the study found that teachers' views were in line with contemporary thinking in mathematics and science education but they did not practice what they believed. For example, they believed that every lesson must have a lesson plan and that when teaching, emphasis should be on processes rather than on products but they never did that themselves.

Teachers' views on aspects of continuing professional development

With regard to organisation and implementation of continuing professional development, the study found that most teachers were of the view that CPD was necessary and that they would attend CPD activities even without being paid allowances but at the end of each CPD activity, participants should be given a certificate. Teachers were not prepared to meet the cost of continuing professional development (CPD) from their pockets. They proposed that the school should pay for them.

Teachers were of the view that fellow teachers should facilitate CPD and that it should take place within the school or resource centres during school holidays. They

proposed that topics for CPD should include skills in coping with heavy teaching loads; teaching pupils with poor science background; catering for individual differences among learners and conducting research.

Topics pupils find difficult to learn

On topics pupils found difficult to learn, the study found that **biology** topics included the following: genetics, effects of man on the ecosystem, parasitism and diversity of organisms. In **chemistry**, topics pupils found difficulty included: stoichiometry and the mole concept, organic chemistry, electricity and chemistry. In **environmental science** topics pupils perceived difficult to learn included the following: electricity, density, reflection, refraction, separation techniques and the universe.

In **junior mathematics**, pupils found the following topics difficult to learn statistics, social and commercial arithmetic, constructions, inequations and inequalities while in **senior mathematics**, they included graphical representation of inequalities, graphs of functions, transformations, trigonometric problems in three dimensions. In **physics**, some topics pupils found difficult to learn were: logic gates, action and use of circuit components, nuclear atom, electromagnetic induction, electronics (cathode ray oscilloscope).

The study demonstrated that topics pupils had difficulty learning were similar to topics teachers had difficulties in teaching. This seems to suggest that pupils' difficulties in certain topics could have been caused by teachers' difficulties in teaching the topics.

Stakeholders Analysis

The study identified a number of potential stakeholders, weaknesses and strength of SMASE and potential roles and responsibilities of various stakeholders.

With regard to potential stakeholders, the study came up with three categories as follows: those with a lot of interest in or influence on SMASE were identified as : MOE, school managers, cooperating partners, subject associations (i.e. teachers), MSTVT. Those with moderate interest in or influence on SMASE were identified as: Donors, Higher Learning Institutions, Line Ministries. Those with least interest in or influence on SMASE were identified as: NGOs, politicians, publishers, PTA/Management boards, Industry, Private sector.

With regard to strengths and weaknesses of SMASE, the study found that some of the strengths of SMASE were: ZAME/ZASE structures exist, potential participants (teachers) available, MOE support available, research data for designing SMASE available, infrastructure (e.g. TRCs) in place, availability of start off funding, availability of support from high institutions of learning. The potential weaknesses of SMASE identified included: low ZAME/ZASE membership, inadequate income, weak communication links within ZAME/ZASE, and inadequate support from school managers.

In case of potential roles and responsibilities for various stakeholders, the study identified the following:

- **institutions of higher learning**: Research and training in research skills, production of learning/teaching materials, training of trainers.
- **cooperating partners and NGOs** : funding and technical support.
- **school managers**: offering support to SMASE and monitoring of progress.
- **subject Associations**: identification of training needs; mobilisation of resources; designing programmes; monitoring and evaluation.
- **standards officers:** monitoring quality of teaching; provide incentives for mainstreaming SMASE; soliciting for support from private sector.

Overall analysis

An analysis of the findings from the situation analysis, the baseline study and the stakeholder analysis, coupled with considerations of literature on continuing professional development of teachers makes the following points stand out:

- The CPD programme should be teacher-driven and firmly rooted in the subject associations, ZAME and ZASE, but acknowledging that the two associations will require a lot of professional, technical, financial, logistical and moral support to enable them mount this mammoth initiative which neither association has ever undertaken before.

- The CPD programme must be school based with departments as nerve centres and closely supported by the country-wide network of Teachers Resource Centres.

- At school level, SMASE should be located in the Headteachers' office with Heads of Department of mathematics and science being focal point persons.

- A comprehensive internal (within the subject associations and MOE) and a external (UNZA and/or consultants) monitoring system be worked out for the main purposes of offering professional support and identifying, documenting and disseminating good practice models.

- ZAME and ZASE jointly work out a system of awarding credits for participation in CPD and seek MOE's approval that certificates of credit shall be additional consideration for career advancement.

Way forward

In view of the foregoing, it is proposed that SMASE be closely modelled along the lines of SPRINT.

Recommendations

1. SMASE will need to re-orient teachers to (a) a wider perspective on CPD which has, so far, been seen as workshops or long duration courses in higher institutions of learning; and (b) see CPD as being not just being good for the education system, but for personal professional growth and satisfaction too for which allowances need not be a pre-condition for participation.

2. SMASE's CPD programme will need to (a) address the problems of both male and female teachers having lower expectations with regards girls' capabilities in the learning of mathematics and science and, (b) to build the capacities of female teachers in particular to be inspirational to all pupils especially girls.

3. SMASE should liase with Colleges of Education and the Universities for staff and students alike to shift from the concept of pre-service training to Initial Teacher Education and wit this shift in paradigm, a corresponding change in their teacher education curricula.

4. SMASE's CPD programme should include an agenda for deepening content knowledge within the practical teaching contexts in which the teachers will operate.

5. ZAME and ZASE to familiarise themselves with the recently released Ministry of Education Strategic Plan and lobby the rightful units in MOE for action to improve the teaching/learning environment in schools.

6. ZAME and ZASE articulate their respective visions more clearly and should work at raising their levels of visibility and relevance in all the corners of the country.

7. SMASE's programme should buttress the strengthening of teachers' content knowledge with a shift in the pedagogical stance towards integration in two aspects. First, the integration of content and teaching methodology; second, the integration of theory and practice.

8. SMASE, in conjunction with MOE's forthcoming Directorates of Teacher Education and Specialised Services and Standards and Curriculum Development Department, should work towards sensitising each teacher of mathematics and science on their inadequacies and to the need for active participation in CPD activities so as to improve on areas they were weak.

9. SMASE's CPD programme should include raising awareness of the aims for which mathematics and science are taught and to the strategies for realising the aims (for example, the fact that the teacher has 'covered' the syllabus or that the pupils have passed is not synonymous to fulfilling the aims for which mathematics and science are taught).

10. SMASE should include on its agenda, the popularisation of the TALULAR concept which FEMSA has already introduced as a small scale school-based intervention in a few primary schools in Zambia.

11. SMASE should work towards orienting teachers to pupils' quality of learning as a primary consideration in classroom as well as whole-school practices.

12. SMASE should (a) promote teacher-research as an integral part of good classroom practice and professional growth; (b) promote research partnerships between cross sections of practitioners in secondary school mathematics and

science education; and (c) create opportunities for dissemination and sharing of research information.

13. SMASE should advocate for an integration of theory and practice in initial teacher education programmes and design its own CPD initiative a similar manner to help teachers reconcile what they believe to be good classroom practice and their actual practice.

14. SMASE should work towards popularising peer support/mentoring as a core activity in professional development.

15. SMASE should source funds to enable teams of key players in SMASE (according to availability of resources) to undertake study visits to Mpumalanga Secondary Science Initiative Project in South Africa as part of a capacity building exercise.

16. SMASE should work out modalities for award of *Credits* for teachers' participation in CPD and any verifiable improvements in classroom practice, as is the case in the SPRINT system. Such credits should build up to certificates of competence of varying degrees.

17. SMASE should seek recognition of certificates of credit for CPD from key stakeholders especially MOE so that the certificates could be a criterion for promotion, bursaries and scholarships.

18. SMASE should sign memoranda of agreement with key stakeholders detailing the partners' roles and obligations paying due respect to the interests, needs and capabilities of the partners in relation to continuing professional development.

19. SMASE should capitalize on the strengths of ZAME and ZASE to consolidate these strengths and utilise them for promotion of its programmes without being overly dependent on other stakeholders for success but still playing a lobbying and advocacy role to invigorate all stakeholders to play their roles to the fullest of their capabilities to improve the learning of mathematics and science.

20. SMASE should develop a strategic plan to enable it develop in a focussed manner.

21. SMASE should work creating synergies with CPD initiatives running in the primary school sector.

22. SMASE should be a school based CPD initiative.

23. SMASE should be designed to on a continuous basis, integrating routine responsibilities of teaching with CPD save for specialized programmes that might need to be done at Teachers Resource Centres .

24. SMASE should a comprehensive monitoring system that is comprehensive yet feasible and playing more of a means for professional support than fault finding.

25. SMASE should incorporate in its design a comprehensive capacity building programme for Headteachers and Heads of Mathematics and Science Departments.

CHAPTER ONE

INTRODUCTION TO THE BASELINE STUDY

1.1 Background

Effective mathematics and science education programmes in schools, colleges, and universities play a key role in the technological development of a nation. This is because in today's world technology and innovation are the basis for sustainable economic and social development (Harding and Apea, 1990). Therefore, to establish a firm technological base it is important to ensure that there is well-grounded teaching and learning of mathematics and science at school level.

In view of this, the Zambian Government with the help of co-operating partners implemented a number of initiatives particularly since the 1980s aimed at improving the effectiveness of mathematics and science teachers. In 1988, for example, the Ministry of Education (MOE) in conjunction with the European Economic Commission (EEC) started the Zambia Mathematics and Science Teacher Education project (ZAMSTEP) to upgrade the content knowledge and pedagogical skills of non-graduate mathematics and science teachers, to enable them teach effectively mathematics and science at senior secondary school level.

Another important project with regard to improvement of teachers' professional skills in mathematics and science was the appropriately named Action to Improve English, Mathematics and Science (AIEMS) project, which was commissioned in 1994 and concluded in 2000. The main objective of AIEMS was to improve the quality of education in Zambia by creating and providing through a nation-wide network of Teachers' Resource Centres (TRCs), a decentralised, sustainable system of in-service education for teachers, initially in English, mathematics, and science, but later in all school subjects (British Council, 1997). AIEMS also encouraged school-based in-service education for teachers which, it was hoped, would have the added benefit of helping teachers realise that they were responsible for their own Continuing Professional Development (CPD), while the system was responsible for creating a support structure.

Initiatives such as ZAMSTEP and AIEMS resulted in some improvement in the teaching of mathematics and science in Zambian schools, but they had some limitations. They started as projects, which by their nature lose momentum once the funded phase is over. They were also Government-driven (top-bottom) rather than teacher-driven (bottom-up), suggesting perhaps that the professional development activities implemented were identified by Government agencies, rather than by the teachers themselves. And in the case of AIEMS in particular, it was observed that a number of teachers did not visit TRCs mainly because some TRCs were located too far from certain schools (Haambokoma, 1998). This meant that such teachers did not utilise all the resources available to them through the AIEMS Project, which regarded teachers' visits to TRCs as an integral part of its programme of in-service delivery.

In view of the above, a different way of addressing the issue of teacher effectiveness in mathematics and science, one that was teacher-driven and which could become part and parcel of teachers' daily professional lives, was needed. Furthermore, educators had noted with concern the continued poor performance on the part of secondary school children in mathematics and science. It was because of these considerations that in 2001 concerned parties in mathematics and science education in Zambia formed a taskforce to explore ways of promoting more cost effective and sustainable CPD for secondary school teachers of mathematics and science. This process gave birth to the idea of a programme entitled *Strengthening of Mathematics and Science in Education* (SMASE), whose main objective is to promote sustainable CPD for mathematics and science teachers through activities of subject associations, namely, the Zambia Association for Mathematics Education (ZAME) and Zambia Association for Science Education (ZASE).

Before SMASE could be implemented it was found necessary to conduct a baseline study to generate information to guide the design of the programme. Japan International Co-operation Agency (JICA) and MOE contracted the Department of Mathematics and Science Education (MSE) of the School of Education, University of Zambia (UNZA), to carry out the study, which had three components, namely:

1. a situation analysis of teacher development in Zambia;
2. a survey of teaching and learning of mathematics and science in secondary schools in Zambia and;
3. an analysis of potential stakeholders' role in further professional development of teachers of mathematics and science in secondary schools.

MSE Department sub-contracted In-service Training Trust (ISTT) to carry out the component on stakeholder analysis.

1.2 Objectives of the Study

The objectives of the study were:

a) to evaluate the effectiveness of past and present teacher development activities relating to Mathematics and Science Education in Zambia.

b) to determine with respect to teachers of mathematics, biology, chemistry, environmental science, and physics in secondary schools:
   - demographic characteristics.
   - topics they find difficult to teach.
   - prevailing teaching trends.
   - training needs and views on Continuing Professional Development.
   - views with regard to selected aspects of the teaching and learning of mathematics and science.

c) to identify topics in mathematics and science which pupils find difficult to learn.

d) to identify stakeholders in mathematics and science education at secondary school level and to determine their potential roles and responsibilities in SMASE.

e) to make a presentation and give recommendations arising out of the findings and analysis from the above studies to the taskforce and other stakeholders on:

- teachers' weaknesses which the SMASE programme should focus on, as suggested by the identified difficult topics in mathematics and science, and prevailing teaching trends and teacher perceptions with regard to selected aspects of mathematics and science teaching.

- roles that could be effectively played by potential stakeholders such as MOE, Teacher Training Institutions, School Managers, etc. in teachers' CPD programmes through subject Associations.

1.3 Terms of Reference

In summary form the team from UNZA and ISTT were tasked to carry out:

a) a situation analysis of teacher development activities;
b) a survey of teaching/learning of mathematics and science in high/secondary schools;
c) stakeholders analysis; and
d) present the findings in a report, which should include conclusions and recommendations.

(Detailed terms of reference appear in Appendix 1).

1.4 Organization of the Report

The report has an executive summary, followed by nine chapters arranged as follows:

Chapter 1 is the introduction to the study. In view of this, the chapter explains the rationale of the study and also gives information on how the study was organised.

Chapter 2 is a situation analysis of teacher development in Zambia. It briefly discusses historical and current characteristics of the Zambian teacher development system and explains the nature of past and present teacher development activities in Zambia of relevance to mathematics and science education at secondary school level, and issues arising from these.

Chapter 3 gives the methodology used in the survey. It identifies the target population and provides information with regard to procedures for sample selection and data collection, and lessons learnt from a pilot study conducted before the main study began.

Chapters 4 – 8 focus on findings of the survey with respect to each of the five school subjects examined, namely: Biology, Chemistry, Physics, Environmental Science and

Mathematics. Each chapter provides information on one of the five school subjects mentioned, relating to demographic characteristics of teachers; topics teachers find difficult to teach; teaching trends and perspectives towards teaching; teachers' views on continuing professional development; topics pupils find difficult to learn; and pupils' opinion on prevailing teaching styles in mathematics and science. There is also a discussion and analysis of the findings, followed by a summary of the findings.

Chapter 9 focuses on the component of the study relating to stakeholders' analysis. The chapter explains the methodology used and gives information on potential stakeholders, similarities between them, and their different potential roles. There is also an analysis of SMASE's possible strengths, weaknesses, opportunities, and threats (SWOT).

Chapter 10 contains overall analysis arising from the Situation Analysis of teacher development in Zambia, the Baseline Survey of teaching/learning of mathematics and science in secondary schools, and the Analysis of Potential Stakeholders in the development of secondary school teachers of mathematics and science and proposes a way forward for SMASE.

1.5 Nomenclature

The Ministry of Education document, *Education in Zambia 2002: Situational Analysis (Draft)* says on the nomenclature for the education system that

> *In accordance with the present policy, the educational system is in the course of adopting the following structure: Basic Schools offering grades 1 - 9, High Schools from grades 10 - 12 and Tertiary Education for learners who have completed grade 12, which includes Teacher Training and Universities. The Basic Education sector is oriented towards the final goal of Universal Basic Education (UBE) and has three levels: Lower Basic for grades 1 - 4, Middle Basic for grades 5 - 7 and Upper Basic for grades 8 - 9. Although the transition from the previous system of primary schools (grades 1 - 7) and secondary (grades 8 012) has begun, it is not yet completed. At present both systems continue to run in parallel.* (MOE, 2002: p.8)

In view of this and in consideration of the fact that the SMASE study focused on Grades 8 to 12, the simpler term 'Secondary School' will be used in this report instead of 'Upper Basic and High School'.

CHAPTER TWO

SITUATION ANALYSIS OF TEACHER DEVELOPMENT

2.1 INTRODUCTION

This chapter is an analysis of teacher development activities and strategies in Zambia, with special reference to mathematics and science education in secondary schools. It begins with a discussion of how the idea of teacher education was first introduced in Zambia, followed by a consideration of the current management and organisation structure of education, ending with a brief review of past and current initiatives in teacher education relevant to mathematics and science education.

2.2 METHODOLOGY

The information presented in this chapter was collected mainly through analysis of relevant existing documents, such as government reports, project reports, studies and books. Documentary analysis involved mainly abstracting from each document those elements considered to be important or relevant, comparing them and grouping together related elements, in order to arrive at an understanding of the ideas, issues, policies, etc., dealt with in the documents (Blaxter, Hughes and Tight, 1996).

2.3 THE TEACHER DEVELOPMENT SYSTEM IN ZAMBIA

2.3.1 Brief History

The idea of formal teacher education was first introduced in Northern Rhodesia (as Zambia was then called until 1964) during the 1880s by American and European missionaries, to help them win more converts to Christianity (Snelson, 1970). When the missionaries first arrived in Northern Rhodesia they used as teachers, Africans from other territories in southern Africa, mainly Basutoland (Lesotho) and Nyasaland (Malawi), but soon concluded that their evangelistic efforts would be more successful if they trained local people conversant with the languages of the territory to be teachers.

The Paris Evangelical Mission Society (PEMS) established the first "teacher-training institution" in Northern Rhodesia. The society started an English Class at Mabumbu (near Mongu) in 1898, which grew into a teacher training institution (Snelson, 1970). Missionary societies elsewhere in the territory made similar efforts, one of the most successful of which was the Primitive Methodists' teacher training institution at Kafue, which was established in 1918. However, lack of co-operation among the different competing missionary societies, each of which was intent on winning the greatest number of converts, meant that there was no uniformity with regard to teacher training syllabuses or patterns of examinations (Mwanakatwe, 1968; Snelson, 1970).

Movement towards systematic teacher training in Northern Rhodesia may be said to have began in the early 1920s, when the Phelps-Stokes Commission on Education in East and Central Africa recommended that in order for education not to remain wasteful and

inefficient standardised teacher training should be established at selected mission stations. In this connection, the Commission also recommended that a new Department of Native Education be created and a director appointed to head it (Snelson, 1970). The Northern Rhodesian Government accepted the recommendations, and appointed Geoffrey Chitty Latham as director of the sub-department of Native Education, under the Department of Native Affairs (Mwanakatwe, 1968; Snelson, 1970; Manchishi, 2001). In order to encourage missionary societies to take seriously the training of their teachers, Latham introduced grants paid to the societies towards the salaries of tutors in teacher training institutions. The result was that, by 1928, the first departmental teacher training examinations were held in Northern Rhodesia. Successful candidates received certificates from the Government, which also provided small grants towards their salaries (Mwanakatwe, 1968; Snelson, 1970). As Snelson points out,

> *the questions [for the teacher training examinations] were based on the standard IV syllabus, together with papers on the theory of teaching and school management. Additional tests in first aid, bandaging and treatment of sores were given by local doctors or nurses....All the certificates given were provisional and subject to confirmation on inspection of the teacher at work by the Director of Native education or someone deputed to him (Snelson, 1970, p. 152).*

In 1929 this early primary teacher education curriculum was revised, based on a model provided by the Uganda Vernacular Teacher Training Syllabus. In this regard,

> *the working week was [now] to consist of 40 periods, each of 45 minutes. Five periods each were to be devoted to religion, educational method, and English; four each to vernacular and arithmetic; two to geography and history; one each to singing, drawing, general knowledge, hygiene and the theory of agriculture; two to carpentry and other handwork, and no fewer than eight to practical agriculture. Twenty minutes' drill was to be given to the students at least four times a week. Students must have at least sixteen weeks of practice teaching during their second and third years (Snelson, 1970, p. 154).*

This new teacher education curriculum persisted until the early 1950s, when it was also revised following the publication of another Government report (i.e. the Binn's Report), which recommended among other things that teacher training should be centralised (Mwanakatwe, 1968; Manchishi, 2001). Meanwhile, the number of teacher training institutions in the territory continued to rise (reaching 8 by 1931) and entry qualifications to teacher training gradually moved up to standard VI. By 1961, an efficient programme of teacher training for the primary sector was in place, with candidates now needing a Form II (i.e. Grade 9) certificate to enter (Mwanakatwe, 1968).

So far, nothing has been said about secondary teacher training for Northern Rhodesian Africans. Training of Africans to teach in secondary school was virtually non-existent before 1964 because the colonial Government was reluctant to provide such training or, indeed, any other form of post-secondary education to local Africans, partly because of European settlers' fear that it would create a cadre of educated Africans, who would

compete with them for white collar jobs (Mwanakatwe, 1968). Mainly because of this, when the new African Government took over in 1964 "the number of local Africans qualified to teach in secondary schools was pathetically small" (Mwanakatwe, 1968, p. 43).

After 1964, in response to a rapid rise in pupil enrolment figures both at primary and secondary levels there was an expansion of teacher training facilities and a reorganisation of the teacher training system. In the primary sector, the rise in pupil numbers was so large that the existing two-year residential teacher training programme was modified to cope with the huge demand for new teachers (Mwanakatwe, 1968). "[To] avoid employing untrained teachers, it was decided to offer a one-year residential course to students entering teacher training colleges at the beginning of 1965, followed by one year at schools as 'student teachers' "(Mwanakatwe, 1968, p. 108). This, however, was an interim measure which came to an end after 1967, when the two-year residential course was reinstated (Mwanakatwe, 1968)

As mentioned above, secondary education for Africans also expanded during the early 1960s. For example, in his inaugural speech in 1966 as UNZA Chancellor Dr. Kaunda stated that, whereas a few years before there was only one senior secondary school in Zambia (i.e. Munali), in 1966 alone 24 new secondary schools were opened (UNZA, 1966). Secondary teacher training for Africans responded to this increase. In fact, in 1961 Chalimbana Teacher Training College had started a three-year course for secondary school teachers, which was underwritten by the University College in Salisbury (now Harare) in Southern Rhodesia. This programme, however, did not last long, as following the Unilateral Declaration of Independence (UDI) from Britain by European settlers in Southern Rhodesia in 1965, the new Government in Zambia decided to discontinue it, since it was no longer possible politically to continue ties with Southern Rhodesia (Mwanakatwe, 1968; Manchishi, 2001; Chelu et al, 1995).

In the meantime, a decision had been made in 1965 to establish a university in Zambia. UDI accelerated movement in this direction, with the result that in 1966 UNZA was opened in temporary accommodation and soon afterwards began offering a one-year Post-Graduate Certificate in Education (PGCE) and a four-year degree course for secondary school teachers. A second institution was opened at Kabwe in 1967 to provide training at diploma level for teachers of junior secondary classes (Mwanakatwe, 1968), among whom must have been some of the first indigenous Zambian secondary mathematics and science teachers. Today, there are ten state or grant-aided primary teachers' colleges nation-wide, and at least eight institutions that prepare secondary school teachers. Among the institutions that prepare secondary school teachers, only five include programmes in mathematics and science education, namely Copperbelt Secondary Teachers' College (COSETCO), George Benson Christian Teachers' College, National In-service Teachers' College (NISTCOL), Nkrumah Teachers' College, and UNZA. (A list of teachers' colleges appears in Appendix 2).

2.3.2. Current Management and Administrative Structure in Teacher Development

Zambia's educational management and administrative structures have been undergoing change in recent years, particularly since 1996 when the MOE published the education policy document, *Educating Our Future*. The changes being implemented are part of the larger Public Service Reform Programme (PSRP) which began in 1993, with the aim of "[developing] a Public Service that is lean, cost-effective, highly motivated and productive and whose authority, responsibility and accountability [are] properly decentralised to the provincial and district levels" (MOE, 2001a, p. 1).

As indicated above, even though the reform programme in education has been underway for several years now, it is not yet complete, particularly at MOE Headquarters. For this reason, the organisation and management structure of MOE will be described as it was before the year 2000. As Lungwangwa *et al* (1995) state, MOE is divided into four main levels, namely: *national headquarters*, *provincial headquarters*, *district education offices*, and the *schools*. Headquarters itself comprises several departments, committees, sections and units. Administratively, "the structure...starts with the Permanent Secretary through the Provincial and District Education Offices to Heads of Schools" (Lungwangwa *et al*, 1995, p. 28).

Towards the year 2000 MOE began establishing Education Boards at provincial, district and school/college level, an action expected to bring about significant change in MOE's power and authority structure, as it means shifting some powers and functions from Headquarters to personnel at local level. Thus, as MOE explains in the policy document *Institutional Roles, Functions and Relationships* (2001c),

> *the...decision to decentralise and establish Education Boards at school, college and district levels is meant to take certain powers in decision making at the points of delivery. This will in turn allow for more rapid reaction and action to problems and/or opportunities that occur at these points...thereby improving the learning environment and consequently the type of education provided (p. iii).*

The Teacher Education Department (TED), which was formed in 1998, is the department at MOE Headquarters responsible for development and deployment of teachers and quality control. TED is headed by a Co-ordinator, who is assisted by two Senior Inspectors of Schools, with responsibility for initial teacher education and CPD of teachers. There is also a National In-service Provider (NIP), whose special responsibilities in TED include overseeing operations of a nation-wide school based in-service programme for teachers, called School Programme of In-service for the Term (SPRINT), and the Primary Diploma by distance programme at NISTCOL, Chalimbana.

TED has also established an office within the UNZA School of Education, whose main function presently is to find ways of creating a viable career structure for primary school teachers and improving their status in society. In the provinces TED's activities are organised by in-service providers at provincial, district, zone and school level, who are responsible for in-service provision to teachers within their areas of jurisdiction.

In MOE's incoming management and organisation structure (shown in Appendix 3) a Directorate of Teacher Education and Specialised Education Services will replace TED. In justifying this new development MOE in *Report on the Restructuring of the Ministry of Education* (2001a p.27) states that:

> *teacher education and training functions have for a long time been spread across many departments and sections such as the Inspectorate, Human resources and Curriculum Development.... This has made accountability difficult and implementation of teacher education ineffective.*
>
> *In addition other specialised functions were fragmented and un-cordinated making it difficult for them to operate effectively. Within the [new] policy of decentralisation, it is also important that schools and colleges [of education] be provided with various services to enhance their education management and delivery. There is need, therefore, to ensure that there exists a body within the Ministry [of Education], which will facilitate the provision and development of policy guidelines on education management and delivery.*

The Directorate (whose functional structure is shown in Appendix 4), will have three units, namely Teacher Education, Education Board Services, and Specialised Education Services, each of which will have supervisory authority over different educational services at national, provincial, district and school level. The Teacher Education section will be headed by a Chief Education Officer, who will be assisted by two principal education officers, responsible for pre-service and in-service education of teachers. The principal education officers will have under them a number of senior education officers responsible for various supporting functions. Specifically, as stated in *Report on the Restructuring of the Ministry of Education*, the Directorate of Teacher education and Specialised Education Services will be responsible for:

- *determination and harmonisation of teacher training programmes.*
- *monitoring of functions of Education Boards.*
- *promotion and strengthening of communication between the Ministry and Education Boards, PTAs and other stakeholders in the delivery and provision of education services (MOE, 2001a, p. 28).*

2.3.3 Career Development

2.3.3.1 Teaching Qualifications

Currently, there are three types of qualifications for entry to the teaching profession in Zambia at school level. To qualify for primary school teaching one has to enrol in a Primary Teacher's College (PTC) for a two-year teacher education programme leading to the award of the Zambia Primary Certificate (ZPC). The ZPC is awarded by the Examinations Council of Zambia (ECZ), which also sets the qualifying examinations. Teachers for Grades 8 and 9 undergo either a two or a three-year teacher education programme leading to the award of a secondary school teachers' diploma.

UNZA awards the two-year diplomas to graduates of its affiliate colleges, which include Nkrumah Teachers' College, Copperbelt Secondary Teachers' College (COSETCO), Technical and Vocational Teachers' College (TVTC), George Benson Christian Teachers' College, Zambia Institute of Special Education (ZAMISE), and National In-service Teachers' College (NISTCOL), which until the early 1990s was involved only in providing in-service education for primary school teachers. Natural Resources Development College (NRDC) and Evelyn Hone College, offer three-year secondary teachers' diplomas in agricultural science and art/music respectively. The Evelyn Hone College diploma is awarded by the Examinations Council of Zambia (ECZ), while teachers graduating from NRDC receive a diploma awarded by the Ministry of Agriculture. NRDC and Evelyn Hone College, however, are not teachers' colleges, and only have a department or unit dealing with teacher education. Teachers for all grade levels in secondary school, including A' level classes, must have a bachelor's degree in the relevant school subject(s), awarded by UNZA or any other acceptable degree awarding institutions (MOE, 1996; 1997). Thus, different bodies in Zambia award teaching qualifications. In particular, due to it's policies of liberalisation, the MOE has recently facilitated the establishment of pre-school teacher training institutions of a private and governmental nature (the latter as exemplified at Kitwe and David Livingstone Teacher Training Colleges. However, they all do it on behalf of the Government, which is responsible for quality control in teacher education, in both state and private colleges. One can say, therefore, that the system of awarding and certifying teaching qualifications in Zambia is centralised.

As mentioned above, secondary school teachers holding diplomas qualify to teach only in the first two grades of secondary education (i.e. Grade 8 and 9). In practice, however, because of a critical shortage of graduate teachers, particularly in mathematics and science, such teachers routinely teach at all levels of secondary education (Oreilly and Murphy, 1985; Kelly, 1991). Indeed, in many secondary schools visited by the present investigators, some of which offered advanced level programmes in mathematics and science, there was not a single Zambian teacher who had degree level teaching qualifications in mathematics. In this connection Kelly (1991 p. 137) makes the observation that:

> *deployment of two-year diploma teachers to teach [mathematics and science] at the senior secondary level does not contribute to high-quality teaching. The diplomates are trained to teach at a lower level....Their position is rendered all the more difficult by the shortage of books and science equipment and the run-down state of many school laboratories. They are not prepared, by training or experience, for the many improvisations and makeshift arrangements that this situation calls for.*

Kelly (1991) however, believes that it would be incorrect to attribute poor student performance in mathematics and science public examinations to the fact that diplomates teach senior secondary classes, since performance had been equally poor even in schools dominated by university graduates. Nevertheless, he concludes that there was little likelihood that the necessary improvements in mathematics and science education at

senior secondary level in Zambia would materialise when so many of the teachers were not qualified to teach at this level.

2.3.3.2 Teachers' Salaries

The starting salary of a teacher in Zambia is determined by the duration of the teacher education programme undertaken, and the perceived worth of the particular qualification obtained. Thus, graduate secondary teachers (whose training usually lasts four years) receive higher salaries than non-graduate teachers with two-year diplomas; and although the ZPC is also a two-year programme, primary teachers are paid less than secondary teachers because the certificate is deemed of less professional value than the diploma. However, the salary gap particularly between primary teachers and secondary teachers with diplomas was reduced significantly in 2001 when primary teachers won an 80 per cent raise in salary while secondary teachers only received 40 per cent raise.

Teachers in Zambia are also entitled to a number of allowances, such as leave pay, departmental headship allowance in secondary school, hardship allowance for teachers in rural areas, and "double session" allowances in primary school (Kelly, 1991). However, a recent study conducted in Lusaka which investigated primary teachers' income and expenditure in the face of a rising cost of living, found that despite the existence on paper of such job entitlements, the monthly salary was really the only entitlement many teachers received from their employer (Nakamba, 2000). "Even the payment of the monthly salary itself [was]...beset with difficulties because almost all teachers in government schools reported receiving their salaries one or two weeks later than the instituted pay day" (Nakamba, 2000, p. 17).

Numerically, teachers' salaries in Zambia have risen rapidly since the 1970s. In reality, however, because of inflation Zambian teachers earn less today than they did before (Kelly, 1991). Thus, in 1996 the MOE reported that "over the past twenty years [teachers] have experienced a progressive decline in their real incomes. Salary levels are now so low that very many teachers must be classed among the poor who are unable to afford all of the essentials of life" (MOE, 1996, p. 118).

Finally, as is generally the case everywhere, teachers in Zambia earn less than professionals with similar qualifications employed outside the education sector (Kelly, 1991; Kubberud, Helland and Smith, 1999). In this connection, data collected by Kelly (1991) suggests that in 1974 professionals with equivalent qualifications working outside the education sector were paid nearly twice as much as their colleagues in education. There is no reason to think that this pattern has changed in recent years. Thus, as MOE observes, it is indeed "remarkable and highly encouraging...that schools continue to function and children continue to learn, even though their teachers are not being well-paid" (MOE, 1996, p. 119).

2.3.3.3 Physical Working Conditions

According to Kubberud, Helland and Smith (1999) one consequence of the lack of financial resources in many developing countries is that such countries "cannot produce an ideal working environment for teachers (and pupils) and thereby bring about an

improvement in quality" (p. 10). This is very true of Zambia. In recent years, the morale of teachers in Zambia has been challenged by among other things low salaries, poor housing, inadequate professional and administrative support, inadequate provision of ongoing professional and personal development, and a reduced status in the community (Kelly, 1998, cited in Tambulukani, 2001).

The issue of staff housing perhaps requires special mention here, as inadequate or unsuitable accommodation can affect teachers' lesson preparation, thereby reducing their effectiveness. The unsatisfactory staff-housing situation in Zambia, particularly with respect to primary school teachers in rural areas, has been well articulated by MOE:

> *[Most] urban primary school teachers make their own off-campus accommodation arrangements, whereas a high proportion of rural teachers are provided with housing on the school site. Much of this rural accommodation is not of a very high standard. Some [of it] is in the form of temporary structures that have long outlasted their ability to provide a decent home for a teacher. Because of the lack of resources for maintenance, several teachers' houses have deteriorated in tandem with the deterioration of the rest of the school plant, and are now in need of extensive rehabilitation (MOE, 1996, p. 119).*

As is well known in Zambia, this situation has often resulted in a number of teachers seeking better-paid jobs in other countries in the sub-region or outside the education sector within Zambia. Many of those who continue to teach in Zambia have taken on additional work to boost their income, something that has often resulted in reduced teacher energy and enthusiasm and increased absenteeism from work.

The MOE is taking steps to improve the situation. "[MOE] in consultation with the parties concerned, will strive for real improvement in the salaries and other conditions of service of teachers. Realistically, however, all negotiations on this matter must be set within the framework of nationally agreed procedures and guidelines and in the context of the state of the economy" (MOE, 1996, p. 119). With regard to staff housing MOE has stated that it will encourage and support local community involvement in rehabilitating existing or constructing new houses, and may also seek donor support.

2.3.3.4 Promotion

As Kubberud, Helland and Smith (1999) point out, in most African countries (including Zambia) promotion of teachers is based on "merit, seniority and increased educational qualifications" (p. 10). Thus, for example, the MOE document *Standards and Evaluation Guidelines* (1997) states that to be a senior teacher in primary school candidates need to have a ZPC with 5 years' post qualifying teaching experience. Moving on to the next position of deputy head requires having either a ZPC or a diploma and three years' experience as senior teacher. Promotion to the position of head of a primary school requires three years' experience as deputy head and possession of a ZPC, diploma or a bachelor's degree in education.

In the secondary sector, to be promoted to the position of head of department candidates must have either a diploma or a bachelor's degree in their teaching subjects and 5 years post qualifying teaching experience. An individual who has had 3 years' experience as head of department may be eligible for promotion to the position of deputy head and, if everything else is okay, may move on to the position of head of school after 3 years' experience in this position (MOE, 1997).

However, Zambia's present educational management and organisation structure allows relatively few openings for the promotion of teachers. And since the available openings involve mainly assuming management or similar positions, teachers getting them have to leave classroom teaching, resulting in loss from teaching of excellent teachers, and also frustration on the part of those who fail to get such positions (MOE, 1996; Kubberud, Helland and Smith, 1999). Indeed, as Kubberud, Helland and Smith point out, this is really not promotion, as it means leaving classroom teaching to do a job that may not involve any teaching at all. Therefore, there is need to create within the realm of classroom teaching new positions of responsibility or salary scales that will allow individual teachers to receive increases in salary and still continue teaching.

2.3.4 Future Strategy in the Ministry of Education

Since the 1970s, MOE has recognised and stressed the central role played by teachers and appropriate teacher education programmes in determining the success of an education system (MOE, 1977; 1992; 1996). In this connection MOE has made the observation that teacher education practices which were adopted in the 1960s and 1970s and persisted until the early 1990s, had proved inadequate as far as new developments in Zambian education were concerned. In the case of primary teacher education in particular the training methods used during the period were characterised by, among others, overloaded and inappropriate content, and promotion of teacher centred methodologies, resulting in limited development of initiative and skill on the part of the teachers (MOE, 1992; 1996). Consequently, Government decided that development of teacher education from 1992 onwards would no longer be merely an exercise in quantitative expansion to keep abreast of needs of an expanding school system. It would include major changes in curriculum, training methodology and examination practices, and would involve a reassessment of qualifications of college lecturers (MOE, 1992).

As a way forward, MOE commissioned a study (Garret and Chikalanga, 1999) to consider, among other things, the quality of teacher education provision in Zambia and to advise on possible contents of a master plan for teacher development in the 21st century. Based on consultations with stakeholders and recommendations from the study the same year MOE published its *Strategic Plan for Teacher Education 2000 - 2015*. The main objectives of the Strategic Plan include raising the status of education, in general, and primary education ,in particular; fostering quality in teacher education; integrating Initial Teacher Education (ITE) and CPD; and transferring responsibility for certain aspects of teacher education from MOE Headquarters to points of delivery.

We describe briefly below three of the important actions being undertaken by MOE to achieve the above objectives, namely: institutional reform, reforming the nature and form of teacher education, and validation of teaching qualifications.

2.3.4.1. Institutional Reform

Currently in Zambia ITE programmes for primary education are based in PTCs while those for secondary education are located in Secondary Teachers' Colleges (STCs) and UNZA School of Education. MOE has concluded that this method of ITE delivery has a number of disadvantages. For example, it has justified and maintained primary school teachers' low salary and status compared to their colleagues in the secondary sector, despite the fact that like their non-graduate colleagues in the secondary sector primary school teachers' ITE programmes also last two years (MOE, 1999). In view of this, the Strategic Plan states that all institutions for ITE delivery (except UNZA and NISTCOL) will be renamed Colleges of Education (CEs). It is hoped, among other things, that this change in nomenclature will go some way in engendering parity of esteem between primary and secondary teacher education. It is also envisaged that in future all CEs will be affiliated to UNZA, which will also be the award-bearing body for all teaching qualifications. In the case of NISTCOL, whose principal function has been to provide in-service education for primary school teachers, the Strategic Plan suggests new functions, namely working together with TED to organise and manage CPD provision for teachers and providing professional development courses for senior education staff. In this connection the Strategic Plan also mentions that Teachers' Resource Centres (TRCs) will play a pivotal role in teachers' CPD and an increasing role in their ITE. This will require closer co-operation between TRCs and CEs.

2.3.4.2. Change in Nature and form of Teacher Education

The Strategic Plan mentions change in the nature and form of teacher education with reference to, for example, the content and length of courses, pedagogical methodologies, and relationships between ITE and CPD. An illustration of how MOE is going about changing the nature and form of teacher education in Zambia is perhaps provided by the introduction of the Zambia Teacher Education Course (ZATEC), which was piloted on the Copperbelt in 1997-99, and extended to all state and grant-aided PTCs in 2000.

ZATEC differs in a number of ways from previous primary teacher education programmes, which assumed that candidates qualified to become teachers once they had undergone a period of teaching practice and had passed the relevant written examinations. As MOE explains in its *Teacher's Curriculum Manual,*

> *the ZATEC course represents a radical shift from previous practice in teacher education and implies a parallel change in basic education practice. It is based on the principle of the integration of the traditional subjects, rather than on their differentiation, to produce a curriculum that is relevant to the local needs. The curriculum recognises the primacy of literacy, numeracy and a number of crosscutting themes, which have been identified as central to the future of Zambia. It stresses the active participation of students in the learning process and encourages*

the development of appropriate use of a wide range of resources. Assessment is made through flexible and innovative procedures that stress the formative rather than the summative [as was the case previously] (MOE, 2001b, p. 12).

ZATEC Students undergo one-year residential training in a PTC, followed by another year of school-based teaching practice under the supervision of both college and school personnel. Thus, ZATEC's design is in line with current thinking in teacher education, which holds that the school is the best place for one to learn about teaching, and that, therefore, student teachers should spend the greater part of their time during ITE in a school learning to teach from practising teachers.

But ZATEC also has shortcomings. For example, the Strategic Plan mentions that ZATEC lacks a sufficient phase focus, that is, its design does not cater for teacher specialisation at different grade levels. Perhaps more serious are complaints from many college lecturers that ZATEC has resulted in reduced contact time with students, with the result that student teachers now have less time to acquire content knowledge than previously. This is a serious shortcoming which may affect negatively the effectiveness of ZATEC graduates, especially that many candidates for primary teacher education in Zambia tend to be weak in certain subject areas, particularly mathematics and science. Many educators in Zambia believe that these problems would be resolved if ZATEC was extended to three years.

With regard to the relationship between ITE and CPD, MOE is promoting the view that teacher education is a continuing process "in which the boundaries between what happens before a teacher is in post and what happens thereafter are blurred" (MOE, 1999, p. 4). In view of this MOE is encouraging closer co-operation between CEs and TRCs, which are already involved in teacher development mainly through SPRINT.

2.3.4.3 Validation and Accreditation of Teaching Qualifications

According to the Strategic Plan, MOE will create a national academic validation body, accountable to TED, which will approve all teaching qualifications in Zambia. Functions of this body will include, among others, setting of standards for various qualifications, and approving both the content and mode of delivery of courses. Furthermore, to safeguard the interests of pupils, parents and the community it is intended to have a professional body for registration of all practising teachers in Zambia, so that only adequately qualified persons will be allowed to practice in any school in the country (see also MOE, 1977, 1996).

2.3.5 Interpretation of the Zambian Teacher Development System

The teacher development system in Zambia is not static. It has been undergoing change since the idea of teacher education was first introduced into the country towards the end of the 19th century. Currently, both MOE's organisation structures and teacher education programmes, particularly for the primary sector, are undergoing change. The MOE's centralised management and organisation structure being replaced assigned different aspects of teacher education to different departments and units within headquarters, resulting in overlap of functions among different offices, to such an extent that it was

impossible to draw a clear organisational chart showing, for example, who was responsible for what, or who should report to whom. It is hoped that the incoming structure will remove such difficulties.

The career structure for teachers particularly in the primary sector will also likely improve. Primary school teachers can now move from the ZPC through SPRINT to the Primary Diploma by Distance, and on to an undergraduate degree in primary education. There is still need though to review secondary teacher education programmes, which have largely remained unchanged since the 1970s. In the case of teacher education programmes for non-graduate secondary mathematics and science teachers the need for change is perhaps long overdue, given that it is mostly non-graduate teachers who teach mathematics and science in senior secondary classes, something for which their ITE did not prepare them. In this connection, it is important to mention that two STCs, COSETCO and Nkrumah Teachers' College (2002), have released a draft document proposing changes in their mathematics teacher education curriculum. The proposed changes are intended to bring the mathematics education curriculum in line with recent developments in both primary and secondary education (particularly with regard to promotion of learner-centred and problem solving teaching approaches) and in society at large. It is also hoped that the proposed changes will strengthen teachers' content knowledge in mathematics, to enable then function effectively as qualified teachers at both junior and senior secondary levels.

With regard to teachers' working conditions, much remains to be done. For example, promotion prospects are still low for both primary and secondary teachers. There is, therefore, need to create new positions and/or salary scales at school level, which will allow teachers to receive promotion without necessarily leaving classroom teaching.

2.4 TEACHER DEVELOPMENT PROGRAMME/ACTIVITIES IN ZAMBIA

2.4.1. Brief Details of Previous and Current Teacher Development Activities

As mentioned earlier, apart from providing regular ITE programmes at UNZA and in the teachers' colleges the Zambian Government, with the help of co-operating partners, has embarked on a number of initiatives aimed at improving teacher effectiveness in selected school subjects, particularly since the 1980s. All the initiatives were aimed at increasing teaching effectiveness. However some, for example ZAMSTEP, focused mainly at increasing teachers' subject content knowledge so that they could teach effectively at higher grade levels; others, such as AIEMS, concentrated more on helping teachers adopt learner-centred and problem solving teaching approaches. Below is a brief review of important initiatives mounted in Zambia, in relation to improvement of the teaching and learning of mathematics and science in secondary schools.

2.4.1.1. Zambia Mathematics and Science Teacher Education Course (ZAMSTEP)

As mentioned earlier in this Report, non-graduate secondary teachers in Zambia are qualified to teach in the first two grades of secondary education, namely grade 8 and 9. However, because of a critical shortage of graduate teachers particularly in mathematics

and science, in many schools non-graduate teachers routinely handle classes from grade 8 to 12, and even "A"level classes, where these exist. To enable non-graduate teachers to teach with confidence mathematics and science in grades 10 to 12 the Government in 1988, with financial help from the European Economic Commission (EEC), started ZAMSTEP, to offer an advanced diploma in mathematics and science. ZAMSTEP also provided short in-service courses for both primary and secondary teachers. It was projected that by 1990 about 250 non-graduate secondary mathematics and science teachers would have obtained advanced diplomas through ZAMSTEP (British Council, 1987; 1991; Hayter and Titheridge, 1990; Musonda, 1990).

In their project terminal report, the British Council state that ZAMSTEP had made a significant contribution to improvement of the quality of teaching of mathematics, science and technology, and should be maintained, particularly that Zambian personnel attached to the Project had gained enough experience to continue it. Although towards the end of the 1990s MOE was contemplating discontinuing ZAMSTEP as a result of the introduction at UNZA of an in-service degree programme in mathematics and science education, ZAMSTEP has continued running at Nkrumah and COSETCO.

2.4.1.2 Action to Improve English, Mathematics and Science (AIEMS)

The AIEMS project began in 1994 and was concluded as a project in 2000. AIEMS was an MOE initiative "designed to improve the quality of education through development of a sustainable system of in-service teacher education...sufficient for all teachers: women and men; rural and urban; primary and secondary" (British Council, 1997, p. iii). As its name indicates, AIEMS initially targeted only teachers of English, mathematics and science. It shifted its focus later to strengthening of in-service provision to all primary and secondary schools teachers, irrespective of the subject(s) they taught. To achieve its purpose AIEMS developed a modular course, which was delivered to teachers through a nation-wide network of 77 TRCs, comprising 14 provincial TRCs and 63 district TRCs. In their final review of the AIEMS Project Nkhata and Arden (2000) report that among the successes achieved by AIEMS were that it had resulted in teachers using a variety of learning aids and showing greater willingness to use more leaner-centred approaches, such as group-work, and that children were livelier and more motivated to learn.

However, studies and progress reports have indicated that many teachers were not visiting TRCS, mainly because of long distances from their schools (Haambokoma, 1998; MOE/DfID, 2000). Such teachers, therefore, did not utilise fully the services provided by the AIEMS Project, which considered TRCs an integral part of its system of in-service delivery. It has also been said that while activities associated with AIEMS were much in evidence at national/provincial level, there was not as much activity at district level, less still at school level. This would suggest that despite its high profile nature at national level, AIEMS did not do much at school/classroom level, where its impact should have been felt the most. And in 1997 a project review team comprising personnel from MOE and ODA concluded that although AIEMS was about improving education, it had not been made clear exactly what improvements in teaching and learning were expected nor how they would be assessed. The team therefore recommended drawing up of performance indicators, which they argued were necessary if AIEMS was to become a

means for encouraging and promoting goal setting by both teachers and schools (MOE/ODA, 1997). AIEMS came to an end as a project in 2000, and all activities previously associated with it were placed under the umbrella of TED.

2.4.1.3 Diploma in Basic Mathematics and Science Education

The Diploma in Basic Mathematics and Science Education has been offered at NISTCOL, Chalimbana, since 1989. It was designed to upgrade the subject-matter content knowledge, teaching skills, and professional attitudes of teachers initially trained to teach Grades 1 - 7, so that they could teach effectively Grade 8 and 9 mathematics and environmental science (Haambokoma and Mumbula, 1997; UNDP/MOE, 1995). The diploma was initiated by the National Science Centre, an organisation which was itself set up by the Government with the help of the UNDP and UNESCO to produce mathematics and science equipment for basic schools and to provide in-service education for mathematics and science teachers (UNDP/MOE, 1995).

Haambokoma and Mumbula (1997), who carried out an evaluation of the course, report that although the Diploma had succeeded in improving teachers' professional skills, it fell short in certain aspects. For example, course lecturers tended to rely on teacher-centred methods; there were shortages of necessary reading materials; and the course was overloaded with content which could not be covered adequately in the time allowed for the programme.

2.4.1.4 School Programme of In-service for the Term (SPRINT)

The idea of SPRINT arose from a realisation that the school was the most effective venue for relevant, sustainable CPD for teachers. SPRINT is presently the main system of in-service provision to teachers in Zambia, particularly at primary school level. As MOE explains in *SPRINT: A Manual for In-service Provision*,

> *The [SPRINT] system is based upon small Teachers' Groups, which meet, on a regular basis to discuss professional issues. Many meetings focus on issues decided by teachers themselves: others are concerned with educational developments arising from outside the school. In addition to these Teachers' Group meetings, schools are visited frequently by in-service providers and teachers attend regular termly meetings at their local resource centres (p. 1.1).*

SPRINT activities at school level are time-tabled and occur, as mentioned in the quotation above, through Teachers' Group (TG) meetings, which are co-ordinated at school level by the School In-service Provider (SIP) and the school head. Beyond the school there are established channels of communication that link the SIP to the Zone In-service Provider (ZIP) for a group of schools, through to the District In-service Provider (DIP), on to the Provincial In-service Provider (PIP), and finally to the National In-service Provider (NIP), who is based within TED.

Through participation in SPRINT teachers earn in-service credits which, once they accumulate to 50 and 150, lead to the award of a *Certificate of In-service Credit*, which indicates that a teacher's professional skills have improved as a result of attendance at TG

meetings. It is likely that in future more teachers, particularly those from the primary sector, will want to participate in SPRINT, since accumulation of a specified number of in-service credits will be used as an entry qualification to the new Primary Diploma by Distance offered by NISTCOL. Currently SPRINT is not available to secondary school teachers, whose opportunities for CPD are still mainly college-based.

2.4.1.5 Bachelor of Education in Mathematics and Science (BEDMAS) Project

The BEDMAS project began in 1998 as a partnership between UNZA School of Education, MOE, and the Belgian Government, to provide a three-year in-service undergraduate degree programme for non-graduate secondary mathematics and science teachers, in order to increase the number of graduate teachers of these subjects in Zambian schools. Increasing the number of graduate mathematics and science teachers in schools had proved difficult in the past mainly because traditional UNZA degree programmes in mathematics and science education tended to produce very few teachers for these subjects, particularly in physics education, where for many years not more than three teachers graduated each academic year. Furthermore, most of the teachers who graduated in mathematics and science sought work outside the education sector, leaving many schools without any graduate teachers in these subjects. It is hoped that BEDMAS, which has been enrolling at least 80 non-graduate teachers (20 each in mathematics, biology, chemistry and physics) since 2000, will help change this situation, as it is expected that it will be returning to schools 50 or more graduate mathematics and science teachers each year from 2003 onwards (UNZA School of Education, Department of Mathematics and Science Education, 1996; 1998).

2.4.1.6 Diploma in Teaching (DT)

The Diploma in Teaching (DT) started in 2000 at UNZA School of Education to provide initial teacher education to university graduates already teaching or intending to teach in secondary schools, but without teacher training. Although it is clear that there are many untrained natural sciences graduates employed as teachers in both state and private secondary schools in Zambia, who could benefit from the programme, owing largely to inadequate publicity so far the DT has attracted only a small number of clients. In addition, the number of teachers in this category is not as many as we thought (Haambokoma *et al* 2002).

2.4.1.7. African Development Bank (ADB) Education Project

This project ran for only a few weeks in 1998/99 and was intended to improve subject content knowledge and professional skills of teachers at two technical high schools (David Kaunda in Lusaka and Hillcrest in Livingstone) in several school subjects, including mathematics and science. The Project, which was initiated by MOE's Zambia Education Projects Implementation Unit (ZEPIU) and financed by the African Development Bank (ADB), also involved upgrading of professional skills of staff at NISTCOL. It is unclear however to what extent this Project was successful, as it was not evaluated.

2.4.1.8. TED/VVOB Collaboration in SPRINT Programme in Central Province

Towards the end of the 1990s VVOB (the Belgian Flemish Office for International Co-operation and Technical Assistance) concluded that TRCs were under-utilised and that "INSET-providers were not always up to their task, partly due to a high turnover rate of staff" (TED/VVOB, 2001, p. 4.). In view of this VVOB in 1999 started a pilot project at Kabulonga Provincial Resource Centre with the main aim of providing training to INSET-providers. Evaluation of the pilot project and views of participants at a workshop in Kabwe (which involved TED, VVOB, lecturers from colleges of education, and INSET-providers at Provincial, District and Zonal resource centres) convinced VVOB that it was necessary to embark on a similar but long-term project in Central Province. The new project, which will run from January 2002 to December 2006, is intended to improve the effectiveness of SPRINT activities in Central Province, through the delivery of quality services offered by well trained INSET providers (TED/VVOB, 2001, p. 2).

As part of its activities the Project has supplied equipment, including computers and stationery, mainly to Zonal Resource Centres (ZRCs), and is in the process of linking the centres electronically so that communication between them is improved. VVOB chose to concentrate its efforts on improving the effectiveness of ZRCs and INSET-providers because it believes that being nearest to teachers "[ZRCs] should become the nerve system of SPRINT" (TED/VVOB, 2001, p. 4.). To this end VVOB is co-operating with DANIDA which intends to build over 100 ZRCs nation-wide. VVOB hopes that by the end of its Project:

- SPRINT programmes will have been translated into modules;
- INSET-providers at Provincial, District, and Zonal levels will have been trained in the use of the modules and will have passed on this knowledge to basic school teachers;
- Electronic Communication between TRCs will have been established; and
- The inspectorate will have become involved in the Project and in the monitoring of effective implementation of learner-centred methods of teaching.

2.4.2 Interpretation of Findings on Past and Current Teacher development programmes/Activities

The information given above with regard to past and current teacher development activities in Zambia shows that a number of Government-driven, mostly donor funded CPD initiatives for teachers of mathematics and science in high/secondary school have been mounted in Zambia, particularly since the 1980s. All the initiatives were intended to increase teacher effectiveness but some focused mostly on increasing teachers' subject content knowledge while others concentrated on trying to help teachers adopt more learner-centred teaching approaches.

Project review teams in most cases concluded that the initiatives had resulted in some improvement in teacher performance. ZAMSTEP graduates for example returned to their schools, and with increased confidence took up teaching duties in senior secondary mathematics and science classes, although no information was available with regard to their effectiveness. And in the case of AIEMS the network of TRCs built throughout the

country will continue to be useful as venues for CPD long after the project has been forgotten.

But the above CPD initiatives also had serious shortcomings. As Manchishi (2002) points out, the programmes were donor-funded projects, which lost momentum or even completely folded up once the funded phase was over, unless another donor came up, sometimes with a different focus. Furthermore, as indicated above, most CPD initiatives were Government-driven, which in many cases also meant that the associated teacher development activities were identified by Government agencies rather by the teachers themselves. This would mean that there was little teach ownership of the programmes, something without which CPD programmes for teachers cannot have a good chance of sustainability. In addition, it was (and still is) traditional during funded CPD programmes in Zambia to give participants some allowances, such as out of pocket allowance. In some cases such allowances were so attractive that it is possible some teachers attended CPD programmes not really to gain the necessary knowledge and skills, but for monetary gain.

This suggests that to be cost-effective and sustainable new CPD programmes should be organised differently. SPRINT seems to be a good start in this direction. It takes place within the school and to a large extent allows teachers to determine the activities for their TG meetings. But even with SPRINT it has been observed that some TGs exhibit reluctance to set up their own agenda for professional development activities, preferring to have these provided to them by District In-service Providers (DIPs). It would seem, therefore, that Zambian teachers have not yet accepted or understood fully the concept of teacher-driven CPD. This is one other issue new CPD programmes must be prepared to contend with.

2.5 SUMMARY OF FINDINGS

This chapter has shown that the teacher education system in Zambia is undergoing change. This is particularly the case with respect to primary teacher education, which is changing both in form and content. However, little has changed in programmes for secondary teacher education since 1970s, although there are now indications that these too will soon be reformed.

It has also been shown that a number of initiatives for improving teaching quality in mathematics and science were implemented particularly since the 1980s. Because most of these initiatives were Government-driven and donor funded, the concept of teacher ownership of CPD programmes was not promoted and it is possible that in some cases teacher participation was due to reasons other than the desire to improve one's professional competence. It is important, therefore, that new CPD initiatives in Zambia promote this concept, as acceptance of it by teachers is an effective way of reducing the cost of such programmes and increasing the chance of their sustainability.

CHAPTER THREE
METHODOLOGY OF THE SURVEY

3.1 INTRODUCTION

A baseline survey was conducted country-wide with the principle intention of:

- Determining the training needs of secondary school teachers of mathematics and science (i.e. Biology, Chemistry, Physics and Environmental Science);
- Establishing a baseline on the teachers' knowledge, attitudes and classroom practices, on the basis of which post-intervention evaluation could be made;
- Generating information to inform the design of a teacher-led programme for strengthening the teaching of mathematics and science.

Specifically, this component of the study was designed to provide data on the following: demographic characteristics of teachers of mathematics and science; topics the teachers found difficult to teach; teaching trends in mathematics and science and perspectives towards teaching; teachers' views on CPD; topics pupils found difficult to learn, and their views with regard to prevailing teaching approaches in mathematics and science.

3.2 DESIGN OF THE SURVEY

A sample survey design was used. This design, which mainly involves the use of questionnaires and interview schedules, enabled the researchers to collect data from the widely scattered teacher/school population, which was drawn from all the nine provinces in Zambia, namely: Copperbelt, Central, Eastern, Northern, North-western, Luapula, Lusaka, Southern, and Western. Both quantitative and qualitative data were collected.

3.3 POPULATION AND SAMPLE

The target population for this study was all Heads of Mathematics and Science Departments and all teachers of mathematics, biology, chemistry, physics, and environmental science in secondary schools. On the side of pupils, the study population was all grade 9 pupils, and all grade 12 pupils taking any of the following subjects: biology, chemistry, physics and mathematics. Grade 9 pupils were picked for the study because they had covered more of the junior secondary syllabuses than did Grade 8 pupils, and were thus in a better position to provide the required information. Grade 12 pupils were chosen from the senior secondary section for similar reasons.

A total of 65 schools and 599 teachers (234 mathematics, 99 biology, 91 chemistry, 97 physics, and 78 environmental science) participated in the study. (The full list of participating schools appears in Appendix 5). The total pupil sample was 1,862. From this total 342 were Grade 9 pupils who completed the Environmental Science questionnaires, while 300 other Grade 9 pupils completed the Junior Mathematics questionnaires. The remainder (i.e. 1220 pupils), were Grade 12 pupils who completed questionnaires as follows: 338 Biology, 338 Chemistry, 339 Physics, and

205 Mathematics. Finally, 92 departmental heads (44 for Mathematics and 48 for Science) also participated in the study.

3.4 SAMPLE SELECTION

Comprehensive lists of all secondary schools in Zambia were obtained from the Planning Unit of the Ministry of Education and from the Examinations Council of Zambia. Schools in each province were grouped into four categories, namely: established government, emerging government, grant aided and private. The term *established government schools* was used in this study to mean schools built by government for purposes of providing secondary education right from inception, while *emerging government schools* referred to former basic schools which were upgraded to secondary school status, often through local community pressure/effort. *Grant-aided schools* were church-owned schools, which received a grant from the Government and whose teachers' salaries were paid by the Government. *Private school* meant schools owned by individuals or companies and run entirely as trusts or business enterprises. Technical schools and national technical schools were also grouped separately. These were schools whose curriculum was biased towards technical subjects, such as design and geometrical drawing, and whose student population comprised mostly high achieving pupils in the province or in the whole country. Twenty per cent of secondary schools per category per province were selected for participation in the study by means of simple random sampling. The process involved writing names of schools on pieces of paper, folding the papers and mixing them thoroughly, before picking randomly one at a time the required number of schools.

All departmental heads in mathematics and science in participating schools were included in the sample. Similarly, all teachers of mathematics and science in the schools were included. At each school, researchers in consultation with local teachers selected the pupils who participated in the study, making sure that there was some gender balance in the resulting pupil sample.

3.5 INSTRUMENTS FOR DATA COLLECTION

Data was collected through questionnaires, lesson observation schedules, interview guides, and document analysis. Thirteen different questionnaires were designed for each of the following categories of respondents: Teachers of Mathematics, Environmental Science, Biology, Chemistry and Physics; learners of Junior Mathematics, Environmental Science, Senior Mathematics, Biology, Chemistry and Physics; and departmental heads for Mathematics and for Science. The questionnaires for teachers contained similar items, which differed only with respect to the nature of subject matter in the school subjects examined, and required writing lists of items and/or ranking items in order of importance. There were also Likert scale-type and open-ended items. Questionnaires for pupils comprised mainly Likert scale-type items.

3.6 PILOT STUDY

Before the main survey was conducted, a pilot survey was carried out in Lusaka schools to test the instruments and procedures for data collection during the period

25th February - 2nd March 2002. Seven schools participated, namely: Munali Boys High, Roma Girls' Secondary, Olympia Basic, Matero Girls', Kamwala High, Libala High, and Kabulonga High School for Boys.

Both pupils and teachers at each school were briefed adequately with regard to the purpose of the study and an appeal was made to them to co-operate fully. A letter from TED to the schools also explained the purpose of the exercise. In all cases, pupils completed questionnaires in the presence of the consultants (but without any teachers present), and were assured of confidentiality. This was important because some questions required pupils to give personal opinions on teachers' behaviour with regard to, for example, attitudes towards teaching, something the pupils would have been reluctant to do if they thought that their teachers would see what they had written.

Observations arising from the pilot survey included the following:

- random sampling of either teachers or pupils would be unrealistic, as it would make the whole procedure of data collection unjustifiably complex and time-consuming.
- the interview schedule for teachers was too long and needed to be shortened.
- triangulation would be necessary to establish the validity of the information provided by respondents.
- some terms used in the questionnaires were unfamiliar to respondents and would need either to be explained or replaced with more familiar ones.

In addition to the pilot survey, draft questionnaires were distributed to members of the SMASE task force who made suggestions for improvement. Based on experiences from the pilot survey and comments from the SMASE task force, instruments for data collection were revised.

3.7 PROCEDURES FOR DATA COLLECTION

Distribution of questionnaires for teachers' and departmental heads to schools was undertaken either by consultants or DIPs.

Consultants undertook field visits to all provinces during the month of March 2002. (The schedule of school visits appears in Appendix 6). For Western, Lusaka, Luapula and Northern provinces consultants carried with them questionnaires to schools and administered them to teachers, heads of mathematics and science, and to pupils; and collected completed questionnaires. In the case of Copperbelt and Southern provinces DIPs distributed questionnaires to schools, while consultants administered questionnaires to pupils. As for North Western, Central and Eastern provinces, teachers questionnaires were distributed to sample schools by DIPs. Consultants made follow up visits to schools to administer questionnaires to pupils. Where possible consultants observed lessons and interviewed teachers, as well as pupils. Some lessons were also recorded on video in Western and North-Western provinces.

CHAPTER FOUR
FINDINGS AND DISCUSSION: BIOLOGY

4.1 DEMOGRAPHIC CHARACTERISTICS OF TEACHERS OF BIOLOGY

Information on the demographic characteristics of teachers of biology who participated in the study is presented in tables 4.1 to 4.7 below.

4.1.1 Sex of teachers

The majority of respondents (76.8%) were males, as Table 4.1 shows.

Table 4.1: Distribution of teachers of biology by sex

	Frequency	Percentage
Male	76	76.8
Female	23	23.2
Total	99	100

The distribution of respondents in Table 4.1 above seems to suggest that there were fewer females compared to males teaching biology at secondary school level. This situation might affect negatively girls' learning of this subject since there were few female role models or none at all in this area that would inspire them to work hard.

4.1.2 Age of teachers

Table 4.2 below shows the distribution of teachers of biology who participated in the study by age.

Table 4.2: Distribution of Teachers of Biology by age

	Frequency	Percentage
Less than 30 years	34	34.3
31 – 40 years	47	47.5
41 – 50 years	16	16.2
More than 50 years	02	2.0
Total	99	100

Table 4.2 shows that most of the respondents were relatively young, over 80 % of them being 40 years old or less. This might be an advantage in the sense that young teachers are generally energetic and still have the interest to teach. However, it might also be a disadvantage in that young teachers are in most cases not settled yet in their career and life prospects and, in such cases, teaching may be affected.

4.1.3 Academic and Professional Qualification of Teachers

With regard to academic qualifications, all teachers who participated in the study were in possession of the O' level standard of education as Table 4.3 below shows.

Table 4.3: Academic/professional Qualifications of Teachers of Biology

	Frequency	Percentage
O' Level	99	100
Diploma in Education	56	56.6
Advanced Diploma in Education	34	34.3
Bachelor of Science	02	2
Bachelor of Science with Education	06	6.1

Although all the teachers had completed senior secondary education, less than 50% had the desired minimum qualifications (i.e. degree or advanced diploma) to teach biology at senior secondary level.

4.1.4 Length of Service as Teacher

According to Table 4.4 below about a third of the respondents (34.3%) had served as teachers for a period of 1 to 5 years while a quarter of the respondents (25.3%) had taught for a period of 6 to 10 years. This meant that in all, slightly over half the number of teachers of biology in participating schools had only about 10 years or less of teaching experience.

Table 4.4: Length of Service as a Teacher

	Frequency	Percentage
Not stated	06	6.1
1 – 5 years	34	34.3
6 – 10 years	25	25.3
11 – 15 years	18	18.2
16 – 20 years	09	9.1
Above 20 years	07	7.0
Total	99	100

4. 1. 5 Specific Subjects Trained to Teach

Respondents were also asked to indicate specific subjects they were trained to teach. The distribution of responses is shown in Table 4.5 below.

Table 4.5: Specific Subjects Trained to Teach

Subject	Number of times subject was mentioned	Percentage
Not stated	3	2.9
Environmental science /general science	56	51.9
Biology	42	38.5
Chemistry	3	2.9
Physics	0	0
Agricultural science	5	4.6
Total	109	100

As Table 4.5 shows, more than half of the total number of participating teachers of biology were in fact trained to teach environmental science in grades 8 and 9. There were also teachers of biology who were trained to teach agricultural science.

4.1.6 Length of Service as Teachers of Biology

Table 4.6 shows the distribution of responses of teachers regarding how long they had been teaching biology.

Table 4.6: Length of Service as Teachers of Biology

	Length of service in years as teachers of biology					
Grade Level	**None**	**1 – 4**	**5 – 9**	**10 – 14**	**15 – 20**	**Above 20**
Grade 10	7.1%	49.5%	25.3%	10.1%	4.0%	4.0%
Grade 11	9.1%	47.5%	24.2%	10.1%	4.0%	5.1%
Grade 12	17.2%	42.4%	21.2%	10.1%	4.0%	5.1%
A-Level	91.9%	5.1%	3.0%	0%	0%	0%

It is clear from Table 4.6 that most of the respondents had taught biology for a period of 1 to 4 years and therefore did not have enough teaching experience in the subject.

4.1.7 Levels of participation of Teachers of Biology in ZASE Activities

Respondents were also asked to indicate their level of participation in ZASE activities. The distribution of their responses is shown in Table 4.7.

Table 4.7: Participation of Teachers of Biology in ZASE Activities

	Frequency	Percentage
Ordinary member	37	37.4
Member of executive committee	06	6
Presented paper(s) at ZASE Annual meeting	0	0
Non of the above	56	56.6
Total	99	100

Table 4.7 shows that fewer than 50% of the respondents were members of ZASE, and none of these had presented papers at ZASE annual meetings.

On the basis of the information presented in Tables 4.1 to 4.7 above, it would appear that most teachers of biology were males, less than 40 years of age, possessed school certificates and diplomas in education and, were specifically trained to teach environmental science. Further more, the majority had little teaching experience in biology and were not members of Zambia Association for Science Education (ZASE).

There are a number of issues which might have contributed to the situation presented above. Generally, most females do not like pursuing careers in science based fields. This was one of the reasons why there were few women teaching biology (Haambokoma, 2000). Another issue is that for many years, the University of Zambia was not graduating a large number of biology teachers to meet the increasing demand for biology teachers nation wide. For example, between 1992 and 2002 , UNZA produced only 61 biology teachers many of whom have not joined the Ministry of Education for various reasons, including poor conditions of service for teachers. This has resulted in a number of biology teachers with degree qualifications pursuing non-teaching jobs within Zambia while others have moved to neighbouring countries particularly those south of Zambia (e.g. Botswana) where they are better paid. Well experienced diploma holders have similarly left for greener pastures elsewhere in the sub-region.

With regard to low levels of participation in ZASE activities, it could be that many teachers were not aware of the existence of ZASE or ZASE was not engaged in activities which would attract teachers to join. The low level of participation by teachers in ZASE activities is a source of concern especially that there are plans to strengthen the teaching of biology through activities of the association.

4.2 TOPICS TEACHERS OF BIOLOGY FOUND DIFFICULT TO TEACH

Information on topics teachers found difficult to teach was collected through asking them to indicate topics they were least comfortable to teach; their levels of Confidence in teaching particular topics in biology and also asking Heads of Departments to state aspects of biology teaching where they felt teachers of biology

needed help to make them more effective than before. The findings are presented below.

4.2.1 Topics teachers were least comfortable to teach

Table 4.8 shows the distribution of responses regarding topics teachers were least comfortable to teach.

Table 4.8: Topics Teachers of biology were Least Comfortable to Teach

Topic	Number of times topic was mentioned	Percentage
Inheritance/genetics	44	25.7
Diversity of organisms	21	12.3
Functions of brain and the nerves	17	9.9
Parasitism	13	7.6
Chemical control of plants	11	6.4
The use and abuse of drugs	11	6.4
Energy flow, food chains and food webs	10	5.8
Homeostasis	8	4.6
Nutrient and water cycles	8	4.6
Support, movement and locomotion	7	4.2
Sexual reproduction in human being	7	4.2
Hormones	6	3.5
Receptors	4	2.4
Aerobic respiration	4	2.4
Total	171	100

Table 4.8 shows that the largest number of participating teachers of biology indicated that they were least comfortable to teach genetics, diversity of organisms and functions of brain and nerves.

4.2.2 Levels of confidence in teaching particular biology topics

As a way of triangulating the information given by respondents above, they were given a list of topics and asked to indicate how confident they were in teaching the topics. They responded as shown in Table 4.9 below.

Table 4.9: Teachers' Confidence Levels in Teaching Particular Biology Topics

TOPICS	Percentage of teachers per category						
	Not stated	Very Confident (VC)	Confident (C)	VC + C	Not confident (NC)	Not sure (NS)	NC + NS
Inheritance/genetics	5.1	31.4	32.2	63.6	28.2	3.0	31.2
Chemical control of plants	1.0	27.3	49.5	76.8	20.2	2.0	22.2
Diversity of organisms	5.1	25.2	47.5	72.7	19.2	3.0	22.2
Functions of brain and nerves	2.0	32.4	50.5	82.9	13.1	2.0	15.1
Receptors	0.0	41.4	44.4	85.8	12.2	2.0	14.2
Energy flow, food chains and food webs	3.0	47.5	36.4	83.9	10.1	3.0	13.1
Parasitism	3.0	38.5	44.4	82.9	10.1	4.0	14.1
Tropism's and toxic responses	1.0	41.4	45.5	86.9	9.1	3.0	12.1

Hormones	0.0	51.5	38.4	89.9	8.1	2.0	10.1
Nutrients and water cycles	3.0	47.5	39.4	86.9	7.1	3.0	10.1
Effects of human beings on the ecosystem	3.0	40.4	46.5	86.9	7.1	3.0	10.1
Anaerobic respiration	1.0	49.5	40.4	89.9	7.1	2.0	9.1
The use and abuse of drugs	3.0	44.4	42.5	86.9	6.1	4.0	10.1
Support, movement and locomotion	0.0	51.5	40.4	91.9	6.1	2.0	8.1
Homeostasis	0.0	54.5	37.4	91.9	6.1	2.0	8.1
Transport in flowering plants	0.0	53.5	38.4	91.9	6.1	2.0	8.1
Sexual reproduction in human beings	5.1	52.6	34.3	90.9	4.0	4.0	8.0

As table 4.9 above shows, most teachers (above 80%) rated themselves highly confident in teaching almost all topics in the syllabus except inheritance, chemical control of plants and diversity of organisms.

4. 2.3 Departmental Heads' perceptions of areas where teachers of biology needed help.

In addition, 48 Heads of Department who participated in the study indicated the following as topics in biology where teachers needed more help to be more effective than was the case before: inheritance, ecology, coordination and response, use and abuse of drugs, diversity of organisms, nutrient cycles, chemical control of plants, skeleton and locomotion, and homeostasis. They also indicated that teachers needed help in practical work.

In short, from the information given in tables 4.8 and 4.9, it would seem that a good number of teachers of biology were of the view that they had no difficulties teaching most of the topics in the biology syllabus. Generally, most teachers were not willing to admit their weaknesses. One member of the Kenyan delegation also reported this tendency on the part of teachers in Kenya to the second regional conference on mathematics and science education held in Nairobi in June 2002. In other words, the culture of self-evaluation did not exist in most teachers and where it did, this was presented in form of 'silence' (i.e. hidden from researchers). However, discussions with pupils who were being taught biology by some of the teachers revealed that teachers had difficulties explaining certain biological concepts in some topics such as alleles, genes in genetics. Many teachers gave notes to pupils straight from textbooks word for word without any explanation. This, therefore, suggests that teachers did not see their weaknesses in their teaching. One other possible reason why teachers rated themselves highly confident in teaching most topics could be that data collection was being done when re-structuring in the Ministry of Education was being talked about and so many teachers did not want to reveal that they had weaknesses in some area.

However, some teachers revealed that they experienced difficulties teaching some topics. Topics which teachers found difficult to teach were: inheritance/genetics, diversity of organisms, functions of the brain and the nerves, chemical control of plants, the use and abuse of drugs, energy flow, food chains and food webs, homeostasis, nutrient and water cycles, support and locomotion and receptors. Interviews with some respondents revealed that they found genetics difficulty to teach because of calculations involved in it and too many similar terms. Not surprisingly, the topics teachers indicated they had difficulties teaching were in most cases the same ones pupils found difficult to learn, as will be shown later in this section.

Some of the topics listed above have also been identified as difficult topics for teachers by other studies. For example, Rugumayo (1978) found that teachers of biology needed help in ecology and genetics. Haambokoma and Mwale (1998) found that in two technical high schools, teachers had difficulties teaching genetics, coordination, use and abuse of drugs, ecology, diversity of living organisms, homeostasis, taxic response, and support and movement.

With regard to practical work, pupils' poor performance in the school certificate examination in the last 10 or so years would suggest that teachers needed further professional development in this area. Examiners' reports point to the fact that drawing specimens, measuring, calculating magnification and food tests were a problem to pupils. This suggests that pupils were not adequately prepared in those areas.

4.3. PREVAILING TEACHING TRENDS IN BIOLOGY

Information on prevailing teaching trends in biology was collected from teachers by asking them to indicate: how frequently they themselves and their pupils carried out certain activities during lessons; methods they used to teach: topics they felt comfortable to teach; topics they felt least comfortable to teach; topics pupils liked; topics pupils disliked. Teachers were also asked to indicate their level of confidence in using certain methods for teaching biology. Information provided by teachers was verified by observing a recorded lesson. The findings are presented below.

4.3.1 Teacher/pupil activities during biology lessons

Table 4.10 below shows the frequency of occurrence of certain teacher/ pupil activities during biology lessons, given in terms of percentages of teachers of biology reporting on them.

Table 4.10: Frequency of Use of Certain Teacher/pupil Activities during Biology Lessons

Teacher/Pupil Activities	Percentage of teachers per category						
	Not Stated	Very Often(vo)	Often (O)	VO + O	Sometimes (S)	Never (N)	S + N
Teacher asks questions , pupils answer	3.0	61.6	27.3	88.9	7.1	1.0	8.1
Teacher talks, pupils listen	1.0	47.5	28.3	75.8	23.2	0.0	23.2
Teacher demonstrates, pupils watch	1.0	34.3	38.4	72.7	25.3	1.0	26.3
Pupils given work to do after classes	0.0	31.3	44.4	75.7	21.2	3.0	24.2
Pupils search for answers to written questions	3.0	21.2	36.4	57.6	36.4	3.0	39.4
Pupils read from printed materials (e.g. textbooks)	2.0	20.2	27.3	47.5	41.4	9.1	5.5
Pupils work out a solution to a problem	2.0	17.2	30.2	40.4	42.4	8.1	5.5
Pupils discuss as a class	1.0	15.2	26.3	41.5	48.5	9.1	57.6
Pupil(s) explain while the rest listen	3.0	12.1	26.3	38.4	53.5	5.1	58.6

Pupils discuss in small groups, teachers guides	1.0	10.1	25.3	36.4	56.6	7.1	63.7
Pupils working in pairs	2.0	7.1	28.3	35.4	55.6	7.1	62.7
Pupils carry out practical in small groups	1.0	5.1	29.3	34.4	55.6	9.1	64.7
Pupils carry out individual practical work	1.0	5.1	29.3	34.4	55.6	9.1	64.7
Class goes outside the classroom to learn	2.0	5.1	20.2	25.3	62.6	10.1	72.7
Pupil(s) demonstrates, the rest watch	2.0	5.1	14.1	19.2	72.7	6.1	78.8
Pupils act roles (role play)	4.0	2.0	9.1	11.1	42.4	42.4	84.8
Team teaching	4.0	2.0	9.1	11.1	27.3	57.6	84.8
Pupils carrying out an extended investigation on an issue	1.0	1.0	10.0	11.0	55.6	32.3	87.9
Pupils listen to a guest speaker	1.0	1.0	4.0	5.0	34.3	59.6	93.9
Pupils play educational games	0.0	1.0	4.0	5.0	26.3	68.7	95.0
Teacher uses video/film to teach	1.0	0.0	4.0	4.0	20.2	74.7	94.5

Table 4.10 above shows that the most frequently used methods by the majority of teachers in teaching biology were question and answer, teacher exposition and teacher demonstration, while methods such as role play, project work, guest speakers or games were rarely used or never used at all. Several reasons were advanced for the none use of these methods by teachers. One is that the teachers were not very knowledgeable in the use of such methods. Some said that these methods were time consuming and did not allow quick coverage of the syllabus.

4.3.2 Methods Teachers Used When Teaching Topics They Felt Comfortable to Teach

Table 4.11 below shows the distribution of responses with respect to methods teachers of biology used to teach topics they felt comfortable to teach.

Table 4.11: Methods Teachers of Biology Use to Teach Topics They Felt Comfortable to Teach

Teaching Methods	Number of times method was mentioned	Percentage
Lecture method	65	30.1
Teacher demonstration	56	25.9
Question and answer	43	19.9
Small group discussion	24	11.1
Small group practical	22	10.2
Problem solving	3	1.4
Pupil demonstration	2	0.9
Individual practical work	1	0.5
Total	216	100

Table 4.11 above shows that the most frequently mentioned methods in this regard were lecture, teacher demonstration as well as question and answer.

4.3.3 Methods Teachers Used to Teach Topics They Felt least Comfortable to Teach

The distribution of responses regarding methods teachers of biology used to teach topics they felt least comfortable to teach is shown in Table 4.12

Table 4.12: Methods Teachers of Biology Use to Teach Topics They Felt Least Comfortable to Teach

Teaching Methods	Number of times method was mentioned	Percentage
Lecture method	48	36.0
Teacher demonstration	22	16.5
Question and answer	19	14.3
Small group discussion	18	13.5
Whole class discussion	16	12.5
Project method	5	3.6
Homework	5	3.6
Total	133	100

Table 4.12 above indicates that the most commonly stated methods for teaching topics teachers felt least comfortable to teach about were teacher exposition, teacher demonstration and question and answer.

4.3.4 Methods Teachers Used When Teaching Topics Pupils Liked

With regard to methods teachers used when teaching topics pupils liked, the responses were distributed as shown in Table 4.13 below.

Table 4.13: Methods Teachers of Biology Used to Teach Topics Pupils Liked

Teaching Methods	Number of times method was mentioned	Percentage of responses
Lecture method	56	27.6
Question and answer	39	19.2
Whole class discussion	28	13.8
Small group discussion	27	13.3
Teacher demonstration	16	7.9
Practical work in small groups	31	15.3
Home work	6	2.9
Total	203	100

On the basis of information in Table 4.13 above, it can be said that teachers of biology were mainly using lecture method as well as question and answer to teach topics pupils liked.

4.3.5 Methods Teachers Used to Teach Topics Pupils Disliked

On teaching methods which teachers used when teaching topics disliked by pupils, respondents answered as shown in Table 4.14 below.

Table 4.14: Methods Teachers of Biology Used to Teach Topics Pupils Disliked

Teaching Methods	Number of times method was mentioned	Percentage of responses
Lecture method	48	39.7
Question and answer	25	20.7
Teacher demonstration	21	17.4
Whole class discussion	16	13.2
Small group discussion	11	9.0
Total	121	100

Table 4.14 above shows that teachers used mainly lecture method as well as question and answer method to teach topics pupils disliked.

4.3.6 Levels of Confidence in using particular Teaching Method

Teachers were requested to indicate their level of confidence in using particular teaching methods. They responded as shown in Table 4.15 below.

Table 4.15: Self-rating of Teachers of biology's level of Confidence in Using Particular Methods for Teaching

Teaching Methods	Percentage of teachers per category						
	Not Stated	Very confident (VC)	Confident (C)	VC + C	Not Confident (NC)	Not sure (NS)	NC + NS
Question and answer	1.0	69.7	28.3	98.0	1.0	0.0	1.0
Demonstration	4.0	69.7	25.3	95.0	1.0	1.0	2.0
Lecture method	2.0	56.5	34.3	90.0	6.1	1.0	7.1
Home work	3.1	44.4	50.6	95.0	2.0	0.0	2.0
Use of printed materials (e.g. textbooks, worksheets etc)	2.0	41.4	48.5	89.9	5.1	3.0	8.1
Problem solving	4.0	36.4	45.5	81.9	9.1	5.0	14.1
Group discussion	1.0	31.3	59.6	90.9	5.1	3.0	8.1
Individual work	4.0	30.3	47.5	77.8	14.1	4.1	18.2
Whole class discussion	2.0	27.3	56.6	83.9	12.1	2.0	14.1
Small group practical work	2.0	26.3	62.6	88.9	9.1	0.0	9.1
Investigation	3.0	26.3	45.5	71.8	17.2	8.0	25.2
Project work	6.0	26.3	40.4	66.7	17.2	10.1	27.3
Field trips	5.1	21.2	44.4	65.6	13.1	16.2	29.3
Pair work	6.0	26.3	40.4	66.7	17.2	10.1	27.3
Team teaching	7.1	11.1	35.4	46.5	22.2	24.2	46.4
Role play	4.0	9.1	38.4	47.5	23.2	25.3	48.5
Educational games	7.0	6.1	25.3	31.4	32.3	29.3	61.6

The pattern emerging from Table 4.15 above is that most respondents perceived themselves to be very confident in the use of question and answer (69.7%), demonstration (69.7%), lecture (56.6%) and homework. They were least confident in the use of educational games, role-play and team teaching. The results also seem to

show a close correlation between the methods teachers used frequently and those they claimed they were very confident in using.

In summary, the teaching trend emerging from the information in Tables 4.10 to 4.15 above is that in most biology lessons, teachers used lecture method, question and answer as well as teacher demonstrations. This implies that most times during biology lessons, pupils were passive while teachers were active, contrary to current expectations in science education that learners should be actively involved in the learning process. A number of educators (Adderly et. al, 1975; Good, 1977; Bligh, 1971; Beard, 1970; Thurber and Collette, 1968; Osborne and Wittrock, 1985; Voss and Brown,1968; Mcleish, 1968; Romey ,1968) have argued that when learners are passive listeners and observers, they do not learn as much as they do when they are actively involved in the learning process. They also cite a number of weaknesses regarding teacher exposition or lecturing during lessons, including failure to attract and hold pupils' attention, lack of opportunities to praise pupils, and the tendency by learners to assume a passive role and low retention of information. The current trend of teaching biology in the sampled secondary schools is, therefore, a source of concern.

Some pupils interviewed confirmed that teachers used teacher-centred approaches. They said that during biology lessons they were expected to be quiet, listen to the teacher, and take down notes. Chibesakunda (1983), Kapolyo (1990) and Haambokoma (1991) above have also reported the pattern of classroom interaction, during biology lessons described. Lesson observations during this study also confirmed this. For example, a biology lesson on pumping action of the heart observed at one secondary school in Western Province showed that the teacher was more active than pupils were. He talked nearly the whole period while pupils sat quietly and listened.

Respondents interviewed justified their use of lecture method in terms of large class sizes, which rendered use of active learning approaches such as discussion difficult to employ. It would appear that teachers were not aware that even a class of many pupils can be interactive. They also argued that they had to employ lecture method to ensure completion of the overloaded syllabus before pupils sat for examination. Some said that they did not have much time to think about the way they would involve learners during lessons because of heavy teaching loads, connected to shortage of science teachers. In some cases however, teachers simply did not have the competence to use active learning approaches.

The above results also suggest that most biology lessons were mainly theoretical and pupils confirmed this in the later parts of this section. During interviews teachers, particularly those in emerging schools, said that they did not have chemicals and apparatus to carry out experiments or to allow pupils carry out experiments in groups. In some schools, what used to be science laboratories had been turned into ordinary classrooms. Lack of laboratory assistants was also said to have contributed to teachers not involving pupils in practical work as it meant more work for the teacher who was already over burdened. Pupils (61.6% boys and 61.5% girls) also confirmed that they did not experiment during biology lessons. Where experiments were conducted, they were mainly verification ones intended to prove what the teacher had said. Experiments, which required learners to investigate problems, were not done.

It appears that teachers did not realise that a number of topics such as ecology, pollination etc. could be best taught outside the classroom as all lessons were held indoors. A fairly large portion of pupil respondents (59.1% of boys and 64.2% of girls) who participated in the study said that they never had a lesson outside the classroom. Teachers were also not aware that it is good practice to invite someone who is knowledgeable in a particular topic either from within the school or the local community to talk to pupils. It was, thus, clear that teachers of biology needed help with regard to choice of appropriate methods to use in particular situations.

4. 4 TEACHERS' VIEWS ON OTHER ASPECTS OF BIOLOGY TEACHING

In order to establish teachers' views with regard to other aspects of teaching biology, respondents were presented with a number of statements on teaching and learning of biology and asked to state if they agreed or disagreed with each statement. They were also given sets of four or more statements and asked to choose 3 statements which they considered reasonably important, and rank them in order of importance using numbers 1, 2 and 3 (1 being most important and 3 being least important). The results of this exercise are presented next.

4.4.1 Perceptions of Teachers of Biology on Teaching and Learning of Biology

Table 4.16 below shows teachers' reactions to statements about teaching and learning of biology.

Table 4.16: Perceptions of Teachers of Biology on Teaching and Learning of Biology

Statement	Percentage of teachers per category						
	Not Stated	Strongly Agree (SA)	Agree (A)	SA + A	Disagree (D)	Strongly Disagree (SA)	SD + D
Every lesson must have a lesson plan	0.0	44.4	36.4	80.8	15.2	4.0	19.2
Processes of science (e.g. observation, measurement) are the most important aspects of biology teaching	1.0	40.4	46.5	86.9	11.1	1.0	12.1
Biology teaching should put emphasis on the products (e.g. facts, knowledge, principles)	5.1	41.4	36.4	77.8	14.1	3.0	17.1
Examination success should be the priority for biology teaching	2.0	9.1	30.3	39.4	47.5	11.1	58.6
School biology is divorced from the real world	1.0	3.0	13.1	16.1	56.6	26.3	82.9
Information contained in official textbooks should not be questioned	1.0	4.0	3.0	7.0	57.6	34.3	91.9
Some pupils are incapable of learning biology	0.0	1.0	15.2	16.2	46.5	37.4	83.9
Girls are on the whole, incapable of becoming good biologists.	0.0	3.0	1.0	4.0	33.3	62.6	95.9

The distribution of responses in Table 4.16 above shows that most respondents (86.9%) were of the view that when teaching biology, process skills (e.g. observation, measurement, classification etc.) should be considered more important than products (such as facts, knowledge, and principles). Furthermore, a large portion of respondents (80.8%) agreed that every biology lesson must have a lesson plan. Also, 58.6% of the respondents did not agree that the main emphasis of teaching biology should be to make pupils pass examinations.

4.4.2 Perceptions on Objectives of Teaching Biology and Organising Biology Content

Tables 4.17 and 4.18 show teachers' ranking of the importance of some objectives for teaching biology and aspects of organisation of biology content respectively. The weightings 3, 2 and 1 were assigned to statements ranked by individual teachers respectively as first, second and third. To obtain the figures in the column headed TOTALS; entries in each row were substituted in the formula:

[3 x frequency in 1st column) + (2 x frequency in 2nd column) + (1 x frequency in 3rd column)]

Thus, row totals were used to rank the statements according to importance as perceived by teachers.

Table 4.17: Teachers' Ranking according to Importance of Objectives for Teaching Biology

Objectives for teaching biology	Frequencies			Totals	Rank
	1st	2nd	3rd		
To be curious about their surroundings and allow them to identify and formulate a problem.	114	18	14	164	1
To facilitate process skills such as observing, measuring, formulating hypothesis, identifying variables, experimenting, interpreting data etc.	35	16	19	156	2
To understand scientific knowledge, such as facts, concepts and principles etc and apply these to the solution of problems.	26	28	14	148	3
To acquire the ability to observe things and events in order to perceive and identify them.	24	25	10	132	4
To be aware of and respond in a positive manner to beauty and orderliness in their environment.	11	15	29	92	5
To be free from bias and superstitions and acquire open and critical mindedness as well as intellectual honesty.	13	14	12	79	6
To acquire ability to recall previous experiences, and to construct their own knowledge of physical phenomena and to be able to identify and explain them.	12	9	24	78	7

As can be seen from the table above, the majority of respondents were of the view that the most important objective of teaching biology was to enable pupils become curious about their surroundings and thus be able to identify problems to be investigated. The second most important objective in their view was to enable learners

master process skills and thirdly to enable learners acquire understanding of scientific knowledge.

With regard to aspects of organisation of biology content, respondents' views are as shown in Table 4.18 below.

Table 4.18: Teachers' Perception of Organising Biology Content

Aspects of organisation of biology content	Frequencies			Totals	Rank
	1st	2nd	3rd		
Organising topics to promote scientific thinking, understanding of knowledge, growth of experimental skills, problem solving skills, and development of interest and positive attitude.	41	22	16	183	1
Organising contents of biology in relation to the nature of learners, their needs and interest, growth levels, etc.	39	17	7	158	2
Organising content to provide opportunities for building scientific concept and principles and applying them to further inquiry tasks, projects and application to daily life and technology.	24	32	22	158	3
Recognizing the importance of pupils' learning difficulties as well as teachers' instructional difficulties.	16	19	22	108	4
Organising content in such a way as to cultivate process of biology and communication skills, to acquire the desire to know, to communicate with others orally and in writing,	12	11	15	73	5

Table 4.18 above shows that organisation of biology topics with a view to promoting scientific thinking, understanding knowledge, acquiring scientific skills, develop interest and positive attitude was ranked first. This was followed by organising biology content with due regard to the nature of learners, their needs, interest etc. The third most important aspect of organizing contents was to provide enough opportunities to learners to build scientific concepts and principles and apply them.

4.4.3 Perceptions on Teaching Methods/Strategies

Table 4.19 shows teachers perceptions with regard to what they considered the most appropriate ways of teaching biology. The ranking was arrived at using the method and formula in section 4.4.2.

Table 4.19: Perceptions of Teachers of Biology on Appropriate Ways of Teaching the Subject

Methods/strategies for teaching biology	Frequencies			Total	Rank
	1st	2nd	3rd		
Utilizing various teaching strategies: problem solving, individual learning, cooperative group learning, project method, demonstration, students experiments, etc.	45	16	11	178	1
Encouraging pupils to give their own ideas and help them to discuss how they differ from those held by scientists, so that they can verify and generalize the phenomenon into scientific concepts and principle	20	20	12	112	2
Conducting lessons to promote learning through activities such as questioning, suggesting, demonstrating, explaining, discussing, presenting, criticizing, asking for evidence, conceptualizing etc.	23	13	16	111	3
Utilizing various teaching facilities and materials, which may be available in the local environment.	19	19	13	108	4
Using charts, diagram, models, materials and analogies to make abstract concepts clear to students etc.	17	20	13	104	5
Utilizing various teaching sites such as classroom, laboratory, school grounds and field in lesson.	17	14	14	93	6
Setting teaching/learning goals, which are explicit, realistic and accepted by students.	9	11	7	56	7
Inviting students' everyday meaning of various experience and alternative interpretation and giving them opportunities to explore and correct their misconception/naïve conception and to draw scientific conclusions by using scientific terms.	3	1	2	13	8

The view of most respondents in Table 4.19 was that using various teaching strategies in teaching biology was the most important followed by encouraging pupils to give their own ideas and helping them to discuss how they differ from scientific ones. Ranked third was conducting lessons in such a way as to promote learning through activities.

4.4.4 Perceptions of Practical Work

Table 4.20 shows teachers' ranking of aspects of practical work in biology. The ranking was calculated using the formula given in section 4.4.2.

Table 4.20: Perspectives of Biology Teachers on Practical work.

Aspects of management of biology practical work	Frequencies			Total	Rank
	1st	2nd	3rd		
Encouraging and guide pupils to perform experiments carefully and accurately	21	26	15	130	1
Devising experiments conducted in such a way as to make pupils think and be conscious of the purpose of performing the experiment.	30	14	11	129	2
Implementing safe laboratory measures.	35	5	9	124	3
Applying classroom management to allow for individual, small group and whole class instruction techniques for planning and carrying out the experiment and data gathering, formulating the generalization by pupils.	22	12	19	109	4
Prepared to handle safely the emergencies that may arise.	16	10	8	76	5
Demonstrating in order to help pupils to understand the concepts and principles of biology.	14	13	7	75	6
Allowing pupils to take a lot of time for observing, measuring and recording.	9	12	5	56	7
Allowing pupils to suggest experiments and observations to answer their own questions.	7	11	13	56	8
Allowing pupils to take a lot of time for communication, interpreting and verifying.	8	7	6	44	9

Table 4.20 shows that most respondents thought that encouraging and guiding learners to perform experiments accurately was the most important aspect as far as practical work was concerned. This was followed by devising experiments conducted in such a way as to make pupils think and be conscious of the aim for carrying out the experiment. Ensuring that laboratory safety rules were observed was rated as the third important consideration in practical work.

4.4.5 Perceptions of Teachers of Biology on Production and Use of Teaching Materials

Table 4.21 shows teachers' views with regard to producing and using teaching materials. The ranking was calculated using the method given in section 4.4.2.

Table 4.21: Teachers of Biology 's Views on Production and Use of Teaching Materials

Production and use of teaching materials	Frequencies			Total	Rank
	1st	2nd	3rd		
Developing and utilizing instructional materials suited to pupils' ability levels and relevant to classroom objectives.	56	18	8	212	1
Adapting and utilizing a variety of instructional material and media such as charts, diagrams, newsprint papers etc.	30	36	16	178	2
Selecting, adapting and utilizing supplementary books, handbooks and other materials for learning use by pupils	21	23	31	140	3
Utilizing the textbooks as the most important resource materials for use in teaching.	13	10	10	69	4

Table 4.21 above shows that most respondents were of the view that making and using teaching/learning materials suited to learners' ability levels and relevant to lesson objectives was most important. Placed second was adapting and using different teaching materials, followed by selecting and using supplementary books and other materials during lessons by pupils.

4. 4.6 Perceptions on Assessing Pupils' Learning

Table 4.22 shows teachers' ranking of assessing pupils' learning of biology. The ranking was arrived at as described in section 4.4.2.

Table 4.22: Teachers of Biology's Perspectives on Assessment of Pupils' Learning

Aspects of assessment of pupils' learning	Frequencies			Totals	Rank
	1st	2nd	3rd		
Developing, improving biology competency tests and evaluation instruments to measure cognitive and process skills.	34	17	8	144	1
Utilizing fair and varied pupil evaluation measures such as paper and pencil tests, essay, tests, checklists, interview, homework etc.	30	18	10	136	2
Utilizing past examination questions.	18	16	13	99	3
Identifying pupils with special needs and providing the necessary support for assistance and guidance.	18	14	14	96	4
Classifying pupils' ability and understanding by utilizing the results of evaluation.	15	16	18	95	5
Utilizing textbook exercises.	16	10	11	79	6
Utilizing results of evaluation for revising instruction and enhancing learning achievement.	10	16	11	73	7
Assigning individual homework appropriate to the level of pupils' ability and give feedback/evaluation promptly.	14	5	7	59	8

Table 4.22 shows that a large number of respondents were of the view that developing competency tests and assessment instruments to measure cognitive and process skills was the most important aspect. Second in the rank was using different kinds of assessment instruments such as tests, checklists, interviews and homework. Ranked third was the use of past examination questions to assess learners.

In summary, the information given in Tables 4.16 to 4.22 above seem to indicate that the thinking of most teachers of biology who participated in the study was in line with the contemporary thinking in biology education. For example, most of them held the view that lesson planning was important for each lesson and that using a variety of teaching strategies was the most effective way of teaching biology. However, although their thinking was in line with the acceptable ways of teaching biology, they were not acting in the way they were thinking.

4.5 VIEWS OF TEACHERS OF BIOLOGY ON ASPECTS OF CONTINUING PROFESSIONAL DEVELOPMENT

Views of teachers of biology on aspects of continuing professional development were obtained by asking respondents to react (agree or disagree) to a number of statements about organisation and implementation of continuing professional development programme.

4.5.1 Reactions of Teachers of Biology to statements on Organisation and Implementation of Continuing Professional Development

Teacher's reaction to statements on organisation and implementation of continuing professional development is given in table 4.23 below.

Table 4.23: Teachers of Biology's Perceptions on Continuing Professional Development

Statements on CPD	Percentage of teachers per category						
	Not stated	Strongly Agree (S/A)	Agree (A)	SA + A	Disagree (D)	Strongly Disagree (SD)	SD + D
CPD is a must for teachers	5.1	64.6	25.2	89.8	5.1	0.0	5.1
CPD programmes are best if they are college/university based	4.0	37.4	25.5	62.7	19.2	14.1	33.3
CPD programmes are best if based at resource centers	2.0	14.1	39.4	53.5	36.4	8.1	44.5
CPD programmes are best if they are school based	2.0	17.2	35.3	52.5	37.4	8.1	45.5
CPD programmes are best if they take place during school holidays rather than during term time	3.0	35.4	32.3	70.7	24.2	5.1	29.3
Short CPD programmes (e.g. one week duration) are better than those of longer duration	3.0	11.1	37.4	48.5	41.4	7.1	48.5
The cost of participation in CPD programmes should be borne by individual participants/schools	3.0	4.1	23.2	27.3	32.3	37.4	69.7
Attendance at CPD programmes should be solely for the purpose of professional growth	3.0	34.3	41.5	75.8	20.2	1.0	21.2
Teachers are the best facilitators for fellow teachers in CPD programmes	3.0	30.3	44.5	74.8	20.2	2.0	22.2
College/university lectures are the best facilitators for teachers in CPD programmes	2.0	30.3	34.5	64.5	29.2	4.0	33.2
INSET providers are the best facilitators for teachers in CPD programmes	6.1	8.1	44.4	52.5	39.4	2.0	41.4
Inspectors are the best facilitators for teachers in CPD programmes	1.0	10.1	21.2	31.3	55.6	12.1	67.7

As the distribution of responses in Table 4.23 above shows, most respondents (89.8%) agreed that CPD was a must for teachers and 75.8% also agreed that attendance at CPD programmes should be solely for purposes of improving one's teaching effectiveness. In addition, 74.8% of the respondents were of the view that fellow teachers were the best facilitators for teachers in CPD programmes. Despite this,

69.7% of the respondents stated that they were not prepared to pay for participation in CPD programmes from their own pockets.

Respondents were also given a list of teaching skills and asked to state, in each case, the extent to which they would need further professional development. Table 4.24 below shows the results.

Table 4.24: Teachers of Biology Needing Further Professional Development in Teaching Skills.

Teaching skills	Percentage of teachers per category						
	Not stated	Very much	Much	VM + M	Not so much	Not at all	NM + N
Teaching pupils poor science background	0.0	55.5	26.3	81.8	15.2	3.0	18.2
Coping with heavy teaching loads	1.0	53.5	18.2	71.7	17.2	10.1	27.3
Use of audio/visual aids	2.0	51.5	21.2	72.7	14.2	11.1	25.3
Teaching at higher grade levels than trained for	2.0	48.5	22.2	70.7	17.2	10.1	27.3
Coping with public examination demands	2.0	47.5	28.3	75.8	16.2	6.0	22.2
Improvising teaching materials	3.0	43.5	30.3	73.8	13.1	10.1	23.2
Handling large biology classes	1.0	43.4	22.2	65.6	21.2	12.2	33.4
Gender sensitive teaching approaches	0.0	41.4	33.3	74.7	20.2	5.1	25.3
Preparing reagents and solutions	2.0	38.4	30.3	71.4	24.2	5.1	29.3
Catering for individual differences among learners	1.0	36.4	39.4	75.8	18.2	5.0	23.2
Knowledge about how pupils learn biology	2.0	35.4	33.3	68.7	22.2	7.1	29.3
Motivating learners	2.0	35.4	23.2	87.9	28.3	11.1	39.4
Preparing specimen such as bones, microscope slides etc	1.0	33.3	34.4	67.7	21.2	10.1	31.3
Use of printed materials (e.g. textbooks, worksheets)	7.0	30.3	20.2	50.5	26.3	16.2	42.5

The distribution of responses in Table 4.24 above shows that the areas where professional development was most required by teachers were with regard to teaching pupils with poor science background, coping with heavy teaching loads, and use of audio/visual aids. Others were teaching at higher grade levels than trained for, coping with public examinations demands, improvising teaching materials, handling large biology classes, and using gender sensitive teaching approaches.

In summary, the data in Tables 4.23 and 4.24 indicates that most teachers of biology regarded CPD important. Furthermore, a good proportion of teachers preferred the resource centre or the school as possible venues for CPD activities and that they should take place during school holidays. This was in agreement with views of secondary school Heads of Science Departments and Head Teachers expressed in another study (Haambokoma, 2001). Teachers were not in favour of paying their own money for participation in the CPD courses but were willing to attend the CPD

courses without getting any allowance at all, provided schools met the cost of their participation.

With regard to content of CPD courses, the majority of teachers of biology strongly felt that they needed training in handling learners with poor background in biology. Teachers in emerging schools particularly requested for this, perhaps because most of their pupils came from rural basic schools most of which lacked laboratory apparatus. Some heads of science departments indicated that there was need to equip classroom teachers with research skills that would enable them to carry out small-scale action research so as to improve their teaching. This agrees with views of Well and Chang (1986); Beeby (1977) and, Shaeffer (1993) who also believe that equipping teachers with research skills would make them more professional. Others also expressed the need to enhance the capacity of teachers in writing teaching and learning materials.

4.6 TOPICS PUPILS FOUND DIFFICULT TO LEARN IN BIOLOGY

Information on topics pupils found difficult to learn was obtained by giving pupil respondents a list of topics and asking them to indicate whether they found the topics they had already covered during lessons easy or difficult to learn. The findings are given in table 4.25 below.

Table 4.25: Pupils rating of the Relative Difficulty of Biology Topics

Topics	Percentage of pupils per category						
	Not stated	Very Difficult (VD)	Difficult (D)	VD + D	Easy (E)	Very Easy (VE)	VE + E
Inheritance (genetic)	10.7	7.7	30.8	38.5	24.6	26.2	50.8
Effects of man on the ecosystem	9.2	6.7	26.7	33.4	38.7	18.7	57.4
Parasitism	10.7	4.6	26.2	30.8	43.1	15.4	58.5
Diversity of organisms	10.7	3.0	24.2	27.2	48.5	13.6	62.1
Receptors	5.7	3.9	21.3	25.2	46.6	22.5	69.1
Hormones	2.8	2.3	19.1	21.4	45.7	30.1	75.8
Chemical control of plants	7.7	4.3	16.3	20.6	50.0	21.7	71.7
Functions of brain and nerves	3.7	4.7	15.6	20.3	51.0	25.0	76.0
Nutrients and water cycles	10.5	2.4	16.5	18.9	48.2	22.4	70.6
Tropism and taxic response	5.4	4,6	13.8	18.4	51.4	24.8	76.2
Homeostasis	3.7	2.2	15.2	17.4	52.0	26.9	78.9
Nutrients	1.5	2.2	14.8	17.0	48.8	32.7	81.5
Anaerobic respiration	3.0	4.0	12.0	16.0	53.0	28.0	81.0
Gaseous exchange in man	3.0	1.0	14.0	15.0	48.0	34.0	82.0
Energy flow, food chains and food webs/ecology	8.2	4.7	10.6	15.3	45.9	30.6	76.5
Aerobic respiration	1.0	3.0	12.0	15.0	52.0	32.0	84.0
Animal nutrition	2.0	0.0	15.0	15.0	53.0	30.0	83.0
Plant nutrition	3.0	1.3	13.1	14.4	55.4	27.2	82.6
Support, movement and locomotion	3.7	3.6	10.5	14.1	43.3	38.9	82.2
Transport in flowering plants	2.0	1.0	13.0	14.0	52.0	32.0	84.0
Transport in man	3.0	1.0	13.0	14.0	51.0	32.0	83.0
Human alimentary canals	2.0	1.0	12.0	13.0	49.0	36.0	85.0
The use and abuse of drugs	4.4	2.6	9.6	12.2	39.1	44.3	83.4
Excretion	2.6	1.1	10.6	11.7	51.8	33.9	85.7

A sexual reproduction	5.2	1.1	8.4	9.5	44.2	41.1	85.3
Enzymes	1.0	0.9	7.3	8.2	49.2	41.6	90.8
Sexual reproduction in human being	7.2	0.9	5.4	6.3	35.1	51.4	86.5
Sexually transmitted diseases	10.7	0.0	5.4	5.4	39.8	44.1	83.9
Diffusion and osmosis	0.3	0.9	4.3	5.2	41.3	53.2	94.5
Specialized cells, tissues and organs	0.9	1.2	3.9	5.1	51.5	42.5	94.0
Cell structure and organization	0.3	0.6	2.7	3.3	38.7	57.7	96.4
Sexual reproduction in plants	6.6	0.0	2.9	2.9	43.8	46.7	90.5

Table 4.25 shows that, most pupils regarded the majority of topics in biology easy to learn. Although most topics were perceived to be easy by the majority of pupils, the information should be taken with some caution. In fact some pupils revealed during interview that they had not been given a test or exercise on some topics to enable them determine whether or not they understood them.

Four topics (genetics, parasitism, and effects of man on the ecosystem and diversity of organisms) were rated as being difficult to learn by a large portion of pupils. Others were receptors, hormones, chemical control of plants, and functions of brain and nerves.

The responses on the four topics indicated as being difficult by a large number of pupils were further analysed in terms of sex of respondents, type of school of respondents and provincial or regional distribution. The analysis revealed that more boys (41.9%) than girls (35.3%) indicated that genetics was difficult to learn. Also more boys (35.5%) than girls (31.8%) indicated that they found the topic ' Effects of man on the ecosystem' difficult to learn. On the other hand, more girls (40.4%) than boys (13%) found parasitism difficult to learn. Similarly a large proportion of girls (38.5%) than boys (11.1%) said that 'Diversity of organisms' was difficult to learn. On average, more girls (36.5%) than boys (25.4%) found the topics: genetics, parasitism, and effect of man on the ecosystem and diversity of organisms difficult to learn. These findings are in line with the School Certificate results of 2000. More girls (35%) than boys (23%) failed biology.

With regard to type of schools, a large proportion of respondents (60%) from private schools said that genetics was difficult to learn, followed by those from grant-aided schools (33.3%). As for the topics 'Effects of man on the ecosystem' and 'Parasitism' more respondents in established government schools found them difficulty to learn compared to those in other types of schools. In case of 'Diversity of organisms', more respondents (100%) in emerging schools found this topic difficult to learn followed by those in established government schools (62.1%).

With respect to regional or provincial distribution of responses on the four topics identified by more respondents as been difficult to learn, the analysis revealed that the largest proportion of respondents who found 'genetics difficult to learn were in Central Province (54.5%) followed by Luapula (50%) and North-Western (50%) provinces. In case of Parasitism, the largest proportion of respondents who said it was difficult to learn were in Copperbelt Province (80%) followed by Luapula (75%) and Western Province (70.6%). As for the topic 'Effect of man on the ecosystem', the largest percentage of respondents was again in Copperbelt Province (69.2%) followed by Central (50%) and Northern Provinces (50%). The topic 'Diversity of organisms'

was indicated as difficult by mostly respondents in Luapula Province (75%) followed by Copperbelt Province (54.5%).

A baseline study done for the AIEMS Project in 1994 also identified inheritance/genetics and other topics such as diversity of organisms, co-ordination and response, nutrient cycles, homeostasis, skeleton and locomotion, ecology, digestion and drugs as being difficult for pupils to learn. Furthermore, a study by Haambokoma and Mwale (1998) undertaken at two Technical High Schools, found that pupils experienced problems in learning about genetics/inheritance, co-ordination, ecology, diversity of living organisms, use and abuse of drugs. Topics such as genetics, ecology, co-ordination and response, use and abuse of drugs, menstrual cycle, and nitrogen cycle have also been identified by teachers as being difficulty for pupils to learn (Zambia National Commission for UNESCO, 1999).

Chief examiners' reports have also revealed that pupils have difficulties in some of the topics cited above. In her report on the performance of candidates in the 2000 School Certificate Examination, the Chief Examiner stated that candidates showed lack of understanding of certain aspects of tropism and taxic responses.

> *It seems many candidates do not know the biological explanation for tropic responses in terms of the 'Auxin Theory'. Most candidates failed to explain how Auxins bring about changes in the observed responses. They do not know where this plant hormone is produced. A few candidates mentioned that Auxins are moved by osmosis.*

The chief examiner also reported that candidates did not understand the operation of the antagonistic muscles. The report for 1997 pointed out that most candidates interchanged the processes and organisms in the nitrogen cycle. In the same report of 1997 examination, the chief examiner reported that candidates showed lack of knowledge of genetics. She went on to say that they seemed not to know genetic terminologies and also lacked understanding of the usage of genetic symbols. The report also indicated that candidates had difficulties in the area of food chains and antagonistic muscles. The chief examiner for the biology practical paper for 2001 revealed that candidates had poor knowledge of osmosis and diffusion. There was a tendency by candidates to mix up the two processes.

Some pupils interviewed expressed different reasons for the difficulties they experienced in learning certain topics. For example, they pointed out that some topics (e.g. genetics) involved calculations, which they did not like. Some explained that certain topics were best learnt when experiments are carried out but these were not being carried out during lessons. Some argued that teachers failed to give adequate explanation on certain topics. It is worth noting that most of the topics, which pupils indicated that they found difficult to understanding were the same topics teachers, indicated they were not comfortable to teach. Some learners interviewed revealed that some teachers only gave notes to the class without any explanation at all. For example, one respondent said "all what the teacher does when he comes is to give notes to a pupil to write on the board and then goes away without explaining". Another reason advanced was that some teachers were too fast when teaching. This is surprising because the pattern that was observed in most schools visited during data collection was that pupils had not covered as much as expected.

4.7 PUPILS' OPINIONS ON TEACHING STYLES OF TEACHERS OF BIOLOGY

Pupils' views on teaching styles of teachers of biology were elicited by giving pupils a list of statements on certain aspects of classroom practice. They were asked to agree or disagree with each of the statements with regard to the classroom practice of their teacher of biology. Table 4.26 below shows the distribution of their responses.

Table 4.26: Pupils' Opinion on Teaching Styles of Teachers of Biology

Teaching Styles	Percentage of pupils per category						
	Not stated	Strongly Disagree (SD)	Disagree (D)	SD + D	Agree (A)	Strongly Agree (SA)	SA + A
Sometimes we work in pairs/groups during biology lesson	2.4	25.7	37.6	63.3	22.5	11.8	34.3
The teacher sometimes takes us out of the classroom to learn	0.8	29.9	32.0	61.9	23.1	14.2	37.3
We perform experiments during biology lessons	1.2	25.1	36.4	61.5	23.7	13.6	37.3
S/he allows us to talk to each other on the topic being taught	2.6	14.8	37.9	52.7	30.2	14.5	44.7
The teacher sometimes asks faster learners to assist their friends	2.3	19.2	32.0	51.2	32.0	14.5	46.5
The teacher varies her/his teaching methods	8.0	13.9	27.5	41.4	33.7	16.9	50.6
S/he asks for our ideas and uses them	1.5	10.1	33.4	43.5	35.5	19.5	55.0
S/he marks homework and tests and gives us feedback quickly	2.7	13.3	29.9	43.2	29.0	25.1	54.1
The teachers gives individual help to pupils who have difficulties	0.9	14.2	27.0	41.2	36.0	21.9	57.9
S/he gives us homework and test regularly	3.3	12.1	29.0	41.1	30.2	25.4	55.6
S/he gives us some exercises to do during the lessons	2.1	13.6	25.7	39.3	33.7	24.9	58.6
The teacher never misses lessons	1.6	11.6	26.3	37.9	33.2	27.3	60.5
S/he does not move from one topic to another before making sure that we have understood	2.0	16.0	21.3	37.3	28.7	32.0	60.7
S/he gives us notes in a manner that encourages us to think	2.6	10.4	25.4	35.8	29.6	32.0	61.6
S/he draws neat and accurate diagrams on the board	1.8	10.4	21.3	31.7	34.3	32.2	66.5
At the end of the lesson, the teacher summarizes the points covered or asks us questions	1.9	12.4	18.9	31.3	34.3	32.5	66.8
S/he explains our mistakes in our work	3.6	10.1	18.6	28.7	35.2	32.5	67.7
Our teacher introduces his/her lessons in an interesting way	0.6	8.3	18.6	26.9	34.6	37.9	72.5
S/he encourages us to give our own views/ideas during the lessons	2.1	5.0	20.4	25.4	41.4	31.1	72.5
S/he calls us by our names when he/she wants us to answer a question	1.1	9.5	15.1	24.6	30.8	43.5	74.3

As Table 4.26 above shows, about 60% of the respondents (65.4% boys and 61.5%) disagreed with the statements that they worked in pairs/groups during biology lessons; that their teacher took them out of the classroom to learn (59.1% boys and 64.2% girls) and that they performed experiments during biology lessons (61.6% boys and 61.5%).

About 50% of the respondents (51.6% boys and 52% girls) held the view that their biology teachers did not allow them to discuss among themselves during biology lessons. This pattern of classroom interaction clearly came out in a video-recorded lesson at one school in Western Province. A similar proportion of respondents also disagreed with the statement that their teachers of biology sometimes asked faster learners during lessons to assist their fellow pupils in class.

About 40% of the respondents did not agree that during biology lessons their teachers used different learning activities. A similar percentage of respondents also disagreed with the assertion that their biology teachers assessed them regularly through use of lesson exercises, homework and tests.

From the reaction given by pupils as shown in Table 27, one can conclude that pupils believed that teachers did not have interest in carrying out experiments during biology lessons. They were also of the view that teachers regarded pupils as people who did not know anything and, therefore, could not make any meaningful contributions during lessons. Pupils also felt that they were not assessed adequately.

Some pupils interviewed also expressed displeasure at the way teachers handled lessons. They complained that some teachers forced them to write notes directly from textbooks while others told too many stories and jokes at the expense of teaching. Teachers also showed lack of seriousness by coming late or missing lessons.

4.8 SUMMARY OF FINDINGS

In summary, the following observations/conclusions can be made from the information presented in this chapter:

4. 8.1 Demographic characteristics

- Teaching of biology was, dominated by male teachers, who were fairly young and had little teaching experience. The majority of them possessed an ordinary diploma in secondary education.
- Participation in ZASE activities amongst teachers of biology was low.

4.8.2 Topics teachers found difficult to teach

- Most teachers of biology believed that they had no difficulties teaching most topics in the biology syllabus, although learners did not seem to agree with them.
- Topics ranked highest as being difficult to teach in biology included: Genetics, Diversity of organisms, Ecology.
- Topics teachers identified as being difficult to teach were in most cases the ones the teachers indicated they were least comfortable to teach.

4. 8.3 Prevailing teaching trends

- Teacher centred teaching methods (lecture method and teacher demonstration) were used mainly. Thus in most biology lessons, learners assumed the passive role of listening and observing.
- The methods of teaching given above were used in all occasions. For example in teaching topics a teacher liked teaching or teaching a topic found difficult to teach.

4.8.4 Teachers perceptions on teaching of biology

- Teachers did not prepare lesson plans, but agreed that it was important to do so.
- Most teachers believed that teaching of process skills should be given more emphasis than teaching of products of science.
- Teachers also believed that both boys and girls were capable of learning biology.
- They were of the view that when organising biology content, topics should be arranged in a way which promoted scientific thinking, understanding of knowledge, acquisition of experimental and problem solving skills, and development of interest and positive attitude.
- Their perception was that using different teaching strategies such as individual learning, group learning, demonstrations etc. was the most appropriate way of teaching. However they did not think that utilising various teaching sites for biology lessons was important.
- With regard to practical work, the majority of teachers were of the view that encouraging and providing guidance to pupils to carry out experiments accurately was the most important aspect.
- In case of teaching aids, most perceived developing and utilizing instructional materials suited to pupils' ability and lesson objective as being most important.
- Although the thinking of teachers of biology was in most cases in line with contemporary thinking in the teaching of biology, their actual practice was different.

4.8.5 Teachers views on aspects of continuing professional development

- Most teachers were of the view that continuing professional development was necessary. They were prepared to attend CPD workshops or seminars without any allowance. However they did not like the idea of paying for CPD activities from their on their own.
- Teachers were equally divided over the venue for CPD activities. Some preferred the Resource Centres while others preferred the school. The majority were of the view that teachers would be the best facilitators during CPD activities.
- There were a number of areas in methodology/education they would like further professional development including research skills.

4.8.6 Topics pupils found difficult to learn and their opinions on teachers' teaching styles

- Topics pupils found difficult to learn included the following: genetics, effects of man on the ecosystem, parasitism, and diversity of organisms. On average more girls than boys found these topics difficult.
- Pupils' opinion on teaching styles of their teachers varied. However the general view was that they were not very happy in the manner some teachers handled lessons particularly with regard to conducting experiments.

CHAPTER FIVE

FINDINGS AND DISCUSSION: CHEMISTRY

5.1 DEMOGRAPHIC CHARACTERISTICS OF TEACHERS OF CHEMISTRY

Information on demographic characteristics of the 91 teachers of chemistry is presented in tables 5.1 to 5.6 below.

5.1.1. Sex and Age of the Teachers

Table 5.1 below shows how the 91 teachers of chemistry who participated in the study were distributed by sex.

Table 5.1: Distribution of Teachers of Chemistry by Sex

Sex of teachers	Frequency	Percentage
Males	83	91.2
Females	8	8.8
TOTAL	91	100

The above table shows that the majority of teachers of chemistry (87.4%) were male and only 8.4% were female. The small number of female science teachers could have negative implications, particularly among schoolgirls. It might, for example, lead girls to conclude that the teaching of chemistry (and perhaps science in general) was something reserved for men, and could thus discourage them from taking up science-based careers. However, the fact that most teachers of chemistry in the schools surveyed were male was not surprising, since studies conducted in Zambia have indicated that the majority of female candidates for secondary school teacher education opt to train as teachers of arts rather than science-based subjects (Haambokoma, 2000).

The survey also showed that 90.1% of the teachers were 40 years old or less, as shown in Table 5.2 below. Thus tables 5.1 and 5.2 suggest that chemistry teaching in secondary schools was almost exclusively a job for young male teachers.

Table 5.2: Distribution of Teachers of Chemistry by Age

Age ranges of chemistry teachers	Frequency	Percentage
Less than 30 years	34	37.4
31-40 years	48	52.7
41-50 years	7	7.7
Above 50 years	2	2.2
TOTAL	91	100

5.1.2. Length of Service as a Teacher:

With regard to length of service as teachers it was found that nearly three-quarters of the teachers of chemistry (i.e. 74.8 %) in the schools surveyed had less than 10 years teaching experience, as shown in Table 5.3 below. It should be noted, however, that Table 5.3 refers to length of service not as a teacher of chemistry but merely as a teacher. It is possible therefore that the number of years some of the teachers had actually taught chemistry was less than the figures shown in Table 5.3 below.

Table 5.3: Length of service as a Teacher

Ranges of length of service in years	Frequency	Percentages
0 – 4	38	41.8
5 – 9	30	32.9
10 – 14	13	14.3
15 – 19	6	6.6
20 and above	4	4.4
TOTAL	91	100

5.1.3. Academic Qualifications of Chemistry Teachers:

It was mentioned above that the majority of teachers of chemistry in the schools surveyed had little teaching experience. This in itself may not affect adversely the quality of teaching. However, when this factor is considered together with the teachers' qualifications shown in Table 5.4 below, it becomes clear that in addition to having little teaching experience most teachers of chemistry had only an ordinary diploma in science education, whereas an advanced diploma in education was the desired minimum requirement for one to teach at senior secondary level.

Table 5.4: Academic/professional Qualifications of Chemistry Teachers

Academic/professional qualification	Number of times qualification mentioned	Percentages
O-level	43	38.4
Diploma in Education	29	25.9
Advanced Diploma in Education	2	1.8
Bachelor of Science with Education	13	11.6
Bachelor of Science	4	3.5
Other (s)	21	18.8
Total	112	100

Although only 38.4% of the teachers (Table 5.4 above) indicated that they had reached the O-level standard of education, the actual percentage should have been 100%, since attaining the O' level standard of education is the minimum requirement for admission to secondary teacher education programmes in Zambia. It would seem that some teachers indicated only their highest qualifications, while others mentioned both their highest qualifications and lower ones. Nevertheless, it is clear from Table 5.4 that most of the teachers of chemistry in the schools visited were diploma holders, as only about 15.1% of them had a degree in science or science education.

With regard to the subjects teachers of chemistry were actually trained to teach, Table 5.5 below gives the picture.

Table 5.5: Specific Subjects Trained to Teach

Specific subjects trained to teach	Number of times subject was mentioned	Percentages
Chemistry	74	28.2
Biology	60	23.1
General / environmental science	60	23.1
Physics	55	21.3
Mathematics	8	3.1
Others (Agricultural science)	3	1.2
Total	260	100

The data in Table 5.5 are rather surprising, as they do not seem to agree with teachers' qualifications as stated in Table 5.4 above. For example, 28.2 per cent of the teachers claimed that they were trained to teach chemistry. This is not possible given that most of the teachers had only an ordinary (not an advanced) diploma in education, which qualifies one to teach grade 8 and 9 environmental science, a composite subject embracing all science subjects. Thus, despite the confusing data, a conclusion one can draw from Table 5.5 above is that most of the teachers of chemistry in the schools surveyed were trained to teach environmental science, but were asked to take up chemistry teaching in senior secondary school owing to a shortage of appropriately qualified teachers.

5.1.4. Levels of Participation in Activities of ZASE:

Teachers of chemistry were also asked to indicate their level of participation in activities of ZASE, as a way of finding out if they were taking advantage of CPD opportunities such membership offered. Table 5.6 below shows the results:

Table 5.6: Level of Participation in ZASE activities

Nature of participation in ZASE	Frequency	Percentages
Non-members	39	42.9
Ordinary member	34	37.4
Member of executive committee	10	11
Presented paper(s) at ZASE annual meeting	0	0
Not stated	8	8.8
TOTAL	91	100

Table 5.6 shows that 42.9 % were not members of ZASE, 37.4 % were ordinary members, 11 % were members of the executive committee, and 8 % did not indicate their status in this regard. None of the teachers who indicated that they were members of ZASE had presented papers at ZASE annual meetings. These data suggest that about half the number of teachers in the schools surveyed were members of ZASE while the other half were not. It would seem, however, that many teachers of chemistry considered themselves members of ZASE simply because they taught a science subject, as face to face interviews revealed that many of those who claimed to be members of ZASE had in fact not paid membership fees for a number of years.

In summary, the above demographic characteristic of teachers of chemistry suggest that chemistry teaching in the secondary/high schools surveyed was done mainly by young male teachers (aged 40 years or below), who were not active in ZASE. Most of these teachers were diploma holders and had less than 10 years teaching experience. Since efforts were made to select a nationally representative sample, one could say that the conclusions reached above concerning demographic characteristics of teachers of chemistry in the schools surveyed applied nation-wide.

5.2 TOPICS TEACHERS OF CHEMISTRY FOUND DIFFICULT TO TEACH

The information presented in this section was collected in three different ways. Teachers were given a list of chemistry topics and asked to state how confident they were in teaching each of them. The teachers were also asked to *list* chemistry topics, which they were least comfortable or most comfortable teaching. Finally, heads of science departments (HODs) were asked to identify areas in chemistry, including aspects of practical work, where they thought teachers needed help to be more effective. This information was used to determine the topics in the chemistry syllabus which teachers found difficult to teach.

5.2.1 Levels of Confidence in Teaching Particular Topics in Chemistry: Table 5.7 below shows teachers' responses when asked to indicate whether or not they were confident that they could teach effectively the topics shown. Entries represent percentages of teachers in each category.

Table 5.7: Teachers' Perception of their Levels of Confidence in handling some Topics in Chemistry

Topics	Not stated	Not confident (NC) (%)	Not sure (NS) (%)	NC + NS (%)	Confident (C) (%)	Very confident (VC) (%)	VC + C (%)
Organic chemistry	1.1	-	36.3	36.3	6.6	56.0	62.6
Non-metals	1.1	-	34.1	34.1	-	64.8	64.8
Metals	1.1	-	27.5	27.5	1.1	70.3	71.3
The periodic table	1.1	-	17.6	17.6	2.2	9.1	81.3
Chemical reactions	2.2	-	11.0	11.0	37.4	59.3	96.7
Electricity and chemistry	1.1	5.5	4.4	9.9	50.5	38.5	89.0
Stoichiometry and the mole concept	1.1	5.5	-	5.5	34.1	59.3	93.4
Energy changes	2.2	4.4	1.1	5.5	42.9	49.5	92.4
Experimental techniques	2.2	3.3	1.1	4.4	35.2	58.2	93.4
Acids, bases and salts	1.1	1.1	-	1.1	24.2	73.6	97.8
The particulate nature of matter	-	-	-	-	18.7	81.3	100.0
Atoms, elements and compounds	1.1	-	-	-	15.4	83.5	98.9

The following may be noticed from the table above:

- In general the teachers of chemistry indicated that they could teach most of the topics listed without difficulty, as shown by the high percentage figures in the column on the extreme right. Thus, for example, almost all the teachers (100% and 98.9% respectively) stated that they could teach with confidence the topics *particulate nature of matter* and *elements and compounds.*

- Only 5.5% of the teachers indicated that they lacked confidence in teaching the topic *stoichiometry and the mole concept*, a topic which earlier studies conducted in Zambian high/secondary schools (African Development Bank, 1998) suggested many teachers found difficult to teach.

- More than one-third of the teachers (i.e. 36.3 %) indicated that they were ***'not sure'*** about how confident they were in teaching *organic chemistry*. 'Not sure' in this case can be taken to mean lack of confidence, as it is not possible that after teaching a particular school subject for a number of years one would not know whether or not one had what it takes to teach effectively a given topic in the syllabus. Table 5.7 above therefore suggests that organic chemistry was one of the topics in chemistry which many teachers had difficulty teaching.

5.2.2. Topics teachers were least comfortable teaching: Teachers where asked to list down any topics in the chemistry syllabus which they were least comfortable teaching. Table 5.8 below gives the results.

Table 5.8: Chemistry Topics which Teachers Felt Least Comfortable to Teach

Topics least comfortable to teach	Number of times topic was mentioned	Percentage
Electricity and chemistry	24	18.6
Organic chemistry	23	17.8
Stoichiometry and the mole concept	18	14.0
Energy changes	17	13.1
Non-metals	12	9.2
Chemical reactions	10	7.8
Experimental techniques	9	7.0
Acids, bases and salts	9	7.0
Metals	4	3.1
The particulate nature of matter	2	1.6
The periodic table	1	0.8
Total	129	100

Table 5.8 shows that the largest number of teachers of chemistry identified *electricity and chemistry*, and *organic chemistry* as topics they were least comfortable teaching, that is, topics they felt they did not understand well enough to teach effectively. The data in Table 5.8 above seems to agree to a large extent with that in Table 5.7 discussed earlier. For example, in both tables organic chemistry is identified by many teaches as a problematic area as far as teaching is concerned. The two tables taken together suggest that *electricity and chemistry*, *organic chemistry*, *stoichiometry and the mole concept*, and *energy changes* were regarded as some of the most difficult topics to teach in chemistry.

5.2.3 Departmental Heads' Perceptions of Chemistry Topics which Teachers Needed Help

Table 5.9 below shows chemistry topics, which, according to science heads of department (HODs), posed some problems for teachers of chemistry to teach.

Table 5.9: Departmental Heads' Perceptions of Chemistry Topics Teachers Found Difficult to Teach.

Topics in which HODS thought teachers would need help	Number of times topic was mentioned	Percentage
Stoichiometry and the mole concept	34	41.0
Organic chemistry	20	24.0
Electricity and chemistry	9	10.8
Energy changes	5	6.0
Acids, bases and salts	5	6.0
The periodic table	3	3.6
Non-metals	3	3.6
Chemical reactions	2	2.5
Metals	2	2.5
Total	83	100

Table 5.9 above shows topics in the chemistry syllabus which heads of science departments (HODs) identified as being the ones teachers of chemistry found difficult to teach. As can be seen from the table, HODs believed that *stoichiometry and the mole concept* and *organic chemistry* were the most difficult chemistry topics to teach.

An examination of tables 5.7, 5.8, and 5.9 above shows that there was some similarity in their information. The data in the tables suggest that the chemistry topics, which HODs believed

teachers found difficult to teach were, by and large, the same ones teachers, were least comfortable to teach. One can conclude therefore that among the topics in chemistry which teachers did not understand well and/or could not teach effectively were, ***Electricity and chemistry***; ***Organic chemistry***; ***Stoichiometry and the mole concept***; and ***Energy changes.*** These topics are rather abstract and difficult to apply/relate to everyday experiences.

With regard to aspects of practical work in chemistry, HODs identified the following (Table 5.10) as areas where teachers needed help to be more effective:

Table 5.10: Departmental Heads' Perception of Aspects of Practical work where Teachers of Chemistry Needed Help

Aspects of practical work in which teachers would need help	Number of times topic was mentioned	Percentage
Performance of titrations (Volumetric analysis)	19	47.5
Ion identification/identification of salts	9	22.5
Preparation of standard/stock solutions	5	12.5
Gas preparations/tests	4	10.0
Idea of accuracy and how to conduct practical work	4	10.0
Total	41	100

As shown in Table 5.10 HODs believed that teachers of chemistry experienced some difficulty with regard to the following aspects of practical work in chemistry: T*itrations (Volumetric analysis), ion identification/identification of salts* and *preparation of standard/stock solutions.* It was important for teachers to master these skills because they were often required when setting up laboratories for practical examinations in chemistry.

5.2.4 Topics teachers felt most comfortable to teach

Table 5.11 below shows chemistry topics which teachers indicated they were most comfortable teaching, that is, topics they regarded as being easy to teach.

Table 5.11: Chemistry Topics Teachers were Most Comfortable Teaching

Topics where teachers were most comfortable to teach	Frequency	Percentage
Atoms, elements and compounds	49	53.8
Acids, bases and salts	49	53.8
Stoichiometry and the mole concept	48	52.7
Organic chemistry	46	50.5
The periodic table	42	46.2
The particulate nature of matter	38	41.8
Chemical reactions	38	41.8
Metals	33	36.2
Experimental techniques	20	22.0
Energy changes	19	20.9
Non-metals	18	19.8
Electricity and chemistry	16	17.6

The data in Table 5.11 above do not seem to agree with what was shown in earlier tables which showed the chemistry topics teachers found difficult to teach. Whereas, for example, Table 5.9 indicated that teachers of chemistry found *organic chemistry* difficult to teach, Table 5.11 above seems to suggest that this topic was somewhere in between, that is, neither too difficult nor too easy to teach. It is possible, however, that to avoid exposing their

weaknesses, teachers did not want to reveal their true status with regard to their ability to teach certain topics. Indeed, HODs stated during face-to-face interviews that many science teachers lacked competence in certain areas of the syllabus adding that, perhaps, colleges of education needed to reconsider the course content of science programmes for non-graduate teachers.

In summary, the data in Tables 5.7 - 5.11 suggest that teachers of chemistry in the schools studied found the following topics difficult to teach: Organic chemistry; Electricity and Chemistry; Stoichiometry and the mole concept, and Energy Changes.

5.3 TEACHING TRENDS IN CHEMISTRY

This section provides an insight into methods used by teachers of chemistry most frequently during lessons, and methods they used when teaching topics perceived to be easy or difficult. This information was necessary as it provided an indication as to whether or not teachers used the most effective teaching methods/strategies in given situations.

5.3.1. Pupil/teacher Activities during Chemistry Lessons: Table 5.12 below shows teachers' responses when asked to indicate the frequency with which each of the activities named in the table occurred during their chemistry lessons.

Table 5.12: Frequency of Occurrence of Some Pupil/teacher Activities during Chemistry Lessons

Nature of pupil/teacher activities during chemistry lessons	Percentage of teachers per category						
	Not stated	Very Often (VO)	Often (O)	VO + O	Sometimes (S)	Never (N)	S + N
Teacher talks, pupils listen	2.2	48.4	40.7	89.1	8.8	-	8.8
Teacher asks questions and pupils answer	3.3	56.0	33.0	89.0	7.7	-	7.7
Pupils given work to do after classes	3.3	33.0	44.0	77.0	18.7	1.1	19.8
Teacher demonstrates, pupils watch	2.2	37.4	37.4	74.8	20.9	2.2	23.1
Pupils search for answers to written questions	2.2	20.9	40.7	61.6	31.9	4.4	36.3
Pupils work-out a solution to a problem	4.4	16.5	41.8	58.3	30.8	6.6	37.4
Pupils discuss as a class	3.3	15.4	37.4	52.8	40.7	3.3	44.0
Pupils read from printed material (e.g. textbooks)	3.3	16.5	29.7	46.2	39.6	11.0	50.6
Pupils working in pairs	5.5	8.8	25.3	34.1	52.7	7.7	60.4
Pupils discuss in small groups, teacher guides	4.4	9.9	22.0	31.9	56.0	7.7	63.7
Class goes outside the classroom to learn	5.5	6.6	18.7	25.3	46.2	23.1	69.3
Pupil(s) demonstrates, the rest watch	3.3	4.4	14.3	18.7	63.7	14.3	78.0
Pupils carry out individual practical work	5.5	2.2	14.3	16.5	49.5	28.6	78.1
Pupil(s) explains while the rest listen	7.7	9.9	33	13.2	45.1	4.4	49.5
Pupils carry out practical in small groups	5.5	5.5	27.5	13.0	53.8	7.7	61.5
Pupils carrying out extended investigation on an issue	4.4	2.2	9.9	12.1	58.2	25.3	83.5
Team teaching	7.7	3.3	5.5	8.8	41.8	41.8	83.6
Pupils act roles (role play)	4.4	4.4	4.4	8.8	35.2	46.2	81.4
Pupils play educational games	4.4	1.1	3.3	4.4	27.5	63.7	91.2
Teacher uses video/film to teach	3.3	1.1	3.3	4.4	20.9	71.4	92.3
Pupils listen to a guest speaker	5.5	2.2	2.2	4.4	42.9	47.3	90.2

The following can be seen from the table above:

- The majority of the teachers (89.1%) mentioned *teacher talks and pupils listen* (i.e. lecture method) as the most frequent activity during chemistry lessons. Second, *teacher asks questions and pupils answer* (question-and answer method), was mentioned by 89% of the teachers. One could say, therefore, that *direct teaching* was the norm as far as chemistry teaching was concerned.

- The table suggests that activities that involved active participation of learners did not occur frequently. For example, the column on the extreme right shows that 91.2%, 83.5%, 78.1%, and 78% of the teachers respectively stated that playing educational games, conducting extended investigations on an issue, individual practical work and pupils demonstrations rarely occurred.

- Team-teaching was not a popular method of teaching in chemistry, as most teachers (83.6%) reported that they rarely or never used it. This may be because teachers did not understand what team-teaching meant and so were not aware of its advantages.

- Most teachers of chemistry (92.1%) stated that they never used audio/visual aids in their teaching. This suggests that abstract scientific concepts were not taught effectively, since children find such concepts easier to learn when models are used to help their comprehension.

5.3.2 Methods Used in Teaching Chemistry Topics Perceived to be Easy

When teachers of chemistry were asked to list down chemistry they regarded as being easy to teach and the methods they often used to teach such topics, four methods emerged to be predominant. These, starting with the most frequently mentioned, were Lecture, Demonstration, Practical work in small groups, and Question and Answer. Teaching approaches rarely used in this regard included field trips, problem solving, individualised practical work, use of video/film and, surprisingly, giving pupils work to do after classes (i.e. giving homework).

5.3.3. Methods Used in Teaching Chemistry Topics Perceived to be Difficult:

With regard to methods teachers often used when teaching 'difficult' topics, teachers' responses showed a similar pattern to that described above in connection with topics perceived to be easy. The lecture method, teacher-demonstration, and pupils-practical work in small groups again topped the list. It would seem, therefore, that teachers tended to use the same methods of teaching regardless of the topic under discussion, whether easy or difficult.

5.3.4. Methods Used in Teaching Topics Pupils Disliked Most

An analysis of the information provided by teachers of chemistry when asked to indicate which methods they often used when teaching topics pupils disliked showed again that *Lecture*, *Demonstration*, *Question and Answer* were mentioned in that order, followed by *whole class discussion.*

Thus it would seem that teachers of chemistry used the same methods (lecture, teacher demonstration, question-and-answer) whether teaching 'easy' or 'difficult' topics, or topics which pupils disliked. This lack of flexibility on the part of teachers might be due in part to the critical shortage in many high/secondary schools visited of laboratory apparatus and chemicals, which meant teachers almost exclusively relying on methods involving mainly giving out information to pupils, such as the lecture. Indeed, teachers' statements during face-

to-face interviews seemed to support this. For example, a teacher in Eastern Province stated that she used the lecture method regularly because *"the school [had] no instruments and chemicals to conduct experiments"*. The result, as one HOD at the school observed, was that pupils only handled laboratory apparatus during examinations.

5.3.5 Levels of Confidence in Using Particular Teaching Strategies

Table 5.13 below shows how teachers of chemistry rated themselves with regard to confidence in using effectively the stated teaching strategies.

Table 5.13: Teachers' Self-evaluation with Regard to Confidence in using the stated Teaching Strategies

Teaching strategies	Percentage s of teachers in each category						
	Not stated	very confident (VC)	Confident (C)	VC + C	Not confident (NC)	Not sure (NS)	NC + NS
Demonstration	1.1	74.7	23.1	97.8	1.1	-	1.1
Question and answer	1.1	70.3	25.3	95.6	2.2	1.1	3.3
Problem solving	2.2	48.4	44.0	92.4	4.4	1.1	5.5
Lecture method	1.1	67.0	25.3	92.3	5.5	1.1	6.6
Use of printed materials (e.g. text books)	3.3	41.8	49.5	91.3	5.5	-	5.5
Home work	1.1	54.9	35.2	90.1	6.6	2.2	8.8
Group discussions	4.4	34.1	56.0	90.0	4.4	1.1	5.5
Individualized work	4.4	36.3	52.7	89.2	3.3	3.3	6.6
Small group practical work	3.3	40.7	46.2	86.9	5.5	4.4	9.9
Investigation	3.3	27.5	52.7	80.2	9.9	6.6	16.5
Whole class discussion	3.3	36.3	42.9	79.2	13.2	4.4	17.6
Pair work	5.5	28.6	46.2	74.8	9.9	9.9	19.8
Project work	5.5	29.7	45.1	74.8	13.2	6.6	19.8
Field trips	7.7	17.6	46.2	63.8	4.4	24.2	28.6
Team teaching	8.8	12.1	44.0	56.1	8.8	26.4	35.2
Role play	4.4	15.4	36.3	51.7	16.5	27.5	44.0
Educational games	4.4	12.1	33.0	45.1	16.5	34.1	50.6
Other (specify):	85.7	6.6	3.3	9.9	-	4.4	4.4

- Table 5.13 shows that most teachers claimed to be either confident or very confident in using Demonstration (97.8%), Problem Solving (92.4%), Lecture Method (92.3%), Homework (90.1%), and group discussion (90%).

- A number of teachers indicated they were either not confident or not sure they could effectively use, for example, educational games (50.6%), role-play (44%), and team-teaching (35%).

This section, therefore, has demonstrated that the most regularly used methods of teaching in chemistry were Lecture, Demonstration, and Question and Answer. Teachers used these methods all the time, whether they where teaching topics perceived to be easy, difficult or topics which pupils tended to dislike. The use of these three topics would seem to have been dictated by a critical shortage of essential laboratory equipment and chemicals in many secondary schools in Zambia, large classes, and teachers' lack of creativity.

5.4. TEACHERS' VIEWS ON OTHER ASPECTS OF CHEMISTRY TEACHING

This section outlines views and beliefs of teachers of chemistry concerning objectives for teaching chemistry, organisation of content, practical work, management of learning, etc.

5.4.1 Perceptions on teaching and learning of chemistry: Teachers of chemistry were asked to react to the statements in Table 5.14 below by stating their level of agreement/disagreement with each statement.

Table 5.14: Percentages of teachers of Chemistry agreeing/disagreeing with the statements shown.

Views on teaching of chemistry	Percentage of teachers per category						
	Not stated	Strongly agree (SA)	Agree (A)	SA + A	Disagree (D)	Strongly disagree (SD)	SD + D
Processes are the most important aspects of chemistry teaching	3.3	50.5	39.6	90.1	6.6	-	6.6
Chemistry teaching should put emphasize on the products (e.g. facts, principles, rules, theories)	3.3	31.9	52.7	84.6	5.5	6.6	12.1
Every lesson must have a lesson plan	4.4	40.7	38.5	79.2	8.8	7.7	16.5
Examination success should be the priority for chemistry teaching	3.3	12.1	26.4	38.5	45.1	13.2	58.3
School chemistry is too divorced from the real world	3.3	3.3	17.6	20.9	45.1	30.8	75.9
Some pupils are incapable of learning chemistry	4.4	2.2	15.4	17.6	37.4	40.7	78.1
Information contained in official textbooks should not be questioned	3.3	1.1	4.4	5.5	45.1	46.2	91.3
Girls are, on the whole, incapable of becoming good chemists	3.3	1.1	3.3	4.4	26.4	65.9	92.3

The following seem to emerge from Table 5.14 above.

- teachers were undecided with regard to whether chemistry teaching should emphasise the processes of chemistry, that is teaching how knowledge is derived, or should focus on products of chemistry, that is concentrating on passing on to children the facts, principles, rules, theories, and so on. As Table 5.14 shows, 90.1% agreed or strongly agreed that *processes are the most important aspects of chemistry teaching,* while at the same time 84.6% thought that *Chemistry teaching should put emphasis on the products*

- 79.2% agreed that *every lesson must have a lesson plan.* However, this was probably just a popular belief, as none of the teachers whose chemistry lessons were observed used a lesson plan.

- teachers almost unanimously rejected certain statements, including *Girls are, on the whole, incapable of becoming good chemists* (92.3%,) and *Information contained in official textbooks should not be questioned (91.3%).* In taking this position the teachers agreed with contemporary thinking in science education.

Thus, apart from their statement with regard to whether or not the processes of chemistry were more important than the products, the teachers' views with regard to what was really important in chemistry teaching and learning coincided with contemporary thinking in science

education. However, as was shown earlier, the teachers' classroom behaviour did not always coincide with their level of understanding of educational theory.

5.4.2 Perceptions on objectives, content and processes of chemistry

Tables 5.15 - 5.20 below show how teachers of chemistry ranked in order of importance statements relating to some aspects of chemistry teaching, such as, objectives for teaching chemistry, organisation of content, practical work, and management of learning. The weightings 3, 2, and 1 were assigned to statements ranked by teachers as first (i.e. most important), second and third respectively. In each case, to obtain the figures under the column headed TOTALS entries in each row were substituted in the following formula:

[3 x frequency in 1st column] + [2 x frequency in 2nd column] + [1 x frequency in 3rd column]

Table 5.15: Teachers' Ranking of Objectives of Teaching Chemistry

Teaching objectives	Frequencies			Totals	Rank
	1st	2nd	3rd		
To facilitate process skills such as observing, measuring, formulating hypothesis, identifying variables, experimenting, interpreting data etc.	38	27	10	178	1
To understand scientific knowledge, such as facts, concepts and principles etc and apply these to the solution of problems.	30	27	15	159	2
To be curious about their surroundings and also allow them to sense and formulate the existence of a problem.	35	12	7	136	3
To acquire the ability to observe things and events in order to perceive and identify them.	22	15	4	100	4
To acquire the ability to recall previous experiences, and to construct their own knowledge of physical phenomena and to be able to identify and explain them.	17	11	15	88	5
To be free from bias, prejudice and superstitions and to acquire open mindedness, critical mindedness and intellectual honesty.	14	14	11	81	6
To be aware of and respond in a positive manner to beauty and orderliness in their environment.	6	11	13	43	7

Table 5.15 above shows that teachers of chemistry regarded facilitating children's acquisition of process skills, such as observing, measuring, formulating hypothesis, identifying variables, experimenting, interpreting data, etc. as the most important objective for teaching chemistry. In this regard, teachers rated as least important the need for children to learn to be aware of, and respond to, beauty and orderliness in their environment.

Table 5.16: Teachers' Perceptions on aspects of Organisation and Presentation of Content in Chemistry

Aspects of organisation/management of content in chemistry	Frequencies			Totals	Rank
	1st	2nd	3rd		
Organising topics to promote scientific thinking, understanding of knowledge, growth of experimental skills, problem solving skills, and development of interest and positive attitudes.	38	29	11	183	1
Organising contents to provide abundant opportunities for building scientific concept and principles and applying them to further inquiry tasks, projects, and concepts and principles and application to daily life and technology.	23	34	16	153	2
Recognising that teaching contents of Biology must be considered in relation to the nature of learners, their needs and interest, growth levels, etc.	26	13	15	119	3
Recognising the importance of student's learning difficulties as well as teachers' instrumental difficulties.	25	13	14	115	4
Organising contents that cultivate process of chemistry and communication skills to acquire the desire to know, to communicate with others orally and in writing,	13	10	17	76	5

As can be seen from Table 5.16 above, according to teachers of chemistry, organising content with a view to promoting development of scientific thinking, problem-solving skills and

positive attitudes, were identified as the most appropriate strategies to be employed when teaching chemistry. It is unclear, however, why the teachers placed organising content with a view to developing in children oral or written scientific communication skills last, as it too appears to be equally important, as far as learning chemistry (or science in general) is concerned.

Table 5.17:Teachers' Ranking of Appropriate Teaching Methods/strategies in Chemistry

Teaching Methods/Strategies	Frequencies			Totals	Rank
	1st	2nd	3rd		
Utilising various teaching strategies: problem solving, individual learning, co-operative group learning, project method, demonstration, students' experiments, etc.	48	17	7	185	1
Conducting lessons to promote learning through activities such as questioning, suggesting, demonstrating, explaining, discussing, presenting, criticising asking for evidence, conceptualising etc.	24	12	10	106	2
Encouraging students to give their own ideas and help them to discuss how they differ from those held by scientists, so that they can verify and generalising the phenomenon into scientific concepts and principle	15	22	10	99	3
Utilising various teaching facilities and materials, which may be available in the local environment.	14	20	13	95	4
Utilising various teaching sites, such as classroom, laboratory, school grounds and fields in lesson.	21	11	9	94	5
Teachers using charts, diagram, models, materials and analogies to make abstract concepts clear to students etc.	15	13	9	80	6
Inviting students' everyday meaning of various experience and alternative interpretation and give them opportunities to explore and correct their misconception/naïve conception and to draw scientific conclusions by using scientific terms.	10	14	13	71	7
Teachers setting teaching/learning goals which are explicit, realistic and accepted by students.	12	9	11	65	8

All the statements given in Table 5.17 above would seem to be of equal validity, as far as the teaching of chemistry in secondary school is concerned. Nevertheless, teachers of chemistry identified utilising various teaching methods/strategies, including problem solving, group work, project method, student experiments, etc. as the most effective approach to teaching chemistry.

Table 5.18: Teachers' Perspectives on Organisation and Management of Practical work in Chemistry

Aspects of organisation and management of Science Laboratory	Frequencies			Totals	Rank
	1st	2nd	3rd		
Devising experiments and conducting them in such a way as to make student think and become conscious of the purpose of performing the experiment.	30	18	9	135	1
Applying classroom management to allow for individual small group and whole class instruction techniques for planning and carrying out the experiment and data gathering, formulating the generalisation by students.	20	27	20	134	2
Encouraging and guide students to perform experiments carefully and accurately	23	19	10	117	3
Implementing safe laboratory measures.	26	7	8	100	4
Demonstrating in order to help students to understand the concepts and principle of physics.	18	16	6	92	5
Selecting, adapting, utilising, repairing, maintaining and managing science equipment and apparatus in laboratory.	16	13	8	82	6
Allowing students to suggest experiments and observations to answer their own questions.	9	11	10	59	7
Allowing students to take a lot of time for observing, measuring and recording.	9	9	11	56	8
Making preparations to handle safely the emergencies that may arise.	16	10	5	73	9
Allowing students to take a lot of time for communication, interpreting and verifying.	3	15	6	45	10

Table 5.18 shows that according to teachers of chemistry, devising and conducting experiments such that children are drawn to think and to become conscious of the purpose of performing experiments was what counted most as far as organisation and management of practical work was concerned. The teachers rated 'allowing students to take a lot of time for communication, interpreting and verifying' as least important in this regard, perhaps because it was viewed as wasting time, particularly that many teachers would be anxious to complete the syllabus quickly to allow children sufficient time to prepare for final examinations. It is also possible that the information in the table above reflected teachers desire to promote classroom activities that put them in the driving seat of the learning process, with children experiencing little or no ownership of classroom activities. Thus, for example, the statement about devising experiments, something done by teachers, was rated as most important, while allowing time for children to investigate and get to the bottom of things, was placed last.

Table 5.19: Teachers' ranking of Aspects of Utilisation and Production of Teaching/learning resources

Material Production and Usage	Frequencies			Totals	Rank
	1st	2nd	3rd		
Developing and utilising instructional materials suited to student's ability levels and relevant to classroom objectives.	45	21	11	188	1
Adapting and utilising a variety of instructional material and media such as charts, diagrams, newsprint papers etc.	29	26	26	165	2
Selecting, adapting and utilising supplementary books, handbooks and other materials for learning use by students.	25	29	25	158	3
Utilising textbook as the most important resource materials for use in teaching.	14	12	15	81	4

Table 5.19 above shows that developing and utilising materials suited to students' ability levels was rated by teachers of chemistry as the most appropriate way to use teaching/earning resources in the classroom. The teachers also identified over-reliance on textbooks as the least effective way to approach teaching tasks. Their judgement in this regard was again in line with contemporary thinking in science education, which holds, for example, that teachers should use their initiative to identify and utilise suitable teaching/learning materials in their local environment, rather than depend entirely on suggestions contained in the textbook.

5.4.3 Views of Teachers of Chemistry on Assessment of Pupil's Progress in Chemistry

To find out their views regarding practices in assessing pupil progress in chemistry, the teachers of chemistry were given a number of statements on different ways of assessing children's work (Table 5.20 below) and asked to rank them in order of importance.

Table 5.20: Teachers' Ranking of Strategies for assessing pupils' Progress in Chemistry

Evaluation measures	Frequencies			Totals	Rank
	1st	2nd	3rd		
Utilising fair and varied student evaluation measures as paper and pencil tests, essay, tests, checklists, interview, homework etc.	35	22	3	152	1
Developing, improve physics competency tests and evaluation instruments to measure cognitive and process skills.	29	17	11	132	2
Identifying students with special needs and providing the necessary support for assistance and guidance.	23	9	21	114	3
Utilising results of evaluation for revising instruction and enhancing learning achievement.	15	27	7	106	4
Assigning individual homework appropriate to the level of students' ability and give feedback/evaluation promptly.	23	7	12	95	5
Utilising past examination questions.	14	10	15	77	6
Classifying students' ability and understanding by utilising the results of evaluation.	12	14	7	71	7
Utilising textbook exercises.	7	12	7	52	8

Table 5.20 shows that teachers of chemistry rated utilising *fair* and *varied* student evaluation measures as the most effective method for assessing children's progress in chemistry, as compared to use of textbook exercises, which they placed last. It is interesting also to note that in their ranking scale, the teachers placed third in importance the need to identify children with special educational needs and make provision for such needs. This, perhaps, reflected the teachers' awareness of MOE policy in this regard, that all children regardless of their physical and/or intellectual condition must be helped to reach their full potential as far as education was concerned.

In short, the information in Tables 5.15 - 5.20 suggests that teachers of chemistry in the schools visited were knowledgeable about contemporary thinking in science education and were in agreement with it. For example, the majority of the teachers agreed with the statement that assessment of pupil progress was more accurate if varied approaches were used to gather the necessary data, than if only one method was used.

5.5 VIEWS OF TEACHERS OF CHEMISTRY ON CONTINUING PROFESSIONAL DEVELOPMENT (CPD)

The information in this section was obtained in two ways: Teachers were asked to react to a number of statements about orgainisation and implementation of CPD; and also to rate their levels of need of CPD with regard to performance of a set of selected classroom skills.

5.5.1 Teachers' Reactions to Statements on Organisation and Implementation of CPD

Table 5.21 below shows the reaction of the teachers of chemistry to statements on organisation and management of CPD programmes.

Table 5.21: Teachers of Chemistry's Reactions to Statements on Mode of Organisation and/or Implementation of CPD

Statements on CPD	Percentage of teachers in each category						
	Not stated	Strongly agree (SA)	Agree (A)	SA + A	Disagree (D)	Strongly disagree (SD)	SD + D
Participants in CPD programs should receive certificates.	4.4	62.6	27.5	90.1	3.3	2.2	5.5
CPD is a must for teachers	4.4	60.4	25.3	85.7	6.6	3.3	9.9
Attendance at CPD programs should be solely for the purpose of professional growth.	4.4	35.2	41.8	77.0	15.4	3.3	18.7
Teachers are best facilitators for fellow teachers in CPD programs	3.3	29.7	45.1	74.8	12.1	9.9	22.0
CPD programs are best if they take place during school holidays rather than during term time	3.3	28.6	38.5	67.1	20.9	8.8	29.7
CPD programs are best if they are school-based	4.4	26.4	37.4	63.8	19.8	12.1	31.9
CPD programs are best if they are college/university-based	4.4	31.9	26.4	58.3	28.6	8.8	37.4
College/university lecturers are the best facilitators for teachers in CPD programs	3.3	24.2	33.0	57.2	33.0	6.6	39.6
Short CPD programs (e.g. 1 week duration) are better than those of longer duration	5.5	17.6	34.1	51.7	33.0	9.9	42.9
CPD programs are best if based at resource centres	5.5	11.0	37.4	48.4	39.6	6.6	46.2
INSET providers are the best facilitators for teachers in CPD programs	4.4	11.0	33.0	44.0	39.6	12.1	51.7
The cost of participation in CPD programs should be borne by individual participants/schools	4.4	7.7	20.9	28.6	31.9	35.2	67.1
Inspectors are the best facilitators for teachers in CPD programs	3.3	4.4	22.0	26.4	45.1	25.3	70.4

Table 5.21 shows that:

- The majority of respondents (85.7 %) agreed that CPD was a must for teachers; it should be solely for purposes of professional development (77 %), and should lead to some form of certification (90.1 %).

- Over half of the respondents (74.8%) agreed that fellow teachers were the best facilitators in CPD programs, and that such programmes should be school-based (63.8 %).

- 70.4 % of the respondents rejected the idea of standards officers facilitating CPD programmes. An almost equally large number (67.1%) were against the idea of paying for participation in CPD programmes from their own pockets.

5.5.2 Areas for further professional development

Table 5.22 below shows how teachers of chemistry assessed their need for further professional development in the areas shown.

Table 5.22: Teachers' Perception of their Extent of Need for Professional Development

Areas in which teachers require further professional development	Percentages of teachers in each category						
	Not stated	Very much (VM)	Much (M)	VM + M	Not so much (NM)	Not at all (NA)	NM + NA
Use of audio/visual aids	3.3	46.2	27.5	73.7	13.2	9.9	23.1
Teaching pupils with poor science background	7.7	45.1	28.6	73.7	14.3	4.4	18.7
Catering for individual differences among learners	6.6	30.8	30.8	71.6	26.4	5.5	31.9
Teaching at higher grade levels than trained for	3.3	44.0	25.3	69.3	17.6	9.9	27.5
Improvising teaching materials	4.4	39.6	29.7	69.3	22.0	4.4	26.4
Coping with heavy teaching loads	6.6	44.0	23.1	67.1	17.6	8.8	26.4
Knowledge about how pupils learn chemistry	7.7	24.2	42.9	67.1	18.7	6.6	25.3
Coping with public examination demands	7.7	36.3	28.6	64.9	22.0	5.5	27.5
Motivating learners	4.4	24.2	39.6	63.8	25.3	6.6	31.9
Knowledge about gender-sensitive teaching approaches	4.4	28.6	28.6	57.2	24.2	14.3	38.5
Use of printed material e.g. worksheets, textbooks	7.7	36.3	13.2	49.5	28.6	14.3	42.9
Handling large chemistry classes	6.6	36.3	26.4	42.7	15.4	15.4	30.8

Table 5.22 shows that:

- There were a number of areas in which the majority of participating teachers of chemistry needed further professional development, for example *use of audio/visual aids (73.7 %), teaching pupils with poor science backgrounds* (73.7%), *catering for individual differences among learners (71.6%), improvising teaching materials* (69.3%), and *coping with public examination demands* (64.9%).
- Interviews with some of the teachers supported the information in the table above. For example, one teacher at a school in Eastern Province mentioned that *"there is need for training in improvisation [of teaching aids] among the teachers so that they could carry on with their work despite the lack of commercial science apparatus"*. And a school administrator from the same province who was also an HOD for science stated that teachers needed further training in science, particularly with regard to *"how they could teach...science subjects [which] they were not trained to [teach]"*, but had to take up owing to a shortage of suitably qualified teachers.

In addition to the above data, some teachers of chemistry included in the teachers' questionnaire statements not mentioned in Table 5.22 above, to highlight their own personal professional development needs. For example, a number of teachers expressed the desire to be helped to develop writing skills necessary for production of learning/teaching materials, with one teacher from Southern Province stating that there was need to develop *"skills in writing [of] teaching and learning materials as well as in research"*.

In summary, the information in tables 5.21 and 5.22 above indicates that most teachers of chemistry recognised and accepted the need to participate in CPD programmes, as long as such programmes led to some form of certification. In addition, the teachers wanted CPD programmes to take place within the school, during school holidays, and to be facilitated by fellow teachers. The programmes should focus particularly on use of audio/visual aids, teaching pupils with poor science backgrounds, catering for individual differences among learners, improvisation of teaching materials, and coping with public examination demands.

5.6 TOPICS PUPILS FOUND DIFFICULT TO LEARN IN CHEMISTRY

The information presented in this section was obtained in two ways. Pupils were given a set of chemistry topics and asked to indicate how easy or difficulty they found learning the topics; and teachers listed topics in the chemistry syllabus which children disliked, as another way of finding out about the topics which children had difficulty understanding. Table 5.23 below shows the chemistry topics identified by pupils as being difficult to learn.

Table 5.23: Pupils' Perception of Difficult Topics in Chemistry

Selected Topics in Chemistry	Percentage of children in each category						
	Not stated	Very difficult (VD)	Difficulty (D)	VD + D	Very easy (VE)	Easy (E)	VE + E
Stoichiometry and the mole concept	2.3	13.4	39.5	52.9	10.7	34.1	44.8
Organic chemistry	4.0	9.0	33.0	42.0	20.0	34.0	54.0
Electricity and chemistry	4.2	9.3	29.7	39.0	11.0	45.8	56.8
Chemical reactions	2.9	6.4	23.1	29.5	21.2	46.5	67.7
Acids, bases and salts	0.7	1.7	25.3	27.0	26.7	45.6	72.3
Energy changes	4.5	3.4	17.3	20.7	21.4	53.4	74.8
Experimental techniques	1.4	2.8	13.4	16.2	32.4	50.0	82.4
Metals	0.4	0.7	14.1	14.8	29.0	55.8	84.8
The periodic table	0.7	1.0	12.8	13.8	43.3	42.3	85.6
Non-metals	4.9	1.8	11.1	12.9	30.1	52.2	82.3
Atoms, elements and compounds	1.5	3.0	6.8	9.8	36.3	52.4	88.7
The particulate nature of matter	0.3	0.9	2.1	3.0	49.7	47.0	96.7

Table 5.23 indicates that:

- A fairly large number of pupils considered *stoichiometry and the mole concept* (52.9 %), Organic chemistry (42 %), and *Electricity and chemistry* (39 %) to be difficult topics to learn.

- In contrast almost all pupils in the sample (96.7%) thought that the topic *Particulate nature of matter to* was the easiest topic to learn in chemistry. Teachers also identified this same topic as one of the easiest to teach in the chemistry syllabus (see Table 5.8).

Table 5.24 below lists the topics which teachers thought pupils did not like.

Table 5.24: Chemistry Topics Teachers thought pupils Disliked

List of Topics	Frequency(i.e. number of teachers)	Percentage
Stoichiometry and the mole concept	62	68.1
Organic chemistry	26	28.6
Electricity and chemistry	19	20.9
Chemical reactions	17	18.7
Energy changes	9	9.9
Acids, bases and salts	6	6.6
Experimental techniques	5	5.5
Metals	4	4.4
Non-metals	4	4.4
The particulate nature of matter	2	2.2
The periodic table	1	1.1

Table 5.24 shows that nearly 70% of the teachers of chemistry identified stoichiometry and the mole concept, as the topic most disliked by pupils, followed by organic chemistry, and electricity and chemistry.

The information in tables 5.23 and 5.24 above agrees to a large extent with what teachers said earlier when asked to list the chemistry topics they were not confident to teach effectively or which they were least comfortable teaching. The topics shown in tables 5.23 and 5.24 above, were more or less the same ones listed by the largest numbers of teachers when asked to name topics in the chemistry syllabus which they were least comfortable teaching (see Table 5.8). One could conclude, then, that the topics which teachers found difficult to teach were by and large the same ones pupils disliked and had difficulty learning. In other words, the topics which teachers did not teach well (perhaps because of failure to understand the associated concepts), translated into topics which children had difficulty in learning, and therefore, began to dislike.

5.7 PUPILS OPINIONS ON PREVAILING TEACHING STYLES IN CHEMISTRY

To obtain further information with regard to prevailing teaching styles in chemistry, pupils were given a list of statements shown in Table 5.25 below, and asked to indicate the extent to which each statement described the classroom behaviour of their teacher of chemistry.

As can be seen from the table:

- the majority of the pupils (90.1%) stated that their *teacher encourages them to study or do the subject during spare time.* An equally large percentage (90%) indicated that they strongly agreed/agreed that their chemistry teacher *encourages them to ask questions if they don't understand.*
- a fairly large number of pupils (64.9%) strongly disagreed/disagreed that *the teacher sometimes takes us out of the classroom to learn.* A further 59.6% disagreed with the statement that their teacher sometimes allowed them to *work in pairs during lessons.*

One can see from this that according to the pupils, the most prevalent teaching styles in chemistry were those which emphasised teachers' authority, mainly exposition of subject matter. Teaching styles that allowed pupils to take ownership of the learning process, such as allowing children to discuss among themselves the topic under discussion, received little attention.

Table 5.25: Pupils' Opinions on Teachers' Approach in Teaching Chemistry

Statement	Percentages of teachers in each category						
	Not stated	Strongly agree	Agree	SA + A	Strongly disagree	Disagree	SD + D
The teacher encourages us to study or do the subject during our spare time	-	50.9	39.2	90.1	2.6	7.3	9.9
S/he encourages us to ask questions if we don't understand	1.5	59.6	30.4	90.0	2.3	6.1	8.4
S/he writes clearly on the board	0.3	51.8	37.1	88.9	4.4	6.4	10.8
S/he uses examples and illustrations during our lesson	0.9	42.7	44.4	87.1	4.7	7.3	12.0
The teacher knows the subject well	-	57.3	28.1	85.4	5.3	9.4	13.7
S/he asks questions clearly	2.0	46.5	38.6	85.1	5.6	7.3	12.9
S/he encourages both girls and boys to answer questions	7.6	48.0	32.5	80.5	3.8	8.2	12.0
Our chemistry teacher always comes early for lessons	0.3	43.3	36.5	79.8	4.1	15.8	19.9
S/he asks questions to both girls and boys	8.5	47.1	32.2	79.3	4.4	7.9	12.3
S/he gives us some exercises to do during the lesson	0.3	38.3	40.6	78.9	6.4	14.3	20.7
S/he also encourages even if one gives a wrong answer	1.2	38.9	38.3	77.2	7.3	14.3	21.6
S/he only punishes when it is very necessary	-	42.7	33.9	76.6	11.1	12.3	23.4
S/he asks questions to both hand-raised and non-hand raised	3.8	44.7	31.6	76.3	5.8	14.0	19.8
S/he draws neat and accurate diagrams on the board	-	36.5	39.8	76.3	4.4	19.3	23.7
S/he explains our mistakes in our work	0.3	29.8	45.0	74.8	8.8	16.1	24.9
At the end of the lesson, the teacher summaries the points covered or asks us questions	0.6	31.9	42.1	74.0	9.6	15.8	25.4
S/he gives us notes in the manner that encourages us to think	0.6	34.5	38.6	73.1	8.2	18.1	26.3
S/he calls us by our names when s/he wants us to answer a question	0.3	39.2	33.6	72.8	8.5	18.4	26.9
Our chemistry teacher introduces his/her lesson in an interesting way	0.9	32.7	39.2	71.9	10.5	16.7	27.2
Our chemistry teacher introduces his/her lesson in an interesting way	0.9	32.7	39.2	71.9	10.5	16.7	27.2
S/he encourages us to give our own views/ideas during the lesson	-	31.0	40.1	71.1	10.5	18.4	28.9
S/he makes the subject enjoyable to learn	0.9	33.9	37.1	71.0	11.1	17.0	28.1
The teacher relates the subject to our everyday life	0.6	26.0	44.7	70.7	9.1	19.6	28.7
S/he gives us homework and tests regularly	0.6	26.9	38.3	65.2	10.2	24.0	34.2
S/he marks the homework and tests and gives us feedback quickly	0.9	26.6	38.3	64.9	11.1	23.1	34.2
The teacher gives individual help to pupils who have difficulties	1.2	20.2	43.0	63.2	16.7	19.0	35.7
Our chemistry teacher never misses lessons	-	27.2	35.4	62.6	11.1	26.3	37.4
S/he does not move from one topic to another before making sure that we have understood	0.9	31.0	30.7	61.7	14.9	22.5	37.4
The teacher sometimes asks faster learners to assist their friends	0.3	23.1	37.4	60.5	16.1	23.1	39.2
The teacher varies her/his teaching methods	0.9	13.5	40.6	54.1	18.7	26.3	45.0
S/he asks for our ideas and uses them	1.8	20.8	32.7	53.5	13.7	31.0	44.7
We perform experiments in her/his lessons	0.3	26.9	26.3	53.2	24.3	22.2	46.5
S/he allows us to talk to each other on the topic being taught	1.5	17.0	25.7	42.7	24.0	31.9	55.9
Sometimes we work in pairs during her/his lessons	1.2	13.5	25.7	39.2	25.7	33.9	59.6
The teacher sometimes takes us out of the classroom to learn	0.9	13.2	21.1	34.3	38.0	26.9	64.9

5.8 SUMMARY OF FINDINGS

The information presented in this chapter has demonstrated the following with regard to demographic characteristics, professional practices, philosophical stances, strengths and weaknesses of teachers of chemistry in secondary schools:

5.8.1. Demographic characteristics:

- Over 90 % of the teachers of chemistry were male and relatively young (aged 40 years or less), and had less than 10 years' teaching experience.

- More than three-quarters had only an ordinary diploma in science education, and were trained to teach environmental science in junior secondary school. Only 18.8 % had degrees in either science or science education.
- Nearly 50 percent claimed to be members of ZASE, although they had not paid membership fees for several years. None had presented papers at ZASE annual meetings.

5.8.2 Chemistry topics teachers found difficult to teach

- Majority of teachers of chemistry identified four topics, namely: Organic Chemistry, Electricity and Chemistry, Stoichiometry and the Mole Concept, and Energy Changes.
- The topics teachers of chemistry identified as being difficult to teach (shown above), were by and large the same ones the teachers said they were least comfortable to teach or were not fully confident they could teach effectively. These were, more or less, the same topics pupils tended to find difficult to learn and disliked.

5.8.3 Teaching methods frequently used during chemistry lessons

- Three methods of teaching were used regularly during chemistry lessons, namely: *Lecture*, *Demonstration*, and *Question and Answer*. These methods were used in all situations, for example whether teaching difficulty topics or easy ones, and whether teaching topics children liked or disliked.
- Teachers' over-reliance on the three methods named above was influenced by, among others, a critical shortage of laboratory equipment and apparatus, heavy teaching loads, and lack of creativity.

5.8.4 Views concerning appropriate pedagogical practices in chemistry education

- Teachers of chemistry were generally knowledgeable about and held views in agreement with acceptable practices in chemistry education. Thus, for example, most teachers of chemistry agreed that assessment of pupil progress was more accurate if it involved the use of fair and varied evaluation measures than if it was based on a single measure; and that both boys and girls could learn and understand chemistry. However, observation of some chemistry lessons indicated that teachers did not practice what they believed.

5.8.5 Views on Continuing Professional Development (CPD)

- Teachers of chemistry were generally in agreement that CPD was a must, should be solely for purposes of professional development, and should lead to some form of certification.
- Most teachers wanted CPD programmes to be held within the school, during school holidays, and to be facilitated by fellow teachers.
- Most preferred areas of CPD focus included: use of audio/visual aids, teaching children with poor science backgrounds, and coping with demands of public examinations.
- Teachers of chemistry were generally against the idea of standards officers facilitating CPD or that individual teachers should meet the cost of participation in CPD programmes.

CHAPTER SIX

FINDINGS AND DISCUSSION: ENVIRONMENTAL SCIENCE

6.1 DEMOGRAPHIC CHARACTERISTICS OF TEACHERS

6.1.1 Sex and Age of the Teachers

Table 6.1 shows the sex distribution of teachers of environmental science that participated in the study.

Table 6.1: Sex distribution of Teachers of Environmental science

Sex of teachers	Frequency	Percentages
Males	53	67.9
Females	25	32.1
Total	78	100

Table 6.1 shows that close to 70% of the teachers of environmental science were males whereas slightly over 30% of respondents were females. This entails that there were fewer female teachers of environmental science than males. However, the ratio is not so bad considering the general state of affairs about women in science.

Regarding the age of respondents in this category, Table 6.2 indicates that most of them were less than 40 years old. A further scrutiny of Table 6.2 shows that 51% ranged between 31 and 40 years old and 38.5% were less than 30 years old. Thus, it can be argued that most of the teachers of environmental science were relatively young.

Table 6.2: Age Distribution of Teachers of Environmental science

Age ranges of Teachers of environmental science	Frequency	Percentage
Less than 30 years	30	38.5
31 – 40 years	40	51.3
41 – 50 years	07	9.0
Above 50 years	01	1.3
Total	78	100

6.1.2 Length of Service as Teachers

Table 6.3 shows the length of service of participants as teachers.

Table 6.3: Length of Service as Teacher

Ranges of length of service, in years	Frequency	Percentages
0 – 4	27	34.6
5 – 9	18	18.0
10 – 14	22	28.1
15 – 19	08	10.3
20 and above	03	3.9
Total	78	100

As can be seen in Table 6.3, the majority (34.6%) of respondents had been teachers between 0 and 4 years inclusive followed by those with teaching experience of 10 to 14 years.

6.1.3 Qualifications of Teachers of Environmental Science

The academic and professional qualifications of respondents in this category are shown in Table 6.4.

Table 6.4:Academic /Professional Qualifications of Teachers of Environmental science

Academic / professional qualification	Frequency	Percentages
O – level	38	48.7
Diploma in Education	34	43.6
Advanced Diploma in Education	01	1.3
Bachelor of science with Education	03	3.8
Others	02	2.6
Total	78	100

Table 6.4 shows that close to half (43.6%) of teachers of environmental science were at least holders of a diploma in education and only 1.3% had in addition, an advanced diploma in education.

Furthermore, only 3.8% were holders of Bachelor of Science with education. However, another small percentages (2.6 %) of the teachers of environmental science had other professional qualifications represented in the table by "other". Among these qualifications were certificate in primary course, laboratory management, commerce and accounts, primary school teaching certificate, diploma in political and social sciences, diploma in agricultural education, certificate of completion in organic chemistry, certificate in education and certificate In applied mathematics and physics.

6.1.4 Specific Subjects Teachers were Trained to teach

Table 6.5 below shows the subject(s) respondents in this category were trained to teach.

Table 6.5: Specific Subjects Trained to Teach

Specific Subject trained to teach	frequency	Percentages (%)
General/Environmental science	74	94.9
Biology	56	71.8
Chemistry	44	56.4
Physics	49	62.8
Mathematics	2	2.6

It is evident from the distribution of responses above that the majority of teachers in this category were trained to teach environmental science. However as can be seen in the table above, they were also teaching other science subjects at higher levels because of the shortage of teachers. Table 6.6 also shows this. This had an adverse effect on the preparation time for teaching environmental science effectively because these teachers spent more time in preparation for teaching subjects they were not trained to teach. This was revealed in interviews with some of environmental science teachers in schools visited.

6.1.5 Teaching Experience at Different Levels

Table 6.6 shows the teaching experience of teachers of environmental science at different grade levels.

Table 6.6: Teaching Experience at Different Grade Levels

Grade level	Ranges of teaching experience in years				
	0 – 4	5 - 9	10 - 14	15 – 19	20 and above
8	48.7	26.9	18.0	5.2	1.3
9	51.3	24.3	19.3	3.8	1.3
10	65.4	20.5	7.7	1.3	1.3
11	70.5	19.2	7.7	1.3	1.3
12	75.6	15.4	6.4	1.3	1.3
A - level	1.3	2.6	-	-	-

Table 6.6 demonstrates that most of the teachers who participated in the study had a short teaching experience (0-4 years).

6.1.6 Levels of Participation of Teachers of Environmental Science in ZASE activities

Another issue of concern was the participation in the Zambia Association for Science Education (ZASE) activities. As Table 6.7 shows, it was discovered that very few teachers had participated in the activities of the association. Close to half of the respondents (48.7%) had not participated in anything at all. This poses a challenge to the operations of SMASE, because SMASE intends to work with teachers involved in ZASE and ZAME.

Table 6.7: Level of Participation in the Zambia Association for Science Education

	Frequency	Percentage (%)
Ordinary member	33	42.3
Member of executive committee	2	2.6
Presented paper(s) at ZASE annual meeting	5	6.4
None of the above	38	48.7
Total	78	100

6.2 TOPICS TEACHERS OF ENVIRONMENTAL SCIENCE FOUND DIFFICULT TO TEACH

Topic teachers of environmental science found difficult to teach were identified using three methods. The first method that the respondents were asked to indicated topics they felt they were less comfortable to teach from a list of topics. Second they were given a list of topics and then asked to indicate their level of confidence in teaching each of the topics given. The third approach was that heads of departments were asked to identify areas in environmental science where they thought teachers needed help to be more effective.

6.2. 1. Topics Teachers were Least Comfortable Teaching

Table 6.8 shows the frequency respondents indicated as being least comfortable to teach a given topic. In the table, the topics are arranged in a descending order of difficulty, starting with the most difficulty at the top and ending with the least difficulty at the bottom.

Table 6.8: Topics Least Comfortable to Teach

Serial Number	Topics	Frequency	Percentage
1	The Universe: the earth, moon and stars, solar system and galaxies.	29	17.7
2	Mammals: their features, classification, *etc*	26	15.9
3	Electricity	16	9.8
4	Energy and its sources	13	7.9
5	Transpiration	10	6.1
6	Intervention of human beings in nature	10	6.1
7	Reproduction in human beings	09	5.5
8	Separation techniques	09	5.5
9	Density	08	4.9
10	Respiration and breathing in human beings	04	2.4
11	Plant and animal cells.	04	2.4
12	Light : reflection, refraction, lenses and dispersion	04	2.4
13	Measurements of temperature, mass, length and volume.	03	1.8
14	Air/gases : composition of air; oxygen and carbon dioxide	03	1.8
15	Birds: its external features, feeding habits, its egg, reproduction and parental care	03	1.8
16	Tropisms	03	1.8
18	Respiration in plants	03	1.8
19	Transfer of heat by convection, conduction and radiation.	02	1.1
20	Introduction to laboratory apparatus	01	0.6
21	Water: its properties and its uses.	01	0.6
22	Expansion in solids, liquids and gases.	01	0.6
23	External features of plants	01	0.6
24	Photosynthesis	01	0.6
25	Blood circulation in human beings	00	0.0

The results in the table above show that a large number of respondents experienced difficulties teaching universe and mammals. It was however surprising that transpiration which seem quite easy to teach was ranked number 5 in Table 6.8 as being difficult to teach.

6.2.2 Levels of Confidence in Teaching Particular Topics in Environmental science

Table 6.9 below shows teachers' responses when asked to state their level of confidence in teaching a particular topic.

Table 6.9: Confidence Levels of Teachers of Environmental science in teaching various Topics

Serial Number	Topics	Not stated (%)	very confident (V C) (%)	Confident (C) (%)	Very confident+ confident (VC +C) (%)	Not confident (N C) (%)	Not sure (N S)
1	Introduction to laboratory apparatus	-	70.5	26.9	97.4	-	2.6
2	Birds: Its external features, feeding habits, its egg, reproduction and parental care	34.6	62.8	34.6	97.4	2.6	-
3	Reproduction in human beings	-	62.8	34.6	97.4	1.3	-
4	Blood circulation in human beings	-	55.1	41.0	96.1	1.3	-
5	External features of plants	1.3	60.3	34.6	94.9	1.3	-
6	Respiration and breathing in human beings		55.1	39.7	94.8	5.1	
7	Water: Its properties and its uses.	2.6	60.3	32.1	92.4	1.3	
8	Measurements of temperature, mass length and volume.	1.3	52.6	39.7	92.3	2.6	2.6
9	Plant and animal cells.	1.3	57.7	34.6	92.3	5.6	
10	Photosynthesis	1.3	55.1	37.2	92.3	2.6	1.3
11	Air/Gases: Composition of air; Oxygen and Carbon dioxide	1.3	57.7	33.3	91	6.4	
12	Density		43.6	46.2	89.8	9.0	
13	Transpiration		53.8	35.9	89.7	2.6	2.6
14	Transfer of heat by convection, conduction and radiation.	1.3	55.1	33.3	88.4	9.0	
15	Respiration in plants		47.4	38.5	85.9	2.6	2.6
16	Light : Reflection, refraction, lenses and dispersion		38.5	46.2	84.7	9.0	3.8
17	Mammals:Their features, classification, *etc*		44.9	35.9	80.8	10.3	1.3
18	Energy and its sources	5.1	29.5	46.2	75.7	12.8	2.6
19	Intervention of human beings in nature	7.7	37.2	34.6	71.8	14.1	2.6
20	Separation techniques	2.6	32.1	38.5	70.6	17.9	
21	Electricity	3.8	29.5	39.7	69.2	17.9	7.7
22	The Universe: the earth, moon and stars; solar system and galaxies.		26.9	41.0	67.9	23.1	3.8
23	Expansion in solids, liquids and gases.		1.3	51.3	52.6	42.3	1.3
24	Tropisms	1.3	4.9	44.9	49.8	6.4	

The results in Table 6.9 show that most of the teachers of environmental science who participated in the study were of the view that they were confident. Surprising, close to half of the respondents indicated that they were not confident in teaching expansion. Other topics cited by some respondents included universe, electricity, separation techniques, intervention of human beings in nature, energy and it's source as well as mammals. There seem to be a strong correlation between the topics teachers of environmental science were less confidant to teach and the topics they found difficult to teach. Although most of the teachers of environmental science mentioned that they were confident to teach various topics as the distribution of responses in Table 6.9 shows, lesson observations in some of the schools revealed a contrary

scenario. This scenario was that most of the teachers had the correct drive and correct psychological perspective in teaching environmental science, but they lacked correct concepts. For example, in one of the lessons observed, "Conduction" of sperms was used in place of "transmission" of sperms as one of the functions of the urethra.

Some of the heads of departments who participated in the study indicated that teachers of environmental science needed help in the following topics in order to be effective in teaching them: electricity, radio and television communication (broadcasting), the universe (solar system), light, separation techniques, intervention of man on nature, energy resources and fuel requirements as well as density. A study by Chengo and Kapolyo (1993) found out that teachers of environmental science had difficulties teaching the following topics: electricity, universe and heat. They also report that these were topics pupils disliked. It could be said that the dislike of the topics was by pupils was caused by poor teaching by teachers. In another study (Haambokoma and Mumbula , 1997) pupil respondents reported that some topics were not well taught by their teachers in particular the following: energy, intervention of man on nature, separation techniques and their industrial applications, qualitative study of electricity, broadcasting, refraction and dispersion of light as well as solar system.

6.3 TEACHING TRENDS IN ENVIRONMENTAL SCIENCE

Information on prevailing trend of teaching environmental science was obtained by asking teachers to indicate how frequently they and pupils carried out certain activities during environmental science lessons and methods they used to teach topics they felt least comfortable to teach as well as methods they used to teach topics pupils they did not like. They were also requested to indicate their level of confidence in using various teaching methods. Some lessons were also observed to determine the nature of interaction during lessons.

6.3.1 Frequency of Use of Certain Methods during Environmental Science Lessons

Table 6.10 shows the frequency of use of certain activities during lessons. how often the given methods were used during environmental science classes.

Table 6.10: Frequency of Use of Certain Activities during Environmental science Lessons

Serial number	Activities	Percentage of teachers per category						
		Not stated	Very Often (VO)	Often (O)	Very often + often	Some Times (S)	Never (N)	S + N
1	Teacher asks questions and pupils answer	1.3	67.9	23.1	91.0	7.7	-	7.7
2	Pupils given work to do after classes	1.3	38.5	46.2	84.7	12.8	1.3	14.1
3	Teacher talks, pupils listen	-	39.7	41.0	80.7	17.9	1.3	19.2
4	Teacher demonstrates, pupils watch	-	39.7	37.2	76.9	23.1	-	23.1
5	Pupils search for answers to written questions	-	17.9	51.3	69.2	26.9	3.8	30.7
6	Pupils discuss as a class	2.6	14.1	41.0	55.1	35.9	6.4	42.3
7	Pupils discuss in small groups, teacher guides	1.3	23.1	28.2	51.3	38.5	9.0	47.5

8	Pupils carry out practical in small groups	1.3	19.2	28.2	47.4	41.0	10.3	51.3
9	Pupils work-work a solution to a problem	9.0	14.1	30.8	44.9	38.5	7.7	46.2
10	Pupils read from printed material (e.g. textbooks)	2.6	10.3	34.6	44.9	43.6	9.0	52.6
11	Pupils working in pairs	5.1	3.8	37.2	41.0	41.0	12.8	53.8
12	Pupil(s) explains while the rest listen	3.8	7.7	23.1	30.8	57.7	7.7	65.4
13	Class goes outside the classroom to learn	-	9.0	21.8	30.8	61.5	7.7	69.2
14	Pupil(s) demonstrates, the rest watch	2.6	5.1	24.4	29.5	51.3	16.7	68
15	Pupils carrying out an extended investigation on an issue	2.6	7.7	14.1	21.8	50.0	25.6	75.6
16	Pupils carry out individual practical work	2.6	5.1	11.5	16.6	48.7	32.1	80.8
17	Pupils act roles (role play)	5.1	3.8	11.5	15.3	35.9	43.6	79.5
18	Pupils listen to a guest speaker	5.1	-	12.8	12.8	43.6	38.5	82.1
19	Team teaching	3.8	3.8	7.7	11.5	32.1	52.6	84.7
20	Pupils play educational games	2.6	1.3	7.7	9.0	25.6	62.8	88.4
21	Teacher uses video/film to teach	2.6	1.3	6.4	7.7	19.2	70.5	89.7

The distribution of responses in Table 6.10 above shows that the most often used method was "Teacher asks questions and pupils answer" while the least used was "use of video/film". This was probably a manifestation that most of the schools were emerging, had no electricity, did not have the facility or did not have well-trained personnel to handle the equipment.

6.3.2. Methods Used to Teach Topics Teachers were Least Comfortable

Table 6.11 shows the frequency a method had been mentioned as being used to teach topics that teachers were least comfortable to teach. The total number of cases was 105.

Table 6.11: Methods used to Teach Topics Least Comfortable to Teach.

Rank	Methods	Frequency	Percentage
1	Teacher talks, pupils listen	45	42.9
2	Teacher asks questions and pupils answer	20	19.0
3	Teacher demonstrates, pupils watch	15	14.3
4	Pupils discuss as a class	10	9.53
5	Pupils read from printed material (e.g. textbooks)	04	2.9
6	Class goes outside the classroom to learn	03	2.9
7	Teacher uses video/film to teach	03	1.9
8	Pupils carry out practical in small groups	02	1.0
9	Pupil(s) explains while the rest listen	01	1.0
10	Pupils discuss in small groups, teacher guides	01	1.0

11	Pupils given work to do after classes	01	1.0
12	Pupil(s) demonstrates, the rest watch	00	0.0
13	Pupils act roles (role play)	00	0.0
14	Pupils carry out individual practical work	00	0.0
15	Pupils work-work a solution to a problem	00	0.0
16	Pupils search for answers to written questions	00	0.0
17	Pupils listen to a guest speaker	00	0.0
18	Team teaching	00	0.0
19	Pupils working in pairs	00	0.0
20	Pupils carrying out an extended investigation on an issue	00	0.0
21	Pupils play educational games	00	0.0

The most popular method was "Teacher talk, pupils listen". It was mentioned 45 times (42.9%). The other three methods were "Teacher asks questions and pupils answer" 20 times (19.0%), "Teacher demonstrates, pupils watch" 15 times 14.3% and "Pupils discuss as a class" 10 times (9.5%). This scenario was confirmed in some of the lessons that were observed. For example, one teacher for most part of the lesson used lecture methods and for a small part used class discussion, which was not handled very well. Pupils were left on their own for a long time without guidance.

On the other side of the spectrum in Table 6.11 were methods with serial numbers 12 to 21. It was shown that these methods were extremely unpopular among the teachers of environmental science in schools, which participated in the study. Yet these were among some methods that could achieve meaningful learning.

6.3.3 Methods Teachers used to Teach Topics Pupils Disliked

Table 6.12 shows the methods frequently used by teachers of environmental science to topics they perceived pupils did not like them. 93 cases were mentioned and each method was mentioned a number of times indicated in the table. There after the percentages were calculated and shown in Table 6.12. The first three methods were the most popular. It appears that these methods were even used incorrectly because they constitute a lecture method. According to Laws (1997), lectures are best for inspiration and for the transmission of information. In this study, it was revealed that pupils were not inspired to like these topics in which the lecture method was used. However, lectures are not effective for teaching concepts (Laws, 1997) hence resulting in rote learning.

Table 6.12: Methods Teachers of Environmental Science Used to Teach Topics Pupils disliked

Serial Number	Methods	Frequency	Percentages
1	Teacher demonstrates, pupils watch	22	23.7
2	Teacher talks, pupils listen	22	23.7
3	Teacher asks questions and pupils answer	17	18.3
4	Pupils carry out practical in small groups	10	10.8
5	Pupils read from printed material (e.g. textbooks)	5	5.4
6	Pupils discuss as a class	05	5.4
7	Pupil(s) demonstrates, the rest watch	03	3.2

8	Pupils carry out individual practical work	03	3.2
9	Pupil(s) explains while the rest listen	02	2.2
10	Pupils discuss in small groups, teacher guides	01	1.1
11	Pupils work-work a solution to a problem	01	1.1
12	Class goes outside the classroom to learn	01	1.1
13	Pupils search for answers to written questions	01	1.1
14	Pupils act roles (role play)	00	0.0
15	Pupils given work to do after classes	00	0.0
16	Pupils listen to a guest speaker	00	0.0
17	Team teaching	00	0.0
18	Pupils working in pairs	00	0.0
19	Pupils carrying out an extended investigation on an issue	00	0.0
20	Teacher uses video/film to teach	00	0.0
21	Pupils play educational games	00	0.0

6.3.4 Level of Confidence in Using Certain Teaching Strategies

Table 6.13 shows self-assessment of teachers of environmental science in using the strategies given.

Table 6.13: Teachers of environmental science' level of confidence in using the given Strategies

Serial Number	Strategies	Percentage of teachers per category						
		Not stated	Very Confident (V C)	Confident (C)	Very confident + confident (V C + C)	Not confident (N C)	Not sure (N S)	(N C + N S)
1	Demonstration	-	71.8	28.2	100	-	-	-
2	Question and answer	1.3	76.9	21.8	98.7	-	-	-
3	Use of printed materials (e.g. text books, worksheets)	1.3	47.4	50.0	97.4	1.3	-	1.3
4	Home work	2.6	51.3	39.7	91.0	5.1	1.3	6.4
5	Group discussions	1.3	39.7	50.0	89.7	9.0	-	9.0
6	Lecture method	5.1	57.7	29.5	87.2	6.4	1.3	7.7
7	Problem solving	2.6	46.2	39.7	85.9	3.8	7.7	11.5
8	Whole class discussion	1.3	34.6	50.0	84.6	9.0	5.1	14.1
9	Small group practical work	5.1	30.8	53.8	84.6	7.7	2.6	10.3
10	Individualised work	2.6	30.8	51.3	82.1	14.1	1.3	15.4
11	Pair work	1.3	23.1	53.8	76.9	11.5	10.3	21.8
12	Investigation	1.3	33.3	43.6	76.9	12.8	9.0	21.8
13	Project work	2.6	26.9	47.4	74.3	15.4	7.7	23.1
14	Field trips	7.7	25.6	39.7	65.3	14.1	12.8	26.9
15	Role play	3.8	14.1	44.9	59.0	23.1	14.1	37.2
16	Team teaching	2.6	16.7	37.2	53.9	24.4	19.2	43.6
17	Educational games	5.1	11.5	25.6	37.1	30.8	26.9	57.7
18	Other (specify):	91.0	3.8	3.8	7.6	-	1.3	1.3

The results in Table 6.12 show confidence levels in descending order with "demonstration" being the one in which they were most confident and "Educational games" being the one they were least confident.

What is coming through from the information presented above is that in most cases teachers were using methods which were teacher- centres i.e. during the lessons, the teachers were more active than pupils. These results confirm the findings of studies (Chirwa, 1992; Phiri, 1992; Nyirenda, 1992; Sarvi, *et. al.* 1992) done under Zambia Educational Materials Project, which reported that teacher-centred teaching approach, was very dominant in lessons observed. It has also observed that most teachers were frequently using methods they were confident in using. This suggests that there is need to make teachers confident in using learner-centred teaching approaches.

6.4 TEACHERS' VIEWS ON OTHER ASPECTS OF TEACHING ENVIRONMENTAL SCIENCE

6.4.1 Perceptions of Teachers on Teaching and learning of Environmental Science

Table 6.14 shows how teachers reacted to statements on teaching and learning of environmental science. Most of them agreed that processes were the most important aspects of environmental science teaching. On the other extreme most of them, disagreed with the statement that girls were on the whole incapable of becoming good environmental scientists. In addition, they believe that lesson plans were an essential part of lesson preparation. Examination success was not a priority among teachers of environmental science.

Table 6.14: Teachers' Reactions to some Statements on Teaching/ learning of Environmental Science

Serial number	Statement	Percentage of teachers per category						
		Not stated	Strongly agree (SA)	Agree (A)	Strongly agree + agree (SA + A)	Disagree (D)	Strongly disagree (SD)	Strongly disagree + disagree
1	Processes are the most important aspects of Environmental Science teaching	3.8	48.7	46.2	94.9	1.3	-	1.3
2	Every lesson must have a lesson plan	5.1	37.2	41.0	78.2	7.7	9.0	16.7
3	Environmental science teaching should put emphasise on the products (e.g. facts, principles, rules, theories)	7.7	28.2	42.3	70.5	19.2	2.6	21.8
4	Examination success should be the priority for Environmental Science teaching	6.4	11.5	21.8	33.3	48.7	11.5	60.2
5	Some pupils are incapable of learning Environmental Science	5.1	5.1	15.4	20.5	48.7	25.6	74.3
6	School Environmental science is too divorced from the real world	5.1	2.6	14.1	16.7	48.7	29.5	78.2
7	Information contained in official textbooks should not be questioned	5.1	1.3	2.6	3.9	53.8	37.2	91.0
8	Girls are, on the whole, incapable of becoming good Environmental scientists	5.1	2.6	1.3	3.9	26.4	64.1	90.5

Tables 6.15 to 6.19 show teachers' ranking according to importance of some aspects in teaching of Environmental Science. The weightings 3, 2, and 1 were assigned to statements ranked by individual teachers respectively as first, second and third. To obtain the figures in the column headed totals, entries in each row were substituted in the formula:

[(3 × frequency in 1st column) + (2 × frequency in 2nd column) + (1 × frequency in 3rd column)]

Thus row totals were used to rank the aspects of teaching environmental science according to importance as perceived by teachers of environmental science.

6.4.2 Perceptions of Teachers on Objectives of Teaching Environmental Science

Table 6.15 shows in descending order how the teachers rated objectives of teaching environmental science. The different statements were given and teachers were asked to choose three, which they considered important. Most believed that facilitating process skills was most important in the teaching of environmental science.

Table 6.15: Teachers' Ranking of Objectives of Teaching Environmental Science

Teaching objectives	Frequency rating			Totals	Rank
	1st	2nd	3rd		
To facilitate process skills such as observing, measuring, formulating hypothesis, identifying variables, experimenting, interpreting data etc.	29	17	10	171	1
To understand scientific knowledge, such as facts, concepts and principles etc and apply these to the solution of problems.	20	23	11	146	2
To be curious about their surroundings and also allow them to sense and formulate the existence of a problem.	29	8	13	131	3
To acquire the ability to observe things and events in order to perceive and identify them.	14	11	6	116	4
To acquire the ability to recall previous experiences, and to construct their own knowledge of physical phenomena and to be able to identify and explain them.	9	11	14	63	5
To be free from bias, prejudice and superstitions and to acquire open mindedness, critical mindedness and intellectual honesty.	6	13	16	60	6
To be aware of and respond in a positive manner to beauty and orderliness in their environment.	9	10	8	55	7

6.4.3 Perceptions of Teachers of Environmental science on Teaching Content and Process skills

Table 6.16 shows how teachers rated the teaching of content and the process. The statements were arranged in descending order.

Table 6.16: Teachers of Environmental Science's Perception of teaching content and process Skills

Teaching contents and process	Frequency rating			Total	Rank
	1st	2nd	3rd		
organizing topics to promote scientific thinking, understanding of knowledge, growth of experimental skills, problem solving skills, and development of interest and positive attitude.	26	25	16	144	1
Recognizing that teaching contents of Environmental Science must be considered in relation to the nature of learners, their needs and interest, growth levels, etc.	28	14	17	129	2
Organizing contents to provide opportunities for building scientific concept and applying them to further inquiry tasks, projects, and concepts and principles and application to daily life and technology.	22	22	17	127	3
Recognizing the importance of student's learning difficulties as well as teachers' instrumental difficulties.	19	11	12	91	4
Organizing contents that cultivate process of Environmental Science and communication skills to acquire the desire to know, to communicate with others orally and in writing,	12	9	7	61	5

A large number of teachers of environmental science perceived that teachers should organise topics to promote scientific thinking, understanding of knowledge, growth of experimental skills, problem – solving skills and development of interest and positive attitude.

6.4.4 Perceptions on teaching methods/strategies by teachers of environmental science

Table 6.17 was also arranged in descending order of importance of the teaching methods and strategies that teachers of environmental science proposed to use.

Table 6.16: Teachers of Environmental Science's ranking of Teaching Methods/strategies

Teaching methods/strategies	Frequency rating			Totals	Rank
	1st	2nd	3rd		
Utilizing various teaching strategies: problem solving, individual learning, cooperative group learning, project method, demonstration, student's experiments, etc.	31	10	11	144	1
Encouraging students to give their own ideas and help them to discuss how they differ from those held by scientists, so that they can verify and generalize the phenomenon into scientific concepts and principle	13	23	10	95	2
Conducting lessons to promote learning through activities such as questioning, suggesting, demonstrating, explaining, discussing, presenting, criticizing, asking for evidence, conceptualizing etc.	15	15	8	83	3

Utilizing various teaching sites such as classroom, laboratory, school grounds and field in lesson.	10	13	6	74	4
Using charts, diagram, models, materials and analogies to make abstract concepts clear to student's etc.	14	7	6	65	5
Utilizing various teaching facilities and materials, which may be available in the local environment.	13	6	12	63	6
Inviting students' everyday meaning of various experience and alternative interpretation and give them opportunities to explore and correct their misconception/naïve conception and to draw scientific conclusions by using scientific terms.	8	12	7	61	7
setting teaching/learning goals, which are explicit, realistic and accepted by students.	12	7	5	55	8

It was found out that most teachers of environmental science perceived utilising various teaching strategies as the most important way of developing conceptual understanding among students. However, in the earlier observations in this study, it was discovered that most teachers of environmental science did not use a variety of methods.

6.4.5 Perceptions of Teachers of Environmental Science on Practical Work

Table 6.18 shows teachers' perceptions of importance of the statements about practical work.

Table 6.18: Teachers' rating of statements on organisation and management of practical work in environmental science

Aspects of organisation and management of practical work	Frequency rating			Totals	Rank
	1st	2nd	3rd		
Encouraging and guide students to perform experiments carefully and accurately	21	22	11	118	1
Revising experiments conducted in such a way as to make student think about the purpose of performing the experiment	25	12	7	106	2
Applying classroom management to allow for individual small group and whole class instruction techniques for planning and carrying out the experiment and data gathering, formulating the generalization by students	17	17	10	95	3
Demonstrating in order to help students to understand the concepts and principles of environmental science	17	11	5	78	4
implementing safe laboratory measures.	20	6	5	77	5
Selecting equipment and apparatus in laboratory	9	9	11	56	6
Handle safely the emergencies that may arise	11	7	5	52	7
Allowing students to take a lot of time for communication, interpreting and verifying	8	7	7	45	9
Teachers allowing students to suggest experiments and observations to answer their own questions	5	9		40	10

As can be seen in Table 6.18, most teachers of environmental science expressed that the need to encourage and guide pupils to perform experiments was the most important aspect of practical work. The second was that of teachers devising experiments conducted in such a way as to make students think as well as being conscious of the purpose of performing the experiments. The third important aspect was that of applying classroom management to allow for individual small group and whole class instruction techniques for planning and carrying out the experiment and data gathering, formulating the generalisation by students.

6.4.5 Perceptions of Teachers of Environmental Science on Production and Usage of Teaching/Learning Materials

Table 6.19 indicates teachers' thinking on development of teaching materials and their use.

Table 6.19: Material Production and Usage

Material Production and Usage	Frequency rating			Totals	Rank
	1st	2nd	3rd		
Teachers developing and utilize instructional materials suited to student's ability levels and relevant to classroom objectives.	40	14	12	160	1
Teachers select, adapt and utilize supplementary books, handbooks and other materials for learning use by students.	19	24	21	126	2
Teachers adapt and utilize a variety of instructional material and media, such as charts, diagrams, newsprint papers etc.	19	25	17	124	3
Teachers utilize the textbooks as the most important resource materials for use in teaching.	8	9	17	59	4

Table 6.19 indicates that most teachers of environmental science were of the view that making and utilising materials suited to students' ability levels in environmental science lessons was the most important. Ranked second was that of selecting, adapting and utilising of supplementary books, handbooks and other materials for learning by students. The third one was that of adapting and utilizing a variety of instructional material and media such as charts, diagrams, newsprint papers etc.
Very few supported the use of textbooks during lessons.

6.4.7 Views on Aspects of Assessing Pupils' Learning

Table 6.20 shows that most teachers of environmental science were for the idea of utilising fair and varied learner evaluation measures such as paper and pencil tests, essays, tests, checklists, interview, homework *etc.* They regarded this as the most important practice of determining if pupils had learnt. This indicated that these teachers believe that the grading process is a valuable measure of student learning (Walvoord & Anderson, 2000 Physics teacher). Teachers ranked second the practice of using results of evaluation for revising instruction and enhancing learning achievement. The third important aspect was that concerned teachers should develop and improve environmental science tests and evaluation instruments to measure cognitive and process skills among students. Surprising, teachers did not see the use of past examination papers to assess learners as being important.

Table 6.20: Teachers of Environmental Science's Views on Aspects of Assessing Pupils' Learning

Aspects of assessment of pupils' learning	Frequency rating			Totals	Rank
	1st	2nd	3rd		
Utilizing fair and varied student evaluation measures as paper and pencil tests, essay, tests, checklists, interview, homework etc.	24	16	7	111	1
Utilizing results of evaluation for revising instruction and enhancing learning achievement.	14	22	12	98	2
Developing, improving Environmental Science competency tests and evaluation instruments to measure cognitive and process skills.	22	11	6	94	3
Assigning individual homework appropriate to the level of students' ability and give feedback/evaluation promptly.	14	11	20	84	4
Identifying learners with special needs and providing the necessary support for assistance and guidance.	16	8	10	74	5
Utilizing past examination questions.	11	9	8	59	6
Classifying students' ability and understanding by utilizing the results of evaluation.	9	11	2	51	7
Utilizing textbook exercise.	5	5	13	38	8

6.5 VIEWS OF TEACHERS OF ENVIRONMENTAL SCIENCE ON ASPECTS OF CPD

Teachers of environmental science were asked to indicate the areas in which they needed further professional development and to react to statements on the organisation and implementation of CPD programs.

6.5.1 Need for further professional development

Table 6.21 shows in descending order the areas in which the teachers needed further professional development. A scrutiny revealed that all areas were above 50%. This could have been an indication that they needed further development in all the areas that were in the table. However, the first three in the table needed immediate attention. These were:

- teaching pupils with poor science background (75.7%),
- catering for individual differences among learners (73.1%)
- knowledge about gender-sensitive teaching approaches (68%).

Table 6.21: Teachers of Environmental Science's Perception of their Need of Professional Development.

Serial Number	Areas	Not stated	Very high (VH)	High (H)	Very high + high (VH + H)	Low (L)	Not at all (NA)	Low + not at all (L + NA)
1	Teaching pupils with poor science background	5.1	38.5	37.2	75.7	16.7	2.6	19.3
2	Catering for individual differences among learners	5.1	35.9	37.2	73.1	16.7	5.1	21.8
3	Knowledge about gender-sensitive teaching approaches	5.1	35.9	32.1	68.0	20.5	6.4	26.9
4	Teaching at higher grade	5.1	42.3	24.4	66.7	19.2	9.0	28.2

	levels than trained for							
5	Motivating learners	6.4	39.7	24.4	64.1	19.2	10.3	29.5
6	Coping with heavy teaching loads	6.4	44.9	19.2	64.1	21.8	7.7	29.5
7	Coping with public examination demands	9.0	30.8	33.3	64.1	21.8	5.1	26.9
8	Improvising teaching materials	6.4	38.5	24.4	62.9	25.6	5.1	30.7
9	Knowledge about how pupils learn chemistry	3.8	32.1	30.8	62.9	29.5	3.8	33.3
10	Use of audio/visual aids	2.6	38.5	21.8	60.3	29.5	7.7	37.2
11	Handling large Environmental Science classes	5.1	30.8	29.5	60.3	28.2	6.4	34.6
12	Use of printed material	2.6	25.6	29.5	55.1	33.3	9.0	42.3

6.5.2 Reactions of the teachers of environmental science to statements on organisation and implementation of continuing professional development

Table 6.22 shows the extent to which teachers of environmental science agreed or disagreed with statements on organisation and implementation of continuing professional development.

Table 6.22: Teachers of Environmental Science's Reactions to Statements on Mode of Organization and /or Implementation of CPD

Rank	Statement	Not stated (%)	Strongly agree (S A) (%)	Agree (A) (%)	Strongly agree + agree (S A) (%)	Disagree (D) (%)	Strongly disagree (S D) (%)	Disagree +Strongly disagree (S D + D) (%)
1	Participants in CPD programmes should receive certificates.	6.4	57.7	33.3	91.0	1.3	1.3	2.6
2	CPD is a must for teachers	7.7	56.4	26.9	83.3	9.0	0.0	9.0
3	CPD programmes are best if they take place during school holidays rather than during term time	6.3	38.5	30.8	69.3	15.4	9.0	24.4
4	Teachers are best facilitators for fellow teachers in CPD programmes	5.2	35.9	33.3	69.2	20.5	5.1	25.6
5	Attendance at CPD programmes should be solely for the purpose of professional growth.	09	20.5	46.2	66.7	17.9	6.4	24.3
6	College/university lecturers are the best facilitators for teachers in CPD programmes	5.1	29.5	37.2	66.7	21.8	6.4	28.2
7	CPD programmes are best if	7.7	38.5	23.1	61.6	25.6	5.1	30.7

	they are college/university-based							
8	CPD programmes are best if based at resource centres	6.4	12.8	44.9	57.7	30.8	5.1	35.9
9	CPD programmes are best if they are school-based	5.2	28.2	28.2	56.4	33.3	5.1	38.4
10	INSET providers are the best facilitators for teachers in CPD programmes	7.7	9.0	43.6	52.6	33.3	6.4	39.7
11	Short CPD programmes (e.g. 1 week duration) are better than those of longer duration	6.4	15.4	29.5	44.9	35.9	12.8	48.7
12	The cost of participation in CPD programmes should be borne by individual participants/schools	6.4	9.0	20.5	29.5	30.8	33.3	64.1
13	Inspectors are the best facilitators for teachers in CPD programmes	7.7	7.7	17.9	25.6	43.6	23.1	66.7

A very interesting finding here was that most of the teachers of environmental science disagreed with the statement that the cost of participation in CPD programs should be borne by individual participants/schools. Only 29.6% agreed. However, 91.0% agreed that Participants in CPD programs should receive certificates. In addition it was revealed that 69.2% of teachers of environmental science believed that teachers were the best facilitators for fellow teachers in CPD programmes and only 25.6% believed that inspectors were the best facilitators for teachers in CPD programmes. This is an indication that most teachers of environmental science preferred fellow teachers as facilitators to inspectors.

6.6 TOPICS PUPILS FOUND DIFFICULTY TO LEARN IN ENVIRONMENTAL SCIENCE

Information on topics pupils found difficult to learn in environmental science was gathered by giving pupils who participated in the study, a list of topics and asking them to indicate whether they found them difficult or easy to learn. The distribution of responses is shown in Table 6.23.

Table 6.23: Topics Pupils Found Difficulty to Learn in Environmental Science

Serial Number	Topic	Not stated	Very difficult (V D) (%)	Difficult (D) (%)	Very difficult + difficult (V D) (%)	Easy (E) (%)	Very Easy (V E) (%)	Easy + Very easy (V E + E) (%)
1	Light: Reflection, refraction, lenses and dispersion	6.5	11.1	25.9	37.0	33.3	23.1	56.4
2	Density	2.8	8.3	25.3	33.6	37.7	25.9	63.6
3	Intervention of human beings on nature	35.8	14.8	17.3	32.1	11.1	21.0	32.1
4	Mammals: their features, classification, etc.	4.6	14.9	16.1	31.0	25.3	39.1	64.4
5	Tropisms	3.1	5.4	24.2	29.6	38.5	28.8	67.3

6	Energy and its sources	22.5	9.2	18.3	27.5	29.2	20.8	49.2
7	Respiration in plants	3.9	4.4	22.0	26.4	49.8	20.0	69.8
8	Separation techniques	40.5	16.2	9.5	25.7	18.9	14.9	33.8
9	Transpiration	6.7	6.7	16.0	22.7	47.4	23.2	70.6
10	Blood circulation in human beings	4.1	4.1	17.6	21.7	51.4	22.9	74.3
11	External features of plants	7.8	5.0	16.1	21.1	45.0	26.1	71.1
12	Measurements of temperature, mass, length and volume	3.5	2.8	16.1	20.9	49.0	28.7	77.7
13	Air/Gases: Composition of air; oxygen and carbon dioxide	4.3	3.6	15.7	19.3	43.6	32.9	76.5
14	Electricity	12.9	5.5	13.4	18.9	40.3	27.9	68.2
15	Photosynthesis	1.7	3.0	12.9	15.9	47.0	35.3	82.3
16	Transfer of heat by convection, conduction and radiation	2.8	1.8	13.5	15.3	43.4	38.4	81.8
17	Reproduction in human beings	7.7	2.9	12.0	14.9	33.5	44.0	77.5
18	The universe: the Earth, Moon and Stars; Solar system and Galaxies.	6.0	3.4	11.1	14.5	47.0	32.5	79.5
19	Plant and animal cells	1.9	1.2	12.8	14.0	46.5	37.6	84.1
20	Respiration and breathing in human beings	1.8	1.8	11.6	13.4	48.2	36.6	84.8
21	Expansion in Solids, liquids and gases	3.2	2.6	7.7	10.3	42.9	43.5	86.4
22	Water: Its properties and its uses	8.6	2.1	4.7	6.8	47.2	37.3	84.5
23	Birds: its external features, feeding habits, egg, reproduction and parental care.	0.7	0.7	2.5	3.2	44.4	51.6	96
24	Introduction to laboratory apparatus	3.6	.8	6.0	1.4	45.2	44.4	89.6

The distribution of responses show that pupils did not find most of the topics difficult to learn. A further scrutiny of topics in Table 6.23 in comparison to topics teachers were least comfortable to teach in table 6.8, showed no correlation. This could have meant that pupils found certain topics difficult to learn, not because of the teachers' comfortability to teach but probably the methods used by teachers as discussed in section 6.2.1.

6.6.1 Topics pupils disliked in Environmental Science

Table 6.24 shows the topics pupils disliked. Upon further scrutiny these topics were closely related to the topics teachers found least comfortable to teach. For example, electricity was position 1 in Table 6.24 while in Table 6.8 it was in position 3, energy and its sources was in position 6 in Table 6.24 while in Table 6.8 it was in position 4, and the universe was position 5 in Table 6.24 while in Table 6.8 it was in position 1. Therefore, it can be safely concluded that teachers of environmental science mentioned that pupils disliked topics in which they were least comfortable to teach.

Again this could have been because of the methods used by the teachers of environmental science.

The topics pupils disliked most, were worked out of 193 cases mentioned by teachers of environmental science. Teachers of environmental science were asked to mention topics that their pupils disliked most. Out of 193 statements available from teachers, each topic was mentioned a number of times as shown in the table under the column frequency. There after, the percentages were calculated.

Table 6.24: Environmental science Topics Pupils Disliked Most

Serial Number	Topics	Frequency	Percentage s
1	Electricity	39	20.2
2	Density	28	14.5
3	Light: reflection, refraction, lenses and dispersion	19	9.8
4	Separation techniques	16	8.3
5	The Universe: the earth, moon and stars as well as solar system and galaxies.	14	7.3
6	Energy and its sources	13	6.7
7	Introduction to laboratory apparatus	10	5.2
8	Measurements of temperature, mass, length and volume.	06	3.1
9	Tropisms	05	2.6
10	Intervention of human beings in nature	05	2.6
11	Water: its properties and its uses.	04	2.1
12	Air/gases : composition of air; oxygen and carbon dioxide	04	2.1
13	Expansion in solids, liquids and gases.	04	2.1
14	Reproduction in human beings	03	1.6
15	Transfer of heat by convection, conduction and radiation.	03	1.6
16	Plant and animal cells	03	1.6
17	Photosynthesis	02	1.0
18	Transpiration	02	1.0
19	Birds: its external features, feeding habits, its egg, reproduction and parental care	01	0.5
20	Respiration in plants	01	0.5
21	Mammals: Their features, classification, etc	01	0.5
22	Respiration and breathing in human beings	00	0.0
23	Blood circulation in human beings	00	0.0
24	External features of plants	00	0.0

6.7 PUPILS' VIEWS ON TEACHERS' TEACHING APPROACH

6.7.1 Pupils' views on their environment science lessons

Pupils were given a list of statements on classroom practice and were asked to state how much they agreed or disagreed. Table 6.25 shows the distribution of responses.

Table 6.25: Pupils' views on their environmental science lessons

Serial Number	Statements	Percentage of pupils in each category						
		Not stated	Strongly disagree (SD)	Disagree (D)	SD + D	Agree (A)	Strongly Agree (SA)	SA + A
1	The teacher sometimes asks faster learners to assist their friends	2.6	15.5	34.2	49.7	27.8	19.9	47.7
2	The teacher sometimes takes us out of the classroom to learn	3.8	19.3	29.8	49.2	25.7	21.3	47.0
3	The teacher never misses lessons	0.9	7.3	40.4	47.7	28.7	22.8	51.5
4	Sometimes we work in pairs during her/his lessons	4.1	15.2	31.9	47.1	32.2	16.7	48.9
5	S/he allows us to talk to each other on the topic being taught	5.3	19.0	26.6	45.6	32.5	16.7	49.2
6	S/he asks for our ideas and uses them	2.9	8.8	27.5	36.3	39.8	21.1	60.9
7	S/he marks the homework and tests and gives us feedback quickly	1.5	14.9	21.3	36.2	34.8	27.5	62.3
8	The teacher gives individual help to pupils who have difficulties	0.6	13.5	21.3	34.8	34.8	29.8	64.6
9	The teacher varies her/his teaching methods	3.5	7.9	26.6	34.5	45.3	16.7	62
10	S/he only punishes when it is very necessary	2.6	13.2	19.9	33.1	36.8	27.5	64.3
11	S/he calls us by our names when s/he wants us to answer a question	1.2	9.6	22.2	31.8	33.0	33.9	66.9
12	The teacher relates the subject to our everyday life	1.8	7.9	23.4	31.3	46.5	20.5	67.0
13	S/he encourages us to give our own views/ideas during the lesson	2.0	5.8	24.3	30.1	36.5	31.3	67.8
14	S/he gives us homework and tests regularly	1.5	14.9	21.3	29.2	34.8	27.5	62.3
15	We perform experiments in her/his lessons	2.6	9.9	17.8	27.7	36.0	33.6	69.6
16	S/he also encourages even if one gives a wrong answer	1.5	11.7	15.2	26.9	37.4	34.2	71.6
17	S/he does not move from one topic to another before making sure that we have understood	0.6	9.1	16.4	25.5	28.9	45.0	73.9
18	The teacher is always punctual for lessons	1.2	8.8	15.5	24.3	38.9	35.7	74.6
19	S/he draws neat and accurate diagrams on the board	1.8	7.6	14.3	21.9	41.8	34.5	76.3
20	At the end of the lesson, the teacher summarises the points covered or asks us questions	2.0	6.7	14.3	21.0	40.1	36.8	76.9
21	S/he gives us some exercises to do during the lesson	2.0	6.1	14.3	20.4	41.8	35.7	77.5
22	S/he explains our mistakes in our work	1.5	7.0	11.7	19.4	45.0	34.8	79.8
23	S/he gives us notes in a manner that encourages us to think	2.0	4.4	12.3	16.7	42.7	38.6	81.3

24	The teacher introduces his/her lesson in an interesting way	2.0	5.6	10.8	16.4	45.9	35.7	81.6
25	S/he makes the subject enjoyable to learn	2.3	3.8	10.8	14.6	41.5	41.5	83.0
26	S/he asks questions clearly	2.3	2.6	8.5	11.1	48.0	38.6	86.6
27	S/he uses examples and illustrations during our lesson	4.1	2.9	7.6	10.5	45.9	39.5	85.4
28	S/he writes clearly on the board	1.8	3.8	6.7	10.5	44.2	43.6	87.8
29	The teacher knows the subject well	-	4.1	6.4	10.5	38.0	51.5	89.5
30	S/he asks questions to both girls and boys	8.2	5.3	4.4	9.8	34.2	48.0	82.2
31	S/he asks questions to both hand-raised and non-hand raised	8.2	5.3	4.4	9.7	34.2	48.0	82.2
32	S/he encourages both girls and boys to answer questions	7.9	3.8	5.6	9.4	34.5	48.2	82.7
33	The teacher encourages us to study or do the subject during our spare time	1.2	3.5	5.6	9.1	33.6	56.1	89.7
34	S/he encourages us to ask questions if we don't understand	2.0	3.5	4.4	7.9	30.1	59.9	90.0

Table 6.25 shows that 49.7% of the pupils said that their teachers did not ask faster learners to assist their friends, 49.25% said that their teachers did not take them out of the classroom to learn, 47.7% said that they did not work in pairs during their lessons, and 47.7% said that their teachers missed lessons.

6.8 SUMMARY OF FINDINGS.

In short, the information presented in this chapter has shown that:

6.8.1 Demographic Characteristics of Teachers of environmental science

There were fewer female teachers of environmental science than males; most of the teachers of environmental science were young, with a short period of service as teachers. Also, 45% of teachers of environmental science were holders of a diploma in education and were trained to teach environmental science. In addition, very few were active participants in ZASE activities.

6.8.2 Topics teachers of Environmental Science found Difficult to Teach

Teachers of environmental science found it difficult to teach: The Universe: the earth, moon and stars; Solar system and galaxies; Mammals: their features, classification, *etc.;* Electricity; Energy and its sources; Transpiration; and the Intervention of human beings in nature.

6.8.3 Prevailing teaching trends

In most environmental Science classes, the common teaching methods used were: Teachers asking questions while pupils answer; Pupils are given work to do after classes; Teachers talk while pupils listen; Teachers demonstrate while pupils watch; Pupils search for answers to written questions.

6.8.4 Teacher's Perceptions towards Teaching Environmental Science

Most teachers of environmental science believed that processes were the most important aspects of Environmental Science teaching. They felt that they should facilitate process skills such as observing, measuring, formulating hypothesis, identifying variables, experimenting, interpreting data etc; foster the understanding of scientific knowledge, such as facts, concepts and principles etc and emphasise the application of these to the solution of problems; They were also of the view that every lesson should have a lesson plan i.e. teachers should plan for every lesson.

In the teaching of content and process, teachers of environmental science believed that Teachers should organize topics to promote scientific thinking, understanding of knowledge, growth of experimental skills, problem solving skills, and development of interest and positive attitude.

Teachers should utilize various teaching strategies: problem solving, individual learning, cooperative group learning, project method, demonstrations, and student's experiments.

In terms of practical work teachers should encourage and guide students to perform experiments carefully and accurately.

On material production, respondents were of the view that teachers should develop and utilise instructional materials suited to student's ability levels and relevant to classroom objectives. In assessment, their perception was that teachers should utilise fair and varied student evaluation measures such as paper and pencil tests, essay, tests, checklists, interview, and homework.

6.8.5 Views of teachers of environmental science on aspects of continuing professional development (CPD)

In terms of continuing professional development (CPD), teachers needed to learn how to teach pupils with poor science background and how to cater for individual differences among learners. On the organisation and implementation of CPD teachers believed that participants should receive certificates and that the program was a must for teachers.

6.8.6 Topics pupils found difficult to learn in environmental science

Pupils found it difficult to learn Light: Reflection, refraction, lenses and dispersion; Density; Intervention of human beings on nature; Mammals; Tropisms; and Energy and its sources. However, they disliked Electricity; Density; Light: Reflection, refraction, lenses and dispersion; Separation techniques; The Universe: the earth, moon and stars; Solar system and galaxies; and Energy and its sources.

CHAPTER SEVEN

FINDINGS AND DISCUSSION: MATHEMATICS

7.1 DEMOGRAPHIC CHARACTERISTICS OF TEACHERS OF MATHEMATICS

7.1.1 Sex of teachers

The distribution of the 234 teachers by sex is shown in Table 7.1 below.

Table 7.1: Distribution of Teacher respondents by Sex.

	Number (No.)	Percentage (%)
Male	211	90.2
Female	22	9.4
Total	233	99.6

The table shows that the teaching of mathematics is predominantly a man's territory with about 90% of the teacher respondents being male and a paltry 9% being female. The male to female ratio was worse for Heads of Department where out of the 44 sampled, only one (2%) was female – indicating a serious gender disparity in leadership in mathematics education. The gross under representation of women at both the teaching and departmental management levels is likely to consolidate the existing stereo-type of mathematics being a male domain.

7.1.2 Age of teachers

The age distribution of the teachers of mathematics that responded to the questionnaires is given in Table 7.2 below.

Table 7.2: Distribution of Teacher respondents by age.

Age	Frequency	Percentage (%)
Less than 30 years	69	29.5
31 – 40 years	129	55.1
41 – 50 years	28	12.0
Above 50 years	6	2.6
Total	234	99.2

The table shows that the majority of teachers of mathematics in Zambia were very young with more than a quarter below 30 years of age and well over three-quarters (84.6%) aged 40 or below. Only 12% are in the age range of 41 to 50 years and a negligible number of teachers, less than 3%, above 50 years of age.

The situation for Heads of Department (HoDs) was that 7 (16%) were less than 30 years of age, 25 (57%) between 31 and 40 years, and 12 (27%) above 40. Thus, the teaching as well as leadership of mathematics education in secondary schools mathematics was largely in the hands of relatively young persons whom, as Table 7.3 below shows, also had modest teaching experience.

7.1.3 Length of Service as a Teacher

Table 7.3: Lengths of Service as a Teacher

	Frequency	Percentage (%)
Less than 6	88	37.7
6 – 10	62	26.5
11 – 15	53	22.6
16 – 20	21	9.0
More than 20	10	4.0
Total	234	100.0

The data in the table shows that relatively new teachers dominated the teaching of mathematics in Zambia. About 38% had five years experience or less and 26% had been teachers for 6 to 10 years. Only 13% had taught for more than 15 years. The situation is not much different for HoDs with nearly half of them having had been teachers for only 10 years or less.

7.1.4 Academic/professional Qualifications

The academic/professional qualifications of the teachers of mathematics are shown in Table 7.4 below.

Table 7.4: Academic/professional Qualification of the Respondents.

At least this qualifications (Highest qualification)	Frequency	Percentage (%)
O' Level	142	60.7
Diploma in Education	69	29.5
Advanced Diploma in Education	07	3.0
Bachelor of Science (BSc.)	0	0.0
Bachelor of Arts with Education	03	1.3
Others	07	3.0

The data does not give a clear picture of teachers' qualifications. However, the dismally small numbers of advanced diploma holders was astonishing let alone the number of graduate teachers. After three decades of the UNZA graduating teachers of mathematics and science, albeit in modest numbers (about twenty each of mathematics and science per year), the numbers of graduate teachers of these subjects could certainly be much larger than the sample revealed.

7.1.5 Subject for which Teachers were Trained to Teach

Respondents were asked to state which subject(s) they were actually trained to teach. Responses are in Table 7.5 below:

Table 7.5: Subject(s) Teachers of Mathematics were trained to Teach.

Subject trained to teach	Frequency	Percentage (%)
Environmental Science/General Science	16	6.8
Biology	7	3.0
Chemistry	7	3.0
Physics	34	14.5
Mathematics	200	85.5
Others	0	0

The table shows that a vast majority of teachers of mathematics (85.5%) were actually trained to teach mathematics. However, what cannot be discerned from the table is the level of training (considering that some might have trained to teach at junior secondary school level while others up to O' level). Teachers of mathematics who were also trained to teach science could be from a much earlier generation of teachers when, for example, Nkrumah Teachers' College used to offer a combination of mathematics and science. As of now there is no institution in Zambia that trains teachers to teach both mathematics and science.

7.1.6 Level of Participation in ZAME

Information was sought on teachers' levels of participation in the Zambia Association for Mathematics Education (ZAME). Responses are captured in Table 7.6 below.

Table 7.6: Teachers' Level of Participation in ZAME

Level of participation in ZAME	Frequency	Percentage (%)
Ordinary member	110	47
Member of Executive Committee	8	3.4
Presented paper at ZAME annual meeting	0	0
Non of the above	111	47.4

Responses show that only about half the number of teachers of mathematics had any form of participation in ZAME. For those who were members, the level of participation did not entail presenting a paper at the Association's annual conference.

7.2 TEACHERS' PERCEPTION OF LEVELS OF DIFFICULTY OF MATHEMATICS TOPICS

Teachers were asked to indicate, at both junior secondary and senior secondary school levels, topics that they felt most comfortable and least comfort to teach. Responses are presented below beginning with junior secondary school topics.

7.2.1 Junior Secondary Mathematics Topics which Teachers were Most Comfortable to Teach

Table 7.7a below shows the topics in the junior secondary school syllabus which teachers listed as the ones they were most comfortable teaching, i.e. those they felt were easy to teach.

Table 7.7a: Topics at Grades 8 and 9 that Teachers were Most Comfortable to Teach

Topics	Frequency	% Responses	% Cases
Sets	112	16.6	60.2
Basic processes of algebra	96	14.3	51.6
Equations and inequations	90	13.4	48.4
Fractions, ratios and percentages	62	9.2	33.3
Number and numeration	61	9.1	32.8
Statistics	55	8.2	29.6
Coordinates	49	7.3	26.3
Construction	38	5.6	20.4
Approximations	34	5.1	18.3
Measurements	19	2.8	10.2
Perimeter, area, surface area, volume	18	2.7	9.7
Social and commercial arithmetic	16	2.4	8.6
Shapes and symmetry	13	1.9	7.0
Mass, money, time	7	1.0	3.8
Estimations	3	0.4	1.6

The table above shows that *sets* was mentioned 112 times in the responses out of a total count of all the topics that were mentioned (respondents could name one or more topics). This represents 16.6% of the number of times *sets* was mentioned and also represents the fact that 60.2% of the respondents mentioned the topic. Thus, *sets* is the topic the biggest majority of teachers are most comfortable to teach at the upper basic school level. *Sets* is followed by *basic processes of algebra*; *equations and inequations; fractions, ratios and percentages*; down to *mass, money and time*; and *estimations*.

Topics teachers were least comfortable teaching are listed in Table 7.7b below.

Table 7.7b: Topics at Grades 8 and 9 that Teachers were Least Comfortable to Teach.

Topics	Count	% Responses	% Cases
Social and commercial arithmetic	70	24.1	44.3
Shapes and symmetry	45	15.5	28.5
Construction	37	12.8	23.4
Measurements	26	9.0	16.5
Number and numeration	25	8.6	15.8
Basic processes of algebra	13	4.5	8.2
Statistics	13	4.5	8.2
Approximations	12	4.1	7.6
Coordinates	11	3.8	7.0
Mass, money, time	10	3.4	6.3
Perimeter, area, surface area, volume	8	2.8	5.1
Sets	7	2.4	4.4
Equations and inequations	5	1.7	3.2
Fractions, ratios and percentages	4	1.4	2.5
Estimations	4	1.4	2.5

The table above shows that *social and commercial arithmetic* was the least popular topic among teachers of mathematics followed by *shapes and symmetry; construction*; down to *fractions, ratios and percentages*; and *estimations*.

There is similarity in the topics teachers were most comfortable teaching and those they were least comfortable with. For example, *sets; equations and inequations*; and *fractions, ratios and percentages* ranked very high among topics teachers were comfortable with and, as expected, these topics ranked low among topics teachers were least comfortable with. The same could be said about *social and commercial arithmetic* and *shapes and symmetry*. There were some surprises, however, that *estimations* and *mass, money and time* ranked low on both lists.

Teachers were further asked to state what, in their view, were the topics their pupils liked most as well as those they disliked most. Teachers' responses are presented in Table 7.7c and Table 7.7d below.

Table 7.7c: Teachers' perception of junior secondary school mathematics topics pupils liked most.

Topics	Count	% Responses	% Cases
Sets	97	22.1	49.5
Equations and inequations	82	18.7	41.8
Basic processes of algebra	57	13.0	29.1
Fractions, ratios and percentages	49	11.2	25.0
Number and numeration	44	10.0	22.4
Coordinates	26	5.9	13.3
Approximations	23	5.3	11.7
Social and commercial arithmetic	19	4.3	9.7
Perimeter, area, surface area, volume	17	3.9	8.7
Measurements	15	3.4	7.7
Mass, money, time	5	1.1	2.6
Estimations	4	0.9	2.0

Table 7.7d: Teachers' Perception of Junior Secondary School Mathematics Topics Pupils least disliked.

Topics	Count	% Responses	% Cases
Social and commercial arithmetic	51	23.0	32.9
Equations and inequations	39	17.6	25.2
Basic processes of algebra	25	11.3	16.1
Measurements	23	10.4	14.8
Coordinates	16	7.2	10.3
Perimeter, area, surface area, volume	14	6.3	9.0
Approximations	13	5.9	8.4
Sets	12	5.4	7.7
Number and numeration	10	4.5	6.5
Fractions, ratios and percentages	9	4.1	5.8
Mass, money, time	7	3.2	4.5
Estimations	3	1.4	1.9

Table 7.7d above suggests that teachers believed that *social and commercial arithmetic* gave pupils difficulties. This was mentioned by 53 teachers, representing 23% of those who responded to this item, and cited in 32.9% of all the topics mentioned. Other topics teachers perceived to be giving pupils problems were *equations and inequations; basic processes of algebra;* and *measurements* in that order.

7.2.2 Senior Secondary Mathematics Topics which Teachers were Most Comfortable Teaching

With regard to senior secondary mathematics topics, teachers' responses on the topics they were most comfortable to teach and those they were least comfortable to teach are presented Tables 7.8a and 7.8b below.

Table 7.8a: Topics at Grades 10 to 12 that Teachers were Most Comfortable to Teach.

Topics	Frequency	% Responses	% Cases
Vectors	81	10.5	40.5
Matrices	67	8.7	33.5
Transformations	56	7.3	28.0
Indices	53	6.9	26.5
Probability	50	6.5	25.0
Trigonometric problems in three dimensions	49	6.4	24.5
Graphs in practical situations e.g. travel graphs and kinematics	43	5.6	21.5
Mensuration (area, circumference, surface area of solids, volumes etc)	40	5.2	20.0
Angles	37	4.8	18.5
Number (natural, prime, factors, sequences, etc)	29	3.8	14.5
Limits of accuracy	22	2.9	11.0
Measures of central tendency (averages)	21	2.7	10.5
Geometrical constructions	19	2.5	9.5
Locus	18	2.3	9.0
Percentages	17	2.2	8.5
Algebraic manipulation e.g. use of brackets and factorisation	16	2.1	8.0
Solution of equations and inequations	16	2.1	8.0
Sine rule, cosine rule	16	2.1	8.0
Functions	14	1.8	7.0
Standard form	14	1.8	7.0
Graphs of functions	11	1.4	5.5
Algebraic representation and formulae	10	1.3	5.0
Pythagoras theorem	9	1.2	4.5
Ratio, proportion and rate	8	1.0	4.0
Fractions and percentages	7	0.9	3.5
Use of logarithm tables	7	0.9	3.5
Bearings	7	0.9	3.5
Data collection, representation, interpretation	7	0.9	3.5
Ordering	6	0.8	3.0
Symmetry	5	0.6	2.5
Mass, length, area, volume, capacity	4	0.5	2.0
Time, money, personal and household finance	3	0.4	1.5
Graphical representation of inequalities	3	0.4	1.5
Use of calculator	2	0.3	1.0
Sine and cosine functions to angles between 90^0 and 180^0	2	0.3	1.0
Cumulative frequency diagrams	1	0.1	0.5

The table shows that there was a wide variety of topics which teachers felt comfortable to teach. Toping the list was *vectors* with 40% of respondents saying they were alright with the topic. More than a quarter of the teachers indicated they felt comfortable teaching *Matrices, Transformation Geometry, Indices* and *Probability.* At the bottom of the list is graphical representation of inequalities followed by *Use of calculator; sine and cosine functions of angles between 90^0 and 180^0*; and *Cumulative frequency diagrams.*

Table 7.8b: Senior Secondary School Mathematics Topics which Teachers were Least Comfortable to Teach.

Topics	Count	% Responses	% Cases
Transformations	49	14.8	30.6
Probability	45	13.6	28.1
Angles	1	0.3	20.6
Trigonometric problems in three dimensions	27	8.2	16.9
Bearings	12	3.6	10.6
Locus	33	10.0	10.6
Vectors	17	5.2	10.6
Graphical representation of inequalities	5	1.5	7.5
Geometrical constructions	12	3.6	7.5
Graphs in practical situations e.g. travel graphs and kinematics	10	3.0	6.3
Ordering		2.4	5.6
Sine rule, cosine rule	8	2.4	5.0
Mass, length, area, volume, capacity	7	2.1	4.4
Use of calculator	6	1.8	3.8
Matrices	6	1.8	3.8
Limits of accuracy	2	1.5	3.1
Use of logarithm tables	5	1.5	3.1
Graphs of functions	10	3.0	3.1
Solution of equations and inequations	1	0.3	3.1
Data collection, representation, interpretation	5	1.5	3.1
Algebraic manipulation e.g. use of brackets and factorisation	5	1.5	3.1
Measures of central tendency (averages)	3	0.9	1.9
Functions	2	0.6	1.3
Estimation	1	0.6	1.3
Time, money, personal and household finance	2	0.6	1.3
Number (natural, prime, factors, sequences, etc)	1	0.3	0.6
Directed numbers	1	0.3	0.6
Standard form	8	0.3	0.6
Percentages	1	0.3	0.6
Indices	4	1.2	0.6
Symmetry	17	5.2	0.6
Mensuration (area, circumference, surface area of solids, volumes etc)	17	5.2	0.6
Sine and cosine functions to angles between 90^0 and 180^0	1	3.0	0.6
Cumulative frequency diagrams	1	0.3	0.6

The responses show that, on the whole, the majority of teachers did not have topics they were particularly uncomfortable to teach. The most unpopular topic, namely,

transformations was cited by only 30% of the teachers. The topics that followed namely *Probability; Angles; Trigonometric problems in three dimensions; Bearings; Locus*; and *Vectors* were mentioned by at least 10% of the respondents. The rest of the topics were mentioned by less than 10% of the 234 teachers sampled.
Teachers were asked to state which topics they thought pupils liked most and which they liked least. The responses are presented in tables 7.10a and 7.10b below.

Table 7.8c: Teachers' Perception of Senior Secondary School Mathematics Topics Pupils liked Most

Topics	Frequency	% Responses	% Cases
Matrices	81	14.3	41.1
Indices	57	10.1	28.9
Vectors	51	9.0	25.9
Graphs in practical situations e.g. travel graphs and kinematics	30	5.3	15.2
Number (natural, prime, factors, sequences, etc)	29	5.1	14.7
Angles	28	5.0	14.2
Solution of equations and inequations	26	4.6	13.2
Mensuration (area, circumference, surface area of solids, volumes etc)	22	3.9	11.2
Transformations	22	3.9	11.2
Trigonometric problems in three dimensions	20	3.5	10.2
Probability	19	3.4	9.6
Algebraic manipulation e.g. use of brackets and factorisation	18	3.2	9.1
Algebraic representation and formulae	16	2.8	8.1
Pythagoras theorem	16	2.8	8.1
Limits of accuracy	15	2.7	7.6
Standard form	14	2.5	7.1
Percentages	14	2.5	7.1
Symmetry	9	1.6	4.6
Locus	9	1.6	4.6
Geometrical constructions	8	1.4	4.1
Functions	7	1.2	3.6
Data collection, representation, interpretation	6	1.1	3.0
Fractions and percentages	5	0.9	2.5
Ratio, proportion and rate	5	0.9	2.5
Graphs of functions	5	0.9	2.5
Sine rule, cosine rule	5	0.9	2.5
Measures of central tendency (averages)	5	0.9	2.5
Use of logarithm tables	4	0.7	2.0
Bearings	4	0.7	2.0
Ordering	2	0.4	1.0
Use of calculator	2	0.4	1.0
Mass, length, area, volume, capacity	2	0.4	1.0
Time, money, personal and household finance	2	0.4	1.0
Graphical representation of inequalities	2	0.4	1.0
Sine and cosine functions to angles between 90^0 and 180^0	2	0.4	1.0
Directed numbers	1	0.2	0.5
Estimation	1	0.2	0.5
Cumulative frequency diagrams	1	0.2	0.5

Teachers were of the opinion that *Matrices; Indices*; and *Vectors* were the topics most popular with pupils at senior level. It is again noticed that these three topics were among the top four that were also teachers' favourite topics.

Table 7.9: Teachers' Perception of Mathematics Topics Senior Secondary School pupils dislike most.

Topics	Frequency	% Responses	% Cases
Probability	74	14.2	38.3
Transformations	73	14.0	37.8
Trigonometric problems in three dimensions	53	10.2	27.5
Mensuration (area, circumference, surface area of solids, volumes etc)	50	9.6	25.9
Locus	34	6.5	17.6
Vectors	31	6.0	16.1
Geometrical constructions	25	4.8	13.0
Sine rule, cosine rule	21	4.0	10.9
Graphs of functions	20	3.8	10.4
Graphs in practical situations e.g. travel graphs and kinematics	17	3.3	8.8
Bearings	17	3.3	8.8
Use of logarithm tables	12	2.3	6.2
Graphical representation of inequalities	12	2.3	6.2
Solution of equations and inequations	10	1.9	5.2
Mass, length, area, volume, capacity	8	1.5	4.1
Angles	8	1.5	4.1
Data collection, representation, interpretation	8	1.5	4.1
Symmetry	6	1.2	3.1
Number (natural, prime, factors, sequences, etc)	5	1.0	2.6
Functions	5	1.0	2.6
Limits of accuracy	5	1.0	2.6
Sine and cosine functions to angles between 90^0 and 180^0	5	1.0	2.6
Cumulative frequency diagrams	4	0.8	2.1
Ordering	3	0.6	1.6
Algebraic representation and formulae	3	0.6	1.6
Algebraic manipulation e.g. use of brackets and factorisation	3	0.6	1.6
Indices	3	0.6	1.6
Percentages	2	0.4	1.0
Measures of central tendency (averages)	2	0.4	1.0
Pythagoras theorem	1	0.2	0.5
Matrices	1	0.2	0.5

Topics, which were disliked by teachers, again, feature high on the list of topics perceived to be a nuisance to pupils. Notable among these were Probability; Transformation geometry; Trigonometric problems in three-dimensions; Locus; and Vectors.

The overall picture was that there did not seem to be any consistence between topics teachers perceived to be liked by pupils to those perceived to be disliked. However, there was a high level of correlation between what teachers were comfortable to teach and topics teachers thought pupils liked. There was equally a high correlation between

what teachers were not comfortable to teach and what they perceived to be disliked by pupils. This correlation between teacher-preference/capacity and pupil-preference/performance made the following question as valid in 1969 as today, that is, "... to what extent are our pupils' failures really our [teachers'] own?" (Law, 1969, quoted in Wain and Woodrow, 1980, p.39)

7.3 TOPICS PUPILS FOUND DIFFICULT TO LEARN

Pupils were given a list of topics covering the whole junior secondary school syllabus (for Grade 9 respondents) and the whole school certificate syllabus (the out-going Cambridge syllabus D, 4024 - for senior secondary school respondents). The pupils were then asked to state whether or not they had done each topic and if they had, to state whether they found the topic Very easy; Easy; Difficult; or Very difficult. The responses were as follows:

7.3.1 Junior Secondary School Pupils

Table 7.10 below shows junior secondary pupils' perception of easy or difficult topics on their syllabus.

Table 7.10: Junior Pupil' Self Assessment on Level of difficulty of Mathematics Topics.

	Not stated	Very Difficult (VD)	Difficult (D)	% VD + D	Easy (E)	Very Easy (VE)	% VE + E
Statistics	8.9	21.4	26.8	48.2	19.6	23.2	42.8
Social and commercial arithmetic	11.0	15.9	22.0	37.9	32.9	18.3	51.2
Construction	8.6	12.9	17.2	30.1	38.7	22.6	61.3
Equations and inequalities	2.4	8.4	20.8	29.2	35.6	32.8	68.4
Estimates	10.2	6.1	20.4	26.5	37.8	25.5	63.3
Basic processes of algebra	3.4	4.9	19.9	24.8	37.2	34.6	71.8
Approximations	3.1	4.7	15.2	19.9	47.1	29.8	76.9
Perimeter, area, surface area, volume	4.6	6.3	12.6	18.9	42.0	34.5	76.5
Mass, money time	8.0	7.1	11.5	18.6	40.7	32.7	73.4
Coordinates	7.6	7.0	9.7	16.7	31.9	43.8	75.7
Fractions, ratios and percentages	5.0	3.8	12.6	16.4	41.6	37.0	78.6
Shapes and symmetry	4.8	7.3	8.1	15.4	32.3	47.6	79.9
Measurements	5.8	3.5	10.5	14.0	42.1	38.0	80.1
Number and numeration	2.9	1.5	8.8	10.3	43.6	43.2	86.8
Sets	2.7	1.0	4.1	5.1	44.3	47.8	92.1

The table shows that the topics pupils had the most difficulty with were *statistics* followed by *social and commercial arithmetic* and *construction.* From the perspective of easiness, pupils felt they had least difficulties with *sets* followed by *number and numeration* and *Measurement.*

7.3.2 Senior Secondary School Pupils

Senior pupils' perceptions of easy/difficult mathematics topics are given in Table 7.11 below. The table shows that the topics senior pupils saw as very difficult to learn were *Graphical representation of inequalities; Graphs of functions; Transformation geometry; Trigonometry in 3-dimension; Kinematics;* and *Mensuration*, in that order. The table further shows that it was only the topics that were done at junior secondary school level that pupils found easy. The easiest topics in the opinion of pupils were *Standard form; Number; Symmetry; Percentages; Angles*; and *Ration and proportion.*

Table 7.11: Senior Pupils Self-Assessment on Level of Difficulty of Mathematics Topics.

	Not stated	Very Difficult (VD)	Difficult (D)	% VD + D	Easy (E)	Very Easy (VE)	% VE + E
Graphical representation of inequalities	5.4	16.3	41.5	57.8	27.9	8.8	36.7
Graphs of functions	3.6	11.7	36.9	48.6	36.0	11.7	47.7
Transformations	2.7	12.0	36.0	48.0	34.7	14.7	48.4
Trigonometric problems in three dimensions	1.6	14.4	32.0	46.4	39.2	12.8	52.0
Mensuration (area, circumference, surface area of solids, volumes etc)	0.6	14.3	27.4	41.7	44.0	13.7	57.7
Graphs in practical situations e.g. travel graphs and kinematics	-	12.1	27.3	39.4	40.9	19.7	60.6
Use of logarithm tables	4.3	14.1	24.5	38.6	37.5	19.6	57.1
Solution of equations and inequations	0.5	8.7	27.2	35.9	46.2	17.4	63.6
Geometrical constructions	6.2	9.3	24.7	35.0	42.3	17.5	59.8
Time, money, personal and household finance	7.2	11.6	23.2	34.8	37.7	20.3	58.0
Data collection, representation, interpretation	2.8	1.4	32.4	33.8	38.0	25.4	63.4
Sine and cosine functions to angles between 90^0 and 180^0	0.7	7.9	25.7	33.6	43.4	22.4	65.8
Bearings	1.4	5.4	27.9	33.3	38.8	26.5	65.3
Vectors	1.3	6.3	25.3	31.6	45.6	21.5	67.1
Probability	0.9	8.3	23.1	31.4	48.1	19.4	67.5
Sine rule, cosine rule	0.7	5.4	24.5	30.9	41.5	27.9	69.4
Locus	1.5	4.5	25.4	29.9	43.3	25.4	68.7
Algebraic representation and formulae	1.6	6.0	23.5	29.5	44.3	24.6	68.9
Mass, length, area, volume, capacity	5.0	1.9	25.0	26.9	51.9	16.3	68.2
Measures of central tendency (averages)	2.8	2.8	21.1	23.9	49.3	23.9	73.2
Algebraic manipulation e.g. use of brackets and factorisation	1.5	5.6	17.9	23.5	41.3	33.7	75.0
Cumulative frequency diagrams	4.1	3.1	15.3	18.4	48.0	29.6	77.6
Functions	1.2	3.0	11.9	14.9	51.8	32.1	83.9
Pythagoras theorem	1.0	2.1	11.5	13.6	38.2	47.1	85.3
Limits of accuracy	8.9	2.2	11.1	13.3	52.2	25.6	77.8
Use of calculator	1.4	2.1	11.1	13.2	41.7	43.8	85.5
Estimation	3.2	1.3	11.6	12.9	47.7	36.1	83.8
Indices	1.5	2.0	9.8	12.0	43.5	43.0	86.5
Matrices	1.2	2.5	9.3	11.8	44.1	42.9	87.0
Directed numbers	8.4	-	11.2	11.2	41.1	39.3	80.4
Ratio, proportion and rate	1.1	0.5	9.6	10.1	58.0	30.9	88.9

	Not stated	Very Difficult (VD)	Difficult (D)	% VD + D	Easy (E)	Very Easy (VE)	% VE + E
Angles	1.0	1.5	8.0	9.5	48.0	41.5	89.5
Ordering	9.7	-	8.8	8.8	40.7	40.7	81.4
Symmetry	1.6	0.8	6.5	7.3	43.5	47.6	91.1
Percentages	4.7	0.5	4.7	5.2	44.6	45.6	90.2
Fractions and percentages	5.3	-	4.7	4.7	41.1	48.9	90.0
Standard form	1.5	1.0	2.5	3.5	42.0	53.0	95.0
Number (natural, prime, factors, sequences, etc)	4.9	0.5	0.5	1.0	48.3	45.4	94.0

The responses of pupils as shown in the table above reflect a high level of confidence in the pupils to the point that it might be said to be unrealistic. In nearly all the topics that pupils had done, the majority found them easy. This includes "notorious" topics like probability, vectors, rules and trigonometric problems in three dimensions. However, these results need to be treated with caution for a number of reasons. One being an apparent general tradition of politeness to show 'visitors' that 'we are good' and to support their teachers. Another could be that only "bright" pupils were being picked by teachers to complete the questionnaires (practical difficulties made random sampling impossible). Yet another possibility could be that teachers dealt with superficial aspects of the topics which pupils found easy.

Going by School Certificate and GCE examination results which show desperately poor performance, the levels of confidence on topics which both the teachers and pupils claim seems to be a gross over estimate. The 2000 SC and GCE mathematics examinations are used as a case in point. The results at national level, in the province with the highest 'pass' percentage (Luapula) and the province with the lowest 'pass' percent (North Western Province) are given in Figures 7a, 7b and 77c below.

Figure 7a

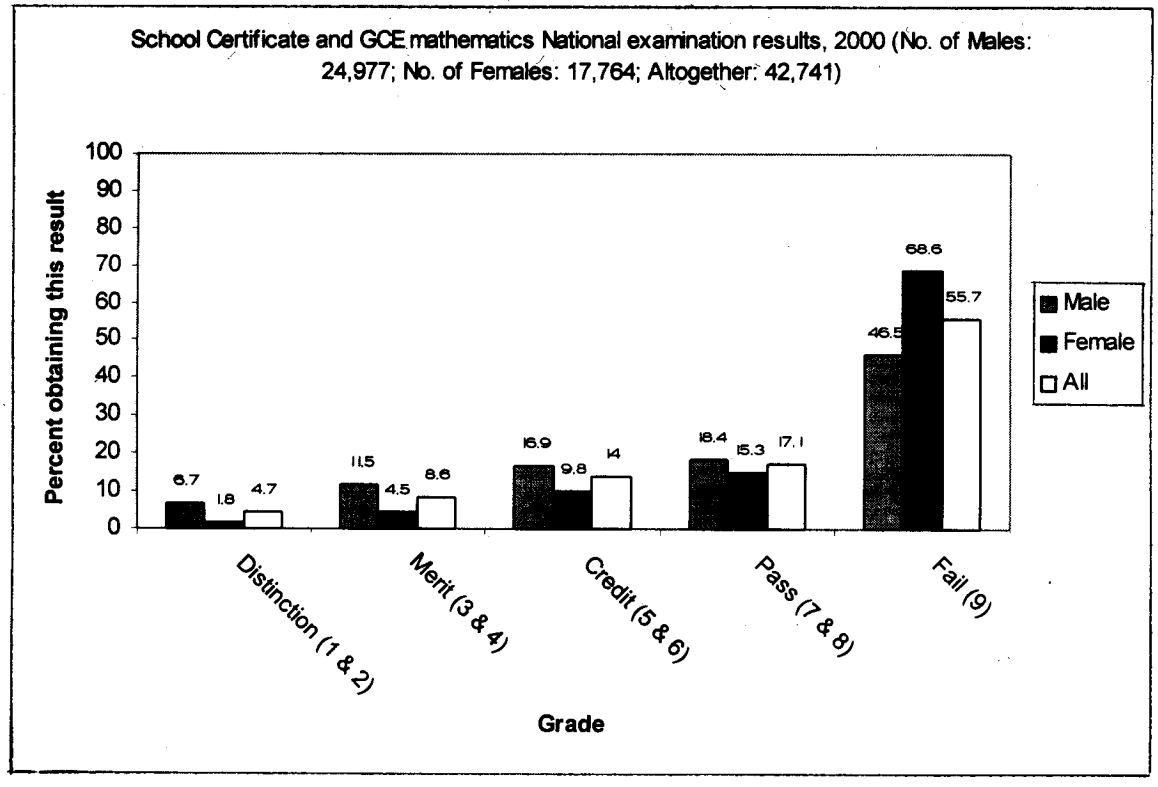

School Certificate and GCE mathematics National examination results, 2000 (No. of Males: 24,977; No. of Females: 17,764; Altogether: 42,741)
Percent obtaining this result
100
90
80
70
60
50
40
30
20
10
0
6.7
1.8
4.7
11.5
4.5
8.6
16.9
9.8
14
18.4
15.3
17.1
46.5
68.6
55.7
Male
Female
All
Distinction (1 & 2)
Merit (3 & 4)
Credit (5 & 6)
Pass (7 & 8)
Fail (9)
Grade

Figure 7b

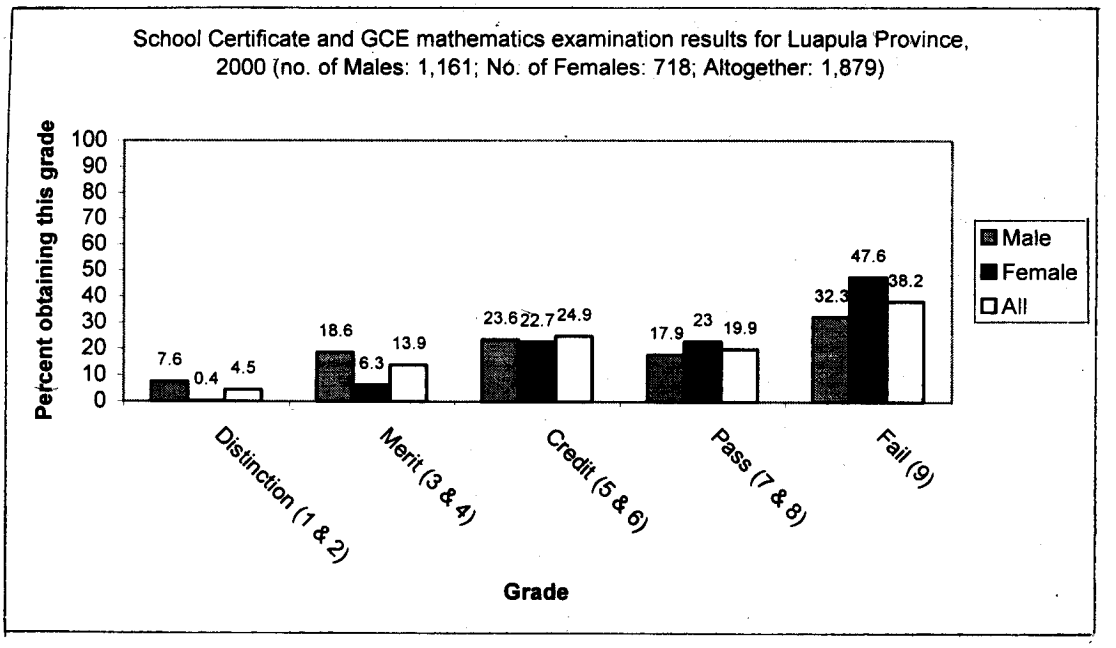
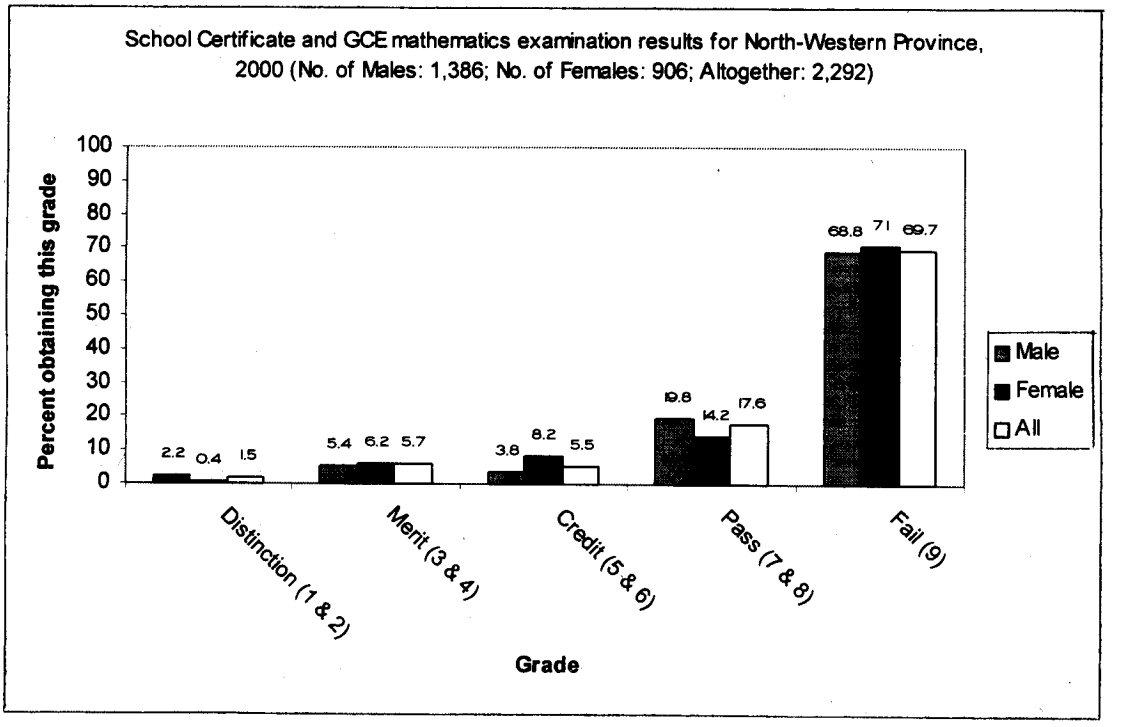


Figure 7c



The above results show that more than half of pupils who sat for he examinations failed and this situation posses totally unacceptable levels of pupil performance.

7.4. TEACHING TRENDS IN MATHEMATICS

The sections below look at teaching trends in mathematics through classroom activities of teachers, teachers' levels of confidence in using certain methods, and HoDs and pupils evaluation of teachers' abilities in this regard.

7.4.1: Teacher – Pupil Activities during Mathematics Lessons

Respondents were asked to indicate how frequently the activities given in the table below were taking place in their teaching of mathematics.

Table 7.12: Frequency of Use of Certain Teacher/pupil Activities During Mathematics Lessons.

Methods	Percentages (%) of teachers per category						
	Not. Stated	Very often (VO)	Often (O)	V.O.+O	Sometimes (S)	Never (N)	S + N
Teacher asks questions and pupils answer	3.8	62.8	26.9	89.7	6.0	0.4	6.4
Pupils given work to do after classes	2.6	58.1	29.9	88.0	9.4	0.0	9.4
Teacher demonstrates, pupils watch	3.0	51.3	31.6	82.9	14.1	0.0	14.1
Teacher talks, pupils listen	3.8	36.3	43.6	79.9	15.0	1.3	16.3
Pupils search for answers to written questions	3.8	19.2	41.0	60.2	30.3	5.6	35.9
Pupils discuss as a class	4.3	12.0	33.3	45.3	45.7	4.7	50.4
Pupil(s) demonstrates, the rest watch	3.8	13.2	31.6	44.8	50.4	0.9	51.3
Pupils read from printed material (e.g. textbooks)	2.6	13.7	29.1	42.8	47.0	7.7	54.7
Pupil(s) explain while the rest listen	5.1	12.8	28.2	41.0	51.3	2.6	53.9
Pupils working in pairs	3.8	9.0	30.8	39.8	50.4	6.0	56.4
Pupils apply work on a solution to a real life problem	6.0	11.1	25.2	36.3	49.1	8.5	57.6
Pupils carry out individual practical work	5.1	17.1	17.1	34.2	45.3	15.4	60.7
Pupils discuss in small groups, teacher listens and guides	3.0	9.4	18.4	27.8	59.4	9.8	69.2
Pupils work on a solution to an unfamiliar maths problem	3.4	4.7	20.9	25.6	57.7	13.2	70.9
Pupils carry out practical work in small groups	2.6	6.8	13.7	20.5	64.1	12.8	76.9
Team teaching	3.8	2.6	10.3	12.9	37.2	46.2	83.4
Pupils carrying out an extended investigation on an issue	5.1	2.1	10.7	12.8	53.8	28.2	82.0
Pupils act roles (role play)	3.8	2.6	8.5	11.1	46.6	38.5	85.1
Class goes outside the classroom to learn	4.7	1.7	7.3	9.0	58.5	27.8	86.3
Pupils play mathematical games	3.8	1.7	5.1	6.8	50.4	38.9	89.3
Pupils listen to a guest speaker	3.8	2.6	3.0	5.6	36.8	53.8	90.6
Teacher uses video/film to teach	3.4	0.0	0.9	0.9	8.5	87.2	95.7

The Table above shows that the majority of the respondents indicated that question and answer mode of teaching was the predominant activity (89.7%) which was followed by other teacher centred activities such as teacher demonstrations, pupils

watching, teacher talking, pupils listening etc. The majority of respondents (89.3%) were not using audio/visual aids, video/film, or mathematical games etc. in teaching. They were not using locally available resources in their teaching.

7.4.2 HoDs perceptions of prevailing teaching styles in mathematics

The 44 Heads of Mathematics Departments were asked how frequently teachers in their department used the techniques of teaching stated in the table below.

Table 7.13: HoDs Views on What Frequently Occur during Mathematics Lessons.

	Percentages (%) of teachers per category						
Techniques	**Not. State**	**Always**	**Usually**	**A+U**	**Sometimes**	**Never**	**S.T.+N**
Teacher asks questions and pupils answer	2.3	38.6	52.3	90.9	6.8	0.0	6.8
Teacher writes on the board and pupils copy	4.6	47.7	29.5	77.2	13.6	4.5	18.1
Teacher demonstrates and pupils watch	2.3	31.8	43.2	75.0	20.5	0.0	20.5
Teacher talks, pupils listen	4.6	25.0	47.7	72.7	20.5	2.3	22.8
Pupils given work to do after classes	2.3	20.5	50.0	70.5	27.3	0.0	27.3
Pupils work-out a solution to a problem	4.5	36.4	25.0	61.4	31.8	2.3	34.1
Pupils search for answers to written questions	4.5	18.2	27.3	45.5	43.2	6.8	50.0
Pupils read from printed material	2.3	9.1	20.5	29.6	52.3	15.9	68.2
Pupils discuss as a class	4.5	2.3	25.0	27.3	59.1	9.1	68.2
Pupil/s explain/talk while the rest listen	4.6	0.0	11.4	11.4	77.3	6.8	74.1
Pupils discuss in small groups, teacher monitors/guides	2.3	0.0	11.4	11.4	81.8	4.5	86.3
Pupils carry out individual practical work	4.5	2.3	9.1	11.4	54.5	29.5	84.0
Pupil/s demonstrate, the rest watch	6.8	4.5	6.8	11.3	79.5	2.3	81.8
Pupils write their own notes	4.5	0.0	6.8	6.8	27.3	61.4	88.7
Pupils carry out practical activity in small groups	2.3	0.0	4.5	4.5	75.0	18.2	93.2
Pupils formulate test questions	4.5	0.0	2.3	2.3	22.7	70.5	93.2
Pupils act roles (role play)	2.3	0.0	0.0	0.0	36.4	61.4	97.8
Class goes outside the classroom to learn	4.5	0.0	0.0	0.0	52.3	43.2	95.5

As can be seen from Table 7.13 above the HoDs observations confirmed what teachers themselves indicated, namely, teacher centred lessons occurred more than learner centred ones. These results tallied with responses from pupils (see Tables 7.26 and 7.27). The majority of pupil respondents also indicated that teacher centred methods were taking place frequently in their classes.

Thus, it could be concluded that 'teacher-centred' methods were predominantly used in mathematics classes in schools. The interviews and lesson observations also supported this conclusion.

7.4.3 Levels of Confidence in Using Particular Teaching Strategies

The table below shows teachers' self assessment with regard to using each of the stated teaching strategies.

Table 7.14: Teachers' Self-rating of their Level of Confidence in Using the Stated Strategies in Teaching Mathematics

Strategies	PERCENTAGES (%) of teachers in each category						
	Not stated	very confident	Confident (C)	V.C. + C	Not confident	Not sure (NS)	N.C. + N.S.
Demonstration	2.6	80.8	16.7	97.5	0.0	0.0	0.0
Question and answer	2.6	72.2	23.5	95.7	1.7	0.0	1.7
Home work	2.6	65.8	28.2	94.0	1.7	1.7	3.4
Teacher exposition	3.8	69.7	23.9	93.6	0.9	1.7	2.6
Problem solving	3.8	52.6	39.7	92.3	2.6	1.3	3.9
Group discussions	3.4	28.2	61.1	89.3	5.6	1.7	7.3
Use of printed materials (e.g. text books, worksheets)	4.7	47.4	38.9	86.3	6.0	3.0	9.0
Individualised work	3.8	39.3	44.0	83.3	8.5	4.3	12.8
Investigation	3.0	27.8	50.0	77.8	14.5	4.7	19.2
Small group practical work	5.6	20.1	57.3	77.4	12.4	4.7	17.1
Pair work	5.1	23.1	54.3	77.4	7.3	10.3	17.6
Whole class discussion	6.0	24.8	51.3	76.1	13.2	4.7	17.9
Mathematical games	3.8	16.2	42.3	58.5	18.8	18.8	37.6
Project work	4.7	16.2	39.7	55.9	15.0	24.4	39.4
Team teaching	6.4	16.7	38.9	55.6	18.8	19.2	38.0
Role play	6.4	11.5	41.9	53.4	22.2	17.9	40.1
Field trips	9.0	8.5	29.1	37.6	18.8	34.6	53.4

From the table above the majority of the respondents indicated that they were confident in almost all of the strategies listed. The table also shows that there was only one teaching strategy, that is, field trips, which the majority of teachers (62.4%) admitted they could not use confidently.

Though many respondents indicated that they were confident in using most of the strategies above, they were not applying them in their classes as demonstrated during lesson observations.

7.4.4 HoDs' Perceptions of Teachers' Competence in Teaching

Table7.15 shows HoDs perceptions of teachers' competence at using the indicated teaching strategies.

Table 7.15: HoDs Ratings of Teachers' Competence at Using Various Strategies

Techniques	PERCENTAGES (%) of teachers in each category						
	Not stated	very competent	Fairly Competent	V.C. + F.C	Slightly Competent	Not Competent	S.C. + N.C.
Question and answer	2.3	63.6	31.8	95.4	2.3	0.0	2.3
Home work	2.3	68.2	27.3	95.5	2.3	0.0	2.3
Tests	4.5	65.9	29.5	95.4	0.0	0.0	0.0
Lecturer/teacher exposition	2.3	65.9	27.3	93.2	4.5	0.0	4.5
Demonstration	4.5	54.5	34.1	88.6	6.8	0.0	6.8
Problem solving	2.3	47.7	40.9	88.6	9.1	0.0	9.1
Use of printed materials (e.g. text books, worksheets)	6.8	45.5	36.4	81.9	11.4	0.0	11.4
Individualised work	9.1	29.5	27.3	56.8	22.7	11.4	34.1
Charts	4.5	18.2	34.1	52.3	34.1	9.1	43.2
Small group practical work	2.3	9.1	40.9	50.0	29.5	18.2	47.7
Whole class discussion	2.3	15.9	31.8	47.7	43.2	6.8	50.0
Group discussions	2.3	13.6	34.1	47.7	43.2	6.8	50.0
Pair work	6.8	9.1	38.6	47.7	29.5	15.9	45.4
Project work/extended investigation	4.5	4.5	25.0	29.5	36.4	29.5	65.9
Role play	6.8	4.5	20.5	25.0	31.8	36.4	68.2
Guest speaker	4.5	4.5	13.6	18.1	15.9	61.4	77.3
Field trips	4.5	2.3	9.1	11.4	29.5	54.5	84.0

The HoDs confirmed that the predominant approaches used in mathematics classrooms were teacher centred such as, question and answer (95.4%), home work (95.5%), test (95.4%), lecture/teacher exposition (93.2%) etc.

The lessons observed in mathematics were all teacher centred. The teachers used question and answer approach in most lessons. They demonstrated good classroom skills of organisation and management for the type of lessons they delivered. They all had established good rapport with their students and to an extent created a favourable teaching and learning environment.

This study also showed that pupils' voice is hardly ever heard in class. An analysis of verbal interaction in class of two mathematics lessons produced, in one case, 80% teacher-talk, 9% pupil-talk and 11% silence or confusion; and in the second case, 12% teacher-talk; 0% and 88% silence or confusion (pupils were working on an exercise in dead silence). In all cases the pupil's voice was missing, teachers were dynamic, but were not giving an opportunity to pupils to verbalise what they were learning. Cockcroft report (1982) said on *discussion* that the ability to say what you mean and mean what you say should be one of the outcomes of good mathematics teaching. The ability according to the report is developed as a result of opportunities to talk about mathematics, to explain and discuss results, which have been obtained. Pupils it would appear are not given this opportunity to talk about mathematics in our schools.

There is need to have distinctive variety in classroom activity unlike what this survey has shown about teaching trends. Professional development for teachers would do well to help teachers provide such a variety of classroom practice.

The teachers' choice of strategy tended to be based on an assumption that pupils did not know much and thus needed assistance in their organisation of new knowledge. The questions posed were limited and focussed on a prior planned sequence of activities or procedures leading to basic facts/knowledge. The assessment/exercise that followed was focussed on finding out whether pupils 'had' the concepts or knowledge of what had been taught.

7.5 TEACHERS VIEWS ON ASPECTS OF MATHEMATICS TEACHING

The section that follows below looks at teacher's views on the teaching of mathematics and other aspects such as objectives, content, process, use of materials and evaluation.

7.5.1: Perceptions on teaching and learning of Mathematics

The table below shows teachers' reactions to the given statements on mathematics and it's teaching. The table shows that 94.1 percent of respondents indicated that the most important feature of mathematics was that it was useful to the individual. Many (93.6%) also indicated that the method used was more important when considering pupil's work than a correct answer and believed that 'practice makes perfect' was an important rule in the teaching of mathematics.

Most respondents also agreed with a number of statements such as, mathematics was particularly suited to developing independent and self reliant habits of mind (87.6%), every lesson must have a plan (83.3%), teaching of mathematics should put emphasis on the products (facts, formulae, rules, procedures) (74.8%), etc. It would appear respondents were not quite sure about the statements they were agreeing to. Many indicated that the 'process' of mathematics (method) was more important than the 'answer' (Product), and yet equally a large number agreed to the statement that the teaching should emphasise the 'products'.

Respondents were divided on some statements, that is, there were almost as many who agreed with the statements as those who disagreed with them. These were: examination success should be the priority for mathematics teaching (40.2% agreed and 57.3% disagreed), mathematics was the simplest and most straight forward subject of all (44.0% agreed while 53.0% disagreed) and mathematics was the easiest subject to teach (45.7% agreed while 51.7% disagreed).

On the whole, however, teachers' views were generally in line with current thinking in mathematics teaching. Nevertheless, certain views though expressed by a minority could not be ignored. Statements such as, "mathematics is commonly believed to be the most repulsive of all subjects" (58.1%), "having a correct answer in mathematics is more important than the method used to get the answer" (5.5%) and "girls are, on the whole, incapable of becoming good mathematicians" (5.2%), were rather worrying particularly when expressed by teachers.

Table 7.16: Extent to Which Teachers Agreed or Disagreed with Aspects of Mathematics Teaching.

	Percentages (%) of teachers in each category						
Statement	**Not stated**	**Strongly agree**	**Agree**	**S.A + A**	**Disagree**	**Strongly disagree**	**S.D + D**
The most important feature of mathematics is that it is useful to the individual.	2.1	57.3	36.8	94.1	3.8	0.0	3.8
The method used is a more important consideration in a pupil's work than having a correct answer	2.6	60.7	32.9	93.6	32.9	2.6	3.9
Practice makes perfect is the most important rule in teaching mathematics	1.7	65.0	28.6	93.6	4.3	0.4	4.7
Mathematics is particularly suited to develop independent and self-reliant habits of mind.	4.3	38.0	49.6	87.6	6.8	1.3	8.1
Every lesson must have a lesson plan	3.0	49.1	34.2	83.3	10.3	3.4	13.7
Teaching of mathematics should put emphasise on the products (e.g. facts, formulae, rules, procedures)	2.6	36.3	38.5	74.8	20.9	1.7	22.6
Guesswork has no place in mathematics	2.1	37.6	35.9	73.5	20.1	4.3	24.4
Female mathematics teachers are regarded by society as in some way peculiar.	2.6	12.8	57.3	70.1	21.8	5.6	27.4
Mathematics must be taught in a rigorous, deductive way.	10.7	11.5	52.6	64.1	22.6	2.6	25.2
Mixed ability groups are too demanding in mathematics to be of real practical use.	2.6	12.0	48.7	60.7	33.8	3.0	36.8
Mathematics is commonly believed to be the most repulsive of all subjects.	6.4	11.5	46.6	58.1	23.5	12.0	35.5
Mathematics is the easiest subject to teach	2.6	16.2	29.5	45.7	43.6	8.1	51.7
Mathematics is the simplest and most straight forward subject of all	3.0	11.5	32.5	44.0	46.6	6.4	53.0
Examination success should be the priority for mathematics teaching	2.6	12.0	28.2	40.2	46.6	10.7	57.3
Too many lessons each week are devoted to mathematics	3.4	7.3	29.5	36.8	50.0	9.8	58.8
The 'O' level mathematics syllabus is too difficult for most pupils	2.6	2.6	29.5	32.1	57.3	8.1	65.4
Mathematics is harder work than most subjects	2.6	6.0	22.2	28.2	46.2	23.1	70.3
School mathematics is too divorced from the real world	3.4	3.4	21.8	25.2	47.0	24.4	71.4
Some pupils are incapable of learning mathematics	3.0	4.7	18.4	23.1	48.7	25.2	73.9
The important thing is to do mathematics and understand later what one has done.	4.3	4.7	15.8	20.5	53.4	21.8	75.2
Having a correct answer in mathematics is more important than the method used to get the answer	2.1	1.7	3.8	5.5	41.0	51.3	92.3
Girls are, on the whole, incapable of becoming good mathematicians.	2.6	2.6	2.6	5.2	39.3	53.0	92.3
Mathematics teachers should not be concerned with applications of mathematics.	2.1	2.1	3.0	5.1	41.5	51.3	92.8
Information contained in official textbooks should not be questioned	3.0	0.4	3.0	3.4	45.7	47.9	93.6

7.5.2: Perceptions on objectives, content and processes of mathematics teaching
Respondents were asked to rank in order of importance statements on objectives of teaching mathematics, aspects of management and presentation of lessons etc. The weightings 3, 2, and 1 were assigned to statements ranked by individual teachers respectively as first, second and third. To obtain the figures in the column headed total, entries in each row were substituted in the formula:

Total = [(3 x frequency in 1^{st} column) + (2 x frequency in 2^{nd} column) + (1 x frequency in 3^{rd} column)]

Thus row totals were used to rank the statements according to importance as perceived by teachers.

The tables 7.17 to 7.21that follow show teachers' ranking according to importance of some statements on teaching of mathematics.

Table 7.17: Teachers Perception of order of importance of Teaching Objectives in Mathematics

Teachers should encourage students to:	1^{st}	2^{nd}	3^{rd}	total	Order of importance
Increase intellectual curiosity and explore ways of mathematical reasoning	77	62	42	397	1^{st}
Acquire and apply skills and knowledge relating to number, measure and space in mathematical situations they will meet in daily life	72	56	35	363	2^{nd}
acquire a foundation appropriate to a further study of mathematics and skills and knowledge pertinent to other disciplines	36	49	53	259	3^{rd}
appreciate the pattern, structure and power of mathematics and derive satisfaction, enjoyment and confidence from understanding of concepts and mastery of skills	38	35	57	241	4^{th}
Develop mathematical language as a means of communication	19	30	23	140	5^{th}

From the table above the respondents indicated increasing intellectual curiosity and exploring ways of mathematical reasoning as the most important objective. These views by teachers were consistent with good practice in mathematics teaching, however, lessons observed did not show that teacher practiced what they believed.

Table 7.18 below shows teachers' ranking of teaching contents and the processes.

Table 7. 18: Teachers' Ranking of Aspects of Teaching Contents and Processes in Mathematics

Teachers,	1st	2nd	3rd	total	Order of importance
Organizing contents to provide abundant opportunities for building mathematical concept and principles and applying them to further inquiry tasks, projects, and concepts and principles and application to daily life.	80	70	40	420	1st
Recognizing that teaching contents of mathematics must be considered in relation to the nature of learners, their needs and interest, growth levels, etc.	84	58	50	418	2nd
Organizing topics to promote scientific thinking and problem solving skills, and development of interest and positive attitude.	55	63	59	350	3rd
Organizing content that cultivates process of mathematics and communication skills to acquire the desire to know, to communicate with others orally and in writing,	13	25	51	140	4th

From the table above respondents indicated organizing contents to provide abundant opportunities for building mathematical concepts and principles and applying them to further inquiry tasks, projects and concepts and principles and application to daily life as being most important. The next best choice was recognizing that teaching contents of mathematics should be considered in relation to the nature of learners, their needs and interest, growth levels, etc. Their third choice was organizing topics to promote scientific thinking as well as problem solving skills and development of interest and positive attitude.

Again, teachers demonstrated good philosophical outlook of content and the process of mathematics. What remained was how they could implement this in their classrooms.

7.5.3 Perceptions on methods and strategies of mathematics teaching

Respondents were asked to rank in order of importance statements on teaching methods and strategies as indicated in the table below;

Table 7.19: Teachers' ranking of statements on organization/presentation of mathematics lessons

Teachers	1st	2nd	3rd	total	Order of importance
Utilizing various teaching strategies: problem solving, individual learning, cooperative group learning, project method, etc.	87	58	32	409	1st
Using charts, diagram, models, materials and analogies to make abstract concepts clear to students etc.	34	56	27	241	2nd
Conducting lessons to promote learning through activities such as questioning, suggesting, demonstrating, explaining, discussing, presenting, etc.	38	31	46	222	3rd
Utilizing various teaching facilities and					

materials, which may be available in the local environment.	31	41	46	221	4th
Setting teaching/learning goals, which are explicit, realistic and accepted by students.	36	17	32	174	5th
Utilizing various teaching sites such as classroom, laboratory, school grounds and field in lesson.	14	25	21	113	6th

From the table above the majority indicated as top priority utilizing various teaching strategies such as problem solving, individual learning, co-operative group learning and project method.

Thus, though respondents indicated and ranked the methods and strategies as shown, they did not apply the same in their classes as the results in section on lesson observations above show.

The idea of using various strategies in teaching and learning should form a significant part of CPD for mathematics teachers.

Respondents were asked to rank the statements on material production and usage below in order of importance. Table 7.20 shows the results.

Table 7.20: Teachers ranking of aspects of Material Production and Usage

Teachers	1st	2nd	3rd	total	Order of Importance
Developing and utilizing instructional materials suited to pupil' ability levels and relevant to classroom objectives.	110	56	42	484	1st
adapting and utilizing a variety of instructional materials and media such as charts, diagrams, newsprint papers etc.	55	72	55	364	2nd
selecting, adapting and utilizing supplementary books, handbooks and other materials for learning use by pupils.	43	65	72	331	3rd
utilizing the textbooks as the most important resource materials for use in teaching.	15	24	33	126	4th

In respondents' opinion, teachers developing and utilizing instructional materials suited to pupil' ability levels and relevant to classroom objectives was rated first. The second statement was teachers adapting and utilizing a variety of instructional materials and media such as charts, diagrams, newsprint papers etc. The third choice was selecting, adapting and utilizing supplementary books, handbooks and other materials for learning use by pupils. It was encouraging however, to note that teachers (respondents) were aware of the power and use of instructional media.

It is important to point out also that many teachers identified materials production and usage as an area they needed for their CPD.

7.5.4 Views on Assessment in Mathematics

The table below shows respondents' ranking of evaluation of student's learning.

Table 7.21: Teachers' ranking of assessment of pupils' learning

	1st	2nd	3rd	total	Order of Importance
Teachers developing, improving mathematics competency tests and evaluation instruments to measure cognitive and process skills.	63	40	37	306	1st
Teachers are able to identify students with special needs and provide the necessary support for assistance and guidance.	56	27	29	251	2nd
Teachers assigning individual homework appropriate to the level of pupils' ability and give feedback/evaluation promptly.	24	45	31	193	3rd
Teachers utilizing fair and varied student evaluation measures such as paper and pencil tests, essay, tests, checklists, interview, homework etc.	30	29	24	172	4th
Teachers utilizing results of evaluation for revising instruction and enhancing learning achievement.	15	42	25	154	5th
Teachers utilizing textbook exercise.	24	19	14	124	6th
Teacher classifies pupils' ability and understanding by utilizing the results of evaluation.	19	17	30	121	7th
Teachers utilizing past examination questions.	14	16	18	92	8th

From the table above respondents ranked teachers developing, improving mathematics competency tests and evaluation instruments to measure cognitive and process skills as first. This tallied with results obtained from pupils' questionnaires. Pupils indicated that their mathematics teachers assessed their work and provided feedback promptly. Thus, it would appear that teachers were adequately attending to their pupils' assessment and evaluation.

7.5.5. HODs Views on Attitudes of Teachers towards Mathematics Teaching

Table 7.22 shows HoDs rating of teachers' eagerness to work in mathematics.

Table 7.22: HoDs Rating of Teachers' Attitudes towards Mathematics Teaching

	PERCENTAGES (%) of teacher per each category						
Aspects of attitudes	**Not stated**	**Very good (VG)**	**Good (G)**	**V.G. + G**	**Satisfactory (S)**	**Poor (P)**	**S. + P.**
Interest in teaching mathematics	2.3	63.6	31.8	95.4	2.3	0.0	2.3
Attendance of lessons	2.3	59.1	34.1	93.2	4.5	0.0	4.5
Punctuality for lessons	2.3	56.8	31.8	88.6	6.8	2.3	9.1
Morale	2.3	38.6	25.0	63.6	25.0	9.1	34.1
Willingness to teach mathematics outside normal lesson time	2.3	27.3	27.3	54.6	27.3	15.9	43.2
Willingness to teach extra classes in the absence of a colleague	4.5	11.4	25.0	36.4	38.6	20.5	59.1
Participation in activities of JETS, e.g. helping children to prepare and present projects papers.	2.3	11.4	27.3	38.7	22.7	36.4	59.1
Participation in activities of ZAME, e.g. attending annual conferences, presenting papers etc.	4.5	4.5	6.8	11.3	27.3	56.8	84.1

From the table above teachers were committed to their work within the confines of the timetable. However, they were not motivated enough to engage in extra work to cover their friends. The HODs also confirmed low participation of teachers in ZAME and JETS activities. It could be said that teachers just performed 'a duty' as specified in the general orders, but did not have a professional predisposition to their work.

What seems to come through in terms of teaching trends in mathematics is that the top four techniques of teaching mathematics which respondents said they used in their classes were 'teacher asks questions and pupils answer'; 'pupils given work to do after classes'; 'teacher demonstrates and pupils watch'; and 'teacher talks, pupils listen'. There are two significant characteristics about the data on teaching trends. The first, as stated earlier, is the predominance of teacher-centred methodologies. The second is the lack of variety within the teacher centred methodologies. Other than practice of skills (through teachers giving pupils work to do), the rest is essentially teacher exposition.

A committee of enquiry into the teaching of mathematics in England and Wales at the beginning of the 1980s addressed the question of desirable ways of teaching. The Committee declined to give definitive ways of teaching mathematics saying that teachers were unique individuals and so were pupils. Topics also differed and so did the circumstances in which the teaching took place. Thus, the methods of teaching have to respond to the multiple variables surrounding each different situation. (Cockcroft, 1982, paragraph 243)

In terms of teaching strategies used, respondents demonstrated awareness of a variety of strategies. They also indicated that they were confident in using almost all teaching strategies except organizing and facilitating field trips. Though the results indicated many of the respondents being confident at using the stated strategies, very few of them utilized the 'learner-centred' strategies in their classrooms, as witnessed during classroom observations. This situation was despite the point that, the past few years in Zambia have seen strong advocacy for learner-centred teaching methodologies. The AIEMS project had *Module 5*, which was meant to orient teachers to learner-centred methodologies especially the use of group work. The Ministry of Education's Primary Reading Programme (PRP) is designed to operate under group-work conditions. A new initiative by MOE's Teacher Education Department (TED) in conjunction with a Belgian quasi governmental NGO, VVOB, is piloting at COSETCO and Nkrumah Secondary Teacher Training Colleges and in a few schools, an initiative called 'Learner Centred and Context Based' teaching of mathematics. These are most welcome developments. However, there is evidence of many children in group-work arrangements who are completely lost and hardly making progress in their learning. Thus, learner-centred methodologies are not an end in themselves, as they do not guarantee that learning is taking place. Whether teacher-centred or learner-centred, the Team is concerned with learning taking place and while acknowledging that learner-centred methodologies are more likely to lead to learning. Since learner-centred is only a means to learning, the team would like to advocate **for learning-centred methodologies** – entailing a teacher to be a reflective practitioner typified by a quotation ~~in~~ an office in one of the schools visited: "I taught the class something and they didn't understand it. I taught it again, they still didn't understand it. The third time I understood it" (author unknown).

7.6 VIEWS OF TEACHERS OF MATHEMATICS ON CONTINUING PROFESSIONAL DEVELOPMENT

The section below presents views of teachers on some aspects of Continuing Professional Development, and areas where they would like further professional development.

7.6.1: Teachers' Reactions to Aspects of Continuing Professional Development

Respondents were asked to indicate against each statement below, whether they agreed or disagreed with it.

Table 7.23: Teachers' Reactions to Statements on Aspects of Organisation/Management of CPD

	Percentages (%) of teachers per each category						
Statement	**Not stated**	**Strongly agree**	**Agree**	**S.A. + A**	**Disagree**	**Strongly disagree**	**S.D + D**
Participants in CPD programmes should receive certificates.	2.6	50.0	44.4	94.4	2.6	0.4	3.0
CPD is a must for teachers	4.3	56.8	34.2	91.0	4.3	0.4	4.7
Attendance at CPD programmes should be solely for the purpose of professional growth.	3.4	34.6	43.2	77.8	17.5	1.3	18.8
Teachers are best facilitators for fellow teachers in CPD programmes	3.4	28.2	48.3	76.5	19.7	0.4	20.1
CPD programmes are best if they are college/university-based	3.0	44.0	23.9	67.9	25.6	3.4	29.0
College/university lecturers are the best facilitators for teachers in CPD programmes	3.4	32.1	32.9	65.0	28.2	3.4	31.6
CPD programmes are best if they are school-based	3.8	23.9	40.2	64.1	26.1	6.0	32.1
CPD programmes are best if they take place during school holidays rather than during term time	3.8	25.6	37.6	63.2	25.6	7.3	32.9
CPD programmes are best if based at resource centres	3.8	9.4	41.9	51.3	39.7	5.1	44.8
INSET providers are the best facilitators for teachers in CPD programmes	3.8	8.5	42.3	50.8	41.5	3.8	45.3
Short CPD programmes (e.g. 1 week duration) are better than those of longer duration	3.4	8.5	33.3	41.8	39.3	15.4	54.7
Inspectors are the best facilitators for teachers in CPD programmes	3.4	6.0	21.8	27.8	54.3	14.5	68.8
The cost of participation in CPD programmes should be borne by the individual teachers/schools	3.0	5.1	17.5	22.6	44.0	30.3	74.3

From the table above the majority of the respondents (91.0%) indicated that Continuing Professional Development was a must for teachers. Also 94.4% indicated that teachers who participated in such programmes should be given certificates.

In terms of facilitation at Continuing Professional Development programmes respondents preferred fellow teachers (76.5%) compared to college/university lecturers (65.0%). They also indicated that the programmes should be school based (64.1%) and that they should take place during school holidays rather than during term time (63.2%).

The majority of the respondents (74.3%) were against the idea that the cost of participation at these programmes should be borne by themselves or their schools.

7.6.2 Suggested areas for further professional development

Respondents were asked about the extent to which they needed further professional development in the areas shown in the table below.

Table 7.24: Extent to which teachers need further professional development with regard to each of the areas shown.

	Percentages (%) of teacher per each category						
Areas	**Not. Stated.**	**Very High**	**High**	**V.H + H**	**Low**	**Not at all**	**L + N.**
Teaching pupils with poor mathematics background	2.6	56.0	23.1	79.1	10.3	8.1	18.4
Teaching at higher grade levels than trained for	2.1	48.7	26.5	75.2	9.4	13.2	22.6
Use of audio/visual aids	2.6	51.7	22.6	74.3	17.1	6.0	23.1
Knowledge about gender-sensitive teaching approaches	2.6	41.0	32.9	73.9	15.8	7.7	23.5
Coping with public examination demands	4.3	33.8	39.3	73.1	15.4	7.3	22.7
Catering for individual differences among learners	2.6	36.3	33.8	70.1	20.5	6.8	27.3
Coping with heavy teaching loads	2.6	40.6	27.8	68.4	14.5	14.5	29.0
Improvising teaching materials	3.4	32.1	35.9	68.0	18.8	9.8	28.6
Knowledge about how pupils learn mathematics	3.4	35.5	30.3	65.8	21.8	9.0	30.8
Handling large mathematics classes	2.1	39.7	25.6	65.3	18.4	14.1	32.5
Motivating learners	3.4	38.5	26.5	65.0	20.9	10.7	31.6
Use of printed material (e.g. textbooks, worksheets)	4.3	27.4	26.5	53.9	21.4	20.5	41.9

From the table above it is clear that the majority of respondents needed further professional development in all the stated areas. The order of preference would be as presented in the table above: teaching pupils with poor mathematics background

(79.1%), at the top, and use of printed material (e.g. textbooks, worksheets) (53.9%) at the bottom.

In addition, during interviews, many teachers said that they found it difficult to employ a variety of teaching methods especially 'learner centred' methods, due to lack of teaching aids, heavy teaching loads, and large classes. Teachers further claimed that they had never seen teacher centred methods at work. In other words, they did not have role models to refer to and were not confident enough to try.

There were also quite a large number of respondents who indicated that they were teaching at higher-grade levels than those they were trained for (75.2%). It would appear, therefore, that there were very few graduates from the University teaching in the schools. In other words, non-graduate teachers taught many of the senior grades (10 – 12) in mathematics from the colleges of education.

In short, teachers needed CPD so that they could perform their work better. They preferred 'fellow teachers' to facilitate and demonstrate 'best' practices to them, though they would also welcome college/university lecturers from time to time. They also preferred the programmes to be based within the school and during holidays. However, teachers were divided on whether CPD programmes should be of short or long duration, but were agreed that CPD should lead to some form of certification.

Teachers were wary about meeting any costs towards their own CPD. It would appear that whatever programmes were to be developed or implemented; the costs' aspects would have to be looked at critically. Finally, mathematics teachers would like professional development programmes in the following areas:

- handling pupils with poor mathematics background and large classes.
- teaching at higher-grade levels than trained for.
- using audio/visual aids and their improvisation
- teaching approaches that are gender sensitive
- coping with heavy teaching loads and examination demands
- how pupils learn mathematics
- motivating learners and;
- using printed materials.

7.6.3 HoDs Perceptions of CPD Activities of Teachers in their Departments

Professional development activities in a department could include team planning of lessons, team teaching, observing one another's lesson and subsequently discussing the lesson, writing learning materials such as pamphlets, carrying out research and conducting seminars and workshops. Heads of department were asked to indicate how often each of such activities took place in their departments. Responses are given in Table 7.25 below.

Table 7. 25: Professional Development Activities in the Department.

Activity	Frequency(n = 44)	Percentage (%)
Team planning of lessons	15	34.1
Team teaching	11	25.0
Observing one another's lessons	27	61.4
Writing learning materials	24	54.5
Carrying out research	6	13.6
Conducting seminars and workshops	16	36.4

The table shows that the above professional development activities were not a regular feature in departments. Only in 'observing one another's lesson' (61.4% of HoDs) and 'writing learning materials' (54.5% of HoDs) did the majority of Heads of Department indicate that the activity took place in their departments. However, apart from one school in Luapula Province, the field work for the survey did not produce any evidence of these activities being part of regular departmental activity neither was there evidence that such activities were seen in the context of teachers' professional development.

7.7 PUPILS OPINION ON PREVAILING TEACHING STYLES IN MATHEMATICS

7.7.1 Senior Mathematics Pupils

Senior pupils' opinion on frequently used teaching approaches in mathematics are presented in the table below:

Table 7. 26: Pupils' Opinion on Teaching Approaches used in Mathematics

	Percentages (%) of teacher per each category						
	Not stated	Strongly Agree (SA)	Agree (A)	SA + A	Disagree	Strongly Disagree	SD + D
S/he uses examples and illustrations during our lessons	1.0	55.1	39.5	94.6	2.0	2.4	4.4
S/he gives us some exercises to do during the lesson	1.0	59.0	35.1	94.1	2.0	2.9	4.9
S/he writes clearly on the board	0.5	60.0	34.1	94.1	3.4	2.0	5.4
The teacher knows the subject well	0.5	61.0	31.7	92.7	5.9	1.0	6.9
S/he asks questions clearly	1.5	38.5	53.2	91.7	5.4	1.5	6.9
S/he encourages us to ask questions if we do not understand	2.0	60.0	30.7	90.7	5.4	2.0	7.4
The teacher encourages us to study/do the subject during our spare time	1.5	46.8	41.5	88.3	8.8	1.5	10.3
S/he asks questions to both girls and boys	8.8	49.8	35.6	85.4	3.9	2.0	5.9
S/he encourages both girls and boys to answer questions	8.3	47.8	36.1	83.9	3.9	3.9	7.8
S/he draws neat and accurate diagrams on the board	1.0	44.9	38.0	82.9	14.6	1.5	16.1

S/he gives us notes in manner that encourages us to think	1.0	44.9	37.1	82.0	9.8	7.3	17.1
S/he makes the subject enjoyable to learn	1.0	41.0	40.5	81.5	14.1	3.4	17.5
S/he explains our mistakes in our work	1.0	31.7	49.8	81.5	13.2	4.4	17.6
Our mathematics teacher is always punctual	1.0	48.8	31.2	80.0	13.7	5.4	19.1
Our mathematics teacher introduces mathematics lessons in an interesting way	1.0	46.8	33.2	80.0	15.6	3.4	19.0
S/he only punishes when it is very necessary	1.0	40.0	37.6	77.6	13.7	7.8	21.5
S/he also encourages even if one gives a wrong answer	0.5	37.1	40.0	77.1	14.1	8.3	22.4
S/he marks the homework and tests and gives us feedback quickly	1.0	38.0	39.0	77.0	14.1	7.8	21.9
S/he gives us homework and tests regularly	2.9	37.6	38.0	75.6	16.1	5.4	21.5
S/he calls us by our names when s/he wants us to answer a question	1.0	42.4	32.7	75.1	18.0	5.9	23.9
The teacher gives individual help to pupils who have difficulties	1.5	33.7	39.0	72.7	15.1	10.7	25.8
At end of lesson, teacher summarises points covered or asks us questions	0.5	29.8	41.5	71.3	19.0	9.3	28.3
S/he encourages us to give our own views/ideas during the lesson	0.5	31.2	40.0	71.2	23.9	4.4	28.3
The teacher sometimes asks faster learners to assist their friends	1.0	33.7	37.1	70.8	17.6	10.7	28.3
S/he asks questions to both hand raised and non-hand raised	1.0	36.6	33.2	69.8	20.5	8.8	29.3
S/he does not move from one topic to another before making sure that we have understood	1.0	34.1	34.6	68.7	19.5	10.7	30.2
Our mathematics teacher never misses lessons	0.5	30.2	35.6	65.8	25.4	8.3	33.7
The teacher varies her/his teaching methods	1.5	17.6	46.3	63.9	26.8	7.8	34.6
The teacher relates the subject to our everyday life	0.5	25.9	35.1	61.0	28.3	10.2	38.5
S/he asks for our ideas and uses them	1.5	16.6	41.5	58.1	29.8	10.7	40.5
S/he allows us to talk to each other on the topic being taught	2.9	16.6	31.2	47.8	25.9	23.4	49.3
Sometimes we work in pairs during her/his lessons	1.5	11.7	29.3	41.0	32.7	24.9	57.6
We perform experiments in her/his lesson	1.0	10.7	23.4	34.1	30.7	34.1	64.8
The teacher sometimes takes us out of the classroom to learn	1.0	3.9	2.4	6.3	35.1	57.6	92.7

From the table above, many respondents indicated that their teachers were practising the stated teaching aspects/approaches during lessons, except for four (4) aspects, namely; "the teacher sometimes taking the class out of classroom to learn (92.7%)", "the teacher sometimes allowing pupils to work in pairs during lessons (57.6%)", "pupils performing experiments in class (64.9%)" and "teachers allowing pupils to talk to each other on the topic being taught (49.3%)". These aspects/approaches could be said to be indicators of 'learner-centred approaches', which it would appear were not being practised in schools.

However, teachers faired very well in attributes/approaches that could be said to be indicators of 'teacher-centred' approaches. The majority of the respondents agreed with such statements as, "the teacher giving pupils notes in a manner that encouraged them to think (82.0%)", "the teacher asking questions clearly (91.7%)", "the teacher

making the subject enjoyable to learn (81.5%)", "the teacher using examples and illustrations during lessons (94.6%)" etc.

The other approaches/attributes could fall in either category; they were generally indicators of 'good practice' in a classroom either in learner centred or teacher - centred approaches. Examples of such are; "the teacher relating the subject to everyday life (61.0%)", "the teacher encouraging pupils to study mathematics during their spare time (88.3%)", "the teacher knowing the subject well (92.7%)", "the teacher encouraging pupils to ask questions if they did not understand (93.3%)" etc.

These results collaborate with the results of classroom observations and interviews conducted with teachers. The organisation of the classes and the lessons observed were teacher centred. The observed lessons were executed, taking into account many of the attributes above thereby ensuring 'active' participation by pupils.

In terms of gender, respondents indicated that their teachers were gender sensitive. For example, with regard to whether both girls and boys should be encouraged to answer questions, 83.9% of the respondents agreed with the statement. Also 88.3% agreed with the statement that teachers asked questions to both girls and boys.

There were no major differences between the responses from girl or boy respondents. In other words, 87.5% of boys and 82.8% of girl respondents indicated that their teachers asked questions to both girls and boys. Similarly 86.6% male and 80.6% female respondents indicated that both sexes were encouraged to answer questions.

In terms of discipline, 77.6% of the respondents indicated that their teachers only punished them when it was absolutely necessary. On statements about punctuality and dedication to duty, 65.8% of respondents indicated that their mathematics teacher never missed lessons and 80.0% indicated that their teachers were always punctual. It could thus be stated that generally mathematics teachers reported to their classes on time and rarely missed lessons. This tallies with observations made by HoDs.

On assessment and evaluation 77.0% of respondents agreed with the statement that their teachers marked the homework and tests and gave feedback quickly. Also 75.6% agreed that their teachers gave homework and tests regularly and 94.1% indicated that they were given exercises to do during lessons. From the opinion of respondents it would appear mathematics teachers generally assess their pupils and provide feedback on time.

The other attributes which teachers practised in their classrooms were; asking questions to both hand raisers and non-hand raiser (69.8% respondents agreed), 72.7% of respondents agreed that their teachers were giving them individual help. About seventy five percent (75.1%) of the respondents indicated that their teacher called them by name when they were required to answer questions.

7.7.2 Junior Mathematics Pupils

Junior mathematics pupils were asked to indicate their opinion on frequently used approaches in mathematics by their teacher. Table 7.27 shows the results.

Table7.27: Junior Mathematics Pupils' Opinion on Prevailing Teaching Approaches in Mathematics

	Percentages (%) of teachers per each category						
	Not stated	Strongly Agree (SA)	Agree (A)	SA + A	Disagree	Strongly Disagree	SD + D
S/he encourages us to ask questions if we don't understand	0.3	62.3	31.0	93.3	4.3	2.0	6.3
S/he gives us some exercises to do during the lesson	1.3	63.7	28.0	91.7	4.3	2.7	7.0
The teacher knows the subject well	0.3	63.7	28.0	91.7	3.7	4.3	8.0
The teacher encourages us to study/do the subject during our spare time	0.7	55.7	33.3	89.0	6.7	3.7	10.4
S/he uses example and illustrations during our lesson	3.7	49.0	39.7	88.7	5.0	2.7	7.7
S/he writes clearly on the board	1.0	50.3	37.7	88.0	8.7	2.3	11.0
S/he asks questions clearly	2.7	36.7	48.7	85.4	7.0	5.0	12.0
S/he encourages both girls and boys to answer questions	7.0	47.3	34.7	82.0	6.3	4.7	11.0
S/he explains our mistakes in our work	1.3	41.0	40.7	81.7	12.7	4.3	17.0
S/he asks questions to both girls and boys	9.7	52.0	29.0	81.0	5.0	4.3	9.3
S/he makes the subject enjoyable to learn	1.7	40.7	37.3	78.0	14.7	5.7	20.4
S/he draws neat and accurate diagrams on the board	4.3	34.3	42.7	77.0	13.7	5.0	18.7
S/he gives us notes in manner that encourages us to think	1.3	37.3	39.0	76.3	15.3	7.0	22.3
Our mathematics teacher is always punctual for lessons	2.3	42.0	33.7	75.7	16.7	5.3	22.0
The teacher gives individual help to pupil who have difficulties	1.7	36.0	39.0	75.0	12.0	11.3	23.3
S/he asks questions to both hand raised and non-hand raised	1.7	41.7	32.7	74.4	15.7	8.3	24.0
S/he calls us by our names when s/he wants us to answer a question	2.3	36.0	38.0	74.0	17.0	6.7	23.7
Our teacher introduces mathematics lessons in an interesting way	1.7	38.0	36.0	74.0	17.3	7.0	24.3
S/he does not move from one topic to another before making sure that we have understood	0.3	44.7	28.7	73.4	14.0	12.3	26.3
S/he gives us homework and tests regularly	2.0	38.0	34.0	72.0	17.3	8.7	26.0
S/he only punishes when it is very necessary	3.7	34.0	37.0	71.0	16.0	9.3	25.3
At end of lesson, teacher summarises points covered or asks us questions	1.0	34.0	36.7	70.7	19.3	9.0	28.3
S/he also encourages even if one gives a wrong answer	5.7	29.7	37,3	67.0	18.3	9.0	27.3
Our mathematics teacher never misses lessons	0.7	31.0	36.0	67.0	26.7	5.7	32.4
S/he marks the homework and tests and gives us feedback quickly	2.7	31.0	34.3	65.3	20.3	11.7	32.0
The teacher varies her/his teaching methods	5.0	22.3	41.0	63.3	24.7	7.0	31.7
S/he encourages us to give our own views/ideas during the lesson	2.7	19.3	42.0	61.3	26.0	10.0	36.0
The teacher relates the subject to our everyday life	3.0	18.3	40.3	58.6	26.7	11.7	38.4
The teacher sometimes asks faster learners to assist their friends	1.0	21.3	36.3	57.6	24.7	16.7	41.4

S/he asks for our ideas and uses them	4.3	19.7	36.0	55.7	30.0	10.0	40.0
We perform experiments in her/his lesson	3.7	18.3	28.7	47.7	29.0	20.3	49.3
Sometimes we work in pairs during her/his lessons	3.0	18.7	25.0	43.7	34.0	19.3	53.3
S/he allows us to talk to each other on the topic being taught	1.3	15.7	26.0	41.7	33.0	24.0	57.0
The teacher sometimes takes us out of the classroom to learn	2.7	8.0	14.0	22.0	39.0	36.3	75.3

From the table above the pattern of responses was similar to the senior mathematics group above. In the opinion of many respondents many of the teaching approaches were being practised in their classrooms. Again, aspects that suggest learner centred approaches received less agreement from respondents. It would appear that teachers preferred exposition in teaching/learning activities in the classrooms rather than giving opportunity to learners themselves. However, they varied their approaches as confirmed by the respondents, 63.3% indicated that their teachers varied their teaching methods.

During the interviews teachers defended their approaches as the best possible in their teaching environment. In their view they handled large classes and lacked teaching/learning materials to be able to use other methods. They further complained about heavy teaching loads and pressure of examinations.

7.8 SUMMARY OF FINDINGS

This chapter has shown that;

7.8.1 Demographic characteristics of teachers

- A majority of teachers of mathematics were male and young in the profession and in terms of age. Many had been teaching for less than six years. Three quarters of them were trained to teach mathematics, though over half were teaching grades not trained for (Grades 10 – 12).

7.8.2 Membership to Subject Association (ZAME)

- There was low level of paid/active membership in ZAME. The majority of teachers of mathematics nonetheless identified themselves with the association (ZAME).

7.8.3 Topics teachers found difficult to teach and pupils found difficult to learn

- The least popular topics among teachers at junior level were 'social and commercial arithmetic', shapes and symmetry', 'construction', and 'estimations'. The topics that pupils at this level found difficult to learn were; 'statistics', 'social and commercial arithmetic', and 'construction'.

- At senior secondary level the unpopular topics were, 'transformations', 'probability', 'angles', 'trigonometric problems in three dimensions', 'bearings', 'locus' and 'vectors'. Pupils at this level found, 'graphical representation of inequalities', 'graphs of functions' 'transformation geometry', 'trigonometry in 3-dimension', 'kinematics' and 'mensuration' difficult to learn.

7.8.4 Teaching trends

- Although teachers were aware of a variety of teaching strategies and claimed confidence at using them, they mostly used teacher-centred approaches in their classes, such as teacher asking questions and pupils answering, pupils given work to do after classes, teachers demonstrating and pupils watching, teacher talking and pupils listening, and pupils searching for answers to written questions.

- Teachers explained that their failure to use of a variety of teaching methods, and particularly learner-centred approaches was due to large classes, lack of teaching/learning materials, heavy teaching loads, and pressure of examinations.

- Teachers were aware of innovative teaching approaches and current thinking in mathematics education. However, they were not practising what they believed.

7.9. Views on Continuing Professional Development

- Teachers had a sound sense of duty. Their attendance and punctuality at lessons was good. However, their professional aptitude was weak exemplified by, low/none participation in professional activities such as JETS, ZAME or other CPD programmes.

- Teachers welcomed CPD programmes. They would like them to be done within the school and during holidays. However, they would not like to pay for CPD activities from their own resources.

- Teachers preferred 'fellow teachers' to facilitate and demonstrate 'best' practices to them, though they would also welcome college/university lecturers from time to time.

- Teachers were divided on question of whether CPD programmes should be of short or long duration, but were agreed that CPD should lead to some form of certification.

CHAPTER EIGHT

FINDINGS AND DISCUSSION: PHYSICS

8.1 DEMOGRAPHIC CHARACTERISTICS OF TEACHERS OF PHYSICS

8.1.1 Sex of teachers

Table 8.1 below shows the distribution ,by sex , of teachers of physics who participated in the study.

Table 8.1: Distribution of teachers of physics by sex

	Frequency	Percentage
Male	90	92.8
Female	7	7.2
Total	97	100

As can be seen in Table 8.1 above, most respondents were males.

8.1.2 Age of teachers

Table 8.2 below shows the distribution, by age, of teachers of physics who participated in the study.

Table 8.2 : Distribution of teachers of physics by age

	Frequency	Percentage
Less than 30 years	36	37.1
31-40 years	47	48.5
41-50 years	11	11.3
More than 50 years	3	3.1
Total	97	100

The majority of respondents were between the age range 31-40 years.

8.1.3 Academic and professional qualification of teachers

Table 8.3 shows that all respondents category reached grade 12.This is expected because in order for one to teach as a secondary school teacher s/he needs to possess at least O' level.

Table 8.3: Academic / professional qualifications of teachers of physics

	Frequency	Percentage
O' Level	97	100.0
Diploma in Education	57	58.8
Advanced Diploma in Education	10	10.3
Bachelor of Science	5	5.1
Bachelor of Science with Education	18	18.6
Bachelor of Arts with Education	1	1.0
Other	5	5.1

However, as can be seen in Table 8.3 only 28.9% (N=28) respondents had the recommended qualification to teach at grades 10 to 12 levels.

8.1.4 Specific subjects for which teachers of physics were trained to teach

With regard to specific subjects teachers of physics were trained to teach, Table 8.4 shows that most of them were trained to teach chemistry.

Table 8.4 : Specific subjects teachers of physics were trained to teach

Subject	Frequency	Percentage
General /Environmental science	66	68.0
Biology	56	57.7
Chemistry	69	71.1
Physics	19	19.6
Mathematics	11	11.3
Other	5	5.1

The possible reason for this is that there are no many teachers trained to teach physics because the University of Zambia has not been producing large number of physics teachers. For example, in the last 10 years only 13 physics teachers graduated. Because of the shortage of physics teachers, teachers trained to teach other science subjects are asked to teach physics.

8.1.5 Length of service as teacher

Respondents were also asked how long they had been teaching. The distribution of responses is shown in Table 8.5 below .

Table 8.5: Length of service as teacher

	Frequency	Percentage
1-5 years	39	40.2
6-10 years	28	28.9
11-15 years	19	19.6
16-20 years	5	5.1
Above 20 years	6	6.2
Total	97	100.0

More than a third of the respondents (40.2%) reported that they had served for a period ranging from 1 to 5 years while about a third of the respondents (28.9%) had taught for a period of 6 to 10 years.

8.1.6 Length of service as teachers of physics

Table 8.6 below shows the distribution of responses of teachers regarding how long they had been teaching physics .

Table 8.6: Length of service as teachers of physics at different grade levels

	Length of service as teachers of physics in years					
Grade Level	None	1-4	5-9	10-14	15-20	Above 20
Grade 10	3.1%	48.5%	31.9%	12.4%	3.1%	4.1%
Grade 11	4.1%	48.5%	31.9%	12.4%	3.1%	4.1%
Grade 12	14.4%	51.5%	27.9%	13.4%	3.1%	4.6%

Table 8.6 above shows that most of the respondents had a short teaching experience at senior secondary school level. The majority of the respondents had only taught for a period ranging from 1 to 4 years.

8.1.7 Levels of participation of teachers of physics in ZASE activities

Respondents were also asked to indicate their level of participation in ZASE activities. The distribution of their responses is shown in Table 8.7 below.

Table 8.7: Levels of participation of teachers of physics in ZASE activities

	Frequency	Percentage
Ordinary member	32	33.0
Member of executive committee	13	13.4
Presented paper(s) at ZASE annual meeting	3	3.1
None of the above	49	50.5
Total	97	100

With regard to level of participation in ZASE, Table8.7 shows that 50.5% of respondents were not members of ZASE. This may be because teachers of physics were not aware of the association's existence, or may be they did not want to be members due to some reasons.

In short , on the basis of the information presented in tables from 8.1 to 8.7 it could be said that most teachers of physics in Zambia were males, less than 40 years old, had only taught physics for a few years and were not members of their professional association (ZASE). Furthermore, most of them were not trained specifically to teach physics.

8.2 TOPICS TEACHERS OF PHYSICS FOUND DIFFICULT TO TEACH

Information on topics which teachers found difficult to teach was obtained through asking respondents to indicate topics they were least comfortable to teach; asking them to indicate their levels of confidence in teaching particular topics in physics and also asking Heads of Departments to state aspects of physics teaching they felt teachers of physics needed help to be better teachers.

8.2.1 Topics teachers of physics were least comfortable to teach

Table 8.8 shows the distribution of responses regarding topics which teachers of physics were least comfortable to teach.

Table 8.8 : Topics teachers of physics were least comfortable to teach

Topics	Frequency	Percentage
Electronics. Cathode ray oscilloscope	32	35.4
Logic gates	18	19.8
Action and use of circuit components	12	13.4
Electricity at rest	12	13.4
Radioactivity	11	12.2
Nuclear atom	11	12.2
Electromagnetic induction	11	12.2
Electromagnetism	10	11.0
Gas laws	9	10.0
Wave motion	9	10.0
Magnetism	8	8.8
Heat capacity. Quantity of heat	8	8.8
Thermal expansion	7	7.7
Pressure	7	7.7
Linear motion	6	6.6
Molecular theory of matter	6	6.6
Melting & boiling. Latent heat	6	6.6
Measurements	4	4.4
Newton's laws of motion	4	4.4
Electromagnetic spectrum	4	4.4
Sound	4	4.4
Convex lens	3	3.7
Density	2	2.4
Scalars & vectors	2	2.4
Elasticity. Hooke's law	2	2.4
Principle of moments	2	2.4
Transfer of heat	2	2.4
Light (refraction, refraction, dispersion)	2	2.4
Energy, work, power, efficiency	1	1.2
Electric circuits	1	1.2
Household electricity	1	1.2
Electric current. Ohm's law	1	1.2

Table 8.8 suggests that most teachers of physics did not feel they were uncomfortable in teaching most topics in the physics syllabus. However, some respondents admitted that they had difficulty teaching certain topics. The most frequently mentioned were: Electronics. Cathode ray oscilloscope (35.4%), Logic gates (19.5%), Action and use of circuit components (13.4%), Electrostatics (13.4%), Radioactivity and Nuclear atom (12.2%) and Electromagnetic induction (12.2%).

8.2.2 Levels of confidence in teaching particular physics topics

As a way of verifying the information given by respondents above, they were given a list of topics in the physics syllabus and asked to indicate how confident they were in teaching the topics. They responded as shown in Table 8.9 below.

Table 8.9: Teachers' confidence levels in teaching particular physics topics

Topics	Not stated	Very confident (VC)	Confident (C)	VC + C	Not confident (NC)	Not sure (NS)	NC+NS
Linear motion	-	61.9	34.0	95.9	4.1	-	4.1
Density	1.1	81.4	13.4	94.8	4.1	-	4.1
Measurements	-	69.1	24.7	93.8	6.2	-	6.2
Newton's laws of motion	-	46.4	44.3	90.7	8.2	1.0	9.2
Principle of moments	-	56.7	34.0	90.7	9.3	-	9.3
Energy, work, power, efficiency	-	69.1	21.6	90.7	9.3	-	9.3
Light (refraction, refraction, dispersion)	-	63.9	24.7	88.6	10.3	-	10.3
Convex lens	1.1	60.8	26.8	87.6	10.3	1.0	11.3
Scalars & vectors	-	47.4	39.2	86.6	13.4	-	13.4
Transfer of heat	1.0	59.8	25.8	85.6	13.4	-	13.4
Sound	1.0	52.6	32.0	84.6	14.4	-	14.4
Magnetism	1.0	52.6	32.0	84.6	14.4	-	14.4
Melting & boiling. Latent heat	1.1	43.3	41.2	84.5	13.4	1.0	14.4
Electric current. Ohm's law	2.0	46.4	36.1	82.5	15.5	-	15.5
Thermal expansion	1.0	48.5	34.0	82.5	16.5	-	16.5
Elasticity. Hooke's law	-	44.3	38.1	82.4	17.5	-	17.5
Wave motion	1.1	53.6	27.8	81.4	16.5	1.0	17.5
Electric circuits	2.0	50.5	28.9	79.4	18.6	-	18.6
Household electricity	2.1	44.3	33.0	77.3	20.6	-	20.6
Electromagnetic spectrum	1.1	47.4	29.9	77.3	21.6	-	21.6
Molecular theory of matter	2.1	39.2	34.0	73.2	24.7	-	24.7
Electricity at rest	2.2	34.0	38.1	72.1	24.7	1.0	25.7
Heat capacity. Quantity of heat	3.2	30.9	38.1	69.0	26.8	1.0	27.8
Radioactivity	3.2	37.0	26.8	63.8	30.9	2.1	33.0
Pressure	4.2	30.9	30.9	61.8	33.0	1.0	34.0
Electromagnetic induction	2.0	25.8	35.1	60.9	36.1	1.0	37.1
Gas laws	3.1	24.7	35.1	59.8	36.1	1.0	37.1
Nuclear atom	2.0	36.1	23.7	59.8	36.1	2.1	38.2
Electromagnetism	2.1	17.5	38.1	55.6	39.2	3.1	42.3
Action and use of circuit components	3.0	10.3	32.0	42.3	52.6	2.1	54.7
Electronics. Cathode ray oscilloscope	4.1	9.3	21.6	30.9	59.8	5.2	65.0
Logic gates	5.6	2.1	11.3	13.4	72.2	8.2	81.0

As Table 8.9 above shows, teachers rated themselves not confident in teaching topics such as Logic gates (81.0%), Electronics. Cathode ray oscilloscope (65.0%), Action and use of circuit components (54.7%), Electromagnetism (42.3%), Nuclear atom (38.2%), Gas laws, Electromagnetic induction (37.1%), Pressure (34.0%), Radioactivity (33.0%), Quantity of heat (27.8%), Electricity at rest (25.7%) and Molecular theory of matter (24.7%). The findings in Table 8.9 above confirm the findings in Table 8.8 .

8.2.3 Departmental Heads' perception of areas where teachers of physics needed help

Responses from 48 Heads of Science Departments , who participated in the study , pointed to the fact that teachers needed help in understanding the following topics (frequency of mention is given in brackets): Electronics (18), Radioactivity (14),

Nuclear physics (12), Current electricity (10), Logic gates (6), Quantity of heat (5),Wave motion (5) and practical aspects concerning the following topics : Electronics (18), Electricity (15), Atomic and Nuclear physics (9), Quantity of heat and Electricity (6), Wave motion (4).

In summary, the information given in Tables 8.8 and 8.9 indicate that most teachers of physics did not think there were difficulty topics to teach in the school certificate physics syllabus. It would appear that the practice of professional self-assessment is not common among teachers of physics.

However, a few teachers revealed that they experienced difficulties teaching such topics as : Logic gates, Electronics. Cathode ray oscilloscope, Action and use of circuit components, Electromagnetism , Nuclear atom , Gas laws , Electromagnetic induction, Pressure, Radioactivity, etc. One reason given by teachers of physics for such difficulties was that they did not have adequate knowledge in these topics.
Some of the topics listed above have also been identified as difficult by other studies. For example, Jumbe and Tindi (1998) found that in two technical high schools, teachers had difficulties teaching: Atomic physics, Electronics, Wave motion, Electricity, Light, Kinetic theory and Gas laws .Teachers had difficulties teaching almost the same topics in SMASSE study, carried out in Kenya in 1999.

8.3 PREVAILING TEACHING TRENDS IN PHYSICS

Information on prevailing teaching trends in physics was collected from teachers by asking them to indicate: how frequently they themselves and their pupils carried out certain activities during lessons; methods they used to teach the following topics they felt comfortable to teach; topics they felt least comfortable to teach; topics pupils liked and topics pupils disliked.
Teachers were also asked to indicate their level of confidence in using certain methods in teaching physics. The information provided by teachers was triangulated by observing recorded lessons. The findings are presented below.

8.3.1 Teacher/pupil activities during physics lessons

Table 8.10 below shows the frequency of occurrence of certain teacher/pupil activities during physics lessons.

Table 8.10: Frequency of use of certain teacher/pupil activities during physics lessons

Teacher/pupil activities	Not stated	Very often	Often (O)	VO+O	Sometimes (S)	Never (N)	S+N
Teacher demonstrates, pupils watch	-	38.1	42.3	74.1	19.6	-	19.6
Pupil(s) demonstrates, the rest watch	-	9.3	13.4	22.7	62.9	14.4	77.3
Teacher talks, pupils listen	-	49.5	34.0	83.5	14.4	2.1	16.5
Pupil(s) explain while the rest listen	1.0	8.2	22.7	30.9	64.9	3.1	68.0
Teacher asks questions, pupils answer	-	62.9	30.9	93.8	6.2	-	6.2
Pupils discuss in small groups, teacher guides	-	11.3	21.6	32.9	59.8	7.2	67.0
Pupils carry out practical in small groups	-	8.2	33.0	41.2	47.4	11.3	58.7
Pupils act roles (role play)	-	-	9.3	9.3	36.1	54.6	90.7
Pupils carry out individual practical work	-	7.2	18.6	25.8	43.3	30.9	74.2
Pupils work out a solution to a problem	-	22.7	34.0	56.7	35.1	8.2	43.3
Class goes outside the classroom to learn	-	1.0	11.3	12.3	51.9	35.8	87.7

Pupils read from printed materials (e.g. textbooks)	-	9.3	29.9	39.2	42.3	18.6	60.9
Pupils are given work to do after classes	1.0	30.9	44.3	75.2	23.7	-	23.7
Pupils discuss as a class ,teacher guides	-	8.2	27.8	36.0	51.5	12.4	64.0
Pupils search for answers to written questions	-	12.4	44.3	56.7	33.0	10.3	43.3
Pupils listen to a guest speaker	1.0	-	1.0	1.0	39.2	58.8	99.0
Team teaching	-	-	9.3	9.3	27.8	62.9	90.8
Pupils work in pairs	-	4.1	27.8	31.9	54.6	13.4	68.1
Pupils carry out an extended investigation on an issue	-	2.1	8.2	10.3	56.7	33.0	89.7
Teacher uses video/film to teach	-	-	2.1	2.1	20.6	77.3	97.9
Pupils play educational games	-	-	-	-	27.8	72.2	100.0

Table 8.10 above shows that the most frequently used methods by majority of teachers in teaching physics were Question and answer, Teacher exposition and Teacher demonstration.

8.3.2 Methods used when teaching topics they felt comfortable to teach

Table 8.11 below shows the distribution of responses with respect to methods used to teach physics topics they felt comfortable to teach.

Table 8.11: Methods teachers of physics use to teach topics they felt comfortable to teach

Teaching methods	Number of times method was mentioned	Percentage
Teacher demonstrates, pupils watch (Demonstration)	70	76.1
Pupil(s) demonstrate, the rest watch	2	2.2
Teacher talks, pupils listen (Lecture)	58	63.0
Pupil(s) explains while the rest listen	1	1.1
Teacher asks questions and pupils answer (Question and answer)	47	51.1
Pupils discuss in small groups, teacher guides	28	30.4
Pupils carry out practical in small groups	36	39.1
Pupils carry out individual practical work	11	12.0
Pupils work out a solution to a problem	10	10.9
Class goes outside the classroom to learn	3	3.3
Pupils read from printed materials (e.g. textbooks)	1	1.1
Pupils given work to do after classes	3	3.3
Pupils discuss as a class, teacher guides	10	10.9
Pupils search for answers to written questions	2	2.2
Pupils working in pairs	2	2.2
Pupils carrying out an extended investigation on an issue	6	6.5

Table 8.11 shows that the most frequently used methods by teachers of physics in teaching physics topics they felt comfortable to teach were Demonstration, Lecture, Question and answer.

8.3.2 Methods teachers used when teaching topics they felt least comfortable to teach

The distribution of responses regarding methods teachers of physics used to teach topics they felt least comfortable to teach is shown in Table 8.12

Table 8.12: Methods teachers used when teaching topics they felt least comfortable to teach

Teaching methods	Number of times method was mentioned	Percentage
Teacher demonstrates, pupils watch (Demonstration)	31	45.6
Teacher talks, pupils listen (Lecture)	50	73.5
Teacher asks questions and pupils answer (Question and answer)	21	30.9
Pupils discuss in small groups, teacher guides	7	10.3
Pupils carry out practical in small groups	5	7.4
Pupils carry out individual practical work	2	2.9
Pupils work out a solution to a problem	1	1.5
Class goes outside the classroom to learn	1	1.5
Pupils read from printed materials (e.g. textbooks)	1	1.5
Pupils discuss as a class, teacher guides	1	1.5
Pupils search for answers to written questions	1	1.5
Pupils listen to a guest speaker	1	1.5
Pupils carrying out an extended investigation on an issue	1	1.5

Table 8.12 above indicates that the most frequently mentioned strategies for teaching topics teachers felt least comfortable to teach were Teacher exposition, Teacher demonstration, and Question and answer.

8.3.4 Methods teachers used when teaching topics pupils liked

Regarding methods they used to teach topics pupils liked, teachers responded as shown in Table 8.13 below.

Table 8.13: Methods teachers of physics used to teach topics pupils liked

Teaching methods	Number of times method was mentioned	Percentage
Teacher demonstrates, pupils watch (Demonstration)	54	65.1
Pupil(s) demonstrates, the rest watch	3	3.6
Teacher talks, pupils listen (Lecture)	41	49.2
Pupil(s) explain while the rest listen	1	1.2
Teacher asks questions, pupils answer (Question and answer)	36	43.4
Pupils discuss in small groups, teacher guides	23	27.7
Pupils carry out practical in small groups	31	37.3
Pupils act roles (role play)	1	1.2
Pupils carry out individual practical work	6	7.2
Pupils work out a solution to a problem	9	10.8
Class goes outside the classroom to learn	2	2.4
Pupils are given work to do after classes	2	2.4
Pupils discuss as a class ,teacher guides	5	6.0
Pupils search for answers to written questions	1	1.2
Team teaching	1	1.2
Pupils carry out an extended investigation on an issue	5	6.0

Three teaching strategies emerge prominently in Table 8.13 above. These are teachers demonstration, followed by Lecture method, and Question and answer.

8.3.5 Methods teachers used to teach topics pupils disliked

The distribution of teachers' responses on methods they used to teach topics pupils disliked is shown in Table 8.14 below.

Table 8.14: Methods used to teach topics disliked by pupils

Teaching methods	Number of times method was mentioned	Percentage
Teacher demonstrates, pupils watch (Demonstration)	40	54.1
Pupil(s) demonstrates, the rest watch	1	1.4
Teacher talks, pupils listen (Lecture)	51	68.9
Teacher asks questions, pupils answer (Question and answer)	26	35.1
Pupils discuss in small groups, teacher guides	14	18.9
Pupils carry out practical in small groups	11	14.9
Pupils carry out individual practical work	4	5.4
Pupils work out a solution to a problem	5	6.8
Class goes outside the classroom to learn	1	1.4
Pupils are given work to do after classes	1	1.4
Pupils discuss as a class ,teacher guides	4	5.4
Pupils search for answers to written questions	1	1.4
Pupils listen to a guest speaker	1	1.4
Team teaching	1	1.4
Pupils carry out an extended investigation on an issue	1	1.4

Table 8.14 above shows that teachers used mainly Lecture, Demonstration, and Question and answer methods to teach topics which pupils disliked.

8.3.6 Levels of confidence in using particular teaching method

Teachers were asked to indicate their level of confidence in using particular teaching methods. They responded as shown in Table 8.15 below.

Table 8.15: Teachers of physics' self-rating of their level of confidence in using particular methods for teaching physics

Teaching methods	Not stated	Very confident (VC)	Confident (C)	VC+C	Not confident (NC)	Not sure (NS)	NC+NS
Demonstration	-	74.2	25.8	100.0	-	-	-
Lecture method	-	57.7	37.1	94.8	5.2		5.2
Group discussions	-	43.3	45.4	88.7	8.2	3.1	11.3
Question and answer	1.0	66.0	33.0	99.0	-	-	-
Whole class discussion	-	22.7	52.6	75.3	15.5	9.3	24.8
Individualised work	-	39.2	34.0	73.2	15.5	11.3	26.9
Small group practical work	-	33.0	55.7	88.7	7.2	4.1	11.3
Field trips	1.0	21.6	43.3	64.9	13.4	20.6	34.0
Home work	1.0	51.5	38.1	89.6	4.1	5.2	9.3
Role play	1.0	8.2	34.0	42.2	20.6	36.1	56.7
Team teaching	1.0	10.3	35.1	45.4	23.7	29.9	53.6
Pair work	1.0	18.6	58.8	77.4	8.2	13.4	21.6
Project work	1.0	23.7	49.5	73.2	11.3	14.4	25.7
Use of printed materials (e.g. textbooks)	1.0	39.2	43.3	82.5	7.2	9.3	16.5
Problem solving	-	47.4	41.2	88.6	6.2	5.2	11.4
Investigation	1.0	34.0	41.2	75.2	9.3	14.4	23.7
Educational games	2.1	8.2	25.8	34.0	23.7	40.2	63.9

The picture emerging from Table 8.15 is that most respondents perceived themselves to be very confident in the use of Demonstration (100%),Question and answer (99.0%), Lecture (94.8%) and Home work (89.6%).They were least confident in use

of Educational games, Role play and Team teaching . The results also suggests a close match between the methods teachers used frequently and those they claimed they were very confident in using.

The teaching trend emerging from the information in Table 8.10 to 8.15 is that in most physics lessons, teachers used Lecture method, Question and answer and Discussion. This implies that most times during physics lessons pupils were passive while teachers were active.

For example, Jumbe and Tindi (1998) found that in two technical high schools teachers did not use: Discovery/inquiry, Field trips, Pupils practical activities, Group work and Games.

Three physics lessons were observed at Parklands, Chongwe and Naboye schools in Lusaka province. The topics observed were "Heating effect of electric current", "Measurements" and " Structure of atom". Generally, the teachers used lecture method, explaining concepts and drawing neat diagrams, arguing that this was necessary since the schools had no apparatus.

At Parklands, a teacher spent 20 minutes explaining the heating effect of an electric current, but did not demonstrate how it works. He explained that a demonstration was unnecessary because Parklands was an emerging school, and there was no physics laboratory, no apparatus, and class was overcrowded.

At Naboye, a teacher was teaching "Structure of atom" and explained that he did not need to have the lesson given in a laboratory because he was presenting a theoretical topic.

At Kabwe High School (Central Province) the Head of Science Department explained that because laboratories had been vandalized the school had long before stopped teaching science subjects in laboratories. Instead teachers presented scientific facts to pupils in the way as teachers taught subjects such as history, English , and pupils took notes. Learners on their part complained that they were not exposed to laboratory apparatus, and that there had been no practicals done in the course of the year. Pupils only encountered laboratory apparatus during final examination.

This may partly explain the Examinations Council of Zambia's (ECZ)(2001) observation about the results of physical sciences examinations in recent years: " There was an increase in the failure rate in all Physical Sciences... There has been a gradual decrease in the number of centres offering O' level physics... Most schools have opted for science (Physics/Chemistry) rather than the Pure Sciences". At the same time schools have been teaching science theoretically without using practical demonstrations. Some pupils interviewed confirmed that teacher-centered teaching methods were mainly used by teachers. They said that during physics lessons they were expected to be quiet, listen to the teacher , and copy notes or observe demonstrations by the teacher.

Teachers of physics interviewed justified their use of lecture method in terms of large class sizes and to ensure completion of the long syllabus before pupils sat for Examination. Some respondents said that they had heavy teaching loads, which made

it difficult for them to prepare learner centered lessons. In some cases, however, teachers simply did not have the competence to use active learning methods.

During interview some teachers also said that they did not have apparatus to carry out experiments or to allow pupils to carry out experiments in groups. In some schools, what used to be science laboratories had been turned into ordinary classrooms. Lack of laboratory assistants also contributed to teachers not involving pupils in practical work, as it meant more work for the teacher who was already over burdened. Heads of science departments at some schools declared that their schools stopped teaching but were only preaching science subjects.

8.4 TEACHERS' VIEWS ON ASPECTS OF PHYSICS TEACHING

In order to establish teachers' views with regard to certain aspects of teaching physics, respondents were presented with a number of statements on teaching and learning of physics and asked to react to these statements (agree or disagree). They were also given sets of four or more statements and asked to choose 3 statements which they considered more important ,and rank them in order of importance, using numbers 1, 2, and 3 (1 being most important and 3 being least important).

8.4.1 Perceptions about the teaching and learning of physics

Table 8.16 below shows teachers' reactions to statements about teaching and learning of physics.

Table 8.16: Teachers of physics perceptions on teaching and learning

Statements	Not stated	Strongly agree (SA)	Agree(A)	SA+A	Disagree (D)	Strongly disagree (SD)	SD+D
Every lesson must have a lesson plan	1.0	38.1	39.2	77.3	13.4	8.2	21.6
Processes of science (e.g. observation, measurement, etc.) are the most important aspects of physics teaching	-	28.9	60.8	89.7	8.2	2.1	10.3
Physics teaching should put emphasis on the products of science (e.g. facts, principles, laws, theories)	-	27.8	53.6	81.4	15.5	3.1	18.6
Examination success should be the priority for physics teaching	1.0	7.2	23.7	30.9	51.5	16.5	68.0
School physics is divorced from the real world	-	5.2	14.4	19.6	51.5	28.9	80.4
Information contained in official textbooks should not be questioned	-	5.2	4.1	9.3	43.3	47.4	90.7
Some pupils are incapable of learning physics	-	1.0	16.5	17.5	63.9	18.6	82.5
Girls are on the whole, incapable of becoming good physicists	-	2.1	3.1	5.2	37.1	57.7	94.8

The distribution of responses in Table 8.16 above shows that most respondents (89.7%) were of the view that when teaching physics , scientific processes should be considered more important than products of science. Further more, a large proportion of respondents (77.3%) agreed that every physics lesson must have a lesson plan.

About 60% of respondents were of the view that passing examinations should not be the main purpose of teaching physics.

8.4.2 Perception about teaching content and objectives

Table 8.17 and 8.18 show teachers' ranking of some objectives for teaching physics and aspects of organisation of physics content respectively. The weightings 3, 2 and 1 were assigned to statements ranked by individual teachers respectively as first, second and third. To obtain the figures in the column headed *Total*, entries in each row were substituted in the *formula:*

Total = {(3 x frequency in 1st column) + (2 x frequency in 2nd column) + (1 x frequency in 3rd column)}

Row totals were used to rank the statements according to importance as perceived by teachers.

Table 8.17: Teachers' ranking according to importance of objectives for teaching physics

Objectives for teaching physics	Frequency			Total	Rank
	1st	2nd	3rd		
To facilitate process skills such as observing, measuring, formulating hypothesis, identifying variables, experimenting, interpreting data etc.	35	19	7	150	1
To be curious about their surroundings and also allow them to sense and formulate the existence of a problem	28	12	16	124	2
To understand scientific knowledge, such as facts, concepts and principles etc. and apply these to the solution of problems	10	31	13	105	3
To acquire the ability to recall previous experiences, and to construct their own knowledge of physical phenomena and to be able to identify and explain them	7	4	22	51	4
To acquire the ability to observe things and events in order to perceive and identify them	6	15	2	50	5
To be aware of and respond in a positive manner to beauty and orderliness in their environment	4	5	17	39	6
To be free from bias, prejudice and superstitions and to acquire open mindedness, critical mindedness and intellectual honesty	2	6	14	32	7

As can be seen from the Table 8.17 above, the majority of respondents were of the view that the most important objective of teaching physics was to enable learners master process skills .The second important objective in their view was to enable pupils to be curious about their surrounding and to identify problems, and thirdly to enable learners acquire understanding of scientific knowledge and apply it to the solution of problems.

Table 8.18 : Teachers' ranking of physics content

Aspects of organization of physics content	Frequency			Total	Rank
	1st	2nd	3rd		
Organizing topics to promote scientific thinking, understanding of knowledge, growth of experimental skills, problem solving skills, and development of interest and positive attitude	32	30	12	168	1
Organizing contents of physics in relation to the nature of learners, their needs and interest, growth levels, etc.	28	15	16	130	2

Organizing content to provide abundant opportunities for building scientific concept and principles and applying them to further inquiry tasks, projects, and concepts and principles and application to daily life and technology	13	22	22	105	3
Recognizing the importance of students' learning difficulties as well as teachers' instrumental difficulties	13	19	20	97	4
Organizing content in such a way as to cultivate process of physics and communication skills to acquire the desire to know, to communicate with others orally and in writing	5	6	15	42	5

Table 8.18 above shows that organizing physics topics with a view to promoting scientific thinking, understanding knowledge, acquiring scientific skills, developing interest and positive attitude, were ranked first. This was followed by the view that teaching content of physics must be considered in relation to the nature of learners, their needs and interest. The third was organizing contents to provide enough opportunities to learners to build scientific concepts and principles and apply them to daily life and technology.

8.4.3 Perceptions on teaching methods / strategies

Table 8.19 shows teachers perceptions with respect to what they considered to be the most appropriate ways of teaching physics.

Table 8.19: Teachers of physics' perceptions on appropriate ways of teaching physics

Methods /strategies for teaching physics	Frequency			Total	Rank
	1st	2nd	3rd		
Utilizing various teaching strategies: problem solving, individual learning, cooperative group learning, project method, demonstration, students experiments, etc.	48	20	11	195	1
Encouraging students to give their own ideas and help them to discuss how they differ from those held by scientists, so that they can verify and generalize the phenomenon into scientific concepts and principle	13	23	15	80	2
Utilizing various teaching facilities and materials which may be available in the local environment	4	15	13	74	3
Utilizing various teaching sites such as classroom, laboratory, school grounds and field in lesson	13	15	5	55	4
Inviting students' everyday meaning of various experience and alternative interpretation and give them opportunities to explore and correct their misconception/naïve conception and to draw scientific conclusions by using scientific terms	8	6	15	51	5
Teachers conducting lessons to promote learning through activities such as questioning, suggesting, demonstrating, explaining, discussing, presenting, criticizing, asking for evidence, conceptualizing etc.	3	4	5	22	6
Teachers setting teaching/learning goals which are explicit, realistic and accepted by students	1	4	9	20	7
Teachers using charts, diagram, models, materials and analogies to make abstract concepts clear to students etc.	1	2	9	16	8

Table 8.19 shows that the view of most respondents was that using various teaching strategies during physics lessons was the most important , followed by encouraging pupils to give their own ideas and helping them to discover how they differed from

conventional ones. Ranked third was utilizing various teaching facilities and materials which may be available in the local environment.

8.4.4 Perception on practical work

Table 8.20 shows teachers' ranking of some aspects of practical work in physics. The ranking was calculated using the method and formula given in section 8.4.2

Table 8.20 : Teachers' ranking of aspects of physics practical work

Aspects of management of physics practical work	Frequency			Total	Rank
	1st	2nd	3rd		
Devising experiments conducted in such a way as to make pupils think and be conscious of the purpose of performing the experiment	29	10	11	118	1
Applying classroom management to allow for individual, small group and whole class instruction techniques for planning and carrying out the experiment and data gathering, formulating the generalization by pupils	15	17	16	91	2
Encouraging and guide pupils to perform experiments carefully and accurately	8	21	12	78	3
Allowing pupils to suggest experiments and observations to answer their own questions	11	12	8	65	4
Demonstrating in order to help pupils to understand the concepts and principle of physics	12	10	9	65	5
Implementing safe laboratory measures	9	5	11	48	6
Teachers are prepared to handle safely the emergencies that may arise	4	6	76	31	7
Teachers select, adapt, utilize, repair, maintain and manage the science equipment and apparatus in laboratory	3	5	2	21	8
Allowing pupils to take a lot of time for observing, measuring and recording	-	4	11	19	9
Allowing pupils to take a lot of time for communication, interpreting and verifying	2	2	4	14	10

Table 8.20 shows that most respondents thought that devising experiments to make students to think and to be conscious of the purpose of performing the experiment was the most important aspect of practical work. This was followed by allowing for individual small group and whole class instruction techniques for planning and carrying out the experiment and data gathering, formulating the generalization by students. Ranked third was encouraging and guiding students to perform experiments carefully and accurately.

8.4.5 Perceptions on production and use of teaching materials

Table 8.21 shows teachers' views with regard to material production and usage of teaching materials .

Table 8.21: Views of teachers of physics on production and usage of teaching materials

Production and use of teaching materials	Frequency			Total	Rank
	1st	2nd	3rd		
Developing and utilizing instructional materials suited to pupils' ability levels and relevant to classroom objectives	56	15	18	216	1
Selecting, adapting and utilizing supplementary books, handbooks and other materials for learning use by pupils	17	27	35	110	2
Adapt and utilizing a variety of instructional material and media such as charts, diagrams, newsprint papers etc.	12	42	17	101	3
Utilizing the textbooks as the most important resource materials for use in teaching	5	6	17	44	4

Table 8. 21 shows that many of the respondents were of the view that developing and using teaching materials suited to learner's ability levels and relevant to lesson objectives was most important. Second was selecting, and utilizing supplementary books, followed by adapting and using different teaching materials during lessons by pupils.

8.4.6 Perceptions about assessing pupils' learning

Table 8.22 shows teachers' ranking of aspects of evaluation of pupils learning of physics.

Table 8.22 : Physics teachers' ranking of aspects of assessment of pupils' learning

Aspects of assessment of pupils' learning	Frequency			Total	Rank
	1st	2nd	3rd		
Developing, improving physics competency tests and evaluation instruments to measure cognitive and process skills	27	14	9	108	1
Utilizing past examination questions	16	9	20	86	2
Utilizing fair and varied pupil evaluation measures as paper and pencil tests, essay, tests, checklists, interview, homework etc.	19	10	7	84	3
Teachers utilizing textbook exercises	9	18	8	71	4
Identifying pupils with special needs and provide the necessary support for assistance and guidance	10	12	14	68	5
Utilizing results of evaluation for revising instruction and enhancing learning achievement	5	16	12	59	6
Assigning individual homework appropriate to the level of pupils' ability and give feedback/evaluation promptly	4	12	9	45	7
Classifying pupils ability and understanding by utilizing the results of evaluation	2	2	7	17	8

Table 8.22 shows that a large number of respondents were of the view that developing competency tests and evaluation instruments to measure cognitive and process skills was the most important. Second in the rank wasthe use of past examination questions to assess learners. Ranked third was utilizing various assessing measures.

In summary, the information given in tables from 8.16 to 8.22 indicates that the thinking of most teachers of physics was in line with the contemporary thinking in physics education, however, in most cases what they did during lessons was different from what they thought should be done.

8.5 VIEWS ON ASPECTS OF CONTINUING PROFESSIONAL DEVELOPMENT

Views of teachers of physics on continuing professional development, were obtained by asking respondents to react (agree or disagree) to a number of statements about organisation and implementation of continuing professional development programme. The findings are presented below.

8.5.1 Reactions to statements on organisation and implementation of continuing professional development

Table 8.23 below shows reactions of teachers to statements on aspects of continuing professional development.

Table 8.23: Reactions of teachers of physics to statements on aspects of continuing professional development

Statement on CPD	Strongly agree (S/A)	Agree (A)	SA + A	Disagree (D)	Strongly disagree(SD	D +SD
CPD is a must for teachers	57.7	28.9	86.6	12.4	1.0	13.4
Teachers are best facilitators for fellow teachers in CPD programmes	29.9	48.5	78.4	6.2	15.4	21.6
Attendance at CPD programmes should be solely for the purpose of professional growth	25.8	48.5	74.3	21.6	2.1	23.7
CPD programmes are best if they take place during school holidays rather than during term time	26.8	44.3	71.1	19.6	8.2	27.8
CPD programmes are best if they are school-based	23.7	43.3	67.0	29.9	2.1	32.0
College/university lecturers are the best facilitators for teachers in CPD programmes	26.8	32.0	58.8	34.0	6.2	40.2
CPD programmes are best if they are college/university-based	37.1	20.6	57.7	29.9	12.4	42.3
INSET providers are the best facilitators for teachers in CPD programmes	6.2	45.4	51.6	37.1	11.3	48.4
Short CPD programmes (e.g. 1 week duration) are better than those of longer duration	12.4	33.0	45.4	42.3	12.3	54.6
CPD programmes are best if based at resource centres	8.2	30.9	39.1	53.6	7.3	60.9
Inspectors are the best facilitators for teachers in CPD programmes	6.2	22.7	28.9	50.5	20.6	71.1
The cost of participation in CPD programmes should be borne by individual participants/schools	5.2	18.6	23.8	37.0	39.2	76.2

The distribution of responses in Table 8.23 shows, that most respondents (86.6 %) agreed that CPD was a must for teachers and a good portion of respondents (78.4 %) agreed that fellow teachers were the best facilitators for teachers in CPD programmes. In addition 74.3 % of respondents were also of the view that attendance at CPD programmes should be solely for purposes of improving one's teaching effectiveness. Despite this, 76.2% of the respondents stated that they were not prepared to pay for participation in CPD programmes from their own salary.

Respondents were also given a list of teaching skills to indicate ,in each case ,the extent to which they would need further professional development. Table 8.24 below shows the reactions of teachers.

Table 8.24: Teachers of physics needing further professional development in teaching skills

Teaching skills	Very much (VM)	Much (M)	VM+M	Not so much	Not at all (N)	NM+N
Teaching pupils with poor science background	46.4	30.9	77.3	15.5	7.2	22.7
Use of audio/visual aids	47.4	26.8	74.2	18.6	7.2	25.8
Catering for individual differences among learners	30.9	42.3	73.2	18.6	8.2	26.8
Knowledge about how pupils learn physics	24.7	45.4	70.1	23.7	6.2	29.9
Improvising teaching materials	28.9	40.2	69.1	22.7	8.2	30.9
Knowledge about gender-sensitive teaching approaches	36.1	30.9	67.0	17.5	15.5	33.0
Coping with heavy teaching loads	37.1	29.9	67.0	20.6	12.4	33.0
Teaching at higher grade levels than trained for	42.3	21.6	63.9	19.6	16.5	36.1
Coping with public examination demands	28.9	34.0	62.9	28.9	8.2	37.1
Handling large physics classes	35.1	26.8	61.9	23.7	14.4	38.1
Use of printed material	26.8	29.9	56.7	23.7	19.6	43.3
Motivating learners	24.7	32.0	56.7	30.9	12.4	43.3

The distribution of responses in the Table 8.24 above shows that the majority of respondents would like to receive further professional development in the following areas: Teaching pupils with poor science background (77.3%), use of audio/visual aids (74.2%), improvising teaching materials (69.1%), coping with heavy teaching loads (67.0%), teaching at higher grade levels than trained for (63.9 %), handling large physics classes (61.9%), and gender sensitive teaching approaches (67.0%).

In summary, the data in tables 8.23 and 8.24 indicate that teachers of physics regarded CPD important. Furthermore, a good proportion of teachers preferred the school as possible venue for CPD activities and that they should take place during school holidays. Teachers were not in favor of paying their own money for participation in the CPD courses but were willing to attend the CPD courses solely for purposes of professional growth and not for monetary gains, provided schools met the cost of their participation.
With regard to content of CPD courses, the majority of teachers of physics strongly felt that they needed training in handling learners with poor background in physics.

8.6 TOPICS WHICH PUPILS FOUND DIFFICULT TO LEARN

Information on topics pupils found difficult to learn in physics was obtained by giving pupil respondents a list of topics in the physics syllabus and asking them to indicate whether they found topics they had already covered during lessons easy or difficult to learn. The distribution of responses is shown in Table 8.25 below.

Table 8.25 : Pupils' rating of the relative difficulty of physics topics

Topics	Not yet done	Very difficul t	Difficul t (D)	VD +D	Easy (E)	Very easy	E+VE
Logic gates	96.2	46.2	23.1	69.3	23.1	7.7	30.8
Action and use of circuit components	91.2	23.3	26.7	50.0	40.0	10.0	50.0
Nuclear atom	86.1	19.1	25.5	44.6	36.2	19.1	55.3
Electromagnetic induction	86.7	17.8	26.7	44.5	42.2	11.1	53.3
Electronics. Cathode ray oscilloscope	94.1	15.0	25.0	40.0	45.0	15.0	60.0
Electromagnetism	88.5	10.3	28.2	38.8	43.6	15.4	59.0
Radioactivity	87.3	16.3	20.9	37.2	48.8	14.0	62.8
Electromagnetic spectrum	52.8	6.3	27.5	33.8	48.8	16.9	65.7
Electric circuits	77.6	5.3	27.6	32.9	47.4	18.4	65.8
Electric current. Ohm's law	71.7	6.3	25.0	31.3	51.0	16.7	67.7
Elasticity. Hooke's law	20.4	2.2	28.9	31.1	45.6	23.3	68.9
Heat capacity. Quantity of heat	40.7	9.5	20.9	30.4	46.8	22.4	69.2
Principle of moments	8.6	5.8	24.2	30.0	47.1	22.9	70.0
Household electricity	78.9	2.4	26.8	29.2	41.5	26.8	68.3
Electricity at rest	76.7	6.3	22.8	29.1	54.4	13.9	68.3
Pressure	52.5	5.6	21.1	26.7	49.1	23.6	72.7
Gas laws	59.3	2.9	23.2	26.1	54.3	18.8	73.1
Scalars and vectors	19.2	2.9	23.0	25.9	40.5	33.6	74.1
Molecular theory of matter	41.3	4.5	18.6	23.1	44.7	31.7	76.4
Light (refraction, refraction, dispersion)	26.3	4.8	16.8	21.6	51.6	26.0	77.6
Newton's laws of motion	6.5	3.2	18.0	21.2	57.7	21.1	78.8
Melting and boiling. Latent heat	25.4	5.1	15.0	20.1	47.8	31.6	79.4
Wave motion	13.9	1.7	16.8	18.5	54.5	26.7	81.2
Convex lens	36.3	2.8	14.4	17.2	53.2	29.2	82.4
Magnetism	50.1	1.8	15.4	17.2	59.8	22.5	82.3
Linear motion	1.5	2.7	13.2	15.9	26.1	58.1	84.2
Thermal expansion	20.6	1.9	12.6	14.7	49.4	37.5	86.9
Energy, work, power, efficiency	4.4	1.9	11.1	13.0	50.3	36.7	87.0
Sound	36.0	1.4	9.7	11.1	61.3	27.2	88.5
Transfer of heat	17.1	0.7	6.0	6.7	47.7	45.2	92.9
Measurements	1.2	1.2	3.0	4.2	52.8	43.0	95.8
Density	2.1	0.9	2.7	3.6	50.3	46.1	96.4

Table 8.25 shows that pupils regarded fairly large number of topics in physics difficult to learn. Some pupils revealed during interview that they had not been given a test on some topics to enable them to determine whether or not they understood them.

However, four topics: Elasticity. Hooke's law, Principle of moments, Quantity of heat, Pressure were rated as being difficult to learn by large portion of pupils. Others were: Logic gates, Electronics. Cathode ray oscilloscope, Nuclear physics , Electricity , Electromagnetism, Gas laws, Molecular theory of matter, Light , Scalars and vectors.

The respondents on the four topics indicated as being difficult by a large number of pupils were further analysed in terms of gender respondents, type of school of respondents and provincial or regional distribution. The analysis revealed that ore

girls (35.3%) than boys (27.7%) indicated that Elasticity. Hooke's law, was difficult to learn. Also more girls (34.5 %) than boys (26.3 %) indicated that they found the topic Principle of moments, difficult to learn. On the other hand , more boys (32.4%) than girls (27.9%) found Quantity of heat difficult to learn. On average ,more girls (31.6%) than boys (27.9%) found the topics: Elasticity. Hooke's law, Principle of moments, Quantity of heat, Pressure as difficult to learn. These findings are in line with the School Certificate results of 2000: more girls (29.0 %) than boys (22.0 %) failed physics.

With regard to type of schools ,a large proportion of respondents (31.8%) from established government and emerging schools said that Elasticity. Hooke's law, was difficult to learn, followed by those from private schools (29.4%). As for the topic Principle of moments, more respondents in established government and grant-aided schools found it difficulty to learn compared to those in other types of schools. In case of Quantity of heat, a large proportion of respondents (58.3%) from grant-aided schools found this topic difficult to learn followed by those in emerging schools (33.4%). As for the topic Pressure more respondents (27.8%) in established government and private schools found it difficulty to learn compared to those in other types of schools.

With respect to regional or provincial distribution of respondents on the 4 topics identified by more respondents as been difficult to learn, the analysis revealed that the largest proportion of respondents who found Elasticity. Hooke's law difficult to learn were in Lusaka Province (47.1%) followed by Northern (41.6%) and Western (36.3%) provinces. In case of Principle of moments, the largest proportion of respondents who said it was difficult to learn were in Copperbelt Province (43.7%) followed by Western (40.8%) and Lusaka Province (32.6%).As for the topic Quantity of heat, the largest percentage of respondents was from North-Western Province (50.0%) followed by Central (45.5%)and Eastern Provinces(42.9%).The topic Pressure was indicated as difficult by most respondents in Eastern Provinces(50.0%) followed by Central Province (42.1%).

Some of the topics listed earlier have also been identified as difficult by other studies. For example, teachers have identified: Electronics, Nuclear physics, Electricity , Electromagnetism, Wave motion, Quantity of heat, and Kinematics as being difficult for pupils to learn (Zambia National Commission for UNESCO,1999).
In SMASSE study, carried out in Kenya in 1999, pupils had difficulties learning the following topics: Electronics, Current electricity, Electromagnetism, Light, Waves, Sound, Gas laws and Molecular theory of matter.

Pupils advanced various reasons for finding certain topics difficult to learn. These included too many formulae and calculations , no/or unclear explanation from teachers. Topics pupils indicated as been difficult are the same ones teachers said they had difficulties teaching (see Table 8.26).

Table 8.26 : Topics perceived as difficult by teachers and pupils

Topics	Teachers perception	Pupils' perception	Not yet done
Measurements	6.2	4.2	1.2
Linear motion	4.1	15.9	1.5
Density	4.1	3.6	2.1
Newton's laws of motion.	9.2	21.2	6.5
Scalars and vectors	13.4	25.9	19.2
Elasticity. Hooke's law	17.5	31.1	20.4
Moments & equilibrium	9.3	30.0	8.6
Energy, work, power, efficiency	9.3	3.0	4.4
Pressure	35.1	36.7	52.5
Molecular theory of matter	24.7	23.6	41.3
Gas laws	37.1	26.1	59.3
Thermal expansion	16.5	14.1	20.6
Heat capacity. Quantity of heat	27.8	30.4	40.7
Melting & boiling. Latent heat	14.4	20.1	25.4
Transfer of heat	12.4	6.7	17.1
Wave motion	17.5	18.5	13.9
Light (refraction, refraction, dispersion)	10.3	21.6	26.9
Convex lens	11.3	17.2	36.3
Electromagnetic spectrum	21.6	33.8	52.8
Sound	14.4	11.1	36.0
Magnetism	13.4	17.2	50.1
Electricity at rest	25.7	29.1	76.7
Electric current. Ohm's law	15.5	31.3	71.7
Electric circuits	18.6	32.9	77.6
Household electricity	20.6	29.2	97..9
Electromagnetic induction.	37.1	44.5	86.7
Electromagnetism.	42.3	38.5	88.5
Electronics. Cathode ray oscilloscope	65.0	35.0	94.1
Action and use of circuit components	54.7	46.7	91.2
Logic gates	80.4	61.6	96.2
Radioactivity	33.0	34.9	87.3
Nuclear atom	38.2	44.6	86.1

8.7 PUPILS' OPINION ON TEACHING STYLES OF TEACHERS OF PHYSICS

Pupils views on teaching styles of teachers of physics were obtained by giving pupils a list of statements on certain aspects of classroom practice. They were then asked to agree or disagree with each of the statements with regard to the classroom practice of their teacher of physics. Table 8.27 below shows the distribution of their responses.

Table 8.27: Pupils' opinion on teaching styles of teachers of physics

Aspects of classroom practice	Strongly Disagree (SD)	Disagree (D)	% SD+D	Agree (A)	Strongly Agree SA)	%SA+A
The teacher sometimes takes us out of the classroom to learn	34.2	27.4	61.6	27.4	10.9	38.3
S/he allows us to talk to each other on the topic being taught	19.8	33.6	53.3	32.2	14.5	46.7
Sometimes we work in pairs during her/his lessons	21.8	28.3	50.1	31.3	18.3	49.6
Our physics teacher never misses lessons	10.9	34.5	45.4	27.7	26.8	54.5
S/he asks our ideas and uses them	17.4	25.1	42.5	35.4	22.1	57.5
The teacher sometimes asks faster learners to assist their friends	20.4	22.1	42.5	35.4	22.1	57.5
S/he gives us homework and tests regularly	13.6	26.3	39.9	37.5	22.7	60.2
The teacher gives individual help to pupils who have difficulties	17.1	20.9	38.0	38.6	23.3	61.9
S/he marks the homework and tests and gives us feedback quickly	14.5	22.7	37.2	36.3	26.5	62.8
We perform experiments in her/his lessons	18.9	14.7	33.6	39.2	26.8	66.0
S/he does not move from one topic to another before making sure that we have understood	11.8	19.8	31.6	34.2	34.2	68.4
S/he calls us by our names when s/he wants us to answer a question	10.3	18.0	28.3	35.4	36.3	71.7
S/he gives us notes in a manner that encourages us to think	9.7	17.7	27.5	39.8	32.7	72.7
S/he makes the subject enjoyable to learn	9.1	18.0	27.1	42.8	30.1	72.9
Our physics teacher introduces her/his lessons in an interesting way	7.4	18.6	26.0	36.3	37.8	74.0
The teacher relates the subject to our everyday life	4.4	20.9	25.3	39.5	35.1	74.6
Our physics teacher always comes early for lessons	5.9	18.6	24.5	38.6	36.9	75.5
S/he explains our mistakes in our work	9.1	15.3	24.4	43.7	31.6	75.3
At the end of the lesson, the teacher summarises the points covered or asks us questions	10.9	12.7	23.6	45.4	31.0	76.4
S/he also encourages even if one gives a wrong answer	8.0	15.0	23.0	47.5	29.5	77.0
S/he encourages us to give our own views/ideas during the lesson	8.3	14.7	23.0	46.0	31.0	77.0
S/he asks questions to both hand-raised and non hand-raised	8.5	14.5	23.0	39.8	37.2	77.0
The teacher varies her/his teaching methods	8.3	13.9	22.2	39.8	38.0	77.8
S/he draws neat and accurate diagrams on the board	6.8	15.3	22.2	38.6	39.2	77.8
S/he only punishes when it is very necessary	9.4	12.1	21.5	46.9	31.6	78.5
S/he gives us some exercises to do during the lesson	6.2	10.9	17.1	46.6	36.3	82.9
S/he asks questions to both girls and boys	7.7	9.4	17.1	37.2	44.8	82.9
S/he encourages both girls and boys to answer questions	4.4	12.7	17.1	39.2	43.7	82.9
S/he writes clearly on the board	4.4	10.3	14.7	38.6	46.6	85.2
The teacher knows the subject well	5.0	8.3	13.3	31.0	55.8	86.8
S/he asks questions clearly	4.7	8.3	13.0	47.5	39.5	87.0
The teacher encourages us to study or do the subject during our spare time	3.2	7.4	10.6	40.7	48.7	89.4
S/he encourages us to ask questions if we don't understand	3.2	6.2	9.4	35.7	54.9	90.6
S/he uses examples and illustrations during our lesson	2.4	5.3	7.7	45.1	47.2	92.3

Analysis of responses revealed that some pupils were of opinion that physics was well taught but others were of the view that it was not well taught. Some of the reasons they put forward: Poor attendance of lessons by some teachers and punctuality; assessment was not regularly and if given, feedback was not given quickly and, pupils were not allowed to discuss issues during lessons.

Some of the responses pupils gave during the study were:

"The school teacher comes only when he wants to come and when he comes to teach he teaches only for 30 seconds and then starts to say stories. And then when you say "Can you teach, sir?" ,he just goes out and never comes back for two days".

"The teacher is very slow in teaching and misses a lot of lessons. Because of his slowness we are very behind in other topics."

"...the explanation is always given without experimenting".

Some of reasons why pupils found difficult to learn physics also have been identified by other studies. For example, Jumbe and Tindi (1998) found that in two technical high schools , pupils had difficulties to learn physics because of..." lack of apparatus, difficult to solve problems, pupils lacking background knowledge". Similar conclusions were made by Zambia National Commission for UNESCO(1999): "Lack of laboratory equipment, hence taught in abstract manner, methodologies used are inappropriate, pupils have inadequate knowledge on mathematical parts".

8.8 SUMMARY OF FINDINGS

In summary, the following observations /conclusions can be made from this chapter:

- Teaching of physics was dominated by male teachers, who were most less than 40 years and had little teaching experience. The majority of them were holders of ordinary diploma in secondary education.
- Participation of teachers of physics in ZASE activities was low.
- Most teachers of physics did not think that thy had difficulties teaching majority of topics in the physics syllabus.
- Topics identified as being difficulty to teach: Electronics. Cathode ray oscilloscope , Logic gates, Action and use of circuit components, Electrostatics, Radioactivity and Nuclear atom, Electromagnetic induction, Electromagnetism, Gas laws and Wave motion.
- Lecture, question and answer and teacher demonstration were mainly used for teaching physics.
- Teachers did not prepare lesson plans, but agreed that it was important to do so.
- Most teachers believed that teaching of process skills should be given more emphasis than teaching of products of science.
- They were of the view that when organising physics content, topics should be arranged in a way which promoted scientific thinking , understanding of knowledge, acquisition of experimental and problem solving skills, and development of interest and positive attitude.

- There perception was that using different teaching strategies such as individual learning, group learning, demonstrations, etc. was the most appropriate way of teaching. But this seem not to have been happening during lessons.
- With regard to practical work, the majority of the teachers were of the view that encouraging and providing guidance to pupils to carry out experiments was the most important aspect.
- Most teachers regarded continuing professional development as necessary. They were prepared to attend CPD workshops or seminars without any allowance. However they did not like the idea of paying for CPD activities from their on their own resources.
- Some teachers preferred the Resource Centres while others preferred the school as possible venues for CPD. The major were of the view that teachers would be the best facilitators during CPD activities.
- Topics pupils found difficult to learn were the same topics teachers had difficulties learning.
- Pupils' opinion on teaching styles of their teachers varied. However the general view was that they were not very happy in the manner some teachers handled lessons.

CHAPTER NINE

STAKEHOLDER ANALYSIS

This chapter presents objectives of the stakeholder analysis and the methodology used. It also includes information on potential stakeholders, their current and future needs, SWOT analysis on SMASE (ZAME and ZASE), and potential roles and responsibilities of various stakeholders with regard to professional development of teachers of mathematics and science through subject associations.

9 .1. INTRODUCTION

Stakeholder analysis involves taking stock of an organisation's position in relation to other organisations that could have an interest in it. This component of the Baseline study was undertaken for the purposes of:

- identifying potential stakeholders in strengthening of mathematics and science education in secondary schools.
- carrying out an analysis of SMASE's strengths, weaknesses and the external opportunities and threats that it faces,
- identifying potential roles that could be effectively played by potential stakeholders and their possible inputs towards professional development of teachers of mathematics and science through the subject association.

9. 2 METHODOLOGY

A two-day workshop was held at ISTT on 3rd and 4th April 2002 to gather data. There were thirty participants drawn from various identified stakeholder institutions, such as ZASE, ZAME, JETS, TED, CDC, MST, UNZA, CBU, COSETCO, NISTCOL, and Nkrumah. Others were secondary school managers, international NGOs such as JICA, VSO, VVOB and local organisations such as FAWEZA, SESTUZ, ZEPH and the Book publishers Association of Zambia (see Appendix 6 for list of participants).

The approach used during the workshop was highly interactive, involving a wide selection of participatory facilitation methods such as group exercises, plenary discussions etc. A number of games were used as icebreakers.

9. 3. POTENTIAL STAKEHOLDERS

Participants were asked to divide themselves into "like theme" groups and identify the stakeholders in SMASE and their current and future needs.
Four groups were formed.

9.3.1 Potential Stakeholders

Each group came up with it's own 'stakeholders map'. However, during the discussion, the participants agreed to combine their ideas to come up with one stakeholder map, as presented in Figure 9.1 below.

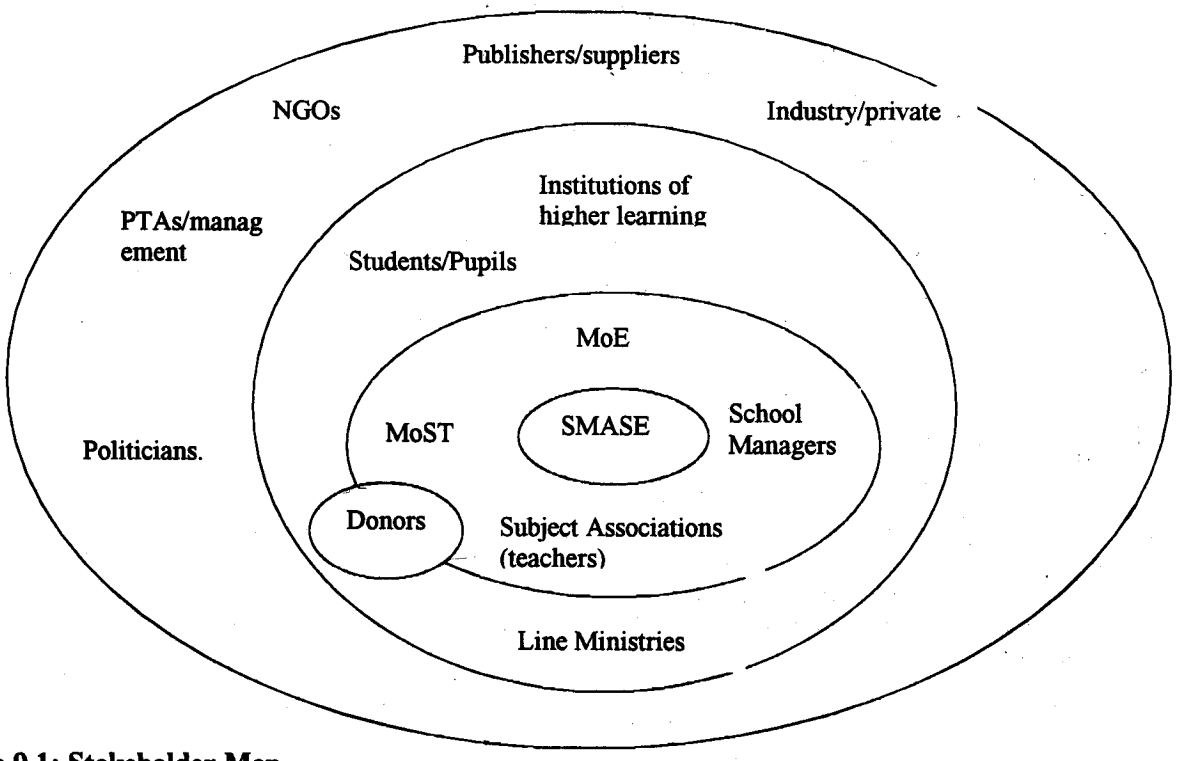


Figure 9.1: Stakeholder Map

Interpretation of figure 9.1 above is outlined below:

The 3 circles around SMASE represent levels of influence of different stakeholders on SMASE. According to the diagram:

a. Groups with the most interest/influence in and/or on SMASE were: Donors, Ministry of Education, School Managers, subject Associations, MoST
b. Groups with moderate interest in or influence on SMASE were: Donors, students/pupils, higher learning institutions and line ministries.
c. Groups with least interest/influence in and/or on SMASE were: NGOs, Politicians, Publishers/Suppliers, PTA/Management boards, Industry, Private sector.

Comments and discussion on stakeholders map

a. Though teachers were the most influential stakeholders, their attitude was still not favourable because they tended not to accept change readily. This aspect was identified and agreed upon by all the participants as one of the problems that the subject associations faced which if not checked would affect the operations of SMASE.
b. Participants agreed that it was important for SMASE to identify its major stakeholders and come up with ways of working with these to maximise its effectiveness and efficiency.
c. SMASE must make as its main goal improvement of the quality of teaching. Therefore, emphasis should be placed on development of teachers' professional skills.
d. Though they were direct beneficiaries, students/pupils were not major stakeholders, hence their appearance in the 2nd circle.

4. Co-operating partners - commitment of implementation from subject associations - political stability - Project proposals - good educational policies - Provisions of technical assistance - Be partners of SMASE in development - Help establish networking system - Accountability by receivers	- Accountability - Good political stability - Sustainability of projects - See results - Continual support to SMASE - Capacity building - Encourage and support the network - Prioritise teaching/learning of maths and science.
5. Line Ministries - Linkages with subject associations - Sensitisation about SMASE - Moral, technical and financial support to SMASE - Good flow of information from SMASE - Well co-ordinated links with SMASE	- End product of SMASE programmes - Well established links with SMASE - Continued support to SMASE
6. Higher Learning Institutions - Good results from schools - Be involved and improvement in research - Production of qualified maths/science teachers - Networking - Well qualified school leavers - Involvement in INSET programmes	- Good results from schools - Influence research - Be resource persons during INSET programmes - Strengthened collaboration and networking - Continued supply of lecturers - Good and improved infrastructure
7. PTA/Management boards - Good results in maths and Science - Sensitisation on INSET programmes - Information about SMASE	- SMASE related jobs - Financial commitment to teacher development - Good education for their children
8. NGOs - Identify themselves with SMASE - Sensitisation about SMASE - Co-operation and commitment - Information - Accountability	- fund selected projects or activities in SMASE - lobby for SMASE support from donors - sensitisation about SMASE - co-operation and commitment

9.3.2 Identified Stakeholders Needs

The groups proceeded to identify the current and future needs of the stakeholders. Below is a presentation of the needs as discussed by all the participants.

Current needs	Future needs
1. **MOE** - Sufficient and qualified teachers - Provision of teaching/learning materials. - Conducive teaching learning environment - Well trained inset providers - Finances - Well equipped laboratories - Competent school managers - Improved learning	- Improved learning - Retention of qualified staff through motivating them - Maintenance of laboratories and other infrastructure - Construction of more laboratories - Train more teachers and in-service training - Better policies to enhance education - More school infrastructure - Production of more teaching /learning materials
2.Teachers/subject Associations - Latest educational material/equipment - Outlet for publishing booklets, journals etc. - Committed members to Continuing professional development (CPD) - To work with Teachers resource centres (TRCs) - Collaboration among subject associations - In-service training /professional development - Motivation and support from government - Research skills - Increased and extended membership - Well established and organised associations	- Improved incentives - Improved infrastructure - Technical and financial support - More linkages with similar associations in the region - Enhanced INSET programmes through TRCs - Take full responsibility of own teachers' development - More support from government - To move toward self sustainability - Engage in action research programmes - Establish own accreditation boards. - Links with material producing bodies
3. School Managers - Highly qualified and motivated teachers - Well equipped schools - Support from government and community - More teachers (qualified) - Well trained school based in-service providers - Sensitisation towards SMASE programmes - Good infrastructure - Create an enabling environment - Manage inset programmes - Good examination results in mathematics and science.	- Staff retention - Continuous supply of teachers - Encourage school in-service programmes - Provision of learning/teaching materials - Adequate classroom - Good results - Accountability - answerable

4. Co-operating partners - commitment of implementation from subject associations - political stability - Project proposals - good educational policies - Provisions of technical assistance - Be partners of SMASE in development - Help establish networking system - Accountability by receivers	- Accountability - Good political stability - Sustainability of projects - See results - Continual support to SMASE - Capacity building - Encourage and support the network - Prioritise teaching/learning of maths and science.
5. Line Ministries - Linkages with subject associations - Sensitisation about SMASE - Moral, technical and financial support to SMASE - Good flow of information from SMASE - Well co-ordinated links with SMASE	- End product of SMASE programmes - Well established links with SMASE - Continued support to SMASE
6. Higher Learning Institutions - Good results from schools - Be involved and improvement in research - Production of qualified maths/science teachers - Networking - Well qualified school leavers - Involvement in INSET programmes	- Good results from schools - Influence research - Be resource persons during INSET programmes - Strengthened collaboration and networking - Continued supply of lecturers - Good and improved infrastructure
7. PTA/Management boards - Good results in maths and Science - Sensitisation on INSET programmes - Information about SMASE	- SMASE related jobs - Financial commitment to teacher development - Good education for their children
8. NGOs - Identify themselves with SMASE - Sensitisation about SMASE - Co-operation and commitment - Information - Accountability	- fund selected projects or activities in SMASE - lobby for SMASE support from donors - sensitisation about SMASE - co-operation and commitment

9. Politicians - commitment to SMASE - to be well informed about issues related to maths and science	- influence increased funding to SMASE
10. Industry - well qualified staff - information - place in school through syllabus	- well qualified staff - continuation of other stated current needs
11. Pupils - participation in JETS - good learning environment - competent teachers and school managers - sensitisation on the need to learn maths and science - enough learning material - encouragement from teachers in maths and sciences	- good results - incentives through bursaries - improved teacher-parent relationships - increased number of higher learning institutions - reward deserving pupils - be involved in teacher evaluation
12. Publishers - to know needs so that they publish good and relevant books - support from teachers who write books and supplementary material - what is in the syllabus	- continued support from schools, government

Comments made by workshop participants on the stakeholders' needs

a. Since stakeholder analysis was a major component of strategic planning, it must establish what SMASE expects of school managers and MoE and vice versa
b. SMASE must realise the importance of the needs of the stakeholders
c. SMASE must try to meet the needs of the stakeholders to enable them co-operate with it.
d. Teachers were the main stakeholders in SMASE. Others were just supportive agents.
e. Teachers must be in the forefront in implementing SMASE programmes; adopting the bottom-up approach.
f. SMASE must create forum for teachers to identify their needs and problem
g. Donors must not be put in the forefront of managing SMASE. Unions or better still professional bodies must assume a greater role.
h. Must increase interaction between stakeholders for exchange of ideas because of the broadness and complexity of SMASE
i. Stakeholders doing research needed regular communication.

9. 4 SWOT ANALYSIS ON SMASE

The findings presented below were a product of discussions among all participants. The strengths and weaknesses of SMASE were basically those of ZAME and ZASE because the two would form SMASE.

9.4.1 Strengths

- Existing structure of associations: There were already the ZAME and ZASE teachers associations through which SMASE could and was operating.
- Teachers were available: There were trained teachers, especially members of ZASE and ZAME, with whom SMASE could work. Therefore, there was no need to recruit members for SMASE.
- Support from MOE through TED was assured. The chairperson of SMASE was actually from TED.
- Curricula are available: The Ministry of Education already had curricula for science and maths subjects. SMASE therefore only needed to improve on these.
- Research based input: The objectives, structure, mode of operations of SMASE were being formulated using data collected from the ongoing research.
- Infrastructure was available: Meanwhile, SMASE was using for its operations the premises of the Subject Associations (ZAME/ZASE/ZIATA/JETS) at the National Science Centre ,in Kabulonga.
- Wide representation of stakeholders: There were many institutions and organisations with interest in SMASE. This could be seen from the number of institutions/organisations represented at the stakeholder analysis workshop.
- Available capacity for development of teaching materials: Members of ZAME and ZASE were all qualified teachers and so had the capacity to develop teaching materials.
- Committed steering committee: SMASE had a steering committee that appeared to be committed and hard working.
- Available start off funding from JICA: JICA had provided funds for research and initial implementation of SMASE programmes.
- Higher learning institution involvement as resource persons: A number of institutions of higher learning, such as UNZA, CBU, NISTCOL and Kwame Nkrumah, had been engaged to provide resource persons for research and other advice.

9.4.2 Opportunities

- Teachers resource centres were available: SMASE could work with these centres to generate more information, distribute materials to teachers, and in the general implementation of its programme to improve the standards of teachers.
- Government commitment: SMASE could lobby for government support in the implementation of its programme and also for financial support.
- Co-operating partners available: SMASE could exploit the good relationship that it had with its co-operating partners to improve its programme.
- Teachers resource centres/INSET available: SMASE could take advantage of the In-service Education for Teachers programmes to influence improvement, for which it was advocating for.
- Good will of PTAs and unions available: PTAs and unions can be made to understand the importance of improving the standards of teaching and learning science and maths. These could then be used in the implementation and monitoring of SMASE.
- Commitment from NGOs available: SMASE could work with NGOs in implementing and lobbying for support for teacher development.
- School managers were available: SMASE could work with these in influencing teacher development to improve science and maths teaching and learning.
- Existence of national science centre to house SMASE in future.
- Existence of National Science Centre for information.

- Availability of publishers: These could be helpful in publication of information about SMASE and the importance of teacher development.
- Availability of subject departments (Maths/Science): All schools had subject departments through which SMASE could work.
- Technological advances: SMASE could take advantage of these to make teacher development easier and effective to match the advancing technology in the world.
- Science /Maths education for all declaration: The declaration made to make science and maths education available to all could be used to influence government, donors, co-operating partners and other potential stakeholders to work with and support the SMASE programme.
- Community support: The communities could be mobilised to understand the importance of science and math education so that they could support SMASE and encourage their children to work hard in science and math subjects.

9.4.3 Weaknesses

- Low membership: ZASE and ZAME still had the problems of low membership and commitment from teachers. Since these basically made up SMASE, it means it also had low membership.
- Negative attitude of teachers towards ZAME/ZASE programmes: This meant that the negative attitude of the teachers to these associations also affects SMASE.
- Inadequate funding because of low membership, few donors and erratic funding from government: Though JICA had provided the initial funds for SMASE, the larger problem still remains of how SMASE would continue its operations in future because of uncertain and erratic funding.
- Inadequate support from school managers: School managers were not giving their full support to ZAME and ZASE (SMASE), especially those without any science or mathematics background.
- Inability to produce teaching/learning materials: Teachers had the capacity to develop teaching/learning materials. However, this capacity was not being exploited owning to a number of factors such as unavailability of resources and low teacher motivation.
- Inadequate publicity/sensitisation: The SMASE programme had not been fully publicised and there were potential partners who did not know about the programme.
- Inadequate capacity to undertake professional staff development activities at all levels: SMASE would mainly focus on professional development of secondary school teachers. This put at a disadvantage teachers of science and maths at primary level and yet these would provide the foundation for learning science and mathematics in secondary schools.
- Insufficient association journals: ZASE and ZAME did not have enough journals to distribute about their associations and the subjects that they specialise in.
- Inadequate income generating activities: ZAME and ZASE did not have enough income generating activities, thus affecting their operations.
- Weak links with similar associations in other countries: ZASE and ZAME did not have provisions for collaboration with similar associations in other countries. However, SMASE had established some collaboration with a similar association in Kenya.
- Weak communication links within the country and between teachers' associations: Subject associations had not taken advantage of technological advances, where available to improve their communication.
- Inadequate transport: ZASE and ZAME did not have adequate transport to enable them carry out their programmes effectively.
- No sustainability plan in place: SMASE did not have an outlined

sustainability plan in place showing how funds would be sourced and operations continued in the near future.
- Inadequate office space to house SMASE.
- SMASE would involve only some teachers in the school.

9.4.4 Threats

- Uncertain political environment: Political/regime changes in Zambia had generally caused anxiety and uncertainty among the people. This has had a number of side effects, such as teachers leaving the country or delayed, cancelled or minimised donor support.
- Weak economy: This made it very difficult for the subject associations to raise funds for their operations. This would also affect SMASE if it did not get continued donor financial support and if it does not come up with viable income generating activities.
- *Donor withdrawal of support /donor dependence: Because of the weak economy, there was a possibility of depending so much on donor funding that programmes would crumble when the donor support was withdrawn.*
- *HIV/AIDS: This has claimed the lives of many professionals in education and* would continue to do so.
- Natural disasters e.g. floods, droughts and others that were likely to interfere with children and teachers going to school.
- Unpredictable education policies: Unstable political and economic environments had lead to a lot of changes in education policies making them very unpredictable.
- Corruption: This was one aspect that had featured so much in the education system in Zambia. Therefore, SMASE should keep guard against it.

9. 5. ROLES AND RESPONSIBILITIES OF POTENTIAL STAKEHOLDERS

Having identified the stakeholders in SMASE and their needs (both present and future), and having done the SWOT analysis of SMASE, the participants listed some responsibilities which each stakeholder would assume in SMASE, in accordance with their organisational and professional backgrounds, to help it carry out its programmes more effectively.

Below is a presentation of the identified potential roles and responsibilities of each stakeholder.

9.5.1 Institutions of Higher Learning

a. Conduct research in collaboration with teachers.
b. Train teachers in research methodologies and provide guidance to teachers doing research.
c. Evaluation of SMASE activities when consulted
d. Providing tailor made short courses for teachers in areas where they are weak (methodology/content)
e. Sensitisation of students on the need to belong to subject associations
f. Proof reading /evaluation of teaching /learning material
g. Present papers at conferences, workshops and seminars
h. Writing teaching/learning materials in collaboration with teachers
i. Conduct training of trainers courses
j. Assist in establishing documentation centre

9.5.2 Donors and NGOs

a. Provide funding (equipment, materials, logistic support etc)
b. Technical co-operation(training, monitoring and evaluation)
c. Provision of information (to promote linkage with other countries)
d. Lobby for support for SMASE
e. Advocate/sensitise /outreach to targeted groups
f. Lobby to government for better education policies and practice methods
g. Supporting and co-operating in implementation
h. Promote the girl-child through teacher development (encourage female teachers to be models)

9.5.3 School Managers

a. Identify and favour SMASE related staff development
b. Supervise INSET school based programmes
c. Support SMASE activities
d. Co-ordinate with TED on school based INSET activities
e. Encourage production of teaching /learning materials in maths and science.
f. Mathematics and science oriented school managers to encourage PTA committees and other associations' heads to support SMASE activities
g. Motivate maths and science teachers through incentives
h. Ensure quality teaching through monitoring.

9.5.4 Subject Associations

a. Identify training needs /staff development
b. Be part and parcel of the development of the programme
c. Own the programme
d. Execution of the programme
e. Be involved in production of teaching /learning material
f. Mobilisation of resources(Material, human, finance)
g. Take the lead in sensitisation of the programme to stakeholders and school managers.
h. Monitoring and evaluation of the programme and feedback to other stakeholders
i. Develop training of trainers programmes
j. Provide union representation on teachers' accreditation body.

9.5.5 Other Stakeholders

CDC - Work with SMASE in curriculum development
- Approval of teacher/learning material

ZEPH - involve teachers in material production

NSC - Production of maths/science teaching /learning materials.
- Solicit funds for SMASE

TED - Development of INSET programmes
- Development of policies
- Development of INSET systems
- Co-ordinate TED programmes
- Facilitate staff development

Standards Office - Ensure quality teaching
- Encourage teachers to get fully involved in SMASE activities

- Promote membership of SMASE
- Provide incentives for mainstreaming SMASE
- Involve the private sector in SMASE activities, promotion and Curriculum development.

9. 6. CONCLUSION

A number of potential stake holders have been identified. Some of them had a lot of interest in or influence on SMASE. Others had moderate interest in or influence on SMASE, while some had little interest in or influence on SMASE.

The SWOT analysis on ZAME and ZASE (SMASE) identified a number of strengths and opportunities which SMASE could capitalise in realising it's goal of developing teachers' professional skills. The SWOT analysis has also revealed some weaknesses and threats on the part of ZAME and ZASE which SMASE must address if it is to achieve it's intended goal.

The stakeholders' potential roles and responsibilities provide an exciting list of opportunities waiting to be capitalised by SMASE. The responsibilities cover the institutions of higher learning in providing human resources development, international donor providing the technical and financial support and school managers providing leadership in the schools. In addition, the subject associations would be committed to providing effective programme management. The Ministry of Education and its specialised units would provide the support ranging from policy direction to teaching/learning material development for science and mathematics development.

CHAPTER TEN

ANALYSIS AND WAY FORWARD

10.1 INTRODUCTION

This chapter gives overall analysis of the findings and proposes a way forward for a school based professional development programme for secondary school teachers of mathematics and science. By way of a recap, the purpose of this three-in-one study; namely a situation analysis of teacher development in Zambia; a baseline survey of the teaching and learning of mathematics and science in secondary schools and; an analysis of potential stakeholders' role in further professional development of teachers of mathematics and science in secondary schools was to generate information to guide the design of a programme to strengthen mathematics and science education in Zambia at the same level. The study was informed mostly by a nation wide sample of pupils, teachers and Heads of Mathematics Department. Data was also obtained from MOE documents, O'level Chief Examiners' reports.

10.2 ANALYSIS

10.2.1 Situation analysis

The situation analysis showed that previous teachers' professional development initiatives were perceived by review teams to have, in some ways to have had resulted in some improvement in teacher performance. However, such reports of success seem more based on anecdotes than on any comprehensive study. In spite of the perceived successes, the CPD initiatives also had serious shortcomings. As Manchishi (2002) points out, the programmes were externally funded projects and lost momentum upon the expiry of the funded phase, unless another external co-operating partner came up and usually with a different focus. Furthermore, most CPD initiatives were Government-driven, which in many cases also meant that the associated teacher development activities were identified by Government agencies rather by the teachers themselves. This meant that there was little teacher ownership of the programmes – an attribute without which CPD programmes for teachers is unlikely to have a good chance of sustainability.

Another aspect of previous CPD programmes is that they had taken the form of either out-of-school workshops or long duration upgrading courses at colleges or universities. Being funded programmes, it was common practice to give participants some allowances, such as out of pocket allowance. In some cases such allowances were so attractive that it was possible some teachers attended CPD programmes not really to gain the necessary knowledge and skills, but for monetary gain. However, teachers at a joint ZAME, ZASE and the Zambia Industrial Arts Teachers' Association (ZIATA) held in Livingstone in September, 2002 denied they attended CPD programmes with such motives. Their view was that teachers attended CPD programmes to improve their professional skills rather than to be given allowances but demanded allowances as a condition of service".

This suggests that to be cost-effective and sustainable, new CPD programmes should be organised differently. SPRINT seems to be a promising initiative in this respect. CPD activities under SPRINT take place within the school and to a large extent allow

teachers to determine the activities for their *Teacher Group* (TG) meetings. But even with SPRINT, it has been observed that some TGs exhibit reluctance to set up their own agenda for professional development activities, preferring to have these provided to them by District In-service Providers (DIPs). It would seem, therefore, that Zambian teachers have not yet accepted or understood fully the concept of teacher-driven CPD. This is a fundamental issue that SMASE will need to contend through a programme of systematic and sustained sensitisation of the teachers.

Recommendation 1: SMASE will need to re-orient teachers to
(a) a wider perspective on CPD which has, so far, been seen as workshops or long duration courses in higher institutions of learning;
(b) see CPD as being not just being good for the education system, but for personal professional growth and satisfaction too for which allowances need not be a pre-condition for participation.

10.2.2 Baseline survey

Gender distribution of teachers: The study has shown that the overwhelming number of teachers of mathematics and science were male. This level of male dominance shown can only go to perpetuate gender stereo-types about mathematics and science being man's territories. Research shows that learning is enhanced if we are able to identify ourselves with the context of what is being learnt. Thus the lack of women teachers of mathematics and science is likely to alienate girls from the learning of these subjects.

Apart from perpetuating the image of mathematics and science as male domains, girls are victims of lower expectations and discouragement by both male and female teachers. In his study, Haambokoma (2000) reports of the sentiments of a female respondent who said

> "*My chemistry teacher at secondary school level was of the view that us girls could not learn chemistry. Very often he used to say that even if he talked for weeks, months and years, we would not understand. This was demoralizing*".

Female teachers of mathematics and science may provide role models in terms of examples of women who have successfully studied mathematics and science. However, it is noted that some women teachers are not inspirational and if anything, some actively contribute to girls' dislike and under-achievement in these subjects. A study done by Female Education in Mathematics and Science in Africa (FEMSA) Zambia revealed that:

> *... both at primary and secondary school levels, pupils were very clear that they preferred to be taught by men. The girls at a secondary schools were of the view that while a few female teachers were effective, the general picture was that women were lazy and absent more often than men (Mwase, et. Al., 1999, p.22)*

Ndhlovu (1999) also found that "women mathematics teachers offered poor models to most of the girls interviewed (p.206)". Thirty (30) of the girls Ndhlovu interviewed (88.2%) said they did not like to be taught by a woman teacher, let alone become mathematics teachers themselves. There have also been some anecdotal by women teachers to the effect that they prefer teaching boys because they find teaching boys more professionally stimulating.

Recommendation 2: SMASE's CPD programme will need to
(a) address the problems of both male and female teachers having lower expectations with regards girls' capabilities in the learning of mathematics and science and,
(b) to build the capacities of female teachers in particular to be inspirational to all pupils especially girls.

Age and length of service: The twin facts that about 30% of teachers of mathematics and science are below the age of 30 and that close to 40% of the teachers have been teaching for less than six years means that the mathematics and science teaching fraternity comprises largely inadequately experienced teachers. This is both a weakness and an opportunity. It is a weakness in that pupils are unable to benefit from insights that come with a teacher's experience in class and related aspects of teaching such as marking examinations and curriculum development. It is an opportunity in that the teachers are in their formative stage of the profession and thus can be nurtured to higher levels of competence and effectiveness. However, this will need liaison with institutions for 'pre-service training' to make a concomitant change from the concept of pre-service training to Initial Teacher Education and in so doing, acknowledging two shifts of emphasis as given in MOE's strategic plan for Teacher Education, viz:

> *"Firstly, it stresses that this is but the first stage in a career-long development. Secondly, it highlights the process intending teachers undergo, emphasizing its educational aspects as distinct from its purely training function"* (MOE, 1999: p.4).

Recommendation 3: SMASE should liase with Colleges of Education and the Universities for staff and students alike to shift from the concept of pre-service training to Initial Teacher Education and wit this shift in paradigm, a corresponding change in their teacher education curricula.

Subject trained to teach: The fact that well over three quarters of teachers of mathematics and science were actually trained to teach mathematics and science respectively is a tremendous opportunity for a professional development initiative. This means that such an initiative would focus on improving teacher competence and effectiveness rather that the 'making' of a teacher. However, whilst noting the vast majority of the teachers are trained in their respective subjects, it is equally note worthy that an equally vast majority were trained to teach at lower levels than where they were operating. (Diploma holders, who were in majority in schools were trained to teach at Grades 8 and 9 only). For example, at a school in Western Province, a diploma holder was teaching A'level mathematics. Going by the syllabuses of the Teachers' Diploma of the secondary school Teachers' Colleges and the A'level

syllabus, a diploma holder would be hard pressed to pass A'level examination himself/herself.

The problem of under-qualification takes a bigger magnitude in science since being trained to teach at junior secondary level also means being a 'generalist' i.e. teacher of environmental science. Teaching at Grades 10 to 12 requires specialisation in the teaching of specific disciplines; these being Biology, Chemistry or Physics.

Recommendation 4: SMASE's CPD programme should include an agenda for deepening content knowledge within the practical teaching contexts in which the teachers will operate.

Raising teacher competence without improving the wider learning environment such as availability and state of laboratories, supply of textbooks, apparatus and consumables will not in itself impact adequately on pupils' quality of learning. However, these variables in the quality of learning may be beyond the capacity of subject association to resolve. What can certainly be done is for ZAME and ZASE to familiarise themselves with the recently released Ministry of Education Strategic Plan and lobby the rightful units in MOE for action to improve the teaching/learning environment in schools.

Recommendation 5: ZAME and ZASE to familiarise themselves with the recently released Ministry of Education Strategic Plan and lobby the rightful units in MOE for action to improve the teaching/learning environment in schools.

Membership of ZAME/ZASE: The study revealed the two problems of, firstly, low membership to the associations and, secondly, low levels of participation of members in the activities of the associations. This situation poses a challenge for any teacher-driven and nation-wide professional development initiative anchored around the subject associations. Thus, once again, a systematic campaign to sensitise teachers to the importance of belonging and being an active participant of a professional organisation will be imperative. Simultaneously, ZAME and ZASE will need to articulate their respective visions more clearly and to raise their profiles to levels where teachers can see cause why they should be active members.

Recommendation 6: ZAME and ZASE articulate their respective visions more clearly and should work at raising their levels of visibility and relevance in all the corners of the country.

Difficult topics: The study showed that there was a high level of correlation between the topics teachers were comfortable to teach and topics teachers thought pupils liked. There was an equally high correlation between what teachers were not comfortable to teach and what they perceived to be disliked by pupils. This correlation between teacher-preference/capacity and pupil-preference/performance makes Law's question as valid in 1969 as it is today, that is, "... to what extent are our pupils' failures really our [teachers'] own?" (Law, 1969, quoted in Wain and Woodrow, 1980, p.39). This means that strengthening content knowledge of the teachers should be one of the goals of a CPD programme for teachers of mathematics and science. But to be of practical value to classroom practice, strengthening subject content will need an

integrated approach from two perspectives. First, is the integration of content and teaching methodology; and second, the integration of theory and practice. For this to be possible, the location of the 'training' has to be the school or at least close to the school so that workshops/seminars in the school deal with content and how that content can be taught and then this would be followed soon after by trying out the ideas in class.

Recommendation 7: SMASE's programme should buttress the strengthening of teachers' content knowledge with a shift in the pedagogical stance towards integration in two aspects. First, the integration of content and teaching methodology; second, the integration of theory and practice.

A worrying trend about 'difficult topics' was teachers' lack of awareness that they had difficulties understanding some of the difficulties they taught (at least failing to acknowledge that they had difficulties) – as exemplified by a teacher who said he had no problems with *averages* and was not aware of any instances in which one average was more appropriate than the others. Thus the teaching of mathematics and science gets reduced to a 'set of tricks that work' detached from the real world. This could mean that the amount of assistance with both the content knowledge and methodology is wider than many teachers are willing to acknowledge.

Recommendation 8: SMASE, in conjunction with MOE's forthcoming Directorates of Teacher Education and Specialised Services and Standards and Curriculum Development Department, should work towards sensitising each teacher of mathematics and science on their inadequacies and to the need for active participation in CPD activities so as to improve on areas they were weak.

Teaching trends: The study confirmed what was already known - that life in the classroom in Zambia revolves around the teacher. In both mathematics and science, the principal mode of instruction is teacher exposition. In science, practical and experiments are vital to the fulfilment of the aims of learning the sciences. For example, the School Certificate Biology syllabus (5090) says the

> *syllabus is designed to have less emphasis on factual material, but a greater emphasis on understanding and application of scientific concepts and principles. This approach has been adopted in recognition of the need for students to develop skills that will be of long term value in an increasingly technological world rather than focussing on large quantities of factual material which may have only short term relevance (UCLES, 1999, p.30)*

The aims of the same Biology syllabus include "to provide, through well designed studies of experimental and practical biological science, a worthwhile educational experience for all students" and to "stimulate students and create and sustain their interest in, and enjoyment of Biology" (UCLES, 1999, p.30). The School Certificate mathematics syllabus D (4024) has among its aims, to "increase intellectual curiosity, develop mathematical language as a means of communication and investigation and explore mathematical ways of reasoning" (UCLES, 2000, p.4). These are lofty ideals.

Yet classroom practice in Zambia is dominated by a culture of 'delivering finished products' and falls far short of contributing to the fulfilment of these aims.

The teaching of mathematics and science in Zambia is not very different from the teaching of information subjects and a reason heard very often for this state of affairs is the pressure to finish the syllabus in readiness for examinations. But in the efforts to 'cover' the syllabus, it appears pupils are left 'naked'. The alarming figures of candidates getting zeros in both Grade 9 and 12 mathematics examinations bears testimony to how the concern for teaching is grossly disproportionate to the concerns for learning.

With regard to teaching trends, the existing scenario means that CPD programmes need to assist teachers come alive to the aims of teaching mathematics and science and the strategies for realising the aims. Teachers will further need to be oriented towards being reflective practitioners who see teaching not as an end, but as a means towards pupils' learning.

Recommendation 9: SMASE's CPD programme should include raising awareness of the aims for which mathematics and science are taught and to the strategies for realising the aims (for example, the fact that the teacher has 'covered' the syllabus or that the pupils have passed is not synonymous to fulfilling the aims for which mathematics and science are taught).

Others common reasons for teaching mathematics and science like information subjects were the lack of laboratories, the lack of apparatus and consumables, the lack of laboratory assistants and over enrolled classes. Whilst these difficulties are acknowledged, there equally need for a greater level of resourcefulness on the part of teachers. In this respect, the concept of Teaching and Learning Using Locally Available Resources (TALULAR) developed at Malawi Institute of Education and introduced in Zambia by FEMSA (FEMSA, 2001) should be given serious consideration for popularisation. Similar past efforts have included 'improvisation' of apparatus and equipment and 'low-tech' mathematics and science apparatus. The TALULAR concept embraces both the concepts of improvisation and low-tech equipment but goes beyond to literary what it says, 'locally available'. This means, for example, that in a number of schools in Zambia today, a computer and indeed ICT, is a locally available resource.

Recommendation 10:SMASE should include on its agenda, the popularisation of the TALULAR concept which FEMSA has already introduced as a small scale school-based intervention in a few primary schools in Zambia.

Learning centred teaching: The past few years in Zambia have seen strong advocacy for learner-centred teaching methodologies. The AIEMS project had *Module 5* which was meant to orient teachers to learner-centred methodologies especially the use of group work. The Ministry of Education's Primary Reading Programme (PRP) is designed to operate under group-work conditions. A new initiative by MOE's Teacher Education Department (TED) in conjunction with a

Belgian quasi governmental NGO, VVOB, is piloting at COSETCO and Nkrumah Secondary Teacher Training Colleges and in a few school, an initiative called 'Learner Centred and Context Based' teaching of mathematics. These are most welcome developments. However, there is evidence of many children in group-work arrangements who are completely lost and hardly making progress in their learning. Thus learner-centred methodologies are not an end in themselves as they do not guarantee that learning is taking place. Whether teacher-centred or learner-centred, the concern with the quality of learning and acknowledging that learner-centred methodologies are more likely lead to learning. Since learner-centred is only a means to learning, there is a case for advocating for learning-centred methodologies – entailing a teacher to be a reflective practitioner.

Recommendation 11:SMASE should work towards orienting teachers to pupils' quality of learning as a primary consideration in classroom as well as whole-school practices.

Research and being a reflective practitioner: The baseline study showed that apart from content areas and methodology areas, some respondents indicated that there was a need to equip teachers with research skills. Beeby (1977-78); Wells and Chang (1986); Farrell and Oliveira (1993) are of the view that involvement of teachers in research activities makes them better teachers. Indeed, 'the teacher as a researcher' is one vital avenue for professional growth and crucial for reflective practice. Perhaps nothing reflects reflective practice more than a quotation from an unknown source saying "I taught the class something and they didn't understand it. I taught it again, they still didn't understand it. The third time I understood it"

Zambia is a long way from institutionalising a culture of research. The difficulty subject associations such as ZAME and ZASE have in raising articles for their journals and conference presentations bears testimony to this. Whilst classroom research should be an integral part of good classroom practice, teachers who wish to carry out more rigorous research could go into partnership with those whose routine jobs requires conducting and/or using research. Such people could be found in universities, Colleges of Education, specialised units of MOE and NGOs, among others. The Professional Support Structure for Primary Education (PSSPE), an MOE initiative but with a secretariat at UNZA is already promoting the concept of partnership in research among various categories of people operating in the primary education sector. The partnership is mutually beneficial to all categories of researchers. The teacher gains further insights into classroom practice while the non teacher researcher is helped to 'get feet onto the actual ground'.

Recommendation 12:SMASE should (a) promote teacher-research as an integral part of good classroom practice and professional growth; (b) promote research partnerships between cross sections of practitioners in secondary school mathematics and science education; and (c) create opportunities for dissemination and sharing of research information.

Teachers' Perception on Teaching Mathematics and Science: The baseline study showed that most teachers of mathematics and science hold views in line with current trends in mathematics and science education. For example, the majority of teachers

indicated that utilizing various teaching strategies such as problem solving, group work, projects, etc were the most effective ways of teaching mathematics and science. They also believed that the teaching should emphasize process skills than products. However, their classroom practice was contrary to what they claimed they believed. This ambivalence needs addressing.

Recommendation 13:SMASE should advocate for an integration of theory and practice in initial teacher education programmes and design its own CPD initiative a similar manner to help teachers reconcile what they believe to be good classroom practice and their actual practice.

Continuing Professional Development: The study has revealed that teachers acknowledge continuing professional development as essential for teacher effectiveness and that it is desirable for CPD programmes to be conducted within the school. Teachers are further willing to have fellow teachers as facilitators because a teacher-facilitator would be in touch with classroom reality. This stand point from teachers is a big opportunity for SMASE since it is at the heart of a teacher driven CPD initiative. However, the position needs to be taken with caution. At the September, 2002 Livingstone joint conference of ZAME, ZASE and ZIATA, there was group work tasks for participants to give their thoughts on the so called difficult topics and to suggest causes for the difficulties. A recurring point raised by each subject group, was the inability of teachers to consult one another. In view of this lack of a culture of peer support and mentoring, the concept of school-based CPD with teacher-facilitators will need to be approached with tact.

Recommendation14: SMASE should work towards popularising peer support/mentoring as a core activity in professional development.

The idea of teachers sharing their knowledge and skills in teaching with other teachers is also an approach being used by Mpumalanga Secondary Science Initiative (MSSI) in the Mpulamanga province, South Africa (PTL/MSSI Team, 2002). This approach is known as "Peer Teacher Learning (PTL) and is done as part of school based INSET. Under this approach, teachers with similar interests in mathematics and science education meet to share classroom experience. SMASE can learn a lot from the experiences of Mpumalanga Secondary Science Initiative Project.

Recommendation 15:SMASE should source funds to enable teams of key players in SMASE (according to availability of resources) to undertake study visits to Mpumalanga Secondary Science Initiative Project in South Africa as part of a capacity building exercise.

A challenge to SMASE will be the attitudinal one as regards the financing of the initiative. As the situational analysis showed, teachers in Zambia are emerging from an era of INSET being workshops and courses accompanied by allowances. A programme without allowances may still be viable with suitable incentives and organisation ability. But what was clear from the baseline study was that teachers were not prepared to pay for their CPD. A group of delegates to the September

tripartite conference of ZAME, ZASE and ZIATA deliberated the issue of incentives for participation in CPD. The group's task and results of its deliberations are presented in the Chart 10.1 below. The non-allowance benefits are still tied to emoluments except for one – the provision of "recognisable certificates". Recognisable certificates for CPD, especially by MOE, might indeed be a vital step towards weaning teachers away from the tradition of being paid for participation in CPD.

In order for a *Credit* system to be effective, there will be need for consensus from all possible users of the *Certificates of Credit* and these would include MOE, Colleges of Education and Universities to avoid some deficiencies that have been experienced under SPRINT. An admission requirement to the Primary Diploma by distance being offered by the National In-Service Teachers' College (NISTCOL) is to have accumulated at least 50 credits under SPRINT. However, the evaluation of the initial experience of running the diploma showed that this criterion was not observed and thereby causing frustration among those who had accumulated a large number of credits (Note: Circumstances leading to the non adherence to the Credits requirement for admission to the Primary Diploma by distance were attributed to the need to meet a specified deadline for starting the programme but that for subsequent intakes, this requirement would be adhered to).

Recommendation 16:SMASE should work out modalities for award of *Credits* for teachers' participation in CPD and any verifiable improvements in classroom practice, as is the case in the SPRINT system. Such credits should build up to certificates of competence of varying degrees.

SMASE should seek recognition of certificates of credit for CPD from key stakeholders especially MOE so that the certificates could be a criterion for promotion, bursaries and scholarships.

Chart 10.1: Group work task and report from the joint ZAME, ZASE and ZIATA conference, September, 2002

Activity 1

It has become traditional in Zambia for participants in CPD Programmes to be given some allowances (e.g. subsistence allowance). Because of this some teachers have participated in CPD activities to receive such allowances rather than to improve their professional skills.

(a) What do you think should be done to wean teachers away from this kind of thinking so that they accept participation in CPD as a personal responsibility?

(b) Discuss what will be the alternative incentives for teachers other than Allowances.

GROUP REPORT

Teachers attend CPD programmes to improve their professional skills rather than to be given allowances but demand for the allowances as a condition of service.

a) What should be done

In case there are teachers that participate in CPD programmes to be given some allowances, the following should be done to wean them away from this kind of thinking:

- Improve their salaries and related allowances
- Sensitise the teachers so that they appreciate the CPD as a personal responsibility apart from being the employers' responsibility
- Funding of schools for CPD activities.
- To avoid teachers leaving the station the CPD programs can be done in schools.

b) Alternative incentives for teachers other than allowances:

- Awarding notches as a result of attending CPD which should affect salaries.
- Offering recognisable certificates to participants of CPD programmes.

10.3 STAKE-HOLDER ANALYSIS

10.3.1 Potential Stakeholders

One of the major determinant of success and sustainability of SMASE will be the active involvement of stakeholders. The stakeholder analysis identified three categories of potential stakeholders (partners) to SMASE, which were (a) groups with the most interest in or influence on SMASE – these were subject associations, ZAME and ZASE; Ministry of Education; co-operating partners; school managers and Ministry of Science and Technology. Groups with moderate interest in or influence on SMASE were identified as institutions of higher learning, co-operating partners pupils and line ministries. Finally, groups with minimal interest in and influence on SMASE in included NGOs, publishers and PTAs. For any of these stakeholders to play an effective role, there will be need define their desired role in and relationship with SMASE.

Recommendation 17:SMASE should sign memoranda of agreement with key stakeholders detailing the partners' roles and obligations paying due respect to the interests, needs and capabilities of the partners in relation to continuing professional development.

10.3.2 SWOT Analysis on SMASE

The analysis strengths, weakness, opportunities and threats to SMASE showed that among the strengths were the fact that the two subject associations at the heart of SMASE, namely ZAME and ZASE, were that they already had some organisational structure, availability of teachers to make further recruitments from and that the associations already enjoyed support from MOE through TED. The weaknesses included the low membership to the two associations, weak financial bases and weak communication links within and across the associations. Among the opportunities were the availability of a large network of Teachers' Resource Centres and INSET delivery system to provide professional support, the availability of cooperating partner with an interest in CPD and government commitment to. The threats included the HIV/AIDS pandemic which was affecting, in one way or another, several teachers in the country; a weak economy which makes it difficult to establish either substantial or predictable sources of funding; and political 'instability' in which policy directions keep changing at unexpected rates.

In light of the above, we recommend that:

Recommendation 18:SMASE should capitalise on the strengths of ZAME and ZASE to consolidate these strengths and utilise them for promotion of its programmes without being overly dependent on other stakeholders for success but still playing a lobbying and advocacy role to invigorate all stakeholders to play their roles to the fullest of their capabilities to improve the learning of mathematics and science.

SMASE should develop a strategic plan to enable it develop in a focussed manner.

SMASE mainly focuses on teacher development of secondary school teachers of mathematics and science. This puts primary school teachers of mathematics and science at a disadvantage considering that they build the foundation for children in learning secondary mathematics and science. Further more many secondary school mathematics and science teachers who participated in this study attributed the poor performance of pupils in mathematics and science at secondary level to poor background at primary level. Nonetheless, it is acknowledged that due to BESSIP whose focus was on the primary school stage (Grades 1 to 7), primary school teachers are already beneficiaries of CPD initiatives that did not reach secondary schools. Such initiatives include SPRINT, PAGE and Basic Competence testing.

Recommendation 19:SMASE should work creating synergies with CPD initiatives running in the primary school sector.

10.4 MODELS OF CPD

10.4.1 Location

Continuing professional Development (CPD) could be categorised in relation to location, that is school based, school focused or centred and off-site. Further the methods of training of the programmes and how teachers/participants are supported is another consideration that could be taken into account.

The school based CPD as the name suggests is located at a school targeting a group of teachers (staff). The main aim according to Craft A. (2000) is about achieving a better match of CPD course to the needs and culture of a particular group of professionals and about having a direct impact on practice. The limitations are that it tends to be 'closed' to outside influence thereby exposing itself to the danger of participants pooling together 'ignorance'. Also constant distractions from schoolwork is commonly experienced.

The school-focused or school-centred professional development is similar to school based in many respects except the location is outside the school itself (could be a resource centre located within the school grounds etc). The programme however is related to the needs of the particular group or school. The disadvantages are similar to the school-based ones.

The third model according to Craft A. (2000) is where off-site and school-based training are linked in what is referred to as the 'cascade' approach. In this model a series of consecutive training processes, each occurring as a result of the previous one, and designed to impact an agreed and consistent body of knowledge, skills and attitudes(p. 23) are done/conducted.

The problematic nature of designing an in-service programme to enhance the teaching and learning of mathematics and science in schools is acknowledged. However, lessons from elsewhere suggest that school-based and focused programmes tend to be more successful. There is a general decrease in emphasis from course-based models of learning towards group focus, based in and /or focused on the school and its collective needs (Craft A. 2000, p. 11).

Recommendation 20: SMASE should be a school based CPD initiative.

10.4.2 Duration

In considering the duration or length of the training, there will be need to think in terms of continuity and sequence in CPD. Programmes which take teachers out of school for a short workshop or course are likely to result in less lasting change than longer programmes especially those with an in-school focus. (Jaworski and Wood 1999, p.132). As Fullan (1982) put it, change is a process not an event. He further says that change is a complex process that takes place over time. Therefore, for impact and realisation of change there will be need for a systematic, continuous and system wide intervention.

Recommendation 21:SMASE should be designed to on a continuous basis, integrating routine responsibilities of teaching with CPD save for specialized programmes that might need to be done at Teachers Resource Centres .

10.4.3 Methods

According to Joyce and Showers (1988) effective training activities should combine theory, modelling (preferred) practice, feedback and coaching for application. At each stage there should be need to reconcile the practice and the theoretical perspectives on which they are based. Other methods/approaches to be explored include action research, working group discussions, visits to other schools, teacher placements, peer networks, mentoring, staff exchange, job shadowing, and or creative use of information communication technologies (ICT) (Craft A. 2000, p. 28)

Whatever approach is adopted for SMASE, the framework for promoting and facilitating professional learning should take into account the following:

- "An appropriate combination of learning settings (on-the-job, near the job, home, library, course etc)
- Time for the study/course/programme, consultation and reflection
- The availability of suitable learning resources
- People (Resource persons) who are prepared (i.e both willing and able) to give appropriate support and
- The learners own capacity to learn and to take advantage of the opportunities available." (Eraut M. 1994, p. 13)

Further, the programmes should build into them a way of measuring the success of the CPD i.e. changes in the classroom behaviour of the teachers involved and improvements in the achievements of pupils in their classes. (Jaworski and Wood 1999, p.132)

Recommendation 22:SMASE should a comprehensive monitoring system that is comprehensive yet feasible and playing more of a means for professional support than fault finding.

10.5 STRATEGIES FOR SYSTEM-WIDE SUSTAINABLE CHANGE

Stoll and de Feiter (1995) propose a number of conditions that are necessary for an initiative such as the one SMASE is about to embark on to have system-wide and sustainable change. The first of these is that "change has to be *systemic*" i.e. the intervention needs to be of sufficient size and scope to identify and grapple with the components of system-wide school transformation. The fact that SMASE will be a nation-wide initiative is an important ingredient in being *systemic*. However, the challenge lies in the nature of secondary school structure – which to a large extent stood in the way of greater successes that AIEMS would have scored in secondary schools (relative to successes in primary schools). This relates to departmental structures. The fact that SMASE, like AIEMS, is targeting only two departments in a school (mathematics and science) for a CPD initiative, whilst the rest of the school it will be life-as-usual, is one of the biggest challenges lying ahead.

A second requirement, according to Stoll and Feiter, is "in-service education must be school focused". This means that the real needs of the school must be identified and programmes developed which are particularised to the needs of that school, thus allowing for best inset practices in CPD to be brought to bear on the need of the specific school. As a teacher-driven initiative, SMASE is on course in this respect.

A third requirement that "management training for the principal together with the staff is essential". In this respect, Stoll and Feiter say that

> *"... management is essential to create an ideal climate for the education to flourish. The optimal use of staff and pupil time and the pursuit of exemplary pedagogic practices are the focus of management efforts. Where normal maintenance functions are efficiently entrenched, development and innovation stands a better chance of being effectively integrated." (Stoll and Feiter, 1995, p.115)*

Indeed, quality management at both school and departmental levels will be vital for the success of SMASE. In both, the Programme for the Advancement of Girls' Education (PAGE) (Mumba, at. al. (1998) and Female Education in Mathematics and Science Education in Africa (FEMSA) Zambia Chapter (Yashini, 2001) monitoring and evaluation reports showed that interventions were only successfully implemented in schools with quality managements which adopted participatory and democratic styles of leadership. Quality management becomes particularly vital in secondary schools because, as said earlier, SMASE will be operating in only two departments. Thus achieving higher levels of teacher competence and effectiveness in only a few teachers in a school amid 'mediocrity' in the rest of the school will be difficult to sustain unless the school management sees this as an opportunity for the whole school to ultimately move to SMASE style CPD.

It can be said that one hindrance to the success of interventions in schools in Zambia is the lack of a whole-school ethos in the implementation. The review team of the Primary Reading Programme (PRP) found that at one school most of the teachers they meat were 'wearing labels' such as Mrs X, PAGE teacher, Mr. Y, NBTL teacher, Ms Z, 'SITE' teacher etc depending on which workshop they had attended. The net effect of this is that even though the intervention might be aimed at whole-school change in

practice, all other teachers leave the implementation to the one or two teachers who attended the orientation workshop for the intervention. To move towards a whole-school ethos requires a headteacher who enlightened, skilful, committed and attracting respect form the whole school community. It needs a vision and a vision holder.

Recommendation 23:SMASE should incorporate in its design a comprehensive capacity building programme for Headteachers and Heads of Mathematics and Science Departments.

Yet another requirement for achieving sustainable change if for school management practices to be democratic to include all staff so that their perceptions are taken seriously. This factor is closely linked to quality management discussed above. Once teachers feel coerced to participate in CPD, chances of success would be seriously diminished.

Stoll and Feiter further say that learner centred classroom practice needs to be fostered. This means that the learner must be provided with an environment in which she is able to construct knowledge for herself and take charge of her own learning experience. The case for Zambia, as the baseline study showed, is that classroom practice in both mathematics and science is heavily teacher centred. In view of the shift of emphasis towards learning centred teaching and the preponderous of teacher centred methodologies, there will be need for concerted and sustained effort at school level to realise this shift in practice.

Closely linked to learner centred teaching, thinking skills must become an explicit component of the curriculum. A common weakness on teachers is to require pupils to 'think like me'. Going with the promotion of thinking skills is the need for an altered classroom ecology. "This means that changes to the classroom content and organisation with a movement away from rows of uniform learners to arrangements which foster a variety of modes of interaction". (Stoll and Feiter, 1995: p.115).

10.6 PROPOSED STRUCTURE OF SMASE

10.6.1 Salient points

- The CPD programme should teacher-driven and firmly rooted in the subject associations, ZAME and ZASE, but acknowledging that the two associations will require a lot of professional, technical, financial, logistical and moral support to enable them mount such a mammoth initiative of a scale neither association has ever undertaken before.

- The CPD programme must be school based with departments as nerve centres and closely supported by the country-wide network of Teachers' Resource Centres and the District school management structure (See Appendix for the district school management structure).

- At school level, SMASE should be located in the Headteachers' office with Heads of Department of mathematics and science being focal point persons.

- A comprehensive internal (within the subject associations and MOE) and an external (UNZA and/or consultants) monitoring system be worked out for the main purposes of offering professional support and identifying, documenting and disseminating good practice models.

- ZAME and ZASE jointly work out a system of awarding credits for participation in CPD and seek MOE's approval that certificates of credit shall be additional considerations career advancement.

10.6.2 Structure of SMASE

In view of the foregoing, it is proposed that SMASE be closely modelled along the lines of SPRINT with the constituent components as shown in Chart 10.2 below. The description of each part is as follows:

The Headteachers's in-service meeting: A meeting held at least once each term and chaired by the Head and is attended by all participants in SMASE, preferably with Heads of other departments also in attendance. The purpose of the meeting is to review the CPD activities of the previous term and to make plans for the coming term.

Departmental meetings/seminars: Mathematics and Science Departments are each expected to meet about one hour per week as a normal part of school routine i.e. time-tabled accordingly. The Head of Department or his nominee is responsible for these meetings. Attendance at such a departmental seminar could entitle a teacher to have one in-service credit recorded on his/her In-service Credit Card. The focus of these meetings is entirely up to the teachers themselves. The details of the meeting are recorded and at the Headteacher's Inservice Meeting, Heads of Department will be required to report on their group's activities and plans.

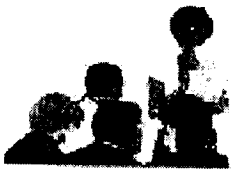
School in-service and monitoring: An Inspector of School and/or an In-service Provider visits each of the schools the at least once per term and all visits are recorded on the School Visit Checklist.

Subject meetings at Teachers' Resource Centres: The District Committee of ZAME and ZASE, in liaison with the District In-service Provider invites teachers of mathematics and science respectively to the District Resource Centre (or a secondary school – wherever facilities and geographical location might be more permitting) for an issue of common interest. Such a meeting could be facilitated by a consultant, whom generally, is a teacher who has been identified to be particularly outstanding on an aspect of teaching. Such a teacher could be given a brief attachment to a TRC to polish up his/her presentation to the level of a module and be paid an honorarium.

ZAME and ZASE District Committees would be responsible for identifying the consultants, setting the agenda for the meetings and seeing to the successful conduct of the meetings. Schools could support the attendance of their teachers to such meetings by way of meeting feeding and transport requirements.

Chart 10.2: Proposed components of SMASE

The following Charrt summarises each of the components of SMASE



Departmental meeting
(once per week)

Departmental Inservice Record

(Book kept in Head's office)

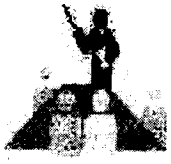
School Inservice Monitoring
(Visit by ZAMEZASE oficials, Ips & ISs

Professional development
Headteacher's meeting
(Head + Teacher's of mathematics

Science)

Miscellaneous in-service activities

ZASE
ZAME
UNZA
COLLEGES



Teacher Inservice Credit Card
(Credits for Inservice)

Subject meeting at Resource centre
(facilitated by consultant who will be selected successful teachers)

Certificate of Competence

Teachers' In-service Credit Card: As recognition of their commitment to professional development, teachers are awarded credits for specific in-service activities. Activities that could qualify for credit include:

- attendance at a departmental seminar/workshop
- demonstrating lessons, in the classroom, to members of the department credits)
- attendance at a subject meeting at the TRC
- performance based on lesson observation schedule

Miscellaneous in-service activities: In addition to those activities undertaken by teachers directly within the SMASE, there will inevitably be other important professional development work which needs to be recognised and recorded such as:

- participation in activities of professional associations such as the Zambia Association for Mathematics Education (ZAME) and the Zambia Association for Science Education (ZASE). These activities could be conferences, study visits, workshops, etc.
- education focused workshops at regional and national level.
- training in new initiatives such as the Programme for the Advancement of Girls' Education (PAGE)

All such activities should be recorded in the appropriate section of the Departmental In-service Record Book.

Departmental In-service Record: This record is in form of a book kept by the Head of department. The book will contain details of all in-service activities that take place in the school, at the resource centre and elsewhere.

10.6.3 Roles in SMASE

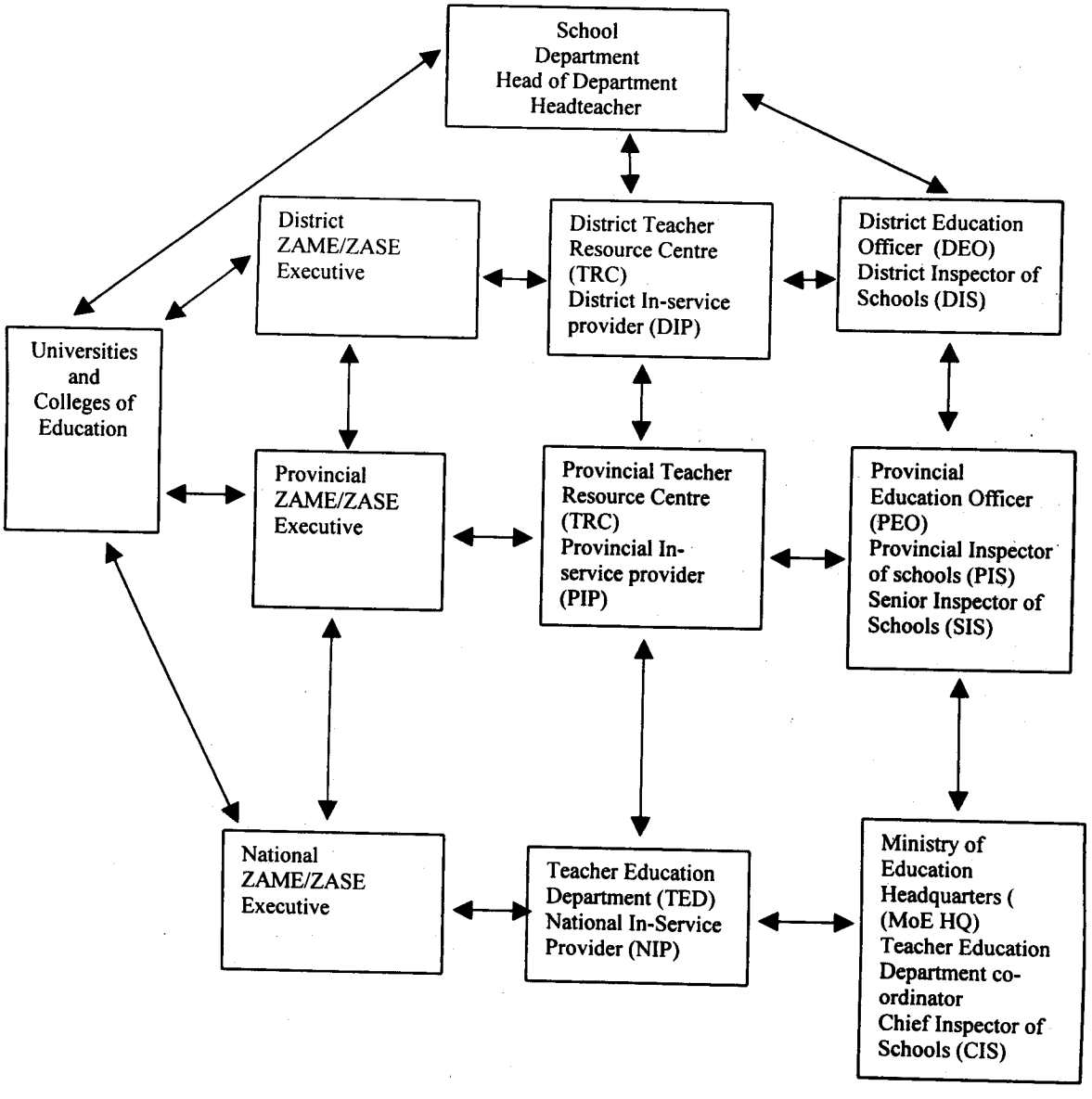
Chart 10.3 below outlines the relationships of individuals and institutions in the implementation of SMASE. The role of each individual/institution is as follows:

The Headteacher: The Headteacher is responsible for ensuring that continuing professional development, through SMASE, features as a normal part of routine throughout the school year and that all teachers participate fully in the programme. Further, he/she is required to monitor the effectiveness of in-service provision in achieving positive change within the classroom.

Head of Department: Working under the direct supervision of the Headteacher, the HoD will responsible for encouraging all teachers to participate as fully as possible in all aspects of continuing professional development in the school. He/she is required to monitor the impact of in-service activities on classroom practice and provide appropriate feedback to teachers.

Teachers: All teachers are expected to participate in the school in-service programme which forms an integral part of the school.

Chart 10.3: Proposed structure for SMASE



District ZAME/ZASE executive committees: The District Committee of ZAME/ZASE will liaise with the District In-service Provider and District Inspector of Schools to identify local needs, local teacher consultants, organise courses and monitor the implementation of SMASE.

District In-service Provider: The District In-service Provider, working in conjunction with ZAME and ZASE district committees and the District Inspector of School, to ensure that SMASE operates effectively in secondary schools in the district.

Provincial ZAME/ZASE executive committees: The Provincial ZAME/ZASE Committee will co-ordinate all SMASE activities in the province and lobby provincial education and other authorities for support to SMASE.

National ZAME/ZASE executive committees: The National ZAME/ZASE Executive Committees will co-ordinate all SMASE activities in the country and lobby MOE Headquarters officials, co-operating partners and all other stakeholders to play their roles to the fullest of their means and capabilities.

Provincial In-service Provider: The Provincial In-service Provider, working in conjunction with ZAME and ZASE provincial committees and the Senior Inspectors of Schools at the Provincial Education Office, to ensure that SMASE operates effectively in secondary schools in the province.

National In-service Provider: The National In-service Provider is responsible for ensuring that SMASE operates effectively in all secondary schools in the country.

District Inspector Schools: The District Inspector of Schools will be required to assess the impact of SMASE in all secondary schools in the district and offer professional and all other possible support.

Principal Inspector of Schools: The Principal Inspectors of Schools will be responsible for ensuring that SMASE is operational in all secondary schools throughout the province and offer professional and all other possible support.

Chief Inspector of Schools: The Chief Inspectors of Schools will be responsible for ensuring that SMASE is operational in all secondary schools throughout the country and see to the two-way flow of monitoring information from school level up to national level and vice versa.

Universities and Colleges of Education: Universities and Colleges of Education will work with all levels of education, from teacher to Chief Inspector of Schools to monitor the implementation of SMASE, carry out joint research with partners in mathematics and science education, identify, document and disseminate good practice models in SMASE.

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APPENDICES

APPENDIX 1: TERMS OF REFERENCE

1. **Situation analysis/Review of Past activities**
   - Review policies, reports and raw data such as pupils' results in relation to teacher development.
   - Examine the current teacher development activities, especially in Mathematics and Science Education, at both basic and secondary level through available literature and data.
   - Carry out a follow-up survey in collaboration with baseline survey team, if necessary.
   - Consolidate and analyze the findings arising from the activities above 4.1 and make a report on them.

2. **Stakeholder analysis**
   - Organize a meeting/workshop with taskforce and some relevant people to identify potential stakeholders and to point out their strength, weakness and current relation to each other.
   - Examine the outcomes from the activity above and draw up rough correlation amongst the stakeholders.
   - Carry out follow-up survey through interviews to the stakeholders, in collaboration with Baseline survey team.
   - Arising from the analysis make recommendations on roles that can be effectively played by potential stakeholders and their possible inputs towards teacher development through the Subject Associations.

3. **Baseline survey**
   - Review the similar activities and their instrument in the past
   - Design, pretest and adjust the instruments for the Survey on the bases of the activity above.
   - Draft the study plan such as method of sampling, timeframe, etc.
   - Send and collect the questionnaires to and from the samples
   - Monitor and follow up the survey through the field trip to selected sites. This activity may include follow-up interviews/survey for the situation analysis and the stakeholder analysis, if necessary.
   - Process and analyze the data and findings from the field, and make recommendations out of the findings and the analysis

4. **Report writing**
   - Drafting and Presentation of an inception and progress report
   - Compilation, Drafting and Presentation of Draft Final Report including method of working, justification of man-days, findings, analysis and comprehensive recommendations.
   - Review and Completion of Final Report

5. **Management of the Study**

- The Study Team will comprise of two sub-teams: the Team of the Consultant,
  which will conduct situation analysis and baseline survey, and the Team of the Sub-Consultant, which will conduct stakeholder analysis.
- The Team Leader of the Consultant will assemble a team of local experts with
  Mathematics and Science Education at both Junior and Senior Secondary level, and Teacher Education/Development
- The Team Leader of the Sub-Consultant will assemble a team of consultants for conducting stakeholder analysis,
- The Team Leader of the Consultant will be responsible for the following activities:
  (a) Preparation and presentation of Baseline survey instrument and concrete study plan as inception,
  (b) Managing and supervising the study and activities in situation analysis and baseline survey,
  (c) Preparation and presentation of Progress Report after the follow up field trips, including the summary of findings and analysis
  (d) Compilation, consolidation and presentation of the Draft Final Report in collaboration with the Team Leader of the Sub-Consultant
  (e) Amendment and Completion of the Final Report in collaboration with the Team Leader of the Sub-Consultant after the Consultative Meeting.
- The Team Leader of the Sub-Consultant will be responsible for the following activities:
  (a) Preparation and presentation of concrete implementation plan as inception,
  (b) Organizing and managing the workshop and subsequent study in stakeholder analysis with another consultant,
  (c) Supervising the activities of another consultant
  (d) Preparation and presentation of Progress Report after the workshop, including the summary of findings and analysis
  (e) Compilation, consolidation and presentation of the Draft Final Report in collaboration with the Team Leader of the Consultant
  (f) Amendment and Completion of the Final Report in collaboration with the Team Leader of the Consultant after the Consultative Meeting.
- The Team Leaders of both the Consultant and the Sub-Consultant will keep frequent communication and consultation with each other in order to pursue the same track in the Study, especially in the process of consolidation of each exercise into a final report.
- Each of the reports stated above must be submitted to JICA through the JICA expert for approval. MOE Representatives and SMASE Interim Committee will also be consulted for their comments before the submission to JICA.

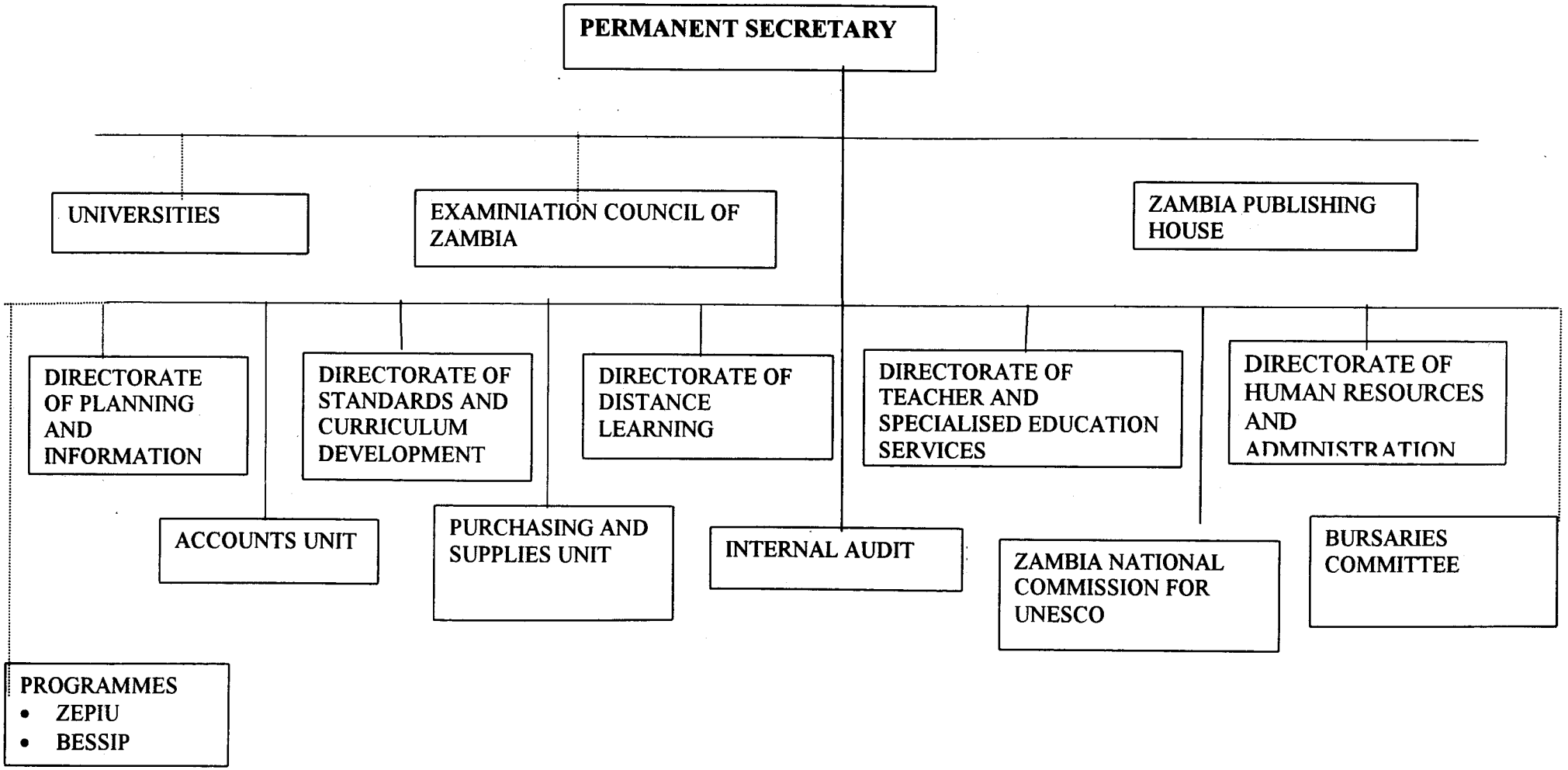
6. **Expected Outputs**

Comprehensive report and recommendation on Effective Machinery and Possible Activities for Teacher Development through subject associations

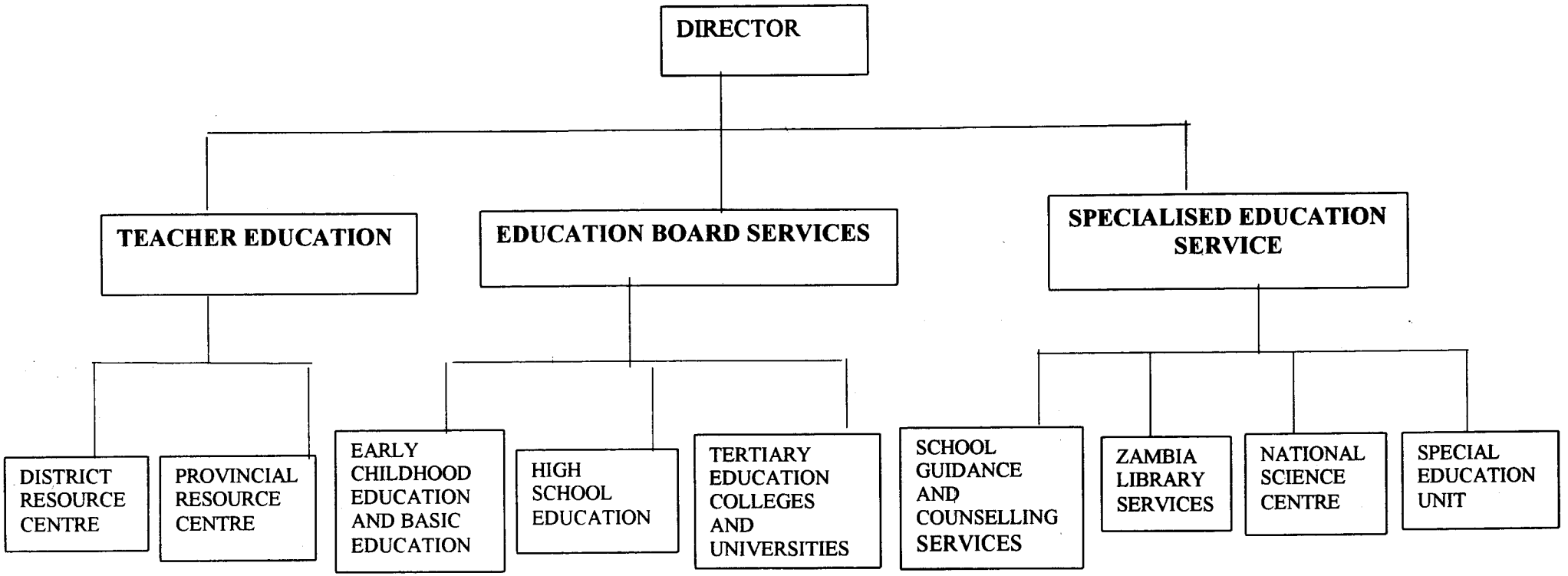
APPENDIX 2: LIST OF TEACHERS' COLLEGES

1. Charles Lwanga Teachers' College
2. Chipata Teachers' College
3. David Livingstone Teachers' College
4. Malcom Moffat Teachers' College
5. Kasama Teachers' College
6. Kitwe Teachers' College
7. Mansa Teachers' College
8. Mongu Teachers' College
9. Solwezi Teachers' College

APPENDIX 3: NEW MANAGEMENT/ORGANISATIONAL STRUCTURE OF THE MINISTRY OF EDUCATION



APPENDIX 4: MANAGEMENT/ORGANISATIONAL STRUCTURE OF DIRECTORATE OF TEACHER EDUCATION AND SPECIALISED EDUCATION SERVICES



APPENDIX 5: LIST OF PARTICIPATING SCHOOLS

WESTERN PROVINCE

Holy Cross Secondary school (teachers and pupils)
Kambule Technical Secondary School (Teachers and pupils)
Kaoma Secondary School (Teachers and pupils)
Limulunga Secondary School (Teachers and pupils)
Mangango Secondary School (Teachers and pupils)

NORTH-WESTERN PROVINCE

Loloma Day Secondary School (Teachers and pupils)
Munkinge Secondary School (Teachers and pupils)
Zambezi Secondary School (Teachers and pupils)
Mutanda Secondary School (Teachers and pupils)

LUAPULA PROVINCE

Kabunda Girls Secondary School (Teachers and pupils)
Mansa Secondary School (Teachers and pupils)
Twingi Secondary School (Teachers only)
Nchelenge Secondary School (Teachers and pupils)
Samfya High School (Teachers only)
St. Clements Secondary School (Teachers and pupils)
St. Mary's Kawambwa Secondary School (Teachers and pupils)

NORTHERN PROVINCE

Ituna Secondary School (Teachers and pupils)
Kasama Boys Secondary Schools (Teachers and pupils)
Kasama Girls Secondary Schools (Teachers and pupils)
Luwingu High School (Teachers only)
Mungwi Technical High School (Teachers only)
St. Teresa Girls Secondary School (Teachers only)

EASTERN PROVINCE

Feni Secondary School (Teachers and pupils)
Chisale Secondary School (pupils only)
Madzimoyo Secondary School (pupils only)
Chipata Day Secondary School (Teachers and pupils)
Katete High School (pupils only)
St. Monica Secondary School (pupils only)

CENTRAL PROVINCE

Chibombo Secondary School (Teachers and pupils)
Mumbwa Secondary School (Teachers only)
Chipembi Secondary School (Teachers only)

Kabwe Secondary School (Teachers and pupils)
Bwacha Secondary School (Teachers and pupils)

COPPERBELT PROVINCE

Helen Kaunda Secondary School (Teachers and pupils)
Mukuba Secondary School (Teachers and pupils)
Kansenshi Secondary School (Teachers only)
Malela Secondary School (Teachers only)
Dominican Convent Secondary School (Teachers and pupils)
Sacred Heart School (Teachers only)
Mpelembe Secondary School (Teachers and pupils)
Simba Secondary School (Teachers only)
Nkana Secondary School (Teachers only)
Tug argan Secondary School (Teachers only)

LUSAKA PROVINCE

Arakan Barracks Secondary School (Teachers and pupils)
Chongwe Secondary School (Teachers and pupils)
David Kaunda Technical High School (Teachers and pupils)
Jacarada Secondary School (Teachers only)
Naboye Secondary School (Teachers and pupils)
St. Mary's Secondary School (Teachers only)
Kasisi Secondary School (Teachers and pupils)
Rhodes Park School (Teachers only)
Kwacha Secondary School (Teacher)
Metropolitan Secondary School (Teachers only)
Parklands Secondary School (Teachers and pupils)

SOUTHERN PROVINCE

Sikalongo Secondary School (Teachers and pupils)
Kabanga Secondary School (Teachers only)
Linda Secondary School (Teachers and pupils)
Choma Secondary School (Teachers and pupils)
St. Marks Secondary School (Teachers and pupils)
Mazabuka Girls Secondary School (Teachers only)
Monze Secondary School (Teachers and pupils)
Chipepo Secondary School (Teachers only)
Siavonga Secondary School (Teachers only)
Nakambala Private School (Teachers only)
Namwianga Secondary School (Teachers only)

APPENDIX 6: SCHEDULE OF SCHOOL VISITS BY CONSULTANTS

DATE/PERIOD	ACTIVITIES
22nd to 27th February 2002	Preparation of instruments for data collection
28th February 2002	Pilot study
From 10th to 27th March 2002	• Distribution of questionnaires • Visits to provinces by consultants Central province: B. Nkhata & V.S. Kostyuk Southern province: C. Haambokoma Eastern province: V. Chabalengula Northern province: B.Z. Ndhlovu Luapula province: B. Nkhata Western province: M. Tabakamulamu/A. Nakamura N/Western province: S. Mbewe/a. Nakamura Lusaka province: Prof. Kostyuk & C. Haambokoma
3rd to 4th April 2002	Stakeholder analysis workshop
5th April to 12th June 2002	• Data input and analysis • Review of literature • Report writing

SCHOOL VISITS

Southern Province

Date	Place Visited	People met/Activities
18th March 2002	• PEOs office (Livingstone) • Linda high school	• Deputy PEO • Principal inspector of schools • Senior inspector of schools (Science) • School managers • Teachers of Mathematics and Science pupils
19th March 2002	• DEOs office (Choma) • Choma secondary school	• District INSET provider • School managers • Teachers of mathematics and science • Pupils
20th March 2002	• St. Marks secondary school (Mapanza)	• School managers • Teachers of mathematics and science • Pupils
21st March 2002	• St. Kalonga Secondary school	• School managers • Teachers of mathematics and science • Pupils
22nd March 2002	• DEO's office (Monze) • Monze secondary school	• Deputy Head • Teachers of mathematics and science • Pupils
Copperbelt Province		
11th March 2002	• PEO's office (Ndola) • Dominican convent	• The PEO and PIS • Deputy Headmistress • Teachers of mathematics and science • Pupils lesson observation
13th March 2002	• Mpelembe secondary school	• The Principal • Vice Principal Academic

		• Vice Principal Administration • Mathematics and science teachers
14th March 2002	• Mukuba High school	• The Headmistress • Mathematics and science teachers • Pupils
15th March 2002	• Helen Kaunda High school	• The Deputy Headmaster • Teachers of mathematics and science • Pupils lesson observation
16th March 1001	• Mpelembe Sec. school	Pupils
Eastern Province		
18th March 2002	• PEO's and DEO's (chipata • Feni day school	• PEO and Inspector of Schools • Head – Feni day • HODs mathematics and science • Physics teachers • Pupils • Lesson observation
19th March 2002	• St. Monica's school	• Headmistress • Pupils
20th March 2002	• Katete boma	• Headmaster • HODs mathematics and science • Pupils • Lesson observation
21st March 2002	• Chisale day school	• Deputy Head and HOD science • HOD mathematics • Science teachers • Pupils • Lesson observation
22nd March 2002	• Chipata day school	• Headmaster • HOD science • Laboratory technician • ZASE coordinator
North Western Province		
25th March 2002	• Loloma high school	• Headmaster • Mathematics and science teachers • Pupils lesson observation
26th March 2002	• DEO's office • Zambezi boarding school	• DIP • Headmaster • Mathematics and science teachers • Pupils lesson observation
27th March 2002	• Mukinge girls school • Mutanda high school • PEO's office	• Deputy Headmaster • Mathematics and science teachers • Pupils • Headmaster • Mathematics and science teachers • Pupils • PEO and PIS
Lusaka Province		
11th March 2002	• Chongwe high school	• School administrators • Administered questionnaires to teachers and pupils • Interviewed pupils and one teacher • Observed one lesson
13th March 2002	• Chongwe high school	• Interview with HOD (science)

		• Collected questionnaires from teachers
14th March 2002	• Naboye high school (Kafue)	• School administrators • Administered questionnaires to teachers and pupils • Observed lesson • Interviewed HOD, teacher and pupils
15th March 2002	• Parklands high school (Chilanga)	• School administrators • Administered questionnaires to teachers and pupils • Observed lesson • Interviewed HOD, teacher and pupils.
16th March 2002	• Kasisi secondary school	• Administered questionnaires to teachers and pupils
26th March 2002	• Rhodes park school • Jacarada school • Kwacha school	• Distribution of questionnaires
27th March 2002	• Arakan barracks school • Metropolitan school	• Distribution of questionnaires

APPENDIX 7: LIST OF WORKSHOP PARTICIPANTS FOR THE STAKEHOLDER ANALYSIS

1.	Edward Tindi	-	MoE-TED.
2.	Rebecca Twelasi	-	JETS.
3.	Adrinnie Kanondo	-	ZAME.
4.	Clothilda Mulele	-	ZAME.
5.	Florence Hanyuma	-	NISTCOL.
6.	Maswabi Mubiana	-	CBU.
7.	Tryson Mtonga	-	CBU.
8.	Mwangana Likando	-	COSETCO.
9.	Benny Mukonde	-	COSETCO.
10.	Mukelabai Mwanambuyu	-	PEO's office-Mongu.
11.	Simon Hikaula	-	CDC.
12.	Elizabeth Nyambe	-	Association of Headteachers, Lsk
13.	Luc Moens	-	VVOB.
14.	Benson Banda	-	ZASE.
15.	Isaac Shawa	-	ZEPH/BPAZ.
16.	Ruth Mvula	-	K. Nkrumah.
17.	Christine Kasonde	-	BPAZ.
18.	Belinda Mwale	-	BPAZ.
19.	Hakushi Hamaoka	-	JICA.
20.	Maybin Muyangwa	-	SESTUZ.
21.	Christopher Haambokoma	-	UNZA.
22.	Kapembwa Musenda	-	VSO.
23.	Paul Zambezi	-	MSTUT.
24.	George Mwanda	-	NSC.
25.	Antonina Ponga-Yashini	-	FAWEZA.
26.	Andrew Nyangu	-	ZAME/PRC.
27.	Safike Kunda	-	HoD-St Joseph's. Kalulushi.
28.	Lemmy Kaunda	-	Lubuto High Sch. Ndola.
29.	Enos Mwape	-	Kasama PRC.
30.	Agnes Chama	-	Samfya PRC

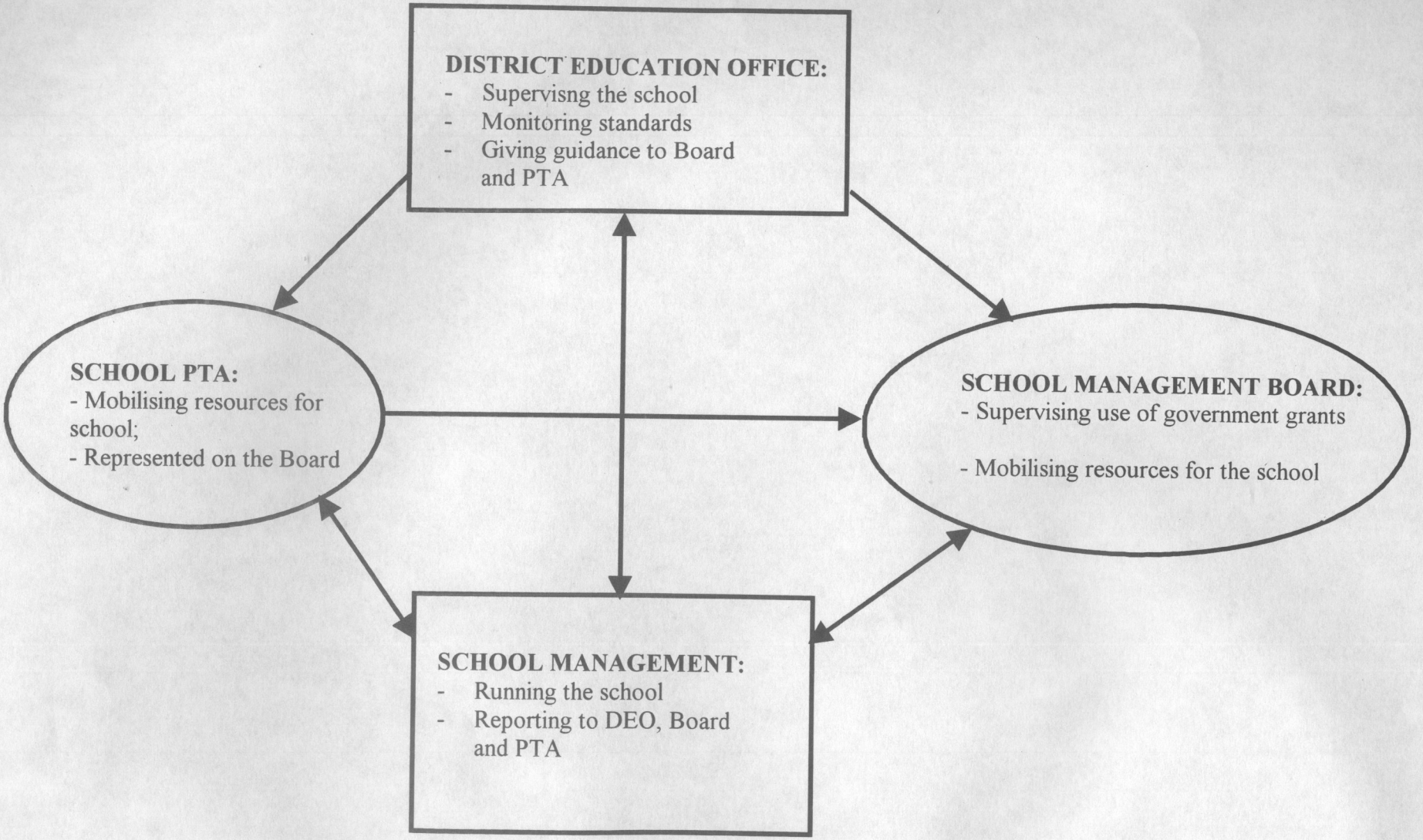
List of facilitators

1.	Mr Russel Mushanga	-	ISTT
2.	Ms Dorothy Nthani	-	ISTT
3.	Miss Monde Lisulo	-	ISTT

Workshop Co-ordinator

Mr	Satoshi Nakamura	-	SMASE.

APPENDIX 8: SCHOOL MANAGEMENT STRUCTURE AT DISTRICT LEVEL



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