Improving primary science teaching in Nigeria: A workshop Approach

by

CORDELIA NWAMAKA ANOSIKE

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Department of Science and Technology
Institute of Education,
University of London.

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This thesis is devoted with love to my husband, Arinzechukwu, my cousin, Obidinma and my late brother, Ogonna, for the inspirations and support they have given to me.

ABSTRACT

Earlier studies have shown that the majority of the teachers in primary schools in Nigeria are ill-equipped to teach science. It was also established that most of these primary school science teachers had rather poor background and training in science. The present study was therefore designed to establish the efficacy of practical workshops as a way of furthering teachers' professional competency in science. This was done through a field study of these teachers in their teaching environment. The investigation was carried out in three phases.

The first phase involved a questionnaire survey covering 180 primary six teachers located in three of the 30 states of Nigeria (Anambra, Kaduna and Plateau). The aim of this survey was to identify the topics in the primary science core curriculum which the teachers found difficult to teach.

It was found that the teachers found magnetism a difficult topic to teach. The second phase involved the mounting of a 2-day in-service training workshop on the teaching of magnetism, for fifty teachers located in Anambra state. The workshop was designed as one of the mechanism for improving the knowledge and teaching skills of the teachers in science.

The third phase of the study involved post-workshop visits, follow-up interviews and the observation of the teachers in action in their own classrooms. The visits were followed by a 1-day workshop which provided an opportunity for the workshop programme to be evaluated as well as for the teachers to meet for mutual exchanges of experiences.

The outcomes of the workshops indicated that the teachers, as a result of their participation in the workshops, had achieved a greater understanding of magnetism and subsequently were able to teach the topic more confidently.

The implications of this study for pre-service and in-service teacher education programmes as well as classroom science teaching practice are discussed.

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DEFINITION OF TERMS USED IN THE RESEARCH

N C E: Nigeria Certificate in Education. This certificate is usually obtained after three years of training in a College of Education or in an Advanced Teachers College. In some cases, this certificate is obtained through an in-service training or after Part-time studies for a period of 4 years(depending on the awarding Institution).

ACE: Association Certificate in Education: This is a certificate obtained after a 2 years part-time study which are usually provided for teachers who had no secondary school background. It is actually a prerequisite to NCE certificate course.

GCE 'O' Level: General certificate Examination.

WASC: West African School Certificate. This is an equivalent of GCE 'O' level certificate obtained after passing through five years of secondary education and sitting for an examination under West African Examination Council (WAEC).

NCC: National Curriculum Committee

N P E: National Policy on Education.

S T A N: Science Teachers Association of Nigeria.

TVTC: Teachers' Vacation Training Course

B.Sc.: Bachelor of Science.

B.Sc. (Ed): Bachelor of Science (Education).

B.Ed. : Bachelor of Education.

B.Ed (Science): Bachelor of Education (Science) (This 'Science' may be Biology, Chemistry or Physics or a combination of all).

P G D E: Post Graduate Diploma in Education. This is open to university graduate and is usually obtained after a 1-year course of study in Education in a University. This one year course is designed to expose the individual to the basic principles of education including the psychology of learning.

SPACE: Science Processes And Concepts Explorations Project.

Grade II Teachers Certificate: This is a certificate obtained after 1, 2, 3, or 5 years of training (depending on entry qualification) through the High Elementary Training Colleges.

Standard IV Certificate: This is obtained after 6 years of primary education. It is known in Nigeria as the 'First School Leaving Certificate'.

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Chapter 1

GENERAL INTRODUCTION

1.0: Introduction

It is believed that the western form of formal education started in Nigeria in the mid 19th century with the coming of European missionaries (Fafunwa, 1991). At first, emphasis was placed on the so called 3Rs: that is, **R**eading, W**R**iting and A**R**ithmetic. These were designed initially to suit the religious and commercial needs of the early colonialists. However, as time went on, it became necessary that the breadth and depth of the curriculum be expanded to take care of the needs of the emergent Nigerian society. Indeed, one of the groups that spearheaded the call for a more relevant and comprehensive educational curriculum was a group of Nigerians, who were anxious that the Nigerian educational system should be brought in line with the trend and development of education in the West, with Britain and USA being the most respected models. These calls led eventually to the setting up by the Federal Government of Nigeria of a number of committees to review the educational curriculum for the whole country. One outcome of this initiative was the convening of a National Curriculum Conference of 1969 (Fafunwa, op cit.) which recommended a total restructuring of the educational policy for the whole country. In line with educational development in the western world, the conference recommended that special emphasis be placed on science, mathematics and technology in the proposed national curriculum. The highlights of the conference were subsequently published by the Federal Government in an official document (first published in 1977 and revised in 1981), now known as the National Policy on Education (NPE). The NPE gave birth to a new educational system called the 6-3-3-4 (details are discussed later in the next section). This system of education was different from the old system (6-5-2-3, details of which are discussed also in the later section of the chapter) not only in the number of years pupils spent at the various stages of their educational training but also in the structure and content of the curriculum. The new system in a sense contained more modern concepts and required more modern techniques of teaching and assessment. In general, it was more demanding than the old system.

According to the NPE document, 'the Federal Government of Nigeria has adopted education as an instrument par excellence for effecting national development' . In it, the need for education is emphasised right from the pre-primary school (nursery) level to the tertiary level. The new system of education was to be the vehicle for achieving the aims of the NPE document. However, due to a number of constraints, the pre-primary level has not yet been formalised as the government had envisaged. In its stead, the primary level became the starting point and the foundation for all the other levels of education (Allison, 1982). Starting from this level, the place of science as a core subject is emphasised. Thus apart from the inculcation of literacy and numeracy and the ability to communicate effectively, one of the objectives of primary education according to the NPE document should be 'the laying of a sound basis for scientific and reflective thinking'. In pursuance of the objective of teaching science, a number of facilitating proposals have also been made. One of them was that the Federal Government was to make available materials and manpower for the teaching of science by appropriately equipping teacher training colleges and by increasing the intake and supply of science teachers. These measures it was hoped, would help to lay a sound foundation for the learning and development of science and technology in Nigeria.

It has to be said that the lofty goal, of laying a sound scientific culture, set up in the National Policy on Education in 1981, which would make the country self-sufficient in manpower and one of the leading members of the international science community, has so far not been realised. It has therefore become necessary for educational researchers to enquire why this goal has not been realised.

Some of the research findings identified a number of factors which were responsible for the non-realisation of the envisaged goal. Some of the factors identified included poor and outdated methods of teaching science, non availability of resource materials for teaching science; negative attitudes toward science by the general public, teachers and pupils alike; and the lack of adequate science preparation on the part of the teachers, amongst others (Ikoku, 1982; Gyuse, 1982; Bahago, 1984; Folayan, 1985) . In particular, Bajah (1984) in his study on the state of science teaching in Nigeria concluded that the most devastating of all the identified factors responsible for the deplorable state of science in the country was the lack of adequate science preparation as well as the lack of an adequate number of qualified teachers[1]. He went further to suggest that the problem must have stemmed from the lack of adequate preparation of the primary school teachers as science teachers during their teacher training years.

Bajah's finding is significant in that it has to be remembered that most of the primary school teachers in Nigeria are non-graduates who did not specialise in science. A good number of them at that time were Grade II teachers[2] whose exposure to science is, to say the least, minimal and ad hoc. Furthermore, they were trained in the period when science was not compulsory in the Teacher education curriculum. Moreover, not many of

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[1] Even though it is about ten years now since Bajah conducted his study and although there has been an increase in the number of qualified teachers at the primary school level, the situation has not changed significantly.

[2] A Grade II teacher is a professionally trained teacher who is usually certificated after a one or two year post secondary training. There are some who do a five year post primary training and qualify. Nevertheless, the scope of his/her science training is minimal.

these teachers offered science at this stage (Abdullahi, 1982; Gyuse, 1983; 1989;). That being the case, Bajah's finding is not surprising at all. Nonetheless, it is one that requires urgent attention. It is the author's view that no educational system can rise above the quality of its teachers. Therefore, the issue of the inadequate science training of the teachers is one that this study sees as crucial in this context. Hence, urgent steps are needed to be taken by government to redress this situation.

At this juncture, it is necessary to look at the political geography of Nigeria in order to see what roles the Federal and other tiers of government are expected to play to achieve the aims of the NPE.

1.1: The Political geography of Nigeria:

Nigeria became an independent and sovereign nation in 1960. At that time, Nigeria was politically organised as a federation of four regions(North, West, Mid-West and East) with a central and later Federal government as well as four regional governments. Following the Nigerian crisis which led to a civil war (1967-1970), the regions were scrapped and 12 States were created by the military administration of General Gowon. Nigeria is also a nation of about 80 million people and over 250 tribes or ethnic groups of which there are three major ones- Hausa/Fulanis (in the old North), Yorubas (in the old West) and Ibos (in the old East). Because of the need to give greater political participation and autonomy to the minority tribes it was then found necessary by the late General Murtala Mohammed military administration, to create 7 more States to increase the number to 19. Owing to the continued pressure by the minority to have states of their own, 2 more States were created by General Ibrahim Babangida's administration bringing the total number of States to 21 in 1986. The crave for the creation of new states did not abate and in order to allow the spread of development essentially towards the minority areas, 9 more States were further created by General Babangida's military administration in 1991,

bringing the total number of States in Nigeria to 30 excluding Abuja, the Federal capital territory, which has the status of a state (see figure 1.1).
In 1979, Nigeria, which had been ruled by the military since 1966, returned to civilian rule with a brand new constitution. That constitution divided Nigeria into 304 Local government areas. Since then, the number of Local government areas has been increased to 589 with the creation of more states in 1991 by the Babangida military administration (Nigerian Newsletter, 1991).

Education in Nigeria has naturally been affected by the political changes that have faced Nigeria since the 19th century. Consequently, the administration of education in Nigeria, will be discussed in the following order:

- Pre-1960 : Colonial Era
- 1960 - 1966 : After independence
- 1966 - 1979: Military era
- 1979 - 1983: Second republic
- 1983 - to present day Military Administration.

1.1.1: Pre-1960 : Colonial era:

It should be noted that prior to 1925, the British colonial government had no clearly defined policy on education in its African colonies. What was considered as the first government statement on this matter was made by the British Privy Council's committee on education in 1847 in which it referred to the need for *'securing better conditions of life and development of the African as a peasant on the land'* (Fafunwa, 1991). With this policy statement, the colonial government began to assist the Christian missions somewhat in their educational work. However, most of the development proposals they (the missions) made did not work out owing to lack of funds. In spite of the very little effort made by the Nigerian central government to assist the missions in the running of the schools, the missions continued to establish more schools. Thus, every mission strove to establish more schools and win more ground for their religious denomination. In this way, the number of unassisted schools continued to increase. In 1920, the Phelps-Stokes fund of the United States of

America in co-operation with the International Education Board set up a commission which was charged to discover whether the education of boys and girls in Nigeria was in line with the development of the country.

The report of the commission showed among other things that:

- education given to African people was not relevant to their needs,
- education in Africa lacked organisation and supervision because there were no clear cut objectives for the African people, and
- the lack of co-operation of the missionaries, and the government to improve education provision was affecting the quality of education. (Fafunwa, 1991).

Owing to the recommendations of the above report, the British colonial government was forced to make some policy adjustments in order to demonstrate its interest in African education. It then enunciated its first policy on education in Nigeria in 1925. This memorandum which guided Nigerian educational policy as well as development from 1925 - 1945 could be said to be the first ever published government policy on Education by the Nigerian government.

As mentioned earlier, before the 1925 memorandum was published, education was principally an affair of the missions which established most of the schools without interference by the colonial government. These missions were responsible for designing the curriculum of the schools but with an eye to producing catechists, lay readers and clergymen. During this period also, the educated man in the Nigerian context was a person who could speak and write English. However, the 1925 memorandum promoted not only the government interest but also its interference in the provision of education. This memorandum guided Nigerian education until 1945 when a new national constitution popularly known as the Richard's constitution was drawn up. The Richard's constitution of 1945 which divided Nigeria into three regions placed education under the jurisdiction of the regional governments. The regional governments thus appointed heads of their education departments, who were

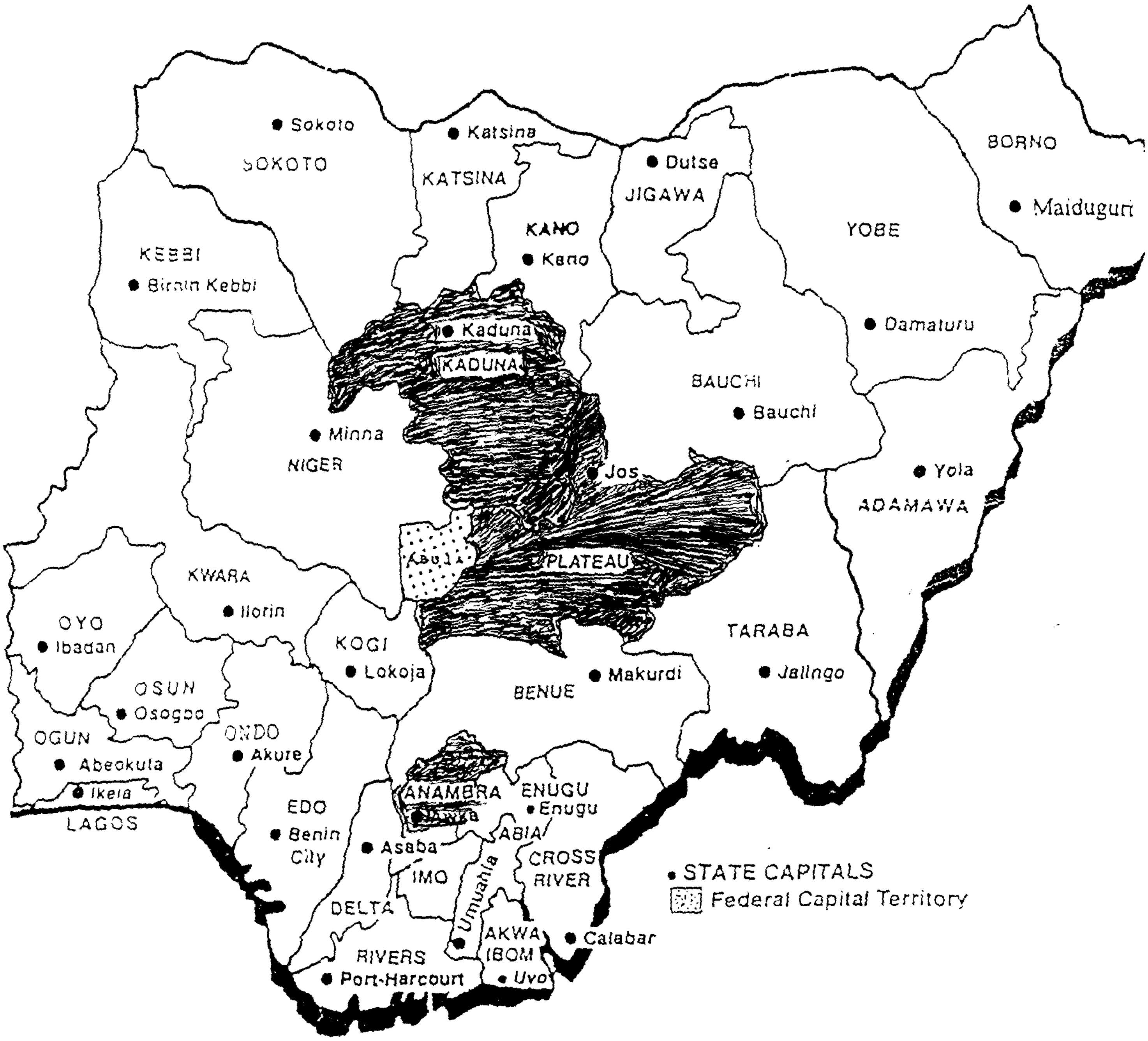

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Figure 1.1: Showing Map of Nigeria with the 31 states including Abuja.

styled commissioners of education, under whose jurisdiction all education matters were placed. Thus, up till 1952, under the then Nigerian education act (No 17) of 1952, education was an affair of the regional governments (Udoh, et al 1990). However, the number of regions was subsequently increased to four after independence and the corresponding adjustments were effected in the administration of education in the country.

1.1.2: 1960 - 1966 : Civilian era.

There was no uniform educational policy among the regions in this era. However, the administration of education at this time was still a regional affair. There were, none the less, variations in the regional government provision for education in this era, but they all possessed one thing in common: they established commissions to study the problems facing education systems as well as making recommendations for improvements- hence, the Oldman's commission in the North (1961), the Banjo's commission in the West (1961), and the Dike's commission in the East (1962) (Udo et al, 1990). Indeed, the most outstanding policy of this era was the introduction of the Universal Primary Education policy which was adopted in the East and West but not in the North.

1.1.3: 1966 - 1979: Military era:

As indicated earlier, the national crisis of 1966-70 saw the creation of 12 states out of the four regions existing in Nigeria at that time. However, in order to secure a central control and an integrated system of education which would guarantee uniform standards as well as a fair distribution of educational facilities while reducing the cost of administration, the existing schools were taken over by the State governments starting with the East Central State (the present Anambra, Imo, Abia, and Enugu States), and subsequently, the Mid-West (made up of the present Edo, and Delta States), and Rivers States. The action was followed by the creation of local and state school boards and management committees by military decrees and edicts. The respective ministries of education were consequently restructured to include the states' school boards as well as the newly created Teachers Service Commissions.

1.1.4: 1979 - 1983: Civilian era.

This was the period when Nigeria returned to a civilian administration. The civilian administration in 1979 brought a lot of changes in educational policies in this period for a number of political reasons. In fulfilment of political campaign promises the civilian government returned most of the schools to their former owners including the voluntary agencies. The coming into force of the new constitution witnessed the division of Nigeria into local government areas. Furthermore, the constitution provided that primary schools be brought under the jurisdiction of the local governments. The constitution (Federal Republic of Nigeria Constitution, Section 4L, Subsection (26-29), 1989) also placed education on the concurrent legislative lists of the federal and state governments thus making educational affairs the concurrent responsibility of both the national assembly and the state houses of assembly.
The above was the situation when the military ousted the civilian administration in December 1983. However, the return of the military into national governance has had little effect on educational policies established in the civilian days.

1.2: A Brief history of the Nigerian System of Education.

In the early stages of Nigeria as a British protectorate, education was mostly in the hands of the missionaries, who established both primary and secondary schools in the south (East, West, Mid-West regions). In the North, which was predominantly Moslem, there were Islamic schools, but later the Christians also started to establish schools in that region.

However, a new era in Nigerian education started with the Macpherson's constitution of 1951 which provided for democratic elections to the regional houses of assembly. That constitution also empowered each region to generate funds through taxes and more importantly, to pass laws on education, health, agriculture and local government. Prior to that, the Richard's constitution of

1945, as indicated earlier, had divided Nigeria into three regions: East, West and North, each with a regional assembly made up of elected representatives and ex-officio members nominated by the regional premier. With the regionalisation of education in 1951, and the rise of three major political parties (the Action Group (AG); the National Council of Nigeria and the Cameroons (NCNC); and the National People's Congress (NPC)) (Ezera, 1960; Crowder, 1978; Uwechue, 1991;) in Nigeria, the then governors became figure heads and did not exercise power as such. However, the rivalry between political parties meant that each party in the region it controlled strove to outdo the others in the social amenities which the government it controlled could provide.

In the West, the Action Group Government led by Chief Obafemi Awolowo, gave priority to education and provided 6 years of free universal and compulsory primary education (UPE) for the Western region in 1955. In the East, the NCNC government led by Dr. Nnamdi Azikiwe proposed in 1957 a similar plan (universal but not compulsory) for eight years free education. In the north, the NPC government led by Sir Ahmadu Bello made stronger efforts towards adult education rather than free primary education. Both the Eastern and the Western free primary education policy failed for many reasons, one of which was inadequate funding of the scheme. The number of years spent in schools also differed from region to region. For example, in the east, the system was 8-5-2-3; That is: eight years of primary education, five years of secondary education, two years of higher secondary school and finally, three years of university education. In the North, it was the 7-5-2-3 system; i.e. seven years of primary education, five years of secondary education, two years of higher secondary school and three years of university education; while in the West, the system was 6-5-2-3. i.e. six years of primary education, five years of secondary education, two years of higher secondary school and finally, three years of university education. The important issue here is that there was no uniformity in the policy.

The Dike and Ikoku committees which were set up in 1958 by the Eastern Regional Government reviewed the problems facing education in the eastern region and suggested among others that the primary education programme was far too long, and they therefore recommended that this period be shortened from 8 to 6 years. Furthermore, they also recommended that government should assume total control of all primary schools in the region.
On the other hand, the school entry age was 6 (particularly in the West) and there was automatic promotion from one class to the other. There was also a general passing out examination taken at the end of the primary school generally known as the 'First school leaving certificate'. With the implementation of the Dike and Ikoku committees' recommendations, both the eastern and western region were effectively operating the same system until after the civil war in 1970 when all the schools were taken over by the federal government.

Prior to the end of the civil war in the early 1970, there was an outcry within the Nigerian teaching community as regards the system and relevance of education in Nigeria. According to Aderalegbe, (1990), a national curriculum conference was thus held in September 1969 comprised of people from all walks of life ranging from representative of parents, and people from the private sector, and business organisations, as well as civil servants, religious bodies, farmers, and workers' unions. One of the recommendations made during that conference led to the eventual birth of the present system of education in Nigeria i.e. the 6-3-3-4. This system simply means, that children are expected to spend six years in primary education, after which they are expected to proceed to a junior secondary school for a further three years to obtain their junior secondary education. After the junior secondary education , the children may wish to terminate their education and then join the labour market or else proceed to a senior secondary school if they wished to continue with formal education. In the senior secondary school, they are expected to spend another three years, specializing in a particular broad field of learning.

On completion of the senior secondary education, they may then qualify for admission into any of the tertiary Institutions for a further period of four years.

This system is different from the old system in many ways. The aims of primary education in the old system according to Fafunwa (1991) may be said to be focused on the acquisition of the following:

a. *reading, writing and arithmetic and thus to develop permanent literacy.*
b. *development of sound standards of individual conduct and behaviour.*
c. *acquisition of some skills and appreciation of the value of manual work.*

Hence to achieve these aims the school curriculum was planned to include such subjects as : arithmetic, physical training, nature study (formally called elementary science), domestic science, needle work and cookery (for girls), music and singing, art and handiwork, as well as English. The medium of communication in the first two or three years of primary schools being any of the local languages. The use of English as a medium of instruction was thus not introduced until the third or fourth year of primary school.

In contrast to the old system, (see figure 1.2) the aims of primary education in the 6-3-3-4 system of education, according to the Federal Government of Nigeria education document of 1981, included the following:

a. *the inculcation of permanent literacy and numeracy and the ability to communicate effectively;*
b. *the laying of a sound basis for scientific and reflective thinking;*
c. *education for citizenship as a basis for effective participation in and contribution to the life of the society;*
d. *character and moral training and the development of sound attitudes;*
e. *the development in the child of the ability to adapt to his/her environment;*

f. the provision of opportunities to the child for developing manipulative skills that would enable him to function effectively in the society within the limits of his capabilities; and

g. the provision of basic tools to the child for his further educational advancement, including his preparation for trades and crafts by linking the school with the trades and crafts of the society.

It will then be seen form the above that the aims of primary education in the 6-3-3-4 policy obviously expected and indeed demanded much from both the child and the teacher. In particular, note should be taken of the fact that at the primary level, the inculcation of scientific and reflective thinking in the children were to be emphasised in contrast to the old system in which it was not even mentioned. In addition, the primary school first leaving certificate was abolished and replaced with a new primary school certificate based on the continuous assessment of the pupils rather than on a single final or exit examination. In order to achieve the aims at the primary level indicated above, the subjects offered in the primary schools in the 6-3-3-4 system differed from those offered in the old system. Significantly, Primary science was made compulsory at all levels of the primary school.

The difference in educational policy in the pre and post- NPE era went beyond the primary level. In fact, these differences covered the aims of education, years spent in school, as well as the subjects offered. In the old system, several avenues to post primary education were employed; these included the secondary grammar school, the secondary modern school, the craft schools, the trade schools or technical schools or trade centres, the Grade II Teachers' Training colleges, and the secondary commercial and comprehensive secondary schools. In the new or 6-3-3-4 system, secondary education was split into only two major parts, namely: junior and senior secondary education. (see figure 1.2). Thus, as mentioned earlier, the first three years of post primary education is spent in the junior secondary school, where the child is exposed to all the subjects which are both vocational and academic. The aim being to expose the child to skills that would enable him/her to know and to adapt to his/her environment

For senior secondary education, the emphasis is placed on the child beginning to specialise in specific areas of study. Thus a child after the senior secondary stage is expected to proceed to a higher institution of learning. Another important aspect of the 6-3-3-4 system concerns the preparation of teachers. Recognising the gap in human resources between the available and the ideal, the new system made provision for crash and emergency programmes for the production of the large numbers of science, commercial, technical and craft teachers needed to teach the relevant subjects in both primary and lower secondary schools. The policy also emphasised the teaching of science in all the teachers' training colleges. But that notwithstanding, teachers were still expected to engage in the production and assessment of educational materials and teaching aids on the one hand, and the planning and development of school buildings as well as furniture, and the evaluation of technical innovations and new techniques, on the other.

1.3: The teacher education in Nigeria:

The first teacher training college in Nigeria was established by the early Christian missionaries (CMS[3]) in Abeokuta, in the former western region. The missionaries who had been active in Nigeria since 1859 had established primary and secondary schools. Other teachers' training colleges were established towards the end of the 19th century by some other missions, such as the Baptist mission and the Wesleyan Methodist missionary society. In the eastern region, there was no formal training for teachers but rather informal provision was made by these missionaries to train homeless boys as well as children of

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[3] The Church Missionary Society.

some village heads who were converted to Christianity. However, in the Northern region, both the formal and informal training of teachers were not provided until the early 20th century, when the first teachers' college (Nassarawa School) was established by the then Director of Education for Northern Nigeria. In fact, Islamic education was more prevalent in the Northern region at this time.

The purpose of the established Teachers' Training Colleges (TTC) at the time as established in the Western or Eastern region, was to train young school leavers to become preachers. As time went by, the number of children taught in the schools rose steeply and the demand for more teachers rose as did the demand for teachers who would train them. The need for more teachers put pressure on the educational system, and therefore called for a change in the scope of teacher education.

At the beginning, the major concern of the missionaries was to train young school leavers to become preachers as well as teachers, and the curriculum centred on religious education with teaching pedagogies. (Fafunwa, 1991). Consequently, the subjects taught included: reading, writing and arithmetic, English language (which was basically an important medium of communication), carpentry, history, and agriculture. Since it was not possible for any one teacher training college to offer all the subjects listed above owing to lack of specialist teachers to teach them, on the job training was strongly emphasised.

In those early days of teacher training, the minimum entry qualification for the Teachers' College was a Standard six certificate or First School leaving Certificate (the equivalent of the present primary six certificate). The system was such that the prospective student or trainee teacher, having passed a standard six certificate examination, was required to serve as a pupil teacher for a period of two years. During such service as a pupil teacher, the trainee teacher would be designated pupil/assistant teacher.

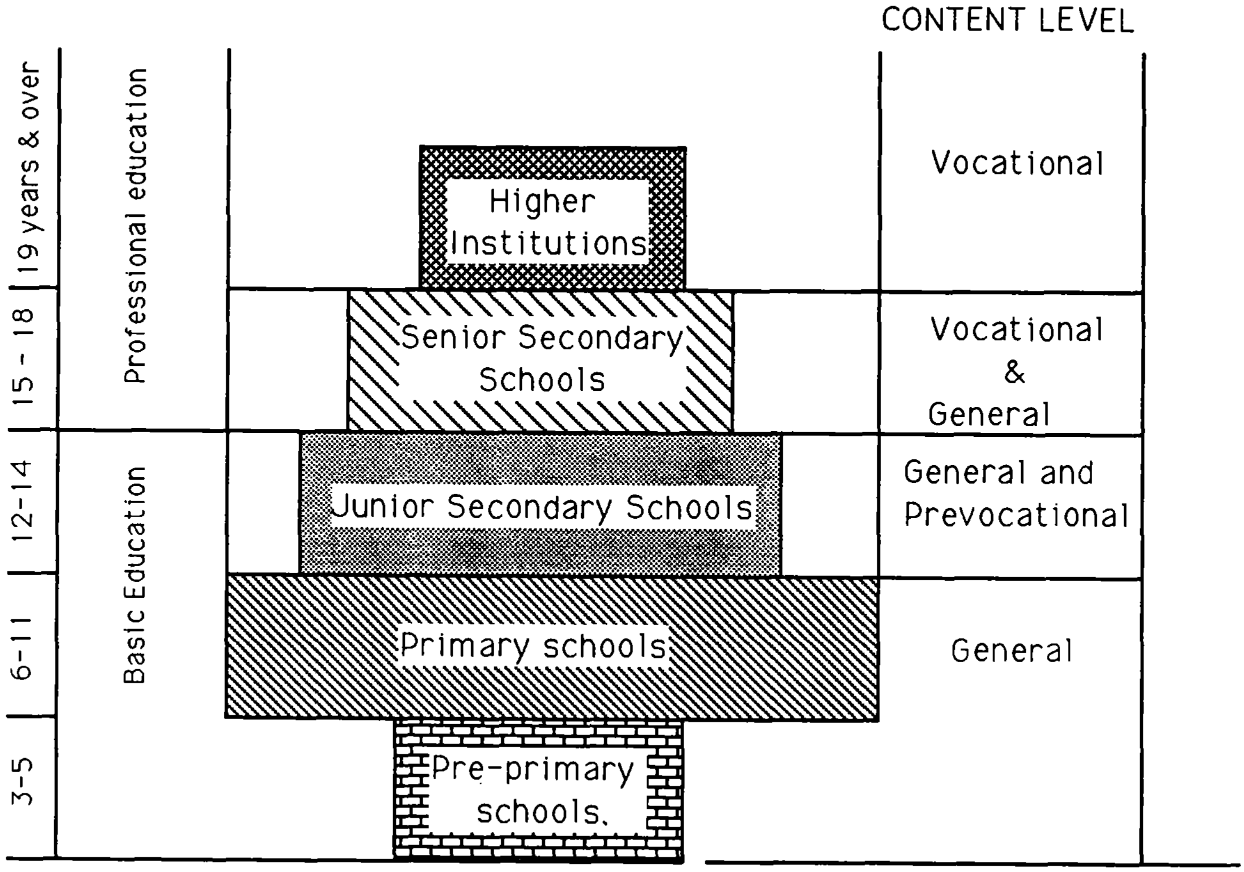

Figure 1.2: A diagrammatic representation of the 6-3-3-4. (Fafunwa, 1991)

It was only after the two years service as a pupil/assistant teacher that the trainee teacher would qualify for training in a teachers' training college for two more years. On successful completion of the two years course, he/she would be awarded a Teachers' Grade III Certificate (see figure 1.3).

According to Fafunnwa (1991) the colonial government of the day, feeling a need to review the issue of the training of teachers, set up a committee in 1925 to look into the quality of the teachers as well as their conditions of service. This committee, headed by Mr Phelps-Stoke, in its report criticised this system of training teachers for several reasons, including the following:

a. *the pupil teachers were overworked in their school work,*
b. *the curriculum was poorly conceived,*
c. *the supervision of the teachers was inadequate, and*
d. *the missions which planned the teacher training programmes did not appear to understand the real purpose of education, as it applied to Nigerians.*

Over time, however, the number of Teachers' Training Colleges continued to increase with more students enrolled. As may be recalled from Nigerian history, there was an amalgamation of the Northern and Southern Provinces in 1914 (Uwechue, 1991). Consequently, education became centrally controlled by the central government. Following this, Mr E. R. J. Hussey became the first director of education in Nigeria. It was under Hussey's leadership that the need to re-orient the educational system, especially along the suggestions made in the Phelps-Stoke committee's report, was recognised. Based on the outcome of the Phelps-Stoke report, there was a total re-orientation and re-organisation of education in Nigeria. Included among the changes made in education was the need to upgrade the teachers' qualification as well as their incentives. Two types of teacher training colleges were then instituted (Grade III Teachers Certificate and Grade II Teachers Certificate). As was discussed earlier, the first involved the training from standard six to the Grade III Teachers'

Certificate. On a successful completion of the course, the Grade III teacher would proceed to High Elementary Teacher's College (HETC) for another two years training. On the successful completion of this training course, the teacher would be awarded a Grade II Teacher's Certificate.

This was then the situation as regards the training of primary school teachers until about 1950, when the demands on the teacher's expertise increased due to socio-economic changes in the country. As more children passed out of the primary schools, more secondary schools started to spring up. It was obvious that the Grade II Teacher's Certificate was neither adequate nor intended to enable the teacher cope with the teaching of subjects studied in the secondary schools. There was clearly a need for teachers specifically trained to handle the greater spread and depth of subjects being studied at the secondary level. Indeed, as this demand continued to rise, the colonial government introduced in 1955 a three-year diploma certificate in education, at the then Yaba Higher college, in order to provide for staff to man the secondary schools. However, more emphasis was placed on science subjects rather than arts subjects at this college. In time, this three years diploma course in education was discontinued and the students who were already admitted and registered for the course were transferred to the then University College, Ibadan, where they transferred to degree courses.

However, before the diploma in education course at the Yaba Higher College was terminated, a commission was set up by the colonial government to look into the training of teachers at the post secondary level. This commission, which was set up in 1945 was led by one Mr Elliot , who was charged to review the quality of education provided to the teaching profession at the post secondary level. This commission in its report proposed a two year teacher training course to be undertaken at the proposed University College in Ibadan, as well as at an Institute of Education to serve the whole of West Africa, and to be located in the then Gold Coast (Ghana). In 1955, Dr Read was appointed the first professor of education and was assigned the job of organizing and establishing an Institute of Education at the University College, Ibadan. Consequently, by the end of the 1957-58 academic session, a one year Post-Graduate Diploma in Education (PGDE) course had been introduced. This diploma course was meant to be taken by holders of a bachelors degree in any number of specialities and was designed to produce secondary school-teachers who were thus exposed to the principles of teaching as well as the psychology of learning. At the same time, an Associateship Certificate in Education (ACE) course was also introduced at the institute. This course which was introduced for the holders of the Grade II Teachers Certificate was intended for senior teachers being prepared or groomed to head primary schools.

Unfortunately, both the Associateship course and the one year Post-degree Diploma in Education course did not attract large number of students, due to the extant poor conditions of service for teachers, not to speak of the reluctance of newly qualified graduates to return to the university for one more year. Another reason which made the Post Graduate Diploma in Education course unpopular in Nigeria, was that the sponsors of candidates for the programme usually insisted that those PGDEs trained under their sponsorship must serve out a scholarship bond for a period of at least five years after qualification. This condition did not sit well with the prospective graduate teachers, many of whom took to teaching only as a last resort. Even so, they were ready to leave their teaching jobs as soon as they were able to secure alternative employment usually in government departments or the private sector.

As a result of the above situation, teacher education at the tertiary level came almost to a halt by the time the Ashby commission on higher education in Nigeria was set up in 1959. Indeed, the commission in its report, noted among other things that an inadequate foundation at a lower level of the educational pyramid would affect education at the higher level. This was emphasised because no products of education would be expected to rise above their teachers. The commission also noted that the inadequacy of education at the primary and secondary schools' levels due to the teachers not being adequately prepared was bound to affect the quality of university education. Consequently, the commission recommended that teachers needed to be specifically trained for the lower secondary schools as well as the Teachers' Training colleges. It also recommended that a Bachelor of Arts or Science degree in Education [BA. (Ed) or B.Sc. (Ed)] should be introduced in the university curriculum. Such a degree would entail the study of four subjects in the first year, and three in each of the second and third years respectively. These subjects would include some aspects of the pedagogies for instruction.

Unfortunately, the Ashby recommendation was not well received by the education faculty of the University College, Ibadan. The university authorities were thus forced to reject these recommendation and instead adopted the one year PGDE. The matter was later taken up in 1961 by a conference of secondary school principals, officers of voluntary agencies, government education officers as well as teachers of Teachers Training Colleges in Nigeria, sponsored by the Carnegie Corporation, New York (Fafunnwa, 1991). The conference agreed that a one year PGDE was not adequate as the sole method of training secondary school teachers. The conference consequently recommended that a three-year Bachelor of Arts or Science (combined Honours) degree in education should be introduced in the universities as suggested in the Ashby report. The suggested programme was subsequently launched at the University of Nigeria, Nsukka. with other Nigerian Universities following later.

At this stage, we may observe that the training of teachers had received considerable support by government at both the State and the Federal levels. The Federal government on its part had given both substantial financial as well as moral support to the training of teachers in the country. Indeed, from the time this programme was launched till about 1983, the Federal government and the State governments in further support of this programme had provided 'bursary' allowances to all student teachers at all levels. These allowances covered not only the school fees but also the living expenses of the student-teachers. These bursaries have continued to this day in spite of the steep downturn in the national economy. In addition, some international organisations such as UNESCO have supported the teacher training programmes in Nigeria through special grants and other aids to enable the Federal and Regional/State governments to establish some Advanced Teachers' Training Colleges (ATTC) for the award of the Nigerian Certificate in Education (NCE) (which is the equivalent of a Grade I Teacher's Certificate). Indeed, the Grade I teachers were originally recommended by the Ashby commission to staff the lower secondary schools and the High Elementary Teachers' colleges. Therefore, to ensure a steady supply of this cadre of teachers, the federal and state governments had launched a crash development programme for teachers in 1968. However, the ATTCs have now been superseded by the new Colleges of Education. Today, almost every State in Nigeria has at least one College of Education.

With the introduction of the 6-3-3-4 system of education and the establishment of Colleges of education, the minimum required professional qualification for teachers serving in Nigerian primary schools is currently the possession of an NCE. This upgrading of teaching qualification has meant that the NCE holders can now tackle the jobs previously assigned to the Grade III or pupil teachers. (see figure 1.4 for details of the hierarchy of teacher training).

1.4: Statement of the Problem

With the introduction of the 6-3-3-4 system, the minimum qualification required of a primary school teacher was set as the Nigerian Certificate in Education (NCE). This requires the student-teacher to be specialised in two teaching subjects which may or may not be in science. It was then expected that, in a few years time, all the primary schools in Nigeria would have specialist teachers in all the subjects irrespective of the school's location.

Unfortunately, the country has up till now, not been able to meet this requirement. Primary science is now taught at all levels of primary education and by every primary school teacher in Nigeria. Indeed, at the primary level, every teacher is assigned a class and is expected to teach all subjects (including science) to the assigned class irrespective of the teacher's background in the individual subjects. At the time that the Teacher's Grade II Certificate was the accepted minimum qualification for teaching at the primary level, science was not a compulsory subject for the Grade II Teacher Certificate examination even though science was taught at all levels in primary schools. That obviously meant that some of the Grade II teachers would not have taken a science course in their training. There was also no opportunity given to teachers for them to retrain in order to adapt to the change to compulsory science teaching in the primary schools. Moreover, the content of the science curriculum (before the introduction of the 6-3-3-4) for the Grade II teachers certificate was quite limited and did not match the demands of the new (6-3-3-4) system in terms of adopting the modern techniques of teaching in science (Okeke, 1985; Okeke & Inomesia; 1985; Ameh, 1990)

Teachers with only the Grade II Teacher's Certificate are many and are still serving in the field. Some of these teachers have taken, or begun to take, in-service part-time training courses to upgrade their academic qualifications to the NCE level, though usually in the areas of principles of education, psychology of education or in philosophy of education.

Hence, even with the emergence of the NCE as a primary teaching qualification, a good majority of teachers who have not been trained in science are still being asked to teach it. One therefore wonders as to the extent that these teachers are being prepared to face the task of teaching science. Dobey and Schafer (1984) had noted that teachers must be scientifically knowledgeable if they are to provide the necessary guidance required from them during the science inquiry processes and of course, if they are to produce desirable concepts attainment in children.

In fact, studies carried out have shown that the majority of the teachers in the primary schools in Nigeria are ill-equipped to teach science (Abdullahi, 1982; Bajah, 1984; Nzewi, 1986; Okeke and Inomesia, 1986; Okeke, 1990;). In specific terms, Abdullahi (1982) observed that most primary school teachers who taught science in the primary schools in the Eastern, Western, Northern and Mid-Western zones of the country had no training at all in science. The work of Abdullahi was extensive, and therefore his findings should be taken seriously. However, other studies carried out by science educators showed that primary school teachers were not only ill-equipped in science, but were also ill-prepared (Abdullahi, 1982; Asun, 1982; Gyuse, 1982;). They note that because of the poor background of these teachers, they tended to teach science by rote.

Of course, this method of teaching does not allow their children to be actively involved in the lessons. Gyuse (1982) and Yoloye, (1982) for example, observed that the teaching technique was mostly teacher-oriented, involving lecturing by teachers, as well as note copying. As a result, passive listening by the pupils became the rule rather than the exception. She further emphasised that thought provoking discussions were rarely, if ever, used by the teachers, while oral questions and answers were only sparingly used. Falayojo et al (1976) obtained findings similar to those of Gyuse (1982) when they studied the interaction profile of science teachers in Bendel State (now Edo and Delta States). They also found that the most typical form of teacher-child interaction was the lecture, followed by classroom discussion, activity and copying of notes, in that order.

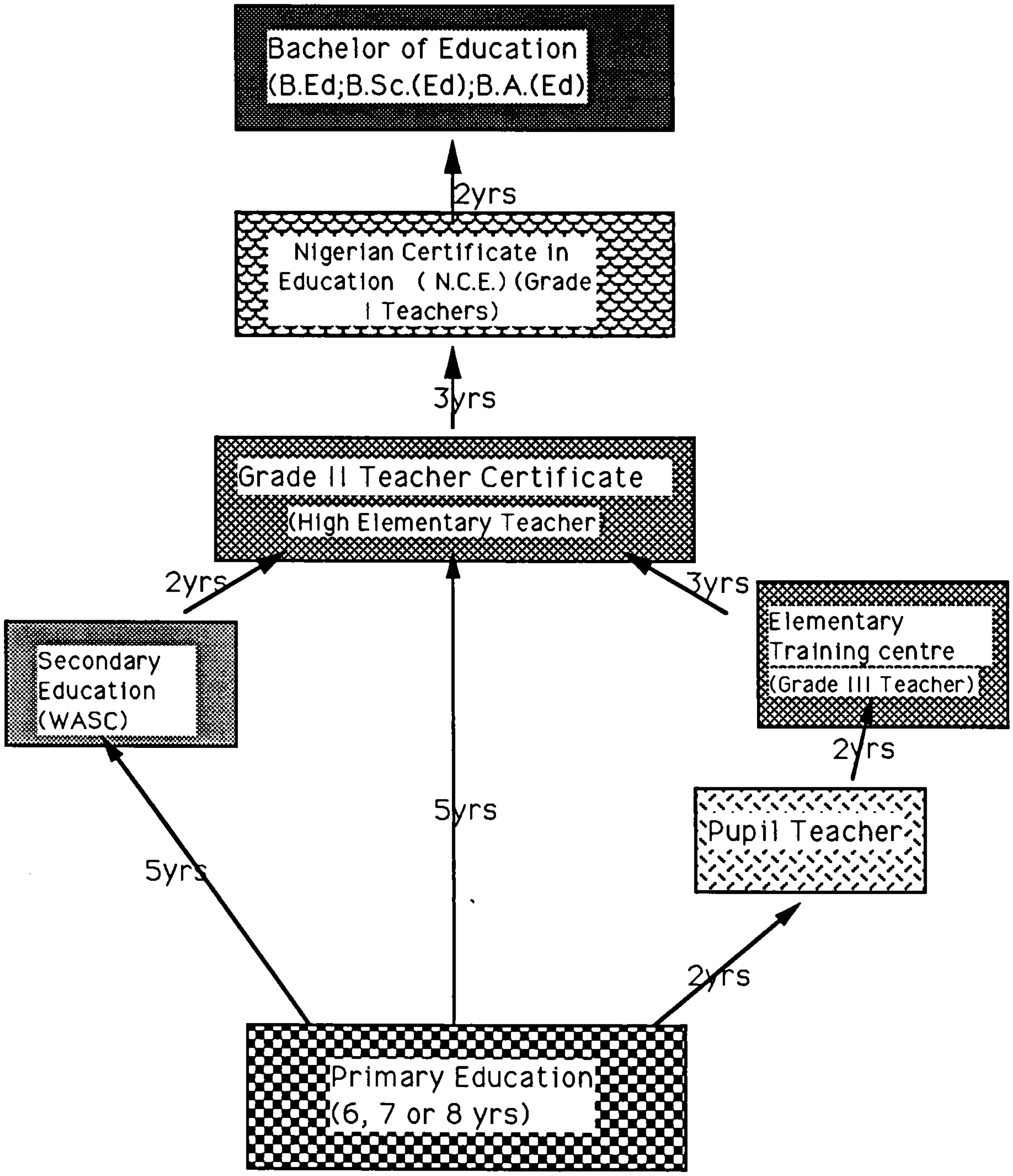

Figure 1.3: Diagrammatic representation of the place of teacher education in the old system of education.

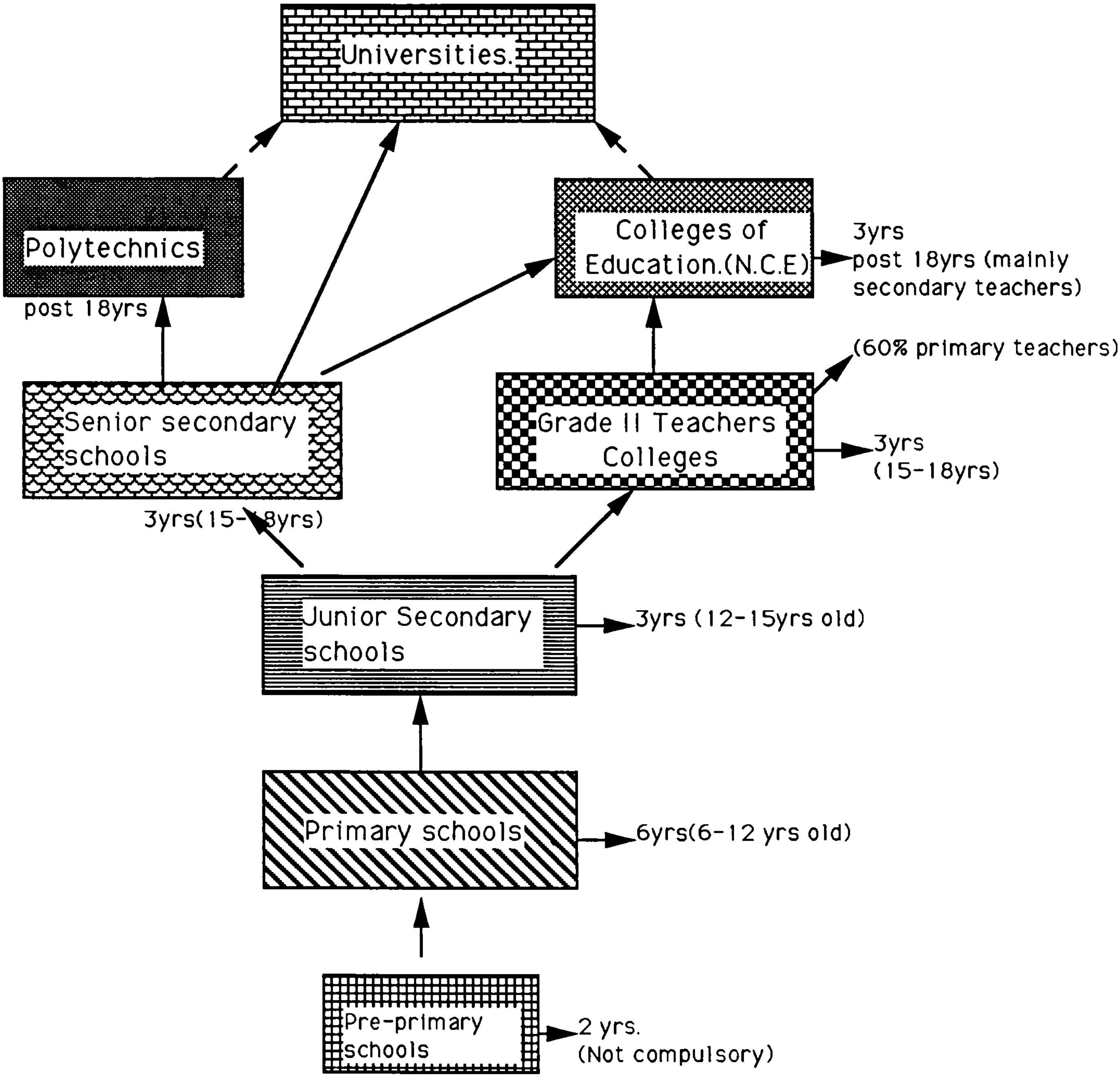

Figure 1.4: Diagrammatic representation of the place of teacher education in the new system of education (6-3-3-4 system).

One may then wonder how effective science teaching can develop in the manner discussed above? The inevitable question is whether one of the objectives of primary education, which according to the NPE policy is the laying of sound scientific and reflective thinking in the child, can be achieved by teaching science in such a didactic way. If these teachers are not academically qualified to teach science, they must obviously be facing problems in teaching some of the topics in science or carrying out some practical activities in science. Since it is impractical, if not almost impossible, to take all the primary school teachers in Nigeria back to the classroom in order to retrain them as science teachers, something has to be done to help them improve their science teaching and thus give them confidence while allowing flexibility in their choice of teaching strategies.

Assuming then that adequate science preparation for the teachers (which they lack according to Bajah (1984) and others) involves mastery of some concepts or topics in science as well as being able to communicate these concepts to the pupils (among other things), then, Bajah's findings would suggest that there must be science concepts or topics in the science curriculum which some of these primary teachers have not mastered. So a possible strategy towards finding a solution to these inadequacies would be to identify the topic(s) in the primary science curriculum which these teachers find difficult to teach.

Unfortunately, to the best of the author's knowledge, no such study has been carried out. Indeed, my own experience indicates that the difficulties that arise need to be investigated or studied. These difficulties include:

a. Inadequacies in initial teacher training/education

b. Limited in-service provision or opportunity for further professional development.

The study that is described in this thesis focuses on how in-service can be used to enhance the professional development of teachers and in particular how teachers can be helped to teach science more effectively. Since it is neither possible nor feasible for me to tackle all the levels of teaching in the primary school science because of economic and time constraints, this research will necessarily focus on the primary six core curriculum content. This is because primary six being the last year in the primary school, the primary six teachers are assumed to be aware of other topics in the primary science core curriculum which should have been covered in the lower primary classes. In addition, since this study would involve the training of the teachers as well as working with the teachers within their classroom setting, it is expected that the children were to be involved in the learning process. the researcher would interact with the children in their classrooms and most communications would be in English language. It is assumed that most children at this level could communicate to a large extent in English which will be easier for the researcher.

As an initial part of the study, it was decided to identify which topics in the primary six science curriculum teachers find difficult to teach. The information from this initial survey can be used in developing a programme of in-service training, in the form of a workshop which will be aimed at compensating for the inadequacies in the pre-service training and knowledge of the teachers with particular respect to one of the topics identified. The final phase of the study will then seek to ascertain the extent to which this programme of training is effective in improving these teachers in that topic.

1.5: The research Investigation

The research would be initiated by, first carrying out a survey which would aim to identify a topic in the primary six primary science core curriculum which the primary six teachers find difficult to teach. Having identified the 'difficult topic', it would then be necessary to organise a workshop to train the teachers in some useful ways of teaching the topic. The workshop process would then involve several steps or stages starting with an initial interview and observation of science lessons of teachers who would participate at the workshop. Both the interview and the observation of the teachers' lessons would be carried out in their respective schools. The initial interview and observation would be followed by a 2-day workshop training for the teachers. The activities at the workshop will focus on the identified topic. After the training, the teachers would be revisited (as a follow-up). The aim of this second visit would be to find out how the teachers were faring with the new knowledge, techniques and resource materials acquired during the 2-day workshop as well as to assist them with any problems they may encounter with the resource materials. In addition, it would be necessary to ascertain the extent to which the teachers perception of the identified topic, as being difficult to teach, had changed as a result of the in-service training workshop.

Thereafter, it may be necessary to bring the teachers together again in a 1-day follow-up workshop to enable them reflect on their experiences individually and as a group. This, it is hoped, would help the teachers in their professional development through discussions carried out within the groups as well as across the groups. This workshop would subsequently be followed by another visit to the schools, three months after the workshop. The aim of this visit would be to find out if the teachers had adopted the learnt techniques and if they used the resource materials. However, this visit would also aim to encourage the teachers to extend the use of the learnt techniques and resource materials to other topics in science.(see figure 1.5 for details of the phases).

1.6: Organisation of the Thesis

In the light of the above discussion, the thesis will be divided into two major parts. The first part of the study will focus on the survey carried out to identify the topic in the primary six science curriculum content which primary six teachers find difficult to teach. This part of the study will be developed in chapters 3 and 4 of the thesis. The second part of the study will focus on the workshop, which will involve an in-service training programme aimed at helping the teachers to overcome their inadequacies, as well as the validation of the programme with a view to ascertaining the extent to which it has helped the teachers to understand the identified topic, and finally, to ascertain the extent to which their confidence in teaching science effectively has been restored or boosted. This part of the research will be developed in chapters 5, 6, and 7. Chapter 8 then gives a general discussions of results, while the general conclusions of the methodology of the thesis as well as recommendations arising from it are presented in chapter 9. Figure 1.5 illustrates the different phases of the investigation and the tools used at each stage.

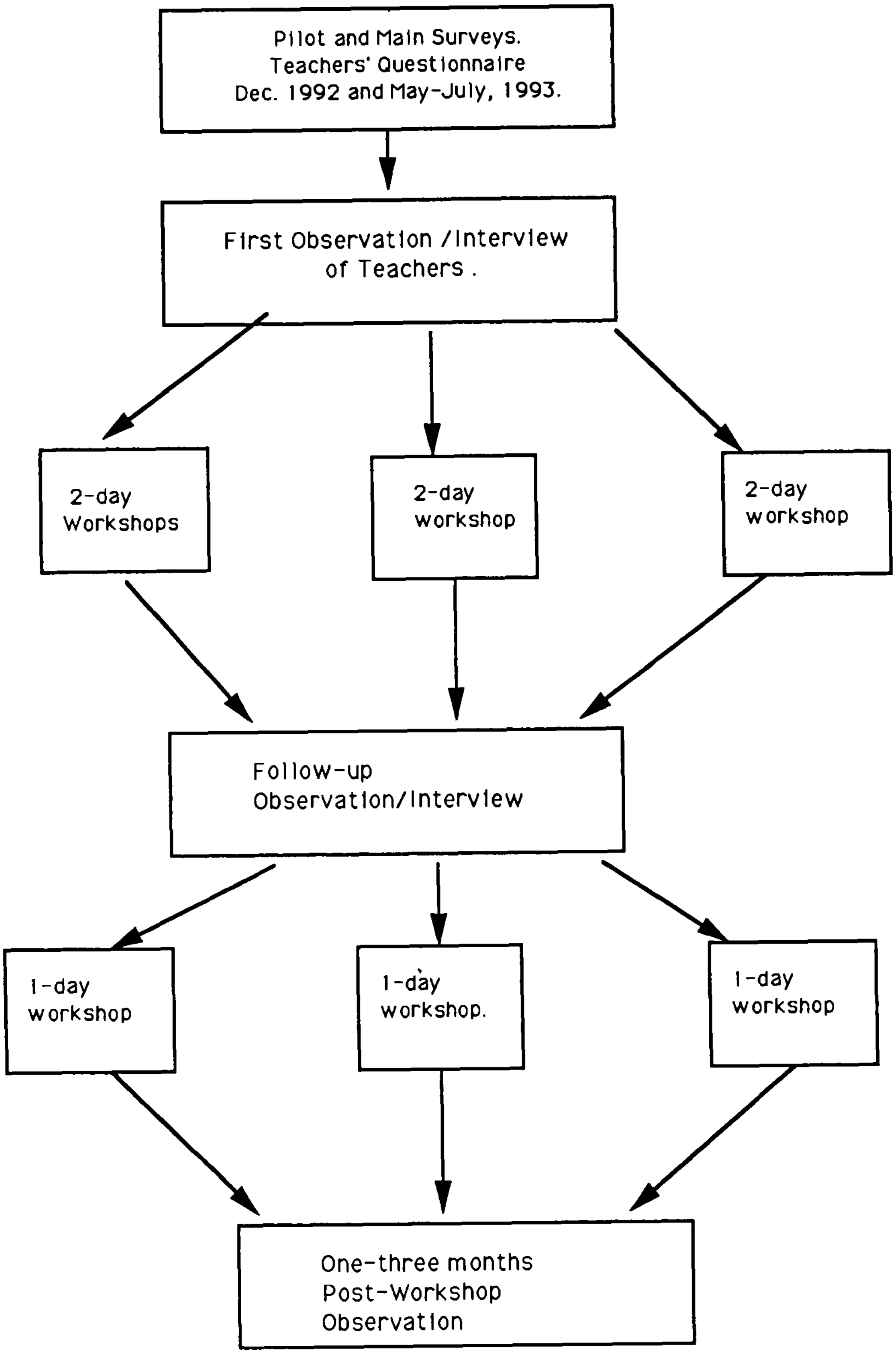

Figure 1.5: A flow chart showing details of different phases of the research investigation.

Chapter 2

THE TEACHING OF SCIENCE IN NIGERIAN PRIMARY SCHOOLS: A REVIEW

2.0: Introduction

The teaching of science in Nigerian primary schools has been facing problems for quite some time now. These problems range from the lack of appropriate teaching resources to the inadequate training of the teaching staff. A number of factors have been identified by researchers in science education as militating against the teaching of science. They include:

- the low status of science teachers as professionals;
- the fact that most primary schools are located in rural areas.
- the impact of gender difference on science teaching;
- the lack of resource materials;

Tilgner (1990) observed that similar problems to those mentioned above were identified by primary school teachers twenty years ago as obstacles to teaching science. However, a world bank document in Kamara (1983) reported a survey of literature on the teacher's background and its influence on the students' achievement especially in science. This background includes, the teacher's sex, age, education attainment , experience, educational attainment, upgrading programmes, credential and certification. From the reports on the literature, it was observed that the most positive influence of the teacher's background on the children's achievement stemmed from the teacher's credentials and certification, teacher's experience and teacher upgrading programmes.

2.1: Problems facing science teaching in Nigeria

So far, not much progress has been achieved in Nigeria in terms of technological development. Because of the relevance of science education to this situation, it is therefore necessary to enquire why development in science education has made less progress than one would have expected. In this regard, Bajah (1984) indicated that the majority of teachers in Nigeria had blamed their inability to teach science in an educationally effective way on the lack of appropriate resource materials. According to Bajah, the teachers were also found to lack confidence in their handling of science equipment and apparatus available to them. Bajah also noted that the teachers suffered from inadequate professional training during their student years.

In addition, some other science educators (such as Ikoku, 1982; Bajah, 1982; 1992; Balogun, 1982; Allison, 1982; Gyuse, 1989; Bahago, 1984; Folayan, 1985; Bomide, 1985;) have suggested other explanations for the slow technological development of Nigeria. These include the inadequate facilities for science teaching, lack of proper funding of science education in schools, the negative attitudes of students, teachers, policy makers, as well as the general public towards science. Of course, it is not easy to form a positive attitude towards science or any other subject if the person involved has feelings of inadequacy about or is uncomfortable with the subject (Mcanarney, 1978).

2.1.1: Teachers' professional experience and science teaching

One of the major factors that facilitate the successful implementation of any teaching programme is the quality of the teachers who must bear the brunt of any implementation process. In Nigeria, the training of primary school science teachers has so far not met with the expectations of the objectives of science teaching within the context of the new 6-3-3-4 system of education.

Indeed, as indicated earlier, a number of investigations have shown that most primary school teachers are inadequately prepared for science teaching. As a result, these teachers teach science in a way that has been shown not to encourage the acquisition of scientific skills as stipulated by the NPE (Gyuse, 1989; Ameh, 1990; Abdullahi, 1980). It must be observed that the teaching of science, especially at the primary level, necessarily involves some practical activities which require the teacher to adopt certain strategies in order to enable the pupils to enjoy a first-hand experience of science during the learning process. In fact, the strategies for teaching primary science as recommended in the National core curriculum, include teaching by discovery, inquiry or experimentation. Unfortunately, according to Odumbunmi (1991) and Ameh, (1990), most of the teachers teaching in the primary schools did not study science during their years of training due to the nature of the curriculum in the teacher training colleges. Thus, the teachers find it difficult to plan appropriate activities using the recommended strategies. It is not surprising that they teach science by lecture, thus encouraging the children to learn by rote, resulting in a lack of real learning.

It is thus clear that the problem of the lack of practical teaching skills on the part of the primary science teacher is a major one and needs to be tackled urgently. In this regard, the Science Teacher's Association of Nigeria (STAN) (1970) has compared the methods of science teaching in the first two years of secondary science with the teachers' qualification and experience. STAN concluded that the major problems confronting inexperienced teachers were those that involve being able to manage and operate in a science laboratory while maintaining adequate safety conditions, as well as planning instructions to achieve a set of stated objectives. The reasons for these problems facing neophyte teachers can be ascribed to their previous poor training as well as their inadequate management of time. Experienced and neophyte teachers differed in their organisation of experimental work. According to Anosike (1987), although the experienced teachers faced similar problems as the inexperienced teachers, the experienced teachers were always able to find a way of solving their problems in contrast to their inexperienced counterparts.

2.1.2: The impact of School location on science teaching

In Nigeria, the location of primary schools in both urban and rural areas is a matter of deliberate policy and has allowed the provision of equal opportunity of education to all citizens irrespective of their location, tribe, religion etc. However, because of the poor conditions of physical infrastructure in rural schools (such as lack of piped water and electricity, and the prevalence of dilapidated school buildings), the children cannot make the most of the learning environment. Moreover, since most rural communities are mostly farmers, verbal communication is usually in the local indigenous language. Consequently, rural children are bound to find the learning of scientific concepts couched in English, the medium of instruction, to be difficult. In urban areas, this problem is much less pronounced because the children are exposed to the mass media such as radio and television. In this regard, Edington (1971) demonstrated that pupils in rural schools performed less well on verbal tests and other school subjects than their urban counterparts.

Ndu (1991), in a survey of the problems of teaching and learning science and technology in the setting of rural environments in Anambra state, concluded that the major constraint on the teaching and learning of science in rural schools included the problems of inadequately equipped science laboratories; the insufficient number of science teachers, inadequate facilities for students to study at home and the insufficient number of science laboratories. However, Ndu also noted that there were some conditions which were available in the rural environments that make them favourable for science teaching. They include the availability of fresh biological specimens, as well as the availability of land for the pursuit of practical agricultural science.

Although Edington and Ndu's results suggest that rural children performed less well in science than their urban counterparts, their studies also identified other conditions in the rural environment which could enhance science learning. In contrast, Obi (1979) in a study of some environmental influences (such as rich vegetation, rivers, hills, rocks, swamps and mangrove forest) and their effect on the teaching of science, suggested that such natural environment did not motivate students to study science in Bendel state (now Delta and Edo states respectively). He argued that given experienced, skilled, trained and effective science teachers, such a natural environment could in fact help to bring about effective science teaching and learning in schools. Likewise, Aleyideino (1989) suggested that the physical natural environment such as the type existing in the Nigerian rural environment in which the child is immersed in, and a culture of superstitious beliefs could be impediments to learn and appreciate science. However, if the child had professionally skilled teachers, who were able to resolve for the child any contradictions between the demands of indigenous and scientific culture, then s/he would excel.

2.1.3: The impact of Gender difference on science teaching

It is generally believed that gender tends to affect a child's choice of subjects to be studied in schools. Indeed, some Nigerians tend to think that boys perform better than girls. This view may be justified on the basis that students' enrolment in science and science-related disciplines at the tertiary level has up till now been dominated by male children. Because of the societal demands on girls as future mothers, they tend to drop out early in school to go into professions or work that will enable them prepare themselves as future housewives. This social factor also affects their choice of school subjects and as a result they do not get to the highest level of education as boys sometimes do. In fact, Erickson and Erickson (1984) in a study carried out on the evidence of female underachievement in science observed that girls achieve considerably below their male counterparts especially in postsecondary enrolment and employment in scientific occupations. On the other hand, some evidence from researchers (e.g. Okeke, 1986) seem to indicate that boys do not always perform better than girls, although it must be admitted that even when girls offer science in secondary schools they tend to be more interested in biology rather than any of the physical sciences, which because of their abstract mathematical requirements are assumed to be more difficult. Indeed, Farrow and Atkinson (1991) noted that there are activities which girls preferred. Nevertheless, the conventional wisdom among the Nigerian public appears to be that boys are more disposed to studying science than girls and also perform better. In this regard, Odunusi (1984) has claimed that gender rather than the age of children affect their attitude towards science significantly. According to him, a negative attitude could have been developed over the years because of several factors that include the fact that science is seen as not being interesting as well as, the poor methods of teaching science, the lack of incentives for both science students and their teachers, and the inadequate facilities for teaching science etc. But as Okeke (1986) rightly observed , there is no law in Nigeria that discriminates against girls in their quest to study science. Okeke has therefore pointed out the following possible factors that could have caused the relatively low achievement of girls in science,:

a) The negative social influences during growth and development,

b) The inadequate school experiences including insufficient vocational guidance, and

c) The extant uninspiring work experiences of women who have ventured into science- based careers.

2.1.4: The importance of science resource materials for the teaching of science

In Nigerian schools, during the past three decades, as in many other countries, science teaching has come to be associated with practical work involving investigation/experimentation, problem solving, and other practical activities. A science lesson that lacks these may be said to be theoretical and didactic in nature. In this case, according to Gyuse (1989) the teacher takes an authoritarian role, while pupils sit passively in the class and listen to the teacher. In such a case, the pupils are obliged to copy the notes given out by the teacher. In order to make science teaching interesting and meaningful, in the author's view, the children must be fully involved in inquiry, discovery, hypothesising, classifying, predicting, and interpreting results among others. These activities, of course, require resource materials, which become the working tools of the pupils. Examples of such science resource materials used in schools include items such as, simple paper clips, test tubes, plastic cups, and in some cases advanced instruments such as complex fractional distillation apparatus. Indeed, Abdullahi (1981) has identified possible resource materials for primary science teaching to include home-made materials (e.g. mud, sand, paper clips), as well as sophisticated equipment like film projectors. These materials are meant to assist the teacher to bring scientific knowledge to the level of the children. In this regard, Balogun (1982) noted that the availability of these science teaching materials would enable the child to develop problem solving skills as well as sound scientific attitudes while developing both interest and manipulative skills useful in later life.

The problem of resource materials is summarised by Abdullahi (1982) and Olotu (1985) who have suggested that lack of equipment for science teaching is another factor militating against the teaching of science in Nigerian primary schools. Olotu in particular noted that students' poor performance in the Grade II teacher's certificate examination resulted from inadequate laboratory facilities and equipment in the teachers' training colleges where the teachers trained. Thus the trainee teachers tended to leave the teachers colleges ill-prepared to mount activities in their science classes which would inspire their children to develop an interest in science, or to consider pursuing careers in science.

The view that primary schools do not require sophisticated or specialist equipment to teach sucessfully is widely recognised. eg. Unesco (Harlen and Elstgeest, 1992).

2.2: Efforts towards the improvement in the teaching of science in Nigerian Primary Schools

The space age ushered in by the launching of the Russian sputnik in 1957 brought in its wake an increased awareness of the importance of science as a tool for national development, not only in the industrialised but also the developing countries. This world-wide event did not go unnoticed in African countries such as Nigeria. Science educators in Nigeria were quick to recognise the necessity and importance of the natural science curriculum being launched in the idiom and context of the indigenous environment. This meant that such a curriculum would strive to use local materials in bringing home to the child the theoretical and practical aspects of science, and thus help the child to assimilate and internalize the new culture of the scientific world.

As a response to the need for a more indigenous science curriculum, which would aim to develop the scientific knowledge of the African child in the context of his/her local environment, the African Primary Science Programme (APSP) (which later became the Science Education Programme for Africa (SEPA)) (Akusoba, *et al*, 1988) was developed in 1965. This programme was designed to enable African children to learn science in a way which recognised that their cultures differed greatly from those of children in other parts of the world, and although it focused on a child-centred learning approach, it also emphasised an open-ended approach in which the teacher acted as supervisor or facilitator and not as an authority. An assessment of this programme after trial for a number of years found it somewhat wanting and this was ascribed to an inadequate preparation of teachers executing the programme. (Johnson, 1970; Duckworth, 1971; Yoloye, 1971.).

Meanwhile some State governments in Nigeria, had independently decided to develop their own science programmes which could address their own immediate circumstances and needs. These local programmes seemed to adopt methods, objectives and philosophy similar to those of the APSP while making necessary changes to suit the local environment. In this regard, the ten Northern States developed a Primary Education Improvement Programme (PEIP) which started in 1970 under the sponsorship of UNESCO and UNICEF (Brown and Reed, 1982). Similarly, the Mid Western State developed the Mid-Western Primary Project. Both the PEIP and the Mid-Western Primary project were remarkably similar to APSP.

The Mid-Western Primary Science Project, developed in 1969 and sponsored by UNESCO, UNDP and UNICEF (Akusoba, *et al*, 1988) differed from the APSP programme in terms of its approach and clarity in its objectives stated in the curriculum materials. The three major features which this programme highlighted are (see Falayajo, Bajah and Yoloye (1976)) as follows:

1. It emphasised the development of science materials for pupils in the primary schools, teacher training and development of teachers' guide.
2. The materials were used in 100 primary schools for trial in the first few years of its development.
3. The programme was revised, amended and restructured during the trial period.

A unique features of this programme was its emphasis on both the teacher training and the trial period of the programme. The teacher training programme for the Mid-Western Primary Science Project had a duration of three months during which the teachers were exposed to the curriculum materials and the processes required to bring about the learning process in the child.

The Primary Education Improvement Programme (PEIP) unlike the Mid-West primary science programme which had a focus purely on science, the PEIP covered all subjects offered at the primary school level including science. The primary science project of the PEIP borrowed both scope and orientation from the Science A Process Approach (SAPA) which originated from United States of America (Gyuse, 1982). According to Gyuse unlike the Mid-Western

Primary Science Project, the curriculum materials of PEIP were first tried in Zaria metropolis but the provision for the training of teachers was carried out by mobile teacher trainers. In addition to the shorter period of training, she commented, that the PEIP faced a lot of problems arising from the large population that it covered. Indeed, unlike the Mid-Western primary programme which was developed for the people of Mid-Western region, (covering a total of only two states, viz: Edo and Delta States) the PEIP was designed to cover the ten Northern States. Furthermore, Gyuse (1982) had also noted that there were problems in the management and co-ordination of its activities which affected both the implementation and the evaluation of the programme.

Other primary science programmes being developed and implemented at this time in other parts of Nigeria included: the Anambra primary science programme; Ogun primary science programme; Oyo primary science programme, etc. These science programmes, nevertheless were modelled after APSP.

The above was then the background to an African evaluation seminar/workshop which took place in Dar Es Salam, Tanzania, in 1978 (Gyuse, 1982; Gbamanja, 1991). It considered the situation of the teaching and learning of science in Africa as a whole, following the emergence of the APSP programme. It was then decided that every African country should develop its own science core curriculum content, taking into account its local environment as well as the availability of locally made resource materials. In addition to this decision, the new policy on education (6-3-3-4) demanded a different programme in science which would strive at delivering the proposed aims stipulated in the NPE.

Subsequently, a panel was set up, by the so-called Primary Reference Committee in Nigeria , to produce the core curriculum for science education at the primary level. The panel members included representatives from the then existing programmes such as PEIP, Mid-Western Primary Science Project, Ife-

Yoruba Project, as well as representatives of the Federal and State Ministries of Education, and finally, representatives of other primary science programmes in other states of Nigeria (Gyuse, 1982). The panel then reviewed all the existing primary science programmes in Nigeria in the light of the content, teaching materials and processes prescribed in the National Policy on Education. A programme was thus developed for the implementation of the new policy on primary education which, according to the NPEC document of 1987 included the following:

a) *The design and production of new national syllabi for primary school subjects recommended by the implementation committee.*

b) *The programming of the national syllabus in each subject into modules preparatory to efficient and effective teaching and the correct continuous assessment practice (which must be uniform) in all primary schools throughout the country.*

c) *The inculcation of modern teaching techniques and continuous assessment in the teacher education curriculum,*

d) *Comprehensive in-service education*[4] *for all primary school teachers on the use of the most modern methods of teaching and correct continuous assessment practice.*

2.2.1: The Primary School Core Curriculum

According to the NPEC (1987) document, the national primary core curriculum which came into existence in 1980 (see Appendix A), consists of all subjects (including science) offered in the primary school from primary one to six. Each subject had a list of topics which were organised into modules to enable those topics to be taught in detail while at the same time aiming to

[4] Provision of an in-service (long-term and short-term) teacher education to the primary teachers to enable them to update their knowledge and skills inorder to adapt to the new materials and techniques required by the new curriculum.

achieve the stated objectives. In addition, the modules were organised to be taught on a termly basis to facilitate a sequential tackling of the tasks.

Each module was designed along the following lines:

a) A reference number for the module,

b) The topic, content or subject matter dealt with in the module,

c) Content elements, comprising a breakdown of the module content into separate smaller units that form the subject matter. These enable the teacher to deal with the topics in small steps.

d) A list of objectives, comprising the knowledge or skills to be acquired by pupils after the teaching/learning interplay in the module.

e) A list of pupils' activities geared towards the achievement of the objectives.

f) A list of teaching aids to be used by the teacher to design appropriate learning activities for the achievement of the stated goals.

g) A list of suggested assessment techniques.

h) A statement about the length of time the work on the module is expected to last.

In the above manner the organisation of the content of the science syllabus into modules was expected to help break the content of the syllabus into well defined learning objectives while compressing its content. Moreover, the classroom learning experiences has been designed to fit the performance of pupils, assessed relative to each of the stated objectives, with a view to enabling the teacher obtain a feedback of the result of each assessment immediately. This immediate remediation procedure thus ensures that a child would expect to master a particular material before going on to another. There is also provision for guidance and counselling in situations where the child had failed to achieve the stated objectives.

The learning activities contained in the modules included inquiry, research, practical work as well as experiment. These learning approaches are expected to enable the children to be actively involved in their own learning and thus reduce to merely accepting information. The organisation of the syllabus content into modules is therefore designed to help the teacher in the task of measuring the learning outcome.

The modules are presented in booklet form for each class and since the system of teaching in the primary school is organised on the basis of one teacher to one class, it became the duty of the head-teacher to ensure that each class teacher received one booklet for his/her guidance.

2.2.2: Primary science core curriculum content

Changes in the primary school science curriculum content have tended to mirror changes in the philosophy of primary education since the 1960s. In particular, the reforms in the aims of education at all levels as presented in the NPE document have driven these changes. As discussed earlier, the development and subsequent introduction of a primary science core curriculum have evolved through a number of stages, starting from APSP which served most of the African countries, to the present NPE which became a national policy document peculiar to Nigeria. For this, primary science was one of the subjects among others for which detailed syllabuses were developed by the Nigerian Federal Ministry of Education. However, the Nigeria Educational Research Council (NERC), in its document of 1982 (NERC, 1982) had noted that the science topics chosen by the committee which drew up the National Core Curriculum for primary education were inadequate especially as regards the inculcation of scientific and reflective thinking in children of this age.

For this reason, according to Gbamanja, (1991), many state governments as well as curriculum organisations decided to develop their own programmes to suit their own immediate environment The NERC document further noted that some curriculum topics, which would have helped in the realisation of the stipulated aims of the primary education as enunciated by the NPE, were not included in the national science core curriculum. This omission, it said, arose from the fact that the drafting committee of the Core Curriculum appeared to have based their work on the existing primary science programmes with a view to determining a core curriculum consistent with the stated objectives of primary school of the NPE. Indeed, the actual involvement of this committee in the selection of topics consistent with the aims of the NPE primary science curriculum proved to be a tedious exercise and, indeed, constituted a serious constraint to any subsequent in-depth assessment of the issue (NERC, 1982).

However, the NERC in 1982 developed yet another core curriculum for primary science which according to this document was meant to further amplify the original National Core curriculum produced by the Federal Ministry of Education and at the same time remedy the inadequacies observed in that curriculum. This later effort was christened, 'Integrated Science for Primary Schools' (NERC, 1982) (See Appendix B).

The Integrated science for primary schools curriculum developed by NERC in 1982 consisted of a total of 22 science topics drawn from across the science disciplines. Some of these topics were designed to extend across all the years (that is, primary 1 to 6) and were arranged in a hierarchical as well as a spiral order. This meant, that some of the curriculum topics resembled a pyramid in which a topic is treated in both depth and breath as the year of study progresses, while other topics were introduced only in particular years of study. Examples of topics which run across all the years of study include; Modelling and Relevant Technology, Health and Safety, and Water. The concept of a pyramidal arrangement of topics may be illustrated with the case of Health and Safety. Thus in year 1, the topic is treated as a simple introduction of the care of the body, as well as safety measures in the home (such as, keeping children away from such sharp and dangerous tools, as razors, etc). By the time the pupil arrives in year 6 the topic would have been developed to include more safety measures not only in the home, but at school, and outdoors (such as, crossing the road, respect for traffic signs, proper storage of drugs, fire hazards, etc.) (See Table 2.1 for details).

On the other hand, some topics were offered only in a total of two or three years of study (see tables 2.1 and 2.2). Examples of such topics are 'Senses' (offered in years 1 and 2); 'Colours' (offered in years 3 and 4); 'Earth and Sky' (offered in years 5 and 6); 'Force' (offered in years 3 and 4). The topics which are offered in only one year of study included; 'changes in Non-living things' (offered in year 5); 'Electric circuit' (offered in year 5); 'Sound' (offered in year 3); and 'Magnets' (offered in year 6).

Indeed, the selection and arrangement of some of the topics for a particular year of study makes one wonder why some of these topics were offered in a particular year of study and not in others. For example, the 'Electric Circuit' topic which was offered only in year 5, could well have been introduced in years 1, 2, 3, or 4 considering that most children are quite familiar with electricity in their homes and should at an early age of six years be able to carry out simple activities in electricity, such as, the lighting of an electric bulb using a short wire and a dry cell (battery). Such a simple activity, if introduced early, should not only bring much excitement to the children but would also motivate them to be more inquisitive about material things in their environment and at the same time help them develop a positive attitude to science as a discipline. Likewise, simple measurements, such as the estimation of length in which the children used their fingers or toes, and the estimation of the weights of everyday objects could be introduced in years 1 and 2.

On the other hand, such topics as, Magnetism which involve some abstract concepts, would expectedly be difficult for children to master between the age of 6 and 9. Thus, the introduction of this topic in a conceptual way at such early age as six years is clearly not such a good idea. In any case, children of 6 to 9 years of age may be expected to be familiar with ceramic magnets (Barrow lloyd-h, 1990) which indeed many may have encountered as toys.

Thus an early introduction of magnetism could involve playing with toys involving magnets. Such an activity in the classroom may be expected to trigger the children's curiosity and in the process enable them appreciate the peculiar properties of magnetic materials later on. This consideration is consistent with that of Akinmade (1985) who argued that the achievement of the objective of scientific and reflective thinking by Nigerian children at the primary level was an unrealistic goal because the children at this stage are not capable of carrying out operations that could enable them acquire such skills. However, he suggested that science topics could be organised in a way that would enable the children to build on prior knowledge for future science learning.

A further examination of the different science topics offered in the various years of primary study suggests that most of the topics of the science syllabus in years 1 and 2 appear to be focused on Environmental Sciences, Modelling and Relevant Technology health.

In year 3, apart from the Modelling and Technology topic, Biology and Physics topics are offered in equal measure, while only one topic in Chemistry is offered. No Astronomy topic is offered at this level.

In years 4 and 5, most of the science topics are represented.

Table 2.1 provides the science topics and the years in which they are expected to be taught as proposed in the National Core Curriculum 1980.

Table 2.1: **Classification of the core curriculum content (1980) into different science disciplines.**

Year of study	Technology	Biology	Physics	Chemistry	Environment	Astronomy
Year 1	Modelling with mud, clay, sand	food senses		Air Water Housing and clothing	Observation of things with the school environment, Health and Safety.	
Year 2	Making simple patterns, objects and figures with different materials, weaving, knitting.	Animal Senses food, plants		Air, water, Housing and clothing	Health and Safety.	
Year 3.	Making flutes, making dyes from plants.	Plants, Animals , Seed germination. Growing plants	Measurements, mirrors, sound, colours, force, Floating..	Air	Different Environment Health and safety.	
Year 4	Identification of materials , wood, wood work, uses of metals, rubber, etc.	food Gardening, The human body	Measurement, colour, force.	Heat and temperature, water	Weather, soil, changes in nature. Health and safety.	
Year 5	Friction and its effect, uses of lubricants, ball belts in drive.	Animals, my body, plants, Health and safety.	Electricity	Air, Heat/temperature soaps.	Rocks Health and safety.	
Year 6	Simple machines, pulleys.	Growing crops.	friction, magnetism		Man and his environment, erosion, pollution, exploitation. Health and safety.	Our earth and sky.

The science topics and the years in which they are offered as proposed in the modified syllabus prepared by NERC are presented in table 2.2.

Table 2.2: **List of Science Topics offered in the primary schools as in the NERC modified curriculum.**

Science Topics selected for primary schools.	Years of study in the primary school.
Air	1, 2, 3, 4, 5.
Animal	2, 3, 4, 5, 6.
Water	1, 2, 3, 4, 5, 6.
Changes in Non-living things	5.
Senses	1, 2.
Classification and Identification	1, 2, 3, 4, 5.
Colours.	3, 4.
Earth and Sky.	5, 6.
Sound.	3.
Electric Circuit	5.
Environment	1, 6.
Food	1, 2, 3, 4.
Rocks and Minerals	5, 6.
Force	3, 4.
Health and safety	1, 2, 3, 4, 5, 6.
Heat	4, 5.
Plants	2, 3, 4.
Housing and clothing.	1, 2, 3, 4.
Light	3, 4, 5.
Magnet	6.
Measurement	3, 4, 5, 6.
Modelling and Relevant Technology	1, 2, 3, 4, 5, 6.

In primary 6, the science core curriculum contains such topics such as Modelling and Relevant Technology, Magnetism, Rocks and Minerals, Earth and Sky, Environment, Animals Health and Safety, Water, Measurement and Animals (see Appendix B). Under each topic, the teaching objectives as well as the lists of required teaching materials are stated. Emphasis is also placed on the use of locally made materials while relevant activities are based within the school environment, but at the same time allowing activities to be carried out outside the school environment as the need arises. In addition, learning through projects that last beyond a class period is encouraged. Such projects are meant to help the children to develop process skills which are passed on through their constant use of these skills to carry out practical tasks. In all this, the teacher acts as a facilitator of learning by assisting the children to discover things on their own.

A corollary to the provisions of the primary six science core content is that the pupils' work is to be assessed regularly through assignments such as weekly tests, mid-term tests and yearly examinations. In particular, the child's cognitive, affective and psycho-motor domains are to be assessed as stated in the general core curriculum discussed above. The final assessment at this level is meant to be used for placement of pupils in the junior secondary schools. In addition, a formal general examination is to be taken at the end of primary six which is organised by the LGEAs concerned.

2.2.3: The assessment of Nigerian pupils in primary science

The aims of education as stated in the Nigerian National Policy on Education have already been enumerated in the first chapter of this work. Because these aims have changed over the years, the methods of assessment of the pupils in science as well as the reason for assessment itself have also changed. With the coming of the 6-3-3-4 system, other approaches to the education of the child nevertheless exist side by side. Those other forms of education (e.g. apprenticeship) tend to be assessed or examined in informal ways. However, assessment in schools is generally concerned with what transpires in the formal classroom setting.

The main purpose of examination in schools in the old system of education was to provide a mechanism for moving students from class to class or for the certification of the successful candidates at the end of their study; which again would facilitate their placement in other institution for further education. However, with the introduction of the new 6-3-3-4 system of education in Nigeria, continuous assessment was emphasised rather than a one-off written examination. In this regard, the Federal Ministry of Education, Science and Technology (1985) had defined continuous assessment as follows:

> *"a mechanism whereby the final grading of a student in the cognitive effective and psychomotor domains of behaviour systematically takes account of all his performances during a given period of school ". p.8*

The Federal Ministry of Education, Science and Technology document (1985) has also identified four characteristics of continuous assessment, namely, systematic, comprehensive, cumulative and guidance oriented.

The process of continuous assessment is now being implemented in both primary and secondary schools. To facilitate a proper handling of continuous assessment, a booklet prepared by the Federal Ministry of Education, Science and Technology (1985) for the cumulative record of pupils performance has been developed (see Appendix Bi). This booklet enumerates aspects of the child's skills that needed to be assessed. These include cognitive , psychomotor, and the affective aspects of the child's development. The booklet is designed to last for a period of six years (for primary) and three years (for the junior secondary) and another three years (for the senior secondary).

The actual final assessment is divided into two major parts: The first part is a continuous assessment part of the child's academic performance consisting of the results of assignments , weekly tests, practical work, projects etc., undertaken during the assessment period and is meant to cover the totality of the child's work throughout this period. This part of the assessment carries 60% of the final grade. However, the particular system of testing and the frequency of the test depends on the individual school.

The second part of the final assessment is the end of year test sometimes set by the LGEA, the State education ministry or the school (depending on the year of study). This usually takes the form of a written examination covering what the child has learnt during the year. These tests are usually taken at the end of a school session or at the beginning of a session. The ensuing examination grade is assigned a weighting of 40% of the child's final assessment. Thus, a child who scores the equivalent of 50 points out of a maximum of 60 points in the continuous assessment part is said to have achieved 50% of the total mark for the course irrespective of whether or not the child sits for any written examination. Consequently, a score of only 40 points (out of a possible 60) obtained on the continuous assessment part would be deemed a pass mark (40%) even when an end of year written examination has not been taken. Although, an automatic promotion from primary six to the junior secondary school is expected in the 6-3-3-4 system, in practice this does not happen. In practice, the children are expected to take an entrance examination to qualify for entry into the junior secondary schools. Consequently, children are specially prepared to pass this examination to enable them gain admission to the junior secondary schools. As a result of the pressure to pass the so-called common entrance examinations to secondary schools, little or no effective assessment is carried out on the affective and the psychomotor domain of the child as stipulated in the 6-3-3-4 system. The net result is that teachers tend to choose a strategy that will enable them to cover a lot of the science syllabus in the shortest time possible, and this they do by lecturing , which leaves the children no alternative than to learn by rote.

2.3. Approaches to teaching science

The Nigerian primary science core curriculum discussed in the previous section is based upon a process model of teaching and learning in science. This model emphasises the development of skills, such as the ability to ask questions and hypothesise, as well as attitudes, knowledge and understanding of scientific concepts. In Nigeria, the implementation of this model of science teaching and learning has been problematic (e.g. lack of confidence on the part of teachers, limited resources and lack of knowledge).

Efforts have been made by science teachers in some part of the world towards possible ways of successfully helping children to understand scientific concepts. These efforts involve the use of certain teaching strategies to make the science discipline meaningful and interesting. These strategies include the use of discovery/inquiry method science (or processed based learning), establishing children's ideas in and specific strategies such as concept mapping. Some of the suggested strategies have been tried with children in various parts of the world (such as the United Kingdom, Australia, United States; an example in the United Kingdom being the Science Processes And Concepts Exploration project (SPACE), 1992; e.g. Osborne *et al* (1992)) and have been found successful for developing scientific concepts and skills in children. Moreover, these strategies have been helpful to the teachers in their efforts to understand not only the child's ability to learn, but also how to improve the child's concept learning ability as well as encourage the child towards the acquisition of theoretical and practical skills in science. Similarly, the use of questions and answers as well as simulation games in science teaching have also promoted positive attitudes, and active involvement while probing the understanding of the children.

2.3.1: Discovery/Inquiry approach to teaching

The need to learn science through the discovery or inquiry approach has been discussed as far back as the 1960s (Schwab, 1962). Discovery methods have had a long tradition in education in some countries, including the UK. The Plowden Report (DES, 1967) for example, endorsed methods based on discovery and practical experience of science as based on the Nuffield Junior Science project (Wastnedge, 1967). Discovery methods have sometimes been equated to practical experience - two terms that are used interchangeably but are not the same (Turner, 1992). It was first suggested that children could be allowed to discover things for themselves - 'pure' discovery being where there is no teacher intervention. This type of discovery was seen to be unrealistic and frustrating as children are unlikely to carry out the 'right' discoveries for themselves. The notion of guided discovery was then introduced which involves greater teacher intervention and direction.

According to Harlen (1992), inquiry learning can be called 'problem solving, since it starts from the identification of a problem which a child may try to find solutions to, through practical work or observation. An inquiry approach to learning like the discovery approach has two versions, namely, the 'structured' and the 'unstructured' approach. The 'structured' approach according to Harlen (1992) is where the child is provided with the question as well as suggestions for the procedures to use and a series of questions which can lead to the solution of the problem. On the other hand, the 'unstructured' approach is where the child is provided with the question without any procedures on how to solve the problem.

Both discovery and inquiry learning are often used interchangeably. Discovery learning, for instance, has been defined in several ways by different people (Bruner, (1960); Sund and Trowbridge, 1967; and Schneider and Renner, (1980); Olarinoye, (1980). According to Scheneider and Renner (1980) discovery involves:

"observing, measuring, experimenting, interpreting, predicting and model building. These activities are designed to lead the learners to expand their mental structures, or systems of transformation developed about the concept. In this phase of the learning cycle, the learner is encouraged to use the language of the concept while engaging in the activities" p505.

Similarly, Sund and Trowbridge (1967) suggested that:

" Inquiry/discovery approach involves instruction that emphasise activities of identifying problems, observing, measuring, classifying, inferring, predicting or making hypotheses, discovering meaningful patterns, designing experiments, interpreting and analysing data, and verifying". p39

Sund and Trowbridge describe the mental processes which are involved in a discovery process as those described above. They further explain that the inquiry approach in learning helps the student to see him/herself as a scientist while discovering new knowledge. The role of the teacher is to direct the learning process, plan and organise the materials, and act as a facilitator. Lazarowitz, *et al* (1978) have also discussed the role of a teacher in an inquiry approach. According to them this requires the teacher

"to use a wide repertoire of behaviours in the classroom such as: stimulating students to identify problems, making observations, asking question, participating in classroom discussion, defining hypotheses... Teachers should be receptive to any answers and results. The role of the teacher is to guide their students in the learning process". p559.

Children are encouraged to learn science in this way by allowing them to discover things on their own through their own careful observations, classification, measurement, prediction etc. In this way, they are groomed to possess the appropriate foundation and experience for future science learning. Harlen (1993), however, noted that it is difficult to use a particular skill in isolation. She also noted that the use of process skills are not sequential or hierarchical, instead the skills are part of a whole, called scientific investigation (Harlen, 1993). According to Schneider and Renner (1980) learning through discovery increases content achievement as well as positive intellectual development. Lazarowitz et al (1978) found in their study that the inquiry method helped in modifying attitudes of prospective teachers in science. Similarly, Stepans Dyche and Beiswenger (1988) observed higher percent of correct responses by prospective elementary teachers who were taught by demonstration method than those who were taught using the expository method.

Turning to the situation in Nigeria, we may observe that the recent downturn in the national economy has made it almost impossible for science to be taught using the discovery or inquiry approach. This is because, these approaches are thought to require the use of well equipped laboratories or science centres in schools, implying the availability of science equipment or resource materials including audio-visual materials, textbooks, and workshop centres. If these materials are lacking, the net effect is to make the teachers resort to teaching in a didactic way, which has the inevitable effect of frustrating them. Although discovery approaches are recommended in the Nigerian National core curriculum for primary science, they are understandably rarely used by most teachers. The teachers justify their inability to adopt these strategies by the unavailability of resources. According to Nzewi (1986) some teachers who use the inadequacy of resource materials to justify their inability to organise practical activities in their science lessons, actually lack the professional training and competence to carry out those practical activities , for what they actually need is the ability to use the available materials within their local environment to teach rather than rely on the western-made science equipment. Peacock (1990) noted that for children from other cultures to appreciate science, they have to be taught by teachers who should draw examples from materials which are familiar to these children in their own culture. One of the problems that faces science teaching in Nigeria as mentioned earlier is that which deals with the teachers lack of knowledge of the subject matter and this inadequacy also affects their ability to plan science teaching incorporating materials within their environment. These teachers tend to view science as a foreign culture that must be taught from a textbook written by experts. This notion that teachers have about science teaching needs to be changed by helping them to make sure that they incorporate dimensions (by ways of selecting examples) that suits their children's environment when planning their science lessons (Peacock, 1990).

2.3.2: Establishing children's ideas

Recent studies on children's ideas on some scientific concepts have suggested that children come to science lessons with firmly held ideas about various concepts of science. These ideas are built from their individual experiences within their immediate environment as well as from adults and peers around them. (Driver, 1981, Driver, Guesne and Tiberghien, 1985, Driver,1989, Harlen, 1992). Osborne and Witrock (1983) identify several methods (e.g. Interview, Nussbaum and Novak, 1976) that have been used to probe the ideas children hold before coming to school. The methods include interviews about objects. This strategy helps teachers not only to know children's starting points but also to identify how previously held ideas could interfere with the new concepts to be learnt. The Constructivist approach[5] to the learning of science emphasises that the first step to a meaningful learning experience is for the ideas that children hold to be initially established (Driver, 1981). According to Gil-Perez and Carrascosa (1990) the constructivist approach or model to science teaching/learning involves conceptual, methodological as well as attitudinal change on the part of both the teachers and the pupils. Indeed, the duty of teachers when using this strategy will therefore be to plan learning

[5] This is an approach that suggests that children construct their own meaning of a particular concept or phenomenon. This approach advocates that children should be given the opportunity to construct their undertstanding of a given concepts by providing them with activities that could help them in exploring their own environment.

activities around these ideas with a view to either helping to confirm or else change them (Driver, Guesne and Tiberghien, 1985; Harlen, 1993). As an example, one may mention the development of children's ideas on Earth (Nussbaum and Novak, 1976), light (Guesne, 1985), heat and temperature (Erickson and Tiberghien, 1985), sky and space (Gibson, 1992), understanding their own bodies (Osborne, 1992), biological phenomena (Bloom, 1990) which have now been established in a number of extant studies.

This approach was specifically used by Neale, Smith and Johnson (1990) during the training of eight primary teachers and they observed a positive result of teachers successfully implementing a conceptual change unit of their own on light and shadows and in changing students' conceptions on similar concepts.

Whilst the study by Neale and his colleagues is based on a small group of teachers the findings are supported by other research such as that of Frost and Turner (1989). Turner (1992) in particular, describes an in-service programme that involved primary teachers, and science co-ordinators in research with primary pupils on nutrition education. From her study it was observed that teachers could apply their understanding of children's ideas about food in their day to day planning of schemes of work on food, and at the same time promote curriculum change in nutrition education within their school. There was also evidence that the teachers' knowledge about food and nutrition improved and that as a result they were able to teach food related topics with greater confidence.

But it must be realised that children need to be convinced of the validity of new ideas before they are able to give up their old ideas and this obviously requires providing them with activities and experiences that would make the right impact. However, this process involves good organisation of the necessary learning materials.

Teachers in some parts of Africa have also been found to hold ideas (sometimes incorrectly) on some scientific concepts or phenomena (Rollnick, 1990; Ameh & Gunstone, 1985; 1992). In Nigeria, Ameh and Gunstone (1992) observed that science teachers, like children, appear to hold ideas which are not scientifically correct, in spite of their being exposed to advanced training in science. These findings have evident implications for the pre - and in-service education of teachers that is discussed later in this thesis.

2.3.3: 'Ask the Object' Strategy

This strategy was first described by Elstgeest in Harlen (1985). It simply involves raising as many questions as possible about any object, event, or phenomenon while the object is present. The importance of asking questions in a science lesson has long been recognised by science teachers. In this regard, Elstgeest (1985) has distinguished questions raised by science teachers as being either productive or unproductive. Elsgeest defines unproductive questions as those which are closed and lead to straight forward answers while questions which are open-ended and require ideas from the students knowledge of the topic or concept are said to be productive. According to Gyuse (1982), primary teachers in Nigeria have been known to ask few questions in the course of their science lessons and even then, these questions are mostly of the closed variety which require the children to recall the information the teacher had given to them earlier. The 'Ask the Object' strategy can therefore serve two main purposes: The first is to help primary teachers to plan their own lessons by thinking through their own questions. Good questions such as relevant and focused questions can lead to useful activities in the science lessons. The second is to enable the teacher ascertain what the child may want to know about a given topic.

In Nigeria, where children tend to be afraid to ask certain questions or even to speak freely in the presence of adults (Chamberlain, 1979) this strategy becomes particularly useful and could help teachers to encourage children to ask questions during science lessons. It can also help the teacher plan activities around the children's questions (Harlen, 1983; Harlen, 1992).

2.3.4: The use of Concept mapping in the teaching and learning science

Concept mapping is a relatively new teaching strategy in Nigeria. It can be used by the classroom teacher in a number of ways to promote learning and interest in science. Concept maps have previously been defined by a number of authors (see for example, Novak, Gowin and Johasen, 1983; Novak and Gowin, 1984; Ault, 1985; Lehman, Carter and Kahle, 1985; Harlen, 1990; Gunstone, 1992). A concept map is a map of ideas or concepts showing the relationship between these ideas in a hierarchically or non-hierarchically form. On the map, link words are used to describe the meaning of each of the concepts as well as the type of relationship existing between any one concept and the others. The use of concept maps has been proposed in the area of learning from a textbook and the mastery of the contents of a novel, (Novak and Gowin, 1984); as well as in the area of lesson preparation , laboratory reports and identification of misconceptions in the learning of concepts, (Ault 1985; Kilshaw, 1990; Holmes, 1991; Cheryl Mason, 1992). Its application is now accepted to have a great impact on both achievement in science, positive attitudes to the learning of science, signal 'misconceptions' or valid creative thinking as well as on assessment in science (Novak and Gowin, 1984; Harlen, 1990; Okebukola, 1990, Mason Cheryl, 1992; and Sally and Mike Willson, 1994; Novak, Gowin and Johansen, 1983).

The effectiveness of a concept map as a teaching strategy involves the ability of the individual to link the concepts with the help of appropriate link words. This exercise therefore involves a good mastery of the language of communication. Horton *et al* (1993) reported that the use of concept maps in nineteen studies carried out on the effective use of concept maps in teaching, showed a medium positive achievement and large positive effects on students' attitudes. According to them, amongst these nineteen studies, the achievement and attitude gains were more pronounced in studies carried out on the learning of biology in Nigerian post-primary schools.

The question then is , to what extent can this strategy be used where the language of teaching is different from the everyday language? Indeed, if the children are not fluent in the use of English, the use of this strategy is bound to be limited because of the children's inability to adopt appropriate link words to link the concepts. Assuming this constitutes a limitation to the use of concept mapping, one must therefore express concern about the extent of the use of the concept mapping strategy in the Nigerian primary classroom. Nevertheless, the concept mapping strategy may be employed by the teacher in order to involve the children in active participation in their classroom work. This strategy allows the teacher to involve pupils in drawing the maps while s/he moves around the classroom, checking pupils' work as well as making suggestions to them either to clarify a point or to correct a misconception observed in their maps.

Although the use of concept mapping as an effective teaching technique is now becoming popular in many parts of the world including Nigeria. Its use in Nigeria is believed as earlier noted to have been confined to adult students (High school and pre-degree students) (Okebukola and Jegede, 1985; 1989; Jegede, Alayemola and Okebukola, 1990).

In practical terms, concept mapping can help the classroom teacher to achieve the following:

- detect the child's understanding of concepts
- identifying any misunderstanding of concepts from the map drawn
- assess the concepts learnt.

However, in spite of the positive effect of the use of concept maps in teaching, it may equally be noted that this strategy if unused by the individual teacher for a long time could lead to problems in his/her ability to present the concepts even when the concepts are well understood (Novak, 1981; Novak and Gowin, 1984; Lehman, Carter and Kahle, 1985; Novak and Musonda, 1991)).

2.3.5: Simulations and games as teaching strategies

The terms games and simulations are often used interchangeably. Some authors have differentiated the two (Ellington and Addingnall, 1981). Turner (1995) suggests that other people perceive games as essentially a part of simulation. According to Ellington and Addingnall (1981) both games and simulations are a way of representing an actual event or situation in a playful way. Thus, games focus on those situations in which the players strive to win while simulation, on the other hand, represents a situation in which the players are just 'acting' to please the audience. However, Turner (1995) classified simulations into three categories, namely:

- role play,
- simulation games, and
- computer simulation.

Simulation games have been found useful in the teaching of complex concepts in science as well as encouraging the learner to master the materials in a more relaxed manner without fear of being criticised (Turner, 1995). However, the application of simulation in the classroom, especially in science teaching, needs proper planning on the part of the teacher to avoid children being carried away with the 'acting' rather than the 'actual' situations. The effective use of simulation games, and computer simulation in teaching in the Nigerian context has also been reported by some authors (See for example Ango, 1982; Gyuse, 1983). In addition, learning through games enables the child to be involved, motivated, demystified, familiarised as well as facilitate the recall of learnt materials.(Eddington and Addingnall, 1981; Ango, 1982).

However, simulation games are not much used in Nigerian classrooms, due to time constraints. Indeed, the most likely type of simulation used is the so-called 'role play', often employed in drama lessons. Simulation games should be encouraged in the primary schools, as they can help in presenting complex materials to a child that is struggling with the foreigness of the English language, in a more relaxed and friendly manner. According to Gyuse (1989) and Okeke and Okpara, (1991) among the many strategies that bring meaningful learning to the Nigerian child, informal approaches such as, learning through imitation and role play appeared to take care of many problems that could occur in the classroom arising from the influence of cultural factors.

It is also pertinent to mention some disadvantages associated with the use of simulation games in teaching. These include; the fact that children are not always able to achieve the stated goals when the material is not well organised, as well as the fact that the time consumed in organizing learning materials could not only be long, but could be boring especially when the games are science oriented(Ango, 1982; Turner, 1995).

It may also be that anything taught in jest is not taken seriously by the child. Thus, when concepts are learnt through simulation games, they may not be taken seriously because the children are carried away by the process itself, to the detriment of the fundamental concepts which are meant to be inculcated. It therefore follows that the teacher must plan and organise the learning materials carefully. It is also helpful to the teacher if he/she takes the trouble to state clearly the objective of the lesson.

Since, the playing of games often involves arguments, and discussions among the players, it is usually a noisy strategy. Hence the teacher has the added problem of good classroom control. It is therefore necessary that the teacher selects the best time to play the game as well as identify the aspect of the topic which the game will cover. Usually, games played after teaching the topic are meant to help children to achieve the following:

- clarify their ideas about what has been learnt previously
- remember and recall what is learnt
- retain ideas that are learnt in the formal lesson.

2.4: In-service Teacher Education.

The importance of in-service teacher education is highly acknowledged by teachers. This is because of the changing nature of the society which makes it obligatory that the school curriculum should change in order to adapt or accommodate the innovations which could be brought about by the changing society. Teachers play an important role in the implementation of any curriculum. Sometimes, the changes are slow. However, it is important to acquaint the teachers with the innovations within the society and the school curriculum. In-service teacher education which can be either long or short term are provided to the teachers for their professional growth which can be either to update their knowledge in the content they teach, or update in the skills they require to teach. Science teaching in the last few decades emphasized the development of process skills in the children. This aspect of science requires that the teacher should be acquainted with the ways of planning instructions to achieve the stated goals.

The preceding section explores possible ways of providing teachers with in-service training in order to help them develop professionally.

2.4.1: Introduction:

In the earlier sections of this chapter, the status of science teaching as well as the problems facing science teaching in Nigeria were reviewed. In particular, it was noted that a major challenge confronts the classroom teachers who are expected to successfully implement the national science core curriculum in their classrooms. Bearing in mind the changes and developments, in curriculum content, objectives, strategy and evaluation techniques involved in the implementation of the National curriculum at the primary level, the NPEC document (1987) has made suggestions regarding possible ways of updating the primary teachers professionally in order to cope with these tasks. These suggestions include a possible in-service teacher education provision which can be either short term or long term. According to this document, *"A long term approach is the inclusion of the new methodologies and techniques in the curriculum of institutions that train teachers be it at the university or lower levels". p1*

On the other hand, a short term approach, according to this document consists of:

" .. the in-servcie education of teachers. Two procedures for organising and organizing and conducting in-service education for teachers can be adopted. These are..

i) the centrally-organised diffusion method; where central bodies such as the Implementation Committee on the National Policy on Education and the National Primary Education Commission organize workshops for primary school inspectors and headmasters who will in turn disseminate the knowledge gained at such workshops to teachers at the local level. This has been done zonally;

ii) the locally-organized interaction and problem solving method: here, teachers in every locality can meet and discuss their problems, share ideas, formulate objectives , agree on methods that will enable the objectives to be achieved and generate pupils' learning activities as well as design and produce teaching aids from local materials". p1

It may be noted that the people who designed the core curriculum discussed earlier in this chapter, had a wonderful proposal in ways of adapting to it. It is therefore unfortunate that in practice, little or none of these courses are provided for the Nigerian teachers for the present time. The provision of types of in-service in Nigeria is discussed in the later part of this section.

2.4.2: In-service training workshop for teachers used outside Nigeria

In other parts of the world , in-service training for teachers assumes a number of formats. The formats vary depending on the participants and the purpose for which the in-service programme is mounted. Nevertheless, it is still possible to delineate some common strands in the in-service training for teachers taking place outside Nigeria. The intention of such actions is to help teachers to:

- remove weakness that are identified in their teaching.
- acquire the ability to learn how their pupils learn.
- be exposed to new teaching strategies .
- develop learning strategies that will help in making their lessons. more interesting and less boring and promote children's learning .
- be updated on innovations that take place in their everyday lives essentially those that are useful in their teaching; and finally,
- be made more effective and confident in carrying out their duties.

Bailey and James (1978) have suggested reasons for failures in in-service programmes which include; lack of relevance to participants, lack of substance in terms of the immediate use of ideas, and inconsistency between practice and theory. They went further to suggest four elements necessary for an effective in-service programme which according to them include:

- Leadership and supervisory skill development
- Teacher self-assessment skills
- Programme familiarization, and
- Management system.

An in-service training model proposed earlier by Harlen (1985) which was also adopted in Turner's work (1992) showed the role of teachers as both co-ordinators and key agents[6] in disseminating information about teaching as well as promoting curriculum change through the impact they make using the skills acquired during an in-service training.

In the INSET model described by Harlen (1985) which was the outcome of discussion at an international workshop, four major components of an in-

[6] These are participants or teachers who will be involved in helping to train other teachers in the areas which they have already gained skills through the inservice training. These key teachers can as well be seen as coordinators.

service training may be identified as the selection of participants, the course design , and those of support and workshop outcomes.

A number of methods for the selection of participants were outlined. These methods include the mechanism of self-selection, as well as compulsory selection[7] of the participants by the workshop organisers. Both of these methods have their own advantages and disadvantages as have been attested to by those who have used them (Harlen, 1985). On the other hand, a self-selection procedure has been found to be useful in such situations , where the participants tend to be keen in the programme, they tend to be confident as well as experienced in their work.

According to Jenkinson *et al* (1994) an INSET follows the cycle as indicated in figure 2.1 below:

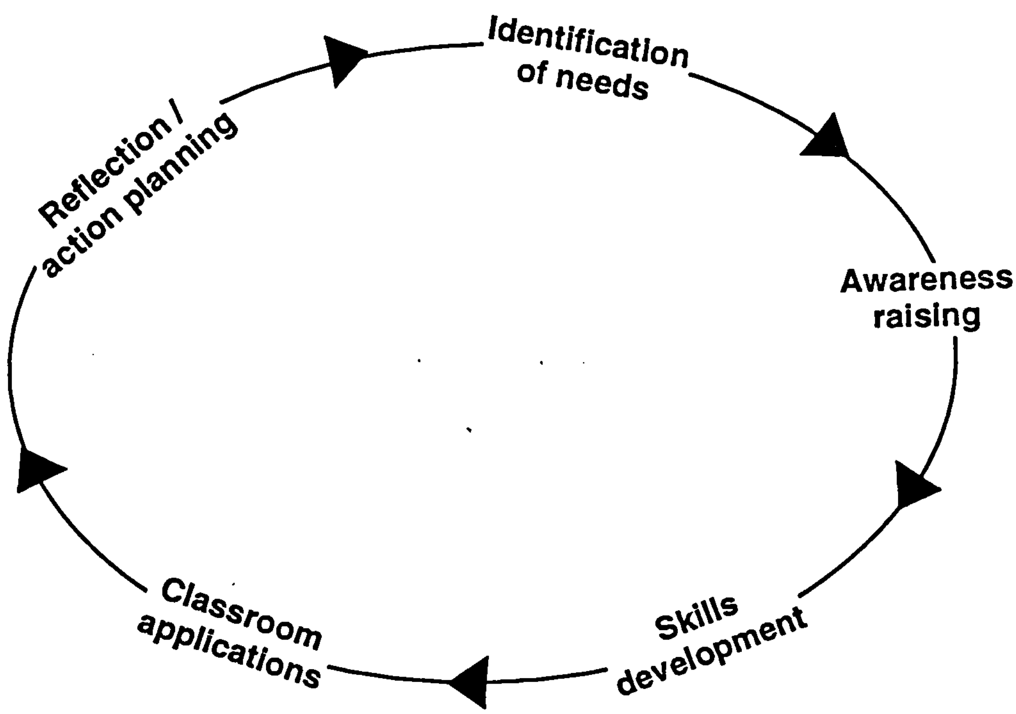

Figure 2.1: Processes involved in an INSET programme (Jenkinson, (ed) 1994)

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[7] This is a situation where the teachers are obliged to attend a workshop irrespective of their perception of the outcomes of the workshop. Self selection of participants on the other hand, involves a situation where the participants choose to attend the workshop because of the benefit they think they have to achieve through such training.

They also suggested several methods towards achieving each stages of the cycle. Such methods as, use of staff questionnaire (for identification of needs); workshop activities (for awareness raising); modelling skills (for skill development); pilot or dry run using new skills , support teaching (for classroom application); and informal small group discussion or tutorials (for reflection/action planning).

Harlen, (1985), Frost and Turner (1987) and Turner, (1992) also identify the importance of support systems for in-service training programmes. Some of these support mechanisms could be internal (e.g. head-teachers or other teachers) while the other could be external (Government as well as non-government science organisations). The outcomes of the in-service programme are expected to be enormous and can be measured through the key agents.

Some of the features enumerated in the above model of INSET are quite interesting and could be applied in the Nigerian situation. However, the self-selection method of the workshop participants which has been found successful in other parts of the world may not work effectively in Nigeria due to the fact that teachers' salaries tend not to be paid regularly. Indeed, most primary school teachers can not afford to pay for in-service training from their pocket. However, with an appropriate financial incentive provided, such a method would be found very attractive to Nigerian teachers. A compulsory selection of participants on the other hand, may not be the best method for selecting Nigerian teachers as workshop participants. However, given appropriate financial sponsorship, most Nigerian teachers would be pleased to attend a workshop where they are compulsorily selected.

Turning now to the issue of course design, one may observe that the situation of in-service training in Nigeria discussed earlier is such that not much impact is being registered even after the teachers have been through a workshop programme. This may be due to the fact that most in-service training programmes in Nigeria do not appear to have a follow-up component that ensures that the participants, when they return to their schools continue to use the learnt materials and techniques (Savage, 1987). Indeed, Harlen (1987) has suggested that a workshop approach affords the trainees the opportunity to try the materials on their own, and thus learn through their own experiences although she also emphasised that there is no evidence that a workshop approach gives the best product of in-service training. However, UNESCO in a study reported by Harlen (1987) has enumerated the benefits of the workshop approach in the retraining of teachers. According to a UNESCO document (Harlen, 1987) they include the following:

- *"the participants are active both mentally and physically. They are involved in experiencing the kind of learning that is being advocated for children, in reflecting, analysing, in creating;*

- *the messages that are conveyed are not transmitted by direct telling but through active involvement.*

- *through handling materials for themselves the confidence is gained that is necessary to providing similar experiences for children.*

- *understanding is achieved by each participant from within rather than from outside; it comes through reflecting on direct experiences and on new ideas which may be presented for discussion.*

- *the product is not knowledge of a set of specific activities for children to do but an appreciation of new kinds of learning and some of the ways of bringing this about in children." p. 8-9.*

It may be observed that the recruitment of key teachers, expected to act as resource persons in their own schools or even outside their schools, is a very important aspect of this model. This is particularly relevant to the Nigerian situation where the constraint of scarce funds could militate against the mounting of such a programme. Nonetheless, in the Nigerian case, the few teachers who are sponsored could serve as 'Key teachers' or agents and carry out similar training of other teachers within and also outside their schools.

2.4.3: In-service training provided to Nigerian primary teachers

The teacher's role can be said to be at the centre of formal education in the sense that s/he directs and overseas the learning process itself as well as organizes the learning materials. Because of the importance of the teacher in the educational system, all State and LGEAs governments in Nigeria have put a lot of effort towards the training or retraining (where possible) of the teacher in order to equip him/her with the skills and competence to perform his/her duties. Since, the school curricula usually change with time in response to changes in the society, the training and retraining of teachers must remain a continuous process.

So far, a number of initiatives have been undertaken by the Nigerian Federal government as well as curriculum organisations in Nigeria towards the provision of in-service training programmes for teachers. Some of the curriculum organisations/associations,(e.g. Science Teachers Association of Nigeria (STAN), Curriculum organisation of Nigeria (CON)), Federal and State Ministries Education have assisted in many ways to organise in-service training for Nigerian teachers to update their knowledge and skills and improve their confidence in handling some areas of science.

Indeed, after the introduction of the 6-3-3-4 system under which, the minimum qualification for initial appointment as a primary school teacher was raised to the NCE, many Colleges of Education, universities and polytechnics began to organise a number of in-service programmes (locally called 'sandwich' courses) targeted at primary school teachers in order to enable them meet the dateline of 1991 set for the implementation of the minimum qualification of the NCE for initial appointment.. The Federal and State owned universities, Polytechnics and Colleges of Education, consequently organized the Diploma in Education courses through the in-service programmes to assist the serving teachers to upgrade their knowledge and skills as well as to raise their confidence levels in various disciplines to cope with the demands of the 6-3-3-4 system. In line with the school year system operating in Nigeria, the majority of these institutions organize their in-service science programmes during the long vacation period which in Nigeria occur usually between the months of July and September The entry qualifications of the candidates are usually Teachers' Grade II certificate or its equivalent. The programme normally lasts for two successive long vacation periods. (i.e. a total of six months of continuous study over the two years). However, the candidates are usually sent home with assignments after their first year of study and the completed tasks are expected to be submitted at the beginning of the following long vacation. In addition, an essay of not less than 10,000 words, written in any chosen area of education is also normally required to be submitted by each student as a partial requirement for the award of the final certificate. The designation of this certificate awarded to the candidates may vary, depending on the issuing institution. Thus, for example, an Associateship of Education Certificate (ACE) is awarded by the University of Nigeria, Nsukka. The ACE holders would subsequently qualify to take further in-service training courses leading to the NCE, and so on. The importance of using INSET as a basis for professional development through the reward of certificates, has already been noted (Harlen, 1985).

Other institutions such as Colleges of Education also organise in-service training courses which lead to the award of the Nigerian Certificate in Education (which is higher than ACE), for which, the required entry qualifications is a Grade II Teachers' certificate. The course normally lasts for four successive long vacation periods. In contrast, the in-service training for the award of the NCE in Integrated Science offered at the College of Education, Kafanchan, under a special arrangement with the Ahmadu Bello University, Zaria, (the actual awarding body) lasts for a period of five long vacations. It may be observed that , a full-time student in a College of Education in contrast would only take a minimum of three academic years to gain the NCE certificate, awarded by an affiliated university.

The Science Teachers Association of Nigeria, (STAN) which started as a professional teachers association has also participated actively not only in curriculum development but in pressing for curriculum reforms in Nigeria. Indeed, STAN has tried to assist the Federal Ministry of Education in their task of updating teachers' skills as well as restoring confidence and keeping teachers abreast with educational development, the world over. One instance of such assistance, provided by STAN was the organisation of short term in-service training programmes for primary school teachers to enable them update their knowledge and skills and thus put them in a better position to implement the national science core curriculum content in science. STAN has also organised other programmes such as conferences, seminars and workshops in support of national objectives in science and technology.

Apart from the usual annual[8] conferences organised by STAN, the association also organises subject panel workshops in a number of subjects, such as primary science, chemistry, biology, and mathematics. Each subject panel is usually expected to organise a 3-4 days workshop at least once a year. The theme of such a workshop is usually selected by the members of the subject panel, and is dictated by the areas of need as requested by the teachers. Usually, effort is made to emphasise the use of locally made resource materials for science teaching, considering that the country may not always afford the imported science equipment. For primary schools, such locally made materials may in any case be more appropriate.

Each panel usually appoints from among its members, individuals to act as co-ordinator(s) of the workshops. The actual contributors to the workshop tend to be interested persons from anywhere provided the contribution comes within the theme of the workshop. The conduct of the panel workshops is such

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[8]A conference is organised by STAN yearly usually between the months of August and September when schools are on vacation and the conference usually includes a few hours of workshops or preconference workshops.

that there is always an emphasis on a workshop approach in which the participants are actively involved in working with materials on their own. In practice every participant is expected to pay a registration fee. Such a fee is usually arranged to be settled on the participant's behalf by the school employing the teacher or else the Local Government Education Authority (LGEA). The conference fees normally exclude board and lodging which are expected to be the responsibility of the participants.

One problem facing the STAN subject panels, concerns finance. Indeed, it is difficult for subject panels to cope with the cost of recruiting the right people as resource contributors because of the high costs involved and the fact that few, if any, contributors are prepared to make any input without being remunerated.

Another problem facing the STAN panel workshops concerns the selection of the workshop participants. This arises from the fact that the majority of the participants are primary school teachers who are often too poor to sponsor themselves to such workshops. Moreover, primary teachers are not allowed to move out of their school location without the prior permission of the supervising LGEA authorities. Furthermore, Education Officers from the LEGAs are likely to make impromptu visits to schools, and may penalise any teacher found absent without permission.

Another type of in-service training programme for primary school teachers is the Teachers' Vacation Training Course (TVTC) provided by the Federal Ministry of Education. This course was aimed at bringing the teachers up to date on innovations in science teaching as well as acquainting them with the pedagogy of science teaching. It was also aimed to look at the curriculum with a view to making sure that the teachers understood its content and methodology. (Akusoba, 1994).

The Science Teacher Vacation Course started in 1986 and was originally designed for primary school teachers to undertake courses that would help them meet the stated objectives. The course duration was 4 to 6 weeks, and was expected to be run in every state of the Federation. The participants were drawn from all the local government areas in Nigeria. The Local Governments were assigned the responsibility of sponsoring the teachers to the workshops by way of providing both board and lodging to those they sponsor, while the Federal Government was expected to fund the resource persons and co-ordinators.

In reality, the TVTC is not achieving all that it could, due to the problem of funding. For example, in the case of Anambra State , where only 15 teachers were involved in this exercise during the 1993/94 academic session, it is easy to see that, with the number of Local Government Education Authorities in the state now at 16, all the local government areas in the state would not have been represented.

Indeed, experience suggests that most in-service training for primary teachers tend to have the following characteristics:

- the teachers are taught in a didactic way which is not an exemplar of what is expected of them in their classrooms

- the resource materials provided for the training workshop tend to be those seen mostly in the big tertiary and secondary institutions and those are virtually impossible to acquire for use in the schools.

- there appears to be no clear focus on the curriculum content required to be taught to the primary child. In any case, the trainers tend to give the trainees hand-outs on topics being taught without much effort to explain how to bring it down to the level of the pupils.

Bearing the above factors in mind, a number of workshop models were considered, (such as the use of electronic media (e.g. radio, television) seminars

, conferences, as well as distance learning all as a preliminary to the design of a teachers training workshop reported in the present study. If one considers the use of television for example, the problem here is that the electric power required to operate television sets are not readily available in rural areas, and even in the urban areas, the supply from the national grid is often erratic. Radio broadcasting on the other hand is handicapped by its inability to project visual images , so important in science teaching. In any case, not all schools or indeed teachers possess their own television or radio sets. This means that the training workshop must involve physical and eye to eye contact, between the trainer and the trainees. But even then, the method could prove inadequate without any facilities for practical activities which needs to be acquired through first hand experience with teaching materials.

However, as will be observed later in this account, the features of the model of in-service training designed in this study are virtually similar to those of Harlen's model (Harlen, 1985). Nevertheless, some modifications have been considered necessary in the Nigerian situation.

In this connection, it is relevant to mention that the problem with the science offered in the Grade II Teachers' training colleges is not only its deficiency in modern methods of teaching but also the fact that most teachers did not in fact offer a science subject during their training, since, science was not compulsory at this level of training. Consequently, it was decided in the present effort that the remediation of the teachers inadequacies as a goal of in-service training could best be provided through the workshop approach.

In designing an in-service remedial training workshop for Nigerian primary science reported in this study, a number of factors have been taken into account. These are as follows:

a) The chances of meeting the aims of the workshop within the constraints of time, space, and limited available resources.

b) The maximum number of teachers that could make for a meaningful remedial training programme.

c) The possibility of how the experience and results of the designed training workshop could subsequently be extended to a wider population of Nigerian primary science teachers.

This model has been proposed for the present study. (see Appendix E and F for the 2-day and 1-day workshop designs).

In conclusion, a review about science teaching in Nigeria with particular attention to the teaching of science at the primary school has shown that science teaching at this level is facing a lot of problems. The chapter has identified the possible factors which militate against the successful science teaching at this level. Some of these problems are directly about the teachers who play a great role in implementing the curriculum in their classroom. It was however, noted that efforts were being made by both the Nigerian Ministry of Education (Federal and State) and some organizations to fight these problems. Unfortunately, the impact of these efforts is quite minimal. Ways in which science teaching can be improved have been carefully analysed in the chapter. The review on different approaches to teaching showed that there is a need for primary teachers in Nigeria to improve in the ways they teach science. These strategies would help both the teachers and the children to understand science concepts better. The model of in-service teacher education described in the chapter provides the context for the study for improving primary teachers' understanding of some science concepts as well as acquisition of necessary skills to teach science which will be considered in chapters 5, 6 and 7.

Chapter 3

RESEARCH METHODOLOGY :WHAT ASPECTS OF SCIENCE DO PRIMARY TEACHERS FIND DIFFICULT TO TEACH

3.0: Introduction

A major motivation for the present study was to develop an in-service training programme for primary science teachers which would enable them overcome the identified inadequacies in their teaching of primary science. Owing to the constraints of time and finance, it was not possible for all the topics in the primary science core curriculum to be covered in the programme. Consequently, it was decided that the in-service training programme should be based on a primary six science curriculum topic identified by the teachers themselves as being difficult to teach. The field study was therefore planned along the following lines:

a) To identify a particular topic in the primary six science core curriculum which teachers found difficult to teach

b) To use the result from (a) to develop an in-service training programme which would help the teachers to overcome their inadequacies in teaching the specified topic.

c) To assess the extent to which the developed training programme has helped the teachers to improve their teaching of science.

d) To determine the extent that the devised training programme has helped the teachers in achieving some measure of professional growth and confidence as primary science teachers.

This chapter therefore identifies the research questions, and outlines the research methodology.

3.1: Research Questions

In the light of the issues presented above, the following questions were identified concerning primary six teachers in Nigerian schools which will help to set the stage for this study:

1) Which topics in the primary science National Core Curriculum do teachers find difficult to teach?
2) Can a programme of in-service training help Nigerian primary school science teachers overcome inadequacies in their teaching?
3) Has the in-service programme helped Nigerian primary science teachers towards a better understanding of an identified topic?
4) Does the in-service training programme enable the Nigerian primary teachers to gain greater confidence as science teachers?

In order to answer the above questions, a number of tools have been developed in this study, the details of some of the tools are discussed in the following sections.

3.2: Methodology

The general methodology for the study as shown in figure 1.5 involves several phases of the research. The methodology of the research described in this chapter concerns only the survey which involves the identification of the problematic topic for teachers to teach. The methodology of the research which concerns the workshop is described in chapters 5 and 7.

The survey was carried out in two parts: namely, the pilot and the main. In addition a supplementary survey was carried out to remedy an omission made in the pilot survey. Each of the surveys will now be discussed in detail as follows:

3.2.1: The questionnaire survey

This aspect of the investigation was approached in two stages; an initial pilot study, and a main study. The pilot survey was carried out from December 1992 to January 1993, and the main survey from May to July 1993. The pilot survey was designed to try the questionnaires which would be used for the main survey. In addition, the pilot survey was carried out to enable a broad view of the problem to be obtained with a view to facilitating a more focused and detailed approach in the main study. The questionnaires used for both the pilot and the main studies were similar except that one further question was incorporated in the main.

The questionnaires (See Appendix C) in both cases were designed to identify the particular topics of the primary six national science core curriculum which primary teachers found difficult to teach. Each questionnaire was divided into two parts (section A and B), and was preceded by an introductory section which elicited appropriate background information. Care was also taken in the introductory briefing to the participating teachers to assure them of the confidentiality of any information they might provide (see Appendix C for covering letter).

Section A of the questionnaire dealt with background information on the schools as well as the individual Primary Six teachers. This consisted of the name and location of the school, as well as the teachers gender, years of experience, academic qualifications, and prior participation in other in-service training programmes. The questionnaire was constructed so as to elicit straight Yes or No answers. The respondents were expected to tick the relevant information applicable to their circumstance from a number of given options and where this was not possible, space was also provided for the respondent to indicate their peculiar situation. The purpose of this background information was to obtain information about individual respondents which could be useful in the subsequent analysis.

Section B of the questionnaire focused on the issue of the teaching of science in Nigerian primary schools. The questions were designed to obtain information on the number of periods of science lessons provided for pupils in the schools , as well as on the teachers' familiarity with the core content of the science curriculum. Thus, in the first part, the topics in the science core curriculum were listed in a table and the teachers were asked to rank them according to the extent of difficulty they found teaching them, using a scale of 1 to 5. Here, 1 would correspond to very easy to teach , while 5 would mean a topic that was found very difficult. For this purpose, ten topics were provided in the order in which they appeared in the published Primary science core curriculum document (see Appendix C).

Another part of the questionnaire was designed to enable the strategies used in teaching the science topics to be determined. The teachers were then asked to rank the strategies according to how often they used them in their classrooms. They were also asked to report on the methods of assessing pupils, choosing from a list of: end of year examinations, end of term examinations, cloze[9] tests, end of module examinations, written work, discussion with pupils, verbal feedback, and weekly tests. The teachers were further asked to rate strategies according to the frequency of their use, based on the categories of: 'Always', 'Sometimes' and 'Never'.

Ratings were also requested for methods of teaching science. The teaching methods asked about included : discovery, use of imagination[10], enquiry,

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[9] Cloze test is a type of test given to children to find out how much they understand the expert language. It is usually in the form of 'fill-in-the-gap' strategy but different in the sense that it is more systematic. It is systematic because the gaps are provided at same interval all the time. It is usually taken from a piece of text designed for that purpose whereby some aspect of the text are removed for the children to fill in the gaps using the appropriate choice. Sometimes, choices are provided.

[10] Imagination strategy in the context of this research is where the teacher allows the children to make predictions of what they could expect as a result of circumstances surrounding a given situation.

problem solving, discussion with pupils and hypothesising. A further column was provided to enable the participating teacher to indicate other methods not listed. Again, the teachers were asked to rate the methods according to the frequency of use (1 for always; 2 for sometimes and 3 for never).

A further part of the questionnaire attempted to bring out the reasons why the teachers found the identified topic(s) difficult to teach. This section was omitted in the pilot questionnaire but was taken care of by the construction of a subsequent questionnaire (designated as a supplementary questionnaire) that was sent to teachers who had responded to the pilot questionnaire. A list of reasons numbered 1 to 7 below were provided and the teachers were then asked to choose a reason or reasons that could explain why the individual topics were found difficult to teach. These were:

1. The ideas involved were difficult to conceptualise
2. The language of communication in the textbooks is not only foreign to the pupils but somewhat complex
3. The material resources available to the teacher as aids were inadequate.
4. The objectives of the curriculum set out for the pupils are too advanced for the children, and therefore inappropriate to their age
5. The materials to be learnt are not relevant to the children's immediate intellectual needs.
6. The teachers' failure to acquire the relevant practical skills in the course of their formal training handicapped them.
7. Reasons other than above.

3.2.2: Description of the Supplementary questionnaire May-July, 1993.

This questionnaire, administered to the teachers of the pilot survey, was designed to take care of some omissions in the teachers' questionnaire used in the pilot survey. It also consists of two parts, designated A and B. (shown in Appendix D).

Section A of the questionnaire was designed to elicit relevant background information, such as, teachers' gender academic qualification, years of experience, professional experience, and of course, the name of the teachers' school. The actual questions were preceded, by explanatory notes about the purpose of the questionnaire as well as a reassurance about the confidentiality of the responses.

Section B was designed to bring out the reasons why teachers found the topics identified as most difficult in the pilot survey difficult to teach. A list of possible reasons provided to the teachers were as shown in the questionnaire in Appendix D. These questions are identical to those asked in the main questionnaire (Appendix C).

The participating teachers were then asked to choose as many reasons as possible, out of the above list to describe their individual reactions.

3.3: Samples for the survey

In both the pilot and the main surveys, teachers were drawn from schools in three states namely, Anambra, Kaduna, and Plateau. The ages of the pupils they taught were in the range, 10-14 years.

Altogether, the questionnaires were sent to 50 teachers in the pilot study and 130 teachers in the main study. The data collected from the three states were then analysed in order to obtain the information such as the following:

i) whether primary science is taught as a separate subject in a given state; ii) the number of teaching periods allocated to science in each state.

3.3.1: School location

Schools and teachers were selected on the basis to reflect the types of schools in the three states. Both rural and urban primary schools were sampled in each state as is shown in Table 3.1. For the purpose of this study, it is necessary to clarify the use of the terms urban and rural areas. Indeed, the classification of an area as being urban or rural is not in fact straight forward in the Nigerian situation. Whereas, in developed countries, a classification of this type is done on the basis of some specific criteria. In developing countries, one may classify an area as urban or rural based on a number of factors, such as demographic or socio-economic. Moreover, in Nigeria, one usually finds that a clear cut classification as is the case in developed countries is not possible and indeed in this study, the availability of certain modern physical infrastructures (e.g. electricity and pipe-borne water) necessary for science teaching has influenced our designation of an area as urban or rural. Furthermore, Obioha (1982) has defined urban and rural areas in terms of the type of relationship that exists between individuals within this population as well as between the people and the land.

Thus, a school location would in the present study be described as urban or rural on the basis of the population density of the area, the economic activity of the area, (e.g. farming or industry), as well as the available physical infrastructures, (such as good access roads, good and steady electricity supply to the school), and the availability of steady pipe-borne water supply, in addition to the availability of an adequately equipped school laboratory/science corner or alternatively, an easy access to a nearby secondary school with such a facility. However, Gyuse (1982) has defined urban schools as those located in an area with a population of at least 20,000 people whose main economic activity are not agricultural. She further defined rural schools, as those located in an area with a population of 20,000 or less of predominantly farmers.

In this study, Gyuse's definition has been adopted with a slight modification that allows for an urban school being located in an area with a population not less than 80,000 people, but with a range of occupation categories that range from teachers, civil servants, private professional practitioners, to traders, etc. In addition, there should be good access roads to such an area and electricity and piped water, shops, hospitals, office buildings, would be taken for granted. However, although a good part of the geographical area designated Anambra state has officially been classified as the 'State Capital Territory' the latter area has only recently been upgraded by the state government as urban. However, in reality most of this area is still clearly rural and therefore is regarded as such for the purpose of this study. The case of the Njikoka Local Government Area, most of which forms part of the 'Anambra State Capital Territory' notwithstanding, the fact that a significant part of it is still very much rural illustrates this point.

Similarly, a rural area is described for this study as that in which , the physical infrastructures expected in an urban area (as described above) will be lacking. In addition, the local population would be less than 50,000 and would comprise mainly of farmers, craftsmen, etc.

In spite of this effort at classification, it should be noted that many of the rural areas of Anambra State do not conform strictly to the above description, since in fact most villages not only have some access roads but harbour many blue and white collar workers who live locally and commute to work to the state capital. On the other hand, schools in clearly urban areas sometimes lack the expected physical infrastructures (e.g. steady supply of electricity and piped water) due to the current downturn in the national economy.

3.3.2: School type

The study has not laid much emphasis on the school type, as its aim was not to investigate the effect of school type on the problem of teaching science. All the schools sampled (rural or urban) therefore covered the three types of schools in existence, namely:-

(a) State government owned primary schools,

(b) Federal government owned primary schools and

(c) the voluntary or non-government agencies owned primary schools. The discussion of each type will be done individually.

i) State government primary schools

These are primary schools within the confines of a State which are run jointly by the Local Government Education Authority (LGEA) and the Federal Government . These primary schools are by law controlled by a Local Government Area Board. Recently, the Federal government undertook the payment of primary school teachers salaries, while a national primary school board was set up to oversee the adequate running of these schools. The State Governments of the area where the school is located plays little or no part in the running of such State primary schools.

ii) Federal government parastatals Primary Schools

These are primary schools within the state which are owned and run by a federal government parastatal for the benefit of its employee's children but adopt similar policies with that of the state owned schools. An example of this type of primary schools are primary schools run by the Federal universities. These schools are mostly found in urban areas. Fees for staff children are moderate but are high for others who are not siblings of the staff.

iii) Voluntary agency or Private Primary Schools

These are primary schools owned by missions, individuals, or private corporate bodies. Although the schools are usually required to run the same policy with the State or parastatal primary schools, the administration (in terms of payment of staff salaries, recruitment of staff, choice of when to resume and vacate school) depends solely on the individual school authority. Most of these schools are mostly found in the urban areas where children of people from different walks of life who can afford the high fees abound.

Generally, the schools sampled were either government or mission owned. Private schools were also sampled in the urban areas, where they are usually found.

Table 3.1: Number of schools from each State and types of school used for the main survey.

State of schools and type	No of teachers (Rural)	Location of school (Urban)	Totals
Plateau			
a. Government schools	5	0	5
b. Federal schools	0	0	0
c. Voluntary Schools	0	4	4
Anambra			
a. Government Schools	21	12	33
b. Federal schools	0	1	1
c. Voluntary Schools	0	0	0
Kaduna			
a. Government schools	7	0	7
b. Federal schools	0	1	1
c. Voluntary Schools	1	19	20
Total	34	37	71

3.3.3: Sample population

Since science is done in all levels of the primary school, it was considered adequate to use primary six teachers especially because this at this stage the children are expected to have covered all aspect of science needed to be done in the primary school and of course would stand in a better position to make a self evaluation of the different topics that they have taught. The initial target sample size for the primary six teachers was sixty, (for pilot) and 180 (for the main) and this was intended to be obtained through random sampling.

a. Pilot study

The population sampling proposed for data collection phase during the December 1992-January 1993 field work, was a random sampling technique. This method could however not be strictly adhered to, partly because of the strike action embarked upon by civil servants in Nigeria at the time, involving the closure of all the State-owned schools in the country. The practical reality encountered during the field work made it difficult, if not impossible for the random sampling technique to be adopted, owing to the fact that many teachers were absent from their schools as a result of the on-going strike action. As a result, the data was collected in the following manner :

- Primary teachers residing either in their various home towns or residing in the schools location (where different) were selected randomly from those who teach primary six pupils. No more than two teachers were selected from any given school.
- Primary Six teachers teaching in both rural and urban areas as well as in both state and voluntary primary schools were included in the sample.

As most of the private schools forming part of the sample were in session and relevant data on the teachers were thus collected. Some of the primary teachers in government schools, even though they were on strike, nevertheless, assisted by providing information. A total of fifty primary six teachers completed the questionnaire.

b. The main survey

The second phase of the survey was carried out in May-July, 1993. The purpose of this phase of the fieldwork was to collect the same kind of data collected on primary teachers in the pilot survey, whilst the schools were in session and teachers were located in their proper classrooms, and to ensure that a wider sample of teachers was reached, since a small sample would hardly provide a sound basis for the results.

During this phase, a visit to Nigeria was not found necessary. Instead, the questionnaires were mailed to locally recruited assistants who were instructed to distribute the questionnaires. In fact, three research assistants (all female), were recruited, one from each of the three states where they were based. Altogether, a total of 130 primary Six teachers were sampled.

The schools from which the teachers were selected were predominantly located in rural Local Government Areas as opposed to the urban Local Government Areas. The ratio of the teachers located in urban to rural Local Government Areas envisaged for the study was 1:2, it was found so in practice. For example, in Anambra and Kaduna States, schools were selected from 3 urban Local Government Area and 6 rural Local Government Areas respectively, while in Plateau state, schools were selected from 2 urban Local Government Areas and 4 rural local government areas. However, the envisaged ratio was achieved in all the three states although more local government areas were sampled from Anambra and Kaduna states. All but one of the private schools sampled were located in urban areas. The number of teachers selected in each state was different it was considered that since Anambra state was to be used for the workshop, it would be sensible to survey more teachers in the state (see Appendix Cviii). But then, even the number allocated to Kaduna and Plateau States was not achieved owing to the fact that it was not possible for the research assistants to cover the landmass involved in these two states unlike in Anambra state. It takes more to travel from one town to the other in Kaduna and Plateau states than in Anambra state.

Table 3.2: **Number of questionnaires sent/returned for analysis.**

State of Schools	No. Sent out	No. Returned	% of Returns
Anambra	80 questionnaire	68	85%
Kaduna	40 ,,	38	95%
Plateau	40 ,,	24	60%
Total	160 ,,	130	81.3%

The total percentage return of the questionnaires from the three states was 81.3%. This was regarded as a good response.

3.3.3c: Sample for the Supplementary Questionnaire survey

In May/July 1993, the teachers involved in the pilot survey were asked to complete a supplementary questionnaire (see section 3.3). Out of the 50 primary six teachers who completed the teachers' questionnaire in December, 1992/January, 1993, 41 completed the supplementary questionnaire. The outstanding 9 teachers were not involved, because some had resigned their jobs while others had in the meantime been transferred to other schools and could not be reached.

3.4: Statistical methods used for the analysis of the survey.

Because of the number of methods used in the collection of data for this study, it was found necessary to employ different approaches to the analysis of data collected. the questionnaire data were analysed using the SPSS software.

3.5: Summary:

In this chapter, the purpose of the research as well as the research questions have been stated. It was also possible to describe the tools or methods involved in the data collection for the survey. In addition, the chapter provided the description of the sample in each of the surveys carried out.

In the following chapter, the analysis of the data collected from the survey will be discussed.

Chapter 4

PRESENTATION AND ANALYSIS OF DATA FROM THE RESEARCH SURVEY

4.0: Introduction

In the last chapter, the methodology used for the survey was described. In this chapter, the data from each survey (pilot and main) will be presented and analysed. In this connection, it should be noted that eventhough the two surveys were carried out at different times nevertheless they were for similar purposes. It will be shown that the pilot survey did indeed provide useful results which provided the justification for a subsequent main survey involving a larger sample. The analysis of data for the survey was carried out on the computer with the SPSS statistical software.

4.1: Presentation of the data

The data from the questionnaires will be analysed in the following order:

- data relating to the background of the school and those of the teachers. (see Appendices Ci to Civ).
- data relating to the primary six science topics which teachers found difficult to teach. (see Appendices Ci and Civ).
- data relating to the reasons given by teachers for identifying any given primary science topic as difficult. (see Appendices Ci and Civ)
- data relating to the teaching strategies used by teachers in teaching primary six science. (see Appendices Cii and Cv)
- data relating to the methods of assessing pupils' work in primary six science. (see Appendices Ciii and Cvi).

The raw data relating to the pilot and the main surveys although obtained at different times have been coded, for the purposes of this analysis, in an almost identical fashion as can be seen in Appendices Ci to Cvi. The raw data are presented in the form of a matrix, the columns representing variables such as the sex of the teachers, academic qualifications, science topics taught, etc., while the rows represent values of these variables, such as the level of difficulty in the teaching of primary school science, etc.,. The interpretation of the coding is in Appendix Cvii.

4.2: Analysis of the data

The purpose of the analysis is to answer the questions posed in chapter 3 as well as to elucidate the nature and trends of the raw data. The raw data were analysed partly manually and mostly by computer using the SPSS software.

Table 4.1a. Background information about the schools and teachers who completed the teachers' questionnaires in December 1992 and January, 1993.

State of schools	No of schools	School location		Total number of teachers	Teachers years of experience			Sex of teachers	
		Urban	Rural		0-4	5-9	10or>	Male	Female
Plateau	10 (27.8%)	5 (50%)	5 (50%)	17 (34%)	4 (23.5%)	8 (47.1%)	5 (29.4%)	2 (11.8%)	15 (88.2%)
Kaduna	8 (22.2%)	2 (25%)	6 (75%)	10 (20%)	0 (0%)	5 (50%)	5 (50%)	5 (50%)	5 (50%)
Anambra	18 (50%)	10 (55.6%)	8 (44.4%)	23 (46%)	4 (17.4%)	8 (34.8%)	11 (47.8%)	5 (21.7%)	18 (78.3%)
Total	36 (100%)	17 (47.2%)	19 (52.8%)	50 100%)	8 (16%)	21 (42%)	21 (42%)	12 (24%)	38 (76%)

Table 4.1b: Continuation of the teachers' background information (pilot survey).

State of schools	Number of schools	School location		Total number of teachers	Academic qualification of teachers			Background in science.		
		Urban	Rural		GradeII	NCE	B.Ed	TTC	Inset	None
Plateau	10 (27.8%)	5 (50%)	5 (50%)	17 (34%)	5 (29.4%)	3 (17.6%)	9 (52.9%)	3 (17.6%)	1 (5.8%)	13 (76.4%)
Kaduna	8 (22.2%)	2 (25%)	6 (75%)	10 (20%)	6 (60%)	1 (10%)	3 (30%)	0 (0%)	0 (0%)	10 (100%)
Anambra	18 (50%)	10 (55.6%)	8 (44.4%)	23 (46%)	4 (22.2%)	6 (26.1%)	13 (56.5%)	10 (43.5%)	0 (0%)	13 (56.5%)
Total	36 (100%)	17 (47.2%)	19 (52.8%)	50 (100%)	15 (30%)	10 20%)	25 (50%)	13 (26%)	0 (0%)	36 72%)

Table 4.2a. Background information about the schools and teachers who completed the teachers' questionnaires in May-July, 1993.(Main)

State	No of schools	School location		Total number of teachers	Teachers years of experience			Sex of teachers	
		Urban	Rural		0-4	5-9	10or>	Male	Female
Plateau	9 (12.7%)	5 (55.6%)	4 (44.4%)	24 (18.5%)	5 (20.8%)	11 (45.8%)	8 (33.3%)	9 (37.5%)	15 (62.5%)
Kaduna	28 (39.4%)	19 (67.9%)	9 (32.1%)	38 (29.2%)	3 (7.9%)	20 (52.6%)	15 (39.5%)	21 (55.3%)	17 (44.7%)
Anambra	34 (47.9%)	16 (47.1%)	18 (52.9%)	68 (52.3%)	7 (10.3%)	18 (26.5%)	43 (63.2%)	10 (14.7%)	58 (85.3%)
Total	71 (100%)	40 (56.3%)	31 (43.7%)	130 (100%)	15 (11.5%)	49 (37.7%)	66 (50.8%)	40 (30.8%)	90 (69.2%)

Table 4.2b: Continuation of the teachers' background information (main survey).

State of school	Number of schools	School location		Number of teachers	Academic qualification of teachers			Background in science.		
		Urban	Rural		Grade II	NCE	B.Ed	TTC	Inset	None
Plateau	9 (12.7%)	5 (55.6%)	4 (44.4%)	24 (18.5%)	9 (37.5%)	15 62.5%)	0 (0%)	2 (8.3%)	0 (0%)	22 (91.7%)
Kaduna	28 (39.4%)	19 (67.9%)	9 (32.1%)	38 (29.2%)	18 (47.4%)	18 (47.4%)	2 (5.3%)	12 (31.6%)	6 (15.8%)	20 (52.6%)
Anambra	34 (47.9%)	16 (47.1%)	18 (52.9%)	68 (52.3%)	14 (20.6%)	45 (66.2%)	9 (13.2%)	14 (20.6%)	4 (5.9%)	50 (73.5%)
Total	71 (100%)	40 (56.3%)	31 (43.7%)	130 (100%)	41 (31%)	78 (60%)	11 (8.1%)	28 (21.5%)	10 (7.7%)	92 (70.8%)

4.2.1: Background data on the schools and teachers

The first section of the questionnaire (section A) had sought information on the teachers background information as well as their school. This included their sex, years of experience, academic qualifications, professional training in science and the school's location.

The data obtained in the pilot survey are presented in Table 4.1ab, it will be seen that the distribution of the location between urban and rural schools is even. The majority of the teachers sampled in all the states were female in Plateau and Anambra states and even in Kaduna state. In terms of academic qualifications , the majority (60%) of the teachers in Kaduna state were Grade II Certificated, whereas in Anambra and Plateau state 56.5% and 52.9% were predominantly B.Ed holders respectively. With regards to the background of the teachers in science , the majority (72%) in all three states had no such background. All the teachers in Kaduna State, in particular, had no science exposure at all. Regarding the issue of number of years of experience in teaching, majority (84%) of the teachers had taught for at least five years in the primary school, while only a few (16%) were fairly new in the field.

The corresponding figures for the main survey are shown in Table 4.2ab. The figures mirror those of the pilot survey in terms of school location, sex distribution of the teachers and teachers' background in science. The main difference is in the academic qualification of the teachers. Here, the majority of the teachers were NCE holders as opposed to B.Ed holders in the pilot survey. A possible explanation for this could be that this is a chance occurrence since the NCE is the minimum academic qualification for primary teachers in Nigeria. As regards the number of years experience of the teachers, a similar trend as in the pilot was observed.

Table 4.3: Number of teachers specifying particular level of perception of difficulty to teach given science topics (Pilot survey).

Science topics	Number of teachers specifying particular level of difficulty of teaching.					
	Levels of difficulty					
	1	2	3	4	5	Total
Animals	17 (34%)	26 (52%)	6 (12%)	1 (2%)	0 (0%)	50
Earth and sky	3 (6%)	20 (40%)	13 (26%)	8 (16%)	6 (12%)	50
Environment	9 (18%)	26 (52%)	12 (24%)	2 (4%)	1 (2%)	50
Health and safety	13 (26%)	26 (52%)	6 (12%)	4 (8%)	1 (2%)	50
Magnet	4 (8%)	9 (18%)	10 (20%)	16 (32%)	11 (22%)	50
Measurement	4 (8%)	16 (32%)	20 (40%)	9 (18%)	1 (2%)	50
Modelling and Relevant technology	0 (0%)	4 (8%)	13 (26%)	19 (38%)	14 (28%)	50
Rocks and Minerals	3 (6%)	8 (16%)	20 (40%)	15 (30%)	4 (8%)	50
Water	18 (36%)	27 (54%)	5 (10%)	0 (0%)	0 (0%)	50

Table 4.4: Number of teachers specifying particular level of perception of difficulty to teach given science topics (Main survey).

Science topics	Number of teachers specifying particular levels of difficulty of teaching.				
	Levels of difficulty				
	1	2	3	4	5
Animals	45 (34.6%)	66 (50.8%)	14 (10.8%)	4 (3.1%)	1 (0.8%)
Earth and sky	9 (6.9%)	48 (36.9%)	27 (20.8%)	36 (27.7%)	10 (7.7%)
Environment	34 (26.2%)	69 (53.1%)	21 (16.2%)	3 (2.3%)	3 (2.3%)
Health and safety	40 (30.8%)	65 (50%)	18 (13.8%)	6 (4.6%)	1 (0.8%)
Magnet	2 (1.5%)	32 (24.6%)	28 (21.5%)	48 (36.9%)	20 (15.4%)
Measurement	11 (8.5%)	58 (44.6%)	38 (29.2%)	20 (15.4%)	3 (2.3%)
Modelling and Relevant technology	2 (1.5%)	13 (10%)	33 (25.4%)	49 (37.7%)	33 (25.3%)
Rocks and Minerals	9 (6.9%)	46 (35.4%)	29 (22.3%)	26 (20%)	20 (15.4%)
Water	45 (34.6%)	54 (41.5%)	22 (16.9%)	8 (6.2%)	1 (0.8%)

Key: 1 = least difficult, 2 = Easy, 3 = Neutral, 4= Difficult, 5 = Most difficult.

4.2.2: Topics which the teachers find most difficult to teach.

The teachers were asked to rank the science topics provided in the questionnaire in order of difficulty as they perceived them (see Teachers questionnaire in Appendix 6).

Table 4.3 shows which topics in the primary six science curriculum teachers find difficult to teach for the pilot survey. The teachers found the 'Modelling and Relevant technology' topic the most difficult topic to teach (28%) followed by magnet (22%). If, however, levels 4 and 5 (difficult and very difficult) are taken together, then 'Modelling and Relevant technology' topic (66%) comes out again as the most difficult followed by the magnetism topic (54%). The same trend is confirmed in the main survey (see Table 4.4) where the corresponding figures are 'Modelling and Relevant technology' (63%); 'Magnet' (52.3%) respectively.

There are also topics (e.g. water and Animals) which teachers found quite easy to teach. (again, see Tables 4.3 and 4.4). These conclusions have also been summarised in Table 4.5 and 4.6 for the pilot and main surveys respectively in which the primary science topics have been ranked according to the order of difficulty of being taught, as perceived by the teachers.

Table 4.5: Order of difficulty of teaching science topics (pilot survey).

Rank	Science topics	Order of difficulty.	
		Number of teachers (levels 4 + 5)	% of teachers (levels 4 + 5)
1	Modelling and Relevant technology	33	66
2	Magnet	27	54
3	Rocks and Minerals	19	38
4	Earth and sky	14	28
5	Measurement	10	20
6	Health and safety	5	10
7	Environment	3	6
8	Animals	1	2
9	Water	0	0

Table 4.6: Order of difficulty of teaching science topics (main survey).

Rank	Science topics	Order of difficulty.
	Number of teachers (levels 4 + 5)	% of teachers (levels 4 + 5)
Modelling and Relevant technology	82	63.1
Magnet	68	52.3
Rocks and Minerals	46	35.4
Earth and sky	46	35.4
Measurement	23	17.7
Health and safety	7	5.4
Environment	6	4.6
Animals	5	3.8
Water	9	6.9

Table 4.7: The reasons for a topic being found most difficult to teach (pilot survey)

Reasons for topics identified as difficult.	Number of teachers n=41	Percentage of teachers.
Ideas difficult to conceptualize.	33	66%
Textbook language found complex.	3	6%
Resources available for teaching topic are insufficient.	27	54%
Set objectives inappropriate to the age of the children. (too abstract).	7	14%
Teachers lacked practical skills that would have been required while in training.	28	56%
Any other reason.	0	0%

Table 4.8: The reasons for a topic being found most difficult to teach (Main survey)

Reasons for topics identified as difficult.	Number of teachers n=130	Percentage of teachers.
Ideas difficult to conceptualize.	80	61.5%
Textbook language found complex.	12	9.2%
Resources available for teaching topic are insufficient.	97	74.6%
Set objectives inappropriate to the age of the children. (too abstract).	11	8.5%
Teachers lacked practical skills that would have been required while in training.	64	49.2%
Any other reason.	0	0%

4.2.3: Why teachers found particular topics as being difficult to teach

A section of the questionnaire used for the main survey had sought to elicit information on why the teachers found some science topics difficult to teach. In this regard, several options were provided to them from which to choose, and where necessary to choose as many options as suits their individual reactions (see Appendix C).

The particular topics which the teachers found difficult to teach is of interest. But the reasons why they found the particular topics difficult to teach represent the key to any effort geared towards improving the ease with which the teachers could teach those topics. An analysis to identify the most important of such reasons has been done on the raw data obtained from both the pilot and main surveys. Table 4.7 shows the result of this analysis for the pilot survey . From this , it will be found that three reasons stand out: (a) the ideas involved in the particular topics were found by the teachers difficult to conceptualize (involving 66% of the teachers sampled), (b) the teachers lacked the practical skills for teaching, that they ought to have acquired during their training (56%), and (c) Resources available for teaching topic are insufficient (54%).

A similar trend was also found for the main survey with the proportion of teachers responding to each of the three reasons being, 74.4%, 49.2% and 61.5% respectively.

Table 4.9: Number of teachers identifying specific methods of teaching science from pilot survey.

Methods of teaching science	**No of teachers identifying methods of teaching science. n = 50**		
	Frequency of teaching methods.		
	Always	Sometimes	Never
Use of imagination	14 (28%)	23 (46%)	13 (26%)
Enquiry/discovery approach	25 (50%)	21 (42%)	4 (13.8%)
Problem solving	26 (52%)	24 (48%)	0 (0%)
Discussion with pupils	41 (82%)	9 (18%)	0 (0%)
Others	0 (0%)	0 (0%)	0 (0%)

Table 4.10: Number of teachers identifying specific methods of teaching science from main survey.

Methods of teaching science	**No of teachers identifying methods of teaching science. n = 130**		
	Frequency of teaching methods		
	Always	Sometimes	Never
Use of imagination	27 (20.8%)	72 (55.4%)	31 (23.8%)
Enquiry/discovery approach	42 (32.3%)	70 (53.8%)	18 (13.8%)
Problem solving	78 (60%)	49 (37.7%)	3 (2.3%)
Discussion with pupils	96 (73.8%)	34 (26.1%)	0 (0%)
Others	0 (0%)	0 (0%)	0 (0%)

4.2.4: Data on teaching strategies.

Another section of the teachers' questionnaire had sought information on the strategies teachers used in teaching science as well as the method they used for assessing primary science (see Appendix Cii and Civ). The raw data have been analysed to gain some insight into the teaching strategies used by the sampled teachers. This information is obviously of some relevance to the issue of science topics that these teachers find most difficult to teach. Clearly, the difficulty surrounding the teaching of a particular topic would vary depending on the teaching strategy adopted. In the case of the pilot survey, Table 4.9 gives the results from this, it may be observed that the teaching method used most often is 'discussion with pupils' reported by 82 % of the teachers sampled followed by problem solving (52%) and enquiry/discovery method (50%). In general, all the listed methods are used in varying degrees with 'discussion' being the main method used supplemented by the others. The same trend was also found in the data from the main survey (Table 4.10) except that two methods (discussion (73.8%) and Problem solving (60%)) stand out as the most frequently used while the others appear in supplementary roles. (see Tables 4.11& 4.12).

The questionnaire however, does not reveal what the teachers understood by discussion, problem solving or enquiry/discovery approaches. However, in the context of their training it can be assumed that they showed some common understanding. This issue is one that needed further study and was explored fully with teachers during the second phase of the research.

Table 4.11: Ranking of teaching methods used by teachers in teaching primary science topics from the pilot survey.

Rank	Teaching methods	Number of teachers responding n = 50	% of teachers responding
1	Discussion with pupils	41	82
2	Problem solving	26	52
3	Enquiry/discovery approach	25	50
4	Use of imagination	14	28
5	Others	0	0

Table 4.12: Ranking of teaching methods used by teachers in teaching primary science topics from the main survey.

Rank	Teaching methods	Number of teachers responding n = 130	% of teachers responding
1	Discussion with pupils	96	73.8
2	Problem solving	78	60
3	Enquiry/discovery approach	42	32.3
4	Use of imagination	27	20.8
5	Others	0	0

Table 4.13: Number of teachers identifying specific methods used in assessing pupils' work in primary science from pilot survey.

Methods of Assessment	No of teachers specifying methods of assessment. n = 50			
	Often	Sometimes	Never	Total
Weekly tests	41 (82%)	9 (18%)	0 (0%)	50 (100%)
End of Module Examination.	21 (42%)	25 (50%)	4 (8%)	50 (100%)
End of year examination	39 (78%)	11 (22%)	0 (0%)	50 (100%)
Drawing test.	12 (24%)	23 (26%)	15 (30%)	50 (100%)
Oral examination	12 (24%)	35 (70%)	3 (6%)	50 (100%)
Others	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Table 4.14: Number of teachers identifying specific methods used in assessing pupils' work in primary science from main survey.

Methods of Assessment	No of teachers specifying particular methods of assessment. n = 130		
	Often	Sometimes	Never
Weekly tests	110 (84.6%)	20 (15.4%)	0 (0%)
End of Module Examination.	44 (33.8%)	71 (54.6%)	15 (11.5%)
End of year examination	116 (89.2%)	13 (10%)	1 (0.8%)
Drawing test.	25 (19.2%)	54 (41.5%)	51 (39.2%)
Oral examination	16 (12.3%)	52 (40%)	62 (47.7%)
Others	0 (0%)	0 (0%)	0 (0%)

4.2.5: Data on methods of assessing pupils work in primary science

Tables 4.13 and 4.14 show the frequencies of number of methods of assessment as reported by the sampled teachers. The results for the pilot survey are shown in Table 4.13 from which it may be observed that the 'weekly test' which was identified by 82% of the sampled teachers is most frequently used, followed by the end of year examination (78%). The other methods play only a supplementary role. Again the same trend is more or less observed in the main survey (see Table 4.14) except that the end of year examination leads with 89.2% responses followed by weekly tests (84.6%). Since assessment in Nigerian primary schools is usually for promotion from one class to the other, the above result is not surprising. Other forms of assessment (such as oral examination, drawing) are usually encouraged in the lower (infant) classes where the children are not able to write properly.

Table 4.15: Ranking of Number of teachers specifying the methods of assessing pupils work in science from pilot survey.

Rank	Assessment methods	Number of teachers responding n = 50	% of teachers responding
1	Weekly tests	41	82
2	End of year examination	39	78
3	End of module examination	42	42
4	Drawing tests	24	24
5	Oral examination	24	24
6	Others	0	0

Table 4.16: Ranking of Number of teachers specifying the methods of assessing pupils work in science from main survey.

Rank	Assessment methods	Number of teachers responding n = 130	% of teachers responding
1	End of year examination	116	89.2
2	Weekly test	110	84.6
3	End of module examination	44	33.8
4	Drawing tests	25	19.2
5	Oral examination	16	12.3
6	Others	0	0

4.3: The implications of the findings

One outcome of the analysis is that the teachers in both the pilot and main surveys, found 'Modelling and Relevant Technology' as the most difficult topic to teach, followed by 'Magnets'. This result is particularly interesting because 'Modelling and Relevant technology' is in fact, an applied science topic while 'Magnet' is a pure science topic. Naturally, a teacher not trained or grounded in the pure sciences, is bound to find an applied science topic difficult to handle, and as the analysis demonstrated, the teachers' background training in science was generally poor and inadequate. In terms of a programme of training to remedy this deficiency in the teachers' background knowledge , it is clear that a workshop designed for this purpose should base its activities on pure science topics. Moreover, since the expertise of the co-ordinator (i.e. myself) of the proposed workshop is mainly in the pure sciences, it made sense that the workshop approach to be utilized in the present research effort be based on the 'magnet' topic, which was the second most difficult topic which the teachers found difficult to teach as identified in this study.

Although the aim of carrying out the pilot survey was to try the material which was used for the main survey, it may now be observed that the results of the pilot survey fully justified the idea of carrying out the main survey. Indeed, the trends of the results delineated in the pilot survey were confirmed in the main survey. However, bearing in mind that statistical errors decrease as the sample size is increased, the results of the pilot survey will in general tend to be less accurate than those of the main survey, where the sample size (of the teachers) was more than two times as large as that of the pilot sample. Thus, point to point correspondences between the results of the pilot and main surveys were not expected. Again, this was found to be so.

CHAPTER 5

PLANNING AND IMPLEMENTING TRAINING WORKSHOPS FOR TEACHERS

5.0: Introduction

The analysis of the data reported in the last chapter shows that relevant technology and magnetism were the topics found by the sampled teachers as the most difficult to teach. The result of the survey also revealed the reasons why these topics were so found. The reasons include the following:

a) The ideas behind the topics proved difficult for the teachers to conceptualize and understand.

b) The teachers lacked the practical skills required to impart scientific knowledge.

c) The resource materials available for science teaching were inadequate .

These findings were valuable as they were helpful in working out the details of the in-service training workshop for the teachers. A programme of in-service training was thus developed to enable teachers to address and improve the inadequacies in their understanding of an identified topic while improving their ability and competence to teach the chosen topic. Based on the work described in the last chapter the topic chosen was magnetism. As noted earlier, the in-service workshop was based on magnetism rather than on technology owing to the fact that the investigator considered it more appropriate to use magnetism, which is a pure science topic, than technology which is more of an applied science.

The actual in-service training workshops were run in Anambra State. This state which was among the three states sampled in the preliminary survey, was chosen mainly for the following reasons;

a) the ease of selection of the teachers

b) the state's circumstance allowed the running of the workshop at a minimum cost.

c) the state was more convenient to the investigator, who happened to hail from there.

The workshop was run in two phases. The first, or Phase 1 of the workshop, was planned for two days, while the second, or phase 2, was to last for only one day (see Appendices E and F). The first day of the phase 1, was used to introduce some strategies that could help the teachers to increase their repertoire of teaching strategies and to explore their own understanding of the science. The second day of phase 1 was focused on carrying out some practical activities on magnetism. The duration for this phase for two days was considered adequate because, not only was the workshop focused only on one topic namely magnetism, but also the workshop tried to give particular emphasis to those aspects of magnetism taught at the primary six level. Altogether, it was considered adequate, considering the cost and organisation required to enable teachers to come out of school to attend.

The second phase of the workshop, planned to take place one to two months after phase 1, was designed to enable the teachers to meet to discuss their progress in implementing strategies discussed and tried out during the first phase of the workshop. It was also intended to consider how the expertise and experience gained could be extended to other topics within the science core curriculum.

As a preliminary step, it was considered valuable for an initial visit to be made to the selected schools in Anambra state with a view to see the schools and to select and interview the prospective workshop participants in order to obtain background information about them. The choice of the participating schools and teachers was restricted to only those that participated in either the pilot or main surveys as discussed in chapter 3. However, in the end, the reality of the field work did not allow this as indeed, not all the teachers who participated in the two surveys participated in the workshop.

5.1: Selection of teachers for the workshop programme

The choice of the participating teachers in the workshop was guided by the choice of the participating schools. In the end, not all the schools that were chosen had participated in the pilot and main surveys, because of the need to keep expenses within the budget as well as the requirement to use schools which were within easy reach, for subsequent visits to provide some support to the teachers.

Before the schools were selected, the workshop co-ordinator visited the headquarters of the chosen Local Government Areas in order to formally discuss the terms of the workshop with the Chief Education Officers(CEOs)-in-Charge of the respective Local Government Education Authorities (LGEA). This was followed up with an official letter to the CEOs in order to formalize the arrangements. The CEOs having approved the proposals, assisted in the designation of schools to be used for the workshop, bearing in mind the importance of selecting only schools that participated in the earlier pilot and main surveys. At the same time, the CEO tried to accommodate those schools with a pronounced need for a retraining of their science teachers. Furthermore, it was considered necessary in the selection of the schools to ensure close proximity of the chosen schools to the state capital (where the co-ordinator was based) as well as the workshop centres to ensure easy accessibility , for purposes of the visits of the co-ordinator as well as for the travelling convenience of the teachers themselves to the workshop venue. In general, the homes of the teachers who participated in the workshop did not exceed a distance of 60 kilometres from the workshop venue.

A total of 50 primary six teachers chosen from 8 (out of the 16) Local Government Areas (LGA) of Anambra state were selected (see Appendix Eii) Three of these Local Government Areas were categorized as urban while the remaining five were deemed to be rural.

The teachers themselves were selected without regard to their academic qualifications, experience, or sex. The LGEAs were requested to write to the selected teachers to advise them of the times and dates of the workshop.

The workshop was carried out in three times at two different centres: namely, Awka and Nnewi. The first workshop held at Government Technical College, Awka (which involved 13 teachers) was carried out to try the materials which were planned for the workshop. The two other workshops involved a total of 37 teachers (held at Government Technical College, Awka and Model Primary School, Nnewi respectively). Teachers were zoned according to their proximity to the venue of the workshop in order to reduce the cost of transporting them to the workshop venue. Apart from the trial group (13) who were picked from the same Local Government area, the main group of teachers (37) were selected from 8 Local Government Areas and this involved transporting them from their place of domicile to the workshop venues. The teachers in the main group were divided into two so as to allow optimum management of the resources available for the workshop.

5.2: The Initial Interview and observation of teachers

Having agreed with the CEOs of the LGEAs on the schools to be involved in the workshop, a visit was then made to each of the schools in order to meet the teachers and to identify those who had completed the questionnaire of an earlier survey. In this regard, the head teachers of the schools were of great assistance. As it turned out, not all the teachers that were met and selected for the workshop, had filled out the questionnaire of the earlier survey. In this circumstance, such teachers as were selected were apprised of the purpose and objectives of the study and they were then interviewed on the spot to obtain their relevant background information. Altogether, the selected teachers were involved in two sets of interviews. The first interview was carried out during the co-ordinator's first visit to the teachers' schools, while the second took place few weeks after the 2-day workshop.

The aim of the first interview was to enable the co-ordinator to:

- familiarise the teachers with the aims and objectives of the investigation.
- to obtain an impression of the quality of science teaching in the chosen schools (through direct interview of the teachers and the observation of their handling of science lessons).
- ascertain what the teachers themselves hoped to gain from the workshop.

The teachers were interviewed individually and given the opportunity to express their perception of science teaching in their school. Altogether, 50 primary six teachers from 41 primary schools were interviewed. As some of the teachers had not participated in the questionnaire survey, and a few had forgotten whether they had completed a questionnaire during the previous year, it was decided to ask all participants to complete a fresh questionnaire and bring it to the workshop. The purpose was to find out if the teachers who participated in the workshop had a different view from the outcomes of the survey.

5.3: Description of interview tools and presentation of findings from the interview.

In the interviews of the teachers discussed above, questions were raised which were structured along the following lines (The interview schedule is shown in Appendix G):

a. ***Background information:*** This section of the interview questions sought such information about the teacher as the name of his/her school, the location of the school, the name of the teacher, the teacher's years of teaching experience, teacher's gender, academic qualifications and finally, the teacher's prior participation in an in-service training programme in science.

b. ***Information on the teaching of Primary science:*** This section sought relevant information on the teaching of primary science, in the chosen school such as the number of teaching periods on the weekly timetable and whether science was taught as a separate subject.

c. ***Information on teaching strategies used in the teaching of science***: This section sought information on the teaching strategies adopted most frequently by teachers in teaching science and the reasons, if any. Other strategies which the teachers would have preferred but were unable to use, were also sought, together with the reasons for such preference.

d. ***Information on the assessment of the pupils' work in science***: In this section the teachers were asked to explain why primary science as such needed to be assessed; and to describe how practical work in science was assessed. They were also asked to indicate what aspects of science they found difficult to assess and why. Finally, the teachers were asked to describe how continuous assessment in primary science is usually carried out.

e. ***Information on what the teachers hoped to achieve during the workshop:*** Teachers were also asked to indicate what they hoped to achieve during the workshops. The teachers' responses will now be considered in some detail in the following sections.

5.3.1: Information on the schools and teachers used for the workshop

The relevant information on the designated schools as well as the teachers selected for the workshop is summarized in Table 5.1. Altogether 41 schools, of which 18 were in urban areas and 23 in rural areas, were the source from which 50 teachers participating were drawn. 76% of the teachers were NCE holders while 24% were B.Ed holders. However, an overwhelming majority of these teachers (92%) had no previous background training in science, either through Grade II Certificate or higher or through an in-service training. programme. The teachers' profile is similar to that obtained from the two surveys (see chapter 4).

5.3.2: Data on the teaching of science.

In order to form a reliable impression about the science teaching background of the teachers, the following questions were raised during the interview:

1. How many science periods were provided to the children in a week?
2. Is science taught as separate subject?
3. Does the teacher agree that magnetism is difficult to teach? If not, what other topic was found difficult by the teacher?
4. What constraints did the teachers experience in the use of the practical activity method of teaching?
5. How did the teachers assess their pupils knowledge of science in the primary schools?
6. What did the teachers hope to achieve by participating in the workshop?

The responses of the teachers to the above questions were collected and analysed. It was found that science was taught as a single subject in the primary schools sampled. It was also observed that all the schools adopted the national primary science core curriculum and used the recommended primary science textbook, (viz.: 'Primary Science' by E. Akusoba) approved by the State Ministry of Education, which pupils are expected to buy. The recommended book was supplemented with a teaching pack consisting of a teachers' handbook and pupils worksheets. However, it was observed that not all schools had this teaching pack, and in some cases, where the handbook was available, the pupils' worksheets were missing. Moreover, the teachers claimed that the pupils were mostly unable to afford to buy both the textbook and the worksheets.

Table 5.1: Background information on the schools and teachers participating in the workshop.

State	No of schools	School location		Total number of teachers	Years of experience			Sex of teachers		Academic qualification of teachers			Background in science.		
		Urban	Rural		0-4yrs	5-9yrs	10>yrs	M	F	Grade II	NCE	B.Ed	TC II	Inset	None
Anambra	41	18 (43.9%)	23 (56.1%)	50 (100%)	5 (10%)	7 (14%)	38 (76%)	2 (4%)	48 (96%)	0 (0%)	38 (76%)	12 (24%)	4 (8%)	0 (0%)	46 (92%)

Regarding the teaching of primary science, 39(or 78%) of the sampled teachers reported that their schools offered just two single 35 minute periods of science a week, while only 11(or 22%) of the teachers reported as many as three single science periods a week. Indeed, no school reported having any double periods. This information indicates that the amount of work covered in these lessons could not be great and that teachers would probably teach by rote in order to cover as much of the syllabus content as possible if their pupils are to pass their examinations.

All of the teachers reported that they had experienced some difficulties or obstacles in using certain strategies (such as practical activities) in their teaching of science. The obstacle reported by the teachers included:

- non availability of suitable resource materials for science teaching
- inadequate allocation of time in the time-table for necessary teaching activities;
- lack of adequate practical experience of the teachers to carry out meaningful activities as part of their science teaching strategy.

On the issue of whether the teachers found magnetism a difficult topic to teach, a majority of 43 (86%) teachers answered in the affirmative. This response may be contrasted with the outcome of the survey reported in chapter 4 in which most of the sampled teachers indicated technology as the topic which they found most difficult to teach. However, here the teachers were only asked to react specifically to the difficulty of teaching magnetism as opposed to ranking the topics in their order of perceived difficulty of teaching. In addition, 23 (46%) of the teachers reported perceiving friction and force difficult to teach.

Surprisingly, none of the teachers reported any problems with their conceptual understanding of magnetism. This finding was different from that of the survey discussed in chapter 4. However, it was understandable that the teachers when discussing magnetism, were reluctant to indicate that they did not understand the topic.

With regard to a good predisposition of the teachers to the workshop, it was found that all the teachers interviewed were interested in attending the workshop. However, the teachers had some practical concerns regarding their ability to attend. These included:

- questions concerning the funding of their participation in the workshop.
- questions concerning benefits they may derive vis-à-vis the objectives of the workshop.
- questions concerning the possibility of obtaining official permission from their LGEAs to attend the workshop.
- questions concerning the suitability of the date and duration of the workshop, vis-à-vis their other commitments.

5.3.3: Data on the teachers' assessment of pupils primary science

A section of the teachers' initial interview dealt with the assessment of pupils in primary science. The purpose was to find out what strategies teachers used to assess pupils' knowledge in primary science and also to find out if they have any difficulties in assessing some aspects of primary science.

The questions raised in this regard included the following:

a) What is the purpose of the assessment of the pupils in primary science?

b) How do the teachers carry out the practical assessment of the pupils in primary science?

c) What aspects of science do the teachers find difficult to assess?

d) How do the teachers structure and organise the continuous assessment of the pupils in primary science?

Having analysed the teachers' responses to these questions, it was observed that all the teachers sampled claimed assessment generally as a means of ascertaining the level of knowledge gained by the pupils in primary science.

The teachers no doubt took for granted the use of examinations for the subsequent assessment and the promotion of the children to the next class. Regarding the assessment of the practical aspects of science, it was noted that the majority (92%) of the teachers sampled claimed that they lacked experience in the assessment of practical activities in science and therefore they did not assess them. However, a few (8%) of the teachers claimed that they used the method of observation and questions to assess practical activities in science. This suggests that the teachers in fact had carried out little or no practical activities in science, and in all probability had taught their science by rote.

Overall, 45 teachers (or 90%) reported that they found the assessment of practical work in science difficult. This result is consistent with the earlier finding suggesting that most of the teachers did not use practical activities as part of their teaching strategy in science, and consequently it was understandable that they found practical work difficult to assess.

Regarding continuous assessment, the teachers reported their compliance with the methods prescribed by the 6-3-3-4 system requiring that continuous assessment of any given subject is based on a combination of weekly and mid-term tests as well as yearly examinations.

5.3.4: Information on the teachers' perception of the objectives of the Workshop

The teachers' interview was also designed to elicit information on the teachers' perception of what they hoped to gain through participating in the workshop. All the teachers were found to have expected their knowledge of magnetism to be enhanced. All also believed that their participation in the workshop would promote their deeper conceptual understanding of magnetism as a topic. This they hoped would put them in a better position to transfer this knowledge to the children. It would also enable them to develop the capacity to exploit local materials for use in handling the practical aspects of primary science.

Through their experience in the workshop, the teachers also hoped to develop the power to excite the children's interest in science, and also to be able to develop appropriate strategies to ease the children's difficulty in grappling with abstract science topics.

5.4: Observation of the teachers in action and the presentation of findings from this observation

5.4.1: Introduction

Having conducted an interview of the teachers, it was considered necessary that they should also be observed teaching science lessons in their own classrooms. This observation exercise was carried out in three phases at different times. The first phase of the observation was carried out immediately after the interview while the second phase took place after the first 2-day workshop. The third and final phase took place three months after the end of the 2-day workshop. For now, the discussion of the observation will be confined to the first phase of the observation while the other phases will be considered in chapter 7. The purpose of the first phase of this observation of the teachers included the following:

- the acquisition of first hand knowledge of how science is taught in the selected primary schools;
- the checking of the consistency between the teaching strategies claimed by the teachers in the initial interview and their actual practice in the classroom;
- ascertaining the strategies used together with their effectiveness in teaching (This will allow comparisons to be made with strategies used by teachers after the workshop in order to determine whether the workshop had made any difference).

For the purposes of this observation, the author's visits to the schools were unannounced to forestall any attempt by the teachers to prepare in order to impress the investigator. However, the teachers' time table had earlier been collected it was possible to visit a teacher when he/she was teaching science. The teacher was then asked to introduce the investigator to the class as just another teacher present to assist the teacher that day. In this way, it was hoped to put the children at ease, and thus allow the class to function in a natural atmosphere. The teacher was then requested to commence his/her primary science lesson. Each lesson lasted 35 minutes.

The actual observation process was structured to address to the following questions:

1. What activities (if any) did the pupils engage in during the science lessons?
2. How much time was allocated to each of the activities?
3. What was the seating position of the children during and after the activities ?
4. What kind of resource materials were provided for the lesson?
5. What teaching strategies did teachers use during the lesson?
6. What kind of questions did the pupils ask in the course of the science lesson?
7. What kind of questions did teachers ask the pupils in the course of a lesson?

(See also the science observation proforma in Appendix H).

5.4.2: Description of the science observation instrument.

The science observation instrument is now widely acknowledge as a way for observing the pattern of science teaching in schools. The observation proforma used in this study was modelled on that developed by Eggleston *et al* (1975). This tool records intellectual transactions occurring in a science lesson, especially those that could result in differences in teaching styles. The instrument used in the present study made use of the 'time sampling technique'[11]. But while Eggleston *et al*'s instrument was developed on a 3 minute time interval, the present instrument used a 5 minute time interval schedule. (see Appendix H). The preference for a 5 minute interval derived in

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[11] This is a grid used in recording behavioural attributes of both the teacher and the pupils in a science lesson. The attributes are recorded as they occur. The time interval given is meant to enable the observer to record a specific attribute(of interest) once at that given time interval.

this study from the fact that it felt more comfortable using a 5 minutes interval instead of the 3 minutes, thus ensuring that any problems which lack of expertise in the tool might cause would be minimised.

In common with the instruments of Eggleston *et al* (1975) and Flanders[12],(in Robson, 1995) the observation instrument possesses the following features:-

- the observer is present at the designated venue.
- all the behavioural attributes to be observed is overt.
- a tick is made when a designated behavioural attribute is observed.
- the same behaviour is not recorded twice in the given time interval.
- where a behaviour is shown across a time boundary that behaviour is recorded within each time interval .
- an individual score is based on the number of time units in which the behaviour occurs.

The total frequency of the defined behaviour in the total observation time was taken. In this study, the total observation time was 35 minutes and the number of time interval units is thus 7.

Following from the above, the major features of science lesson observed in the present study include:-

- The actual time interval spent by the teachers in passing relevant information to the pupils during a science lesson. (This include both the imparting of relevant information on the topic, as well as questions asked and instructions given for practical investigations, etc.)
- The activities of the teachers during a science lesson.
- The type of questions asked by teachers in the course of science lessons.
- The frequency of children's intervention during a science lesson.
- The type of activities which children are involved in during science lessons.

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[12] Flander's technique in Robson (1995) shows that the code of the category that is observed is recorded as many times as it occurs within the time interval

- The proportion of the lesson devoted to practical activities during the 35 minutes of a science lesson.
- The type of resource materials provided for the science lesson.
- The fraction of a science lesson period involving use of materials for practical activities.

5.4.3: Description of the initial observation of teachers' science lessons

Table 5.2 presents a summary of the information obtained from the observation of the 50 teachers while in action in the classroom. The rows of Table 5.2 represent the behavioural attributes and time intervals while the columns represent the number of teachers performing a particular task at each given time.

Table 5.2: The number of teachers who engaged in a particular activity at different stages of the science lessons observed from initial observation. (n = 50).

Behavioural Attributes	**Time Interval in minutes.**						
	0-5	**5-10**	**10-15**	**15-20**	**20-25**	**25-30**	**30-35**
Teacher talk	50	50	45	40	47	50	50
Questions: Closed-type	46	23	19	10	16	27	45
Questions: Open type.	-	-	-	-	-	-	-
Teacher perform activity	-	-	2	2	2	-	-
Teacher write on board.	43	39	24	21	29	39	42
Pupils Answer question.	44	16	11	3	9	10	42
Pupils' ask question.	-	-	-	-	-	-	-
Pupils' perform activity.	-	-	1	1	1	1	-
Pupils' draw concept mapping or other type of diagrams.	-	-	1	1	1	-	-
Pupils' copy notes.	-	-	-	1	1	5	41
Pupils' seek assistance from teacher.	-	-	1	1	1	-	-
Chart used.	1	2	4	6	5	2	3
Science Equipment used.	-	-	-	-	-	-	-
Local materials used.	-	-	2	2	2	-	-
Lesson concluded.	-	-	-	-	-	-	15

5.4.4: Analysis of data from the initial observation of the teachers' in the classroom

Results from the initial observation of teachers showed that all the teachers talked during the first 10 minutes as well as in the final 10 minutes of the lesson. Indeed, the majority of the teachers talked to the pupils in each 5 minutes interval of the lesson as indicated in Table 5.2 The information was in the form of giving instructions or raising questions which were all of the closed-type.

The closed-type questions required a brief definite response from the child, such as a 'yes' or 'no' answer. The majority of the teachers asked at least two questions of this type during the first five minutes of the lesson as well as the final five minutes. All of the teachers asked at least two such questions during the lesson observed. The questions at the beginning of the lessons checked the children's initial or previous knowledge on the topic, while the questions raised at the end of the lesson were meant to check the children's understanding of the topic at the end of the lesson. A typical example of a teacher who used the bulk of the closed-type questions in her class within this time interval was the teacher coded T10 and in this instance most of the questions raised by this teacher were aimed at confirming what she had already told the children earlier. Such questions include:

- What is a magnet?
- What is a magnet made of?
- Does a magnet have poles?

In fact, it was observed in this teacher's lesson that the children answered mostly in a group, rather than individually. Some teachers however, used closed-type questions sparingly throughout the lesson.

One outstanding behavioural attribute of the pupils observed in most teachers lessons involved children listening to the teachers communicating either in the form of instructions or questions. From the above, it was easy to infer that whenever a teacher is talking, the children are expected to listen. Indeed, it was found that in nearly all the teaching sessions observed, the children spent more time listening to the teachers' talking than performing other activities.

Almost all the teachers (96%) were observed to use the lecture or didactic teaching method as their main strategy. Indeed, only 2 (4%) out of the 50 teachers made any effort to employ practical demonstration investigations as a strategy. In one lesson observed a teacher/pupil demonstration was in progress while in the other, the pupils carried out the activities by themselves after watching the teacher perform similar activity. The teacher coded T21, who allowed the children to carry out an activity was observed demonstrating the importance of the presence of air (oxygen) in the process of combustion by using an empty can, some pieces of paper and a match stick. This, was done by lighting the pieces of paper and allowing them to burn after which she asked the children to estimate how long it took to burn the paper. This activity was subsequently repeated except that the paper was covered with the can in order to limit the supply of air (oxygen). The children were than required to repeat the experiment for themselves.

All the teachers were observed writing on the blackboard at some stage during the observed lesson. Indeed, most of them did so during the first 5 minutes as well as during the final 5 minutes of the lesson. However, the blackboard was used sparingly by many teachers during the middle of the lesson i.e. between (i.e. 10-15) and (15-20) time intervals. This writing usually took the form of writing the date, the topic of the lesson, relevant sentences or words about the topic (considered new to the children), or writing a statement or instruction(s) to be carried out during the lesson.

The children were observed to copy the material written on the blackboard by the teachers mostly towards the end of the lesson. The children were at no time seen reading to their teacher, their friends/peers or to themselves. The children were also not observed to ask questions in the course of the lesson.

Only six of the teachers were observed using charts to illustrate their subject matter. This occurred mostly in the middle of the lessons , although a few teachers presented their charts at the beginning, but these charts usually took the form of pictures of things that related to the environment which were easily brought to the class. A few of the teachers introduced their pictures at the end of the lesson to clarify some points. For example (T35) brought a chart of animal drawings, mainly domestic animals found in the children's local environment such as goats, cows etc., with which the children were already familiar. A greater impact would have been obtained , had the teacher asked the children to observe these animals in their homes prior to the lesson. Another teacher (T43) displayed a chart consisting of a drawing of the structure of a human tooth. However, in the course of the lesson, the children were obviously not listening to the teacher. But worse still, some were asleep while others were busy chatting among themselves oblivious of the efforts of the teacher. No teacher was observed using any science equipment as teaching aid.

Altogether, the observed lessons tended to end rather weakly. In fact, most lessons were not formally concluded, although in some cases the teachers tried to end with a few straightforward questions with obvious answers. Most of the teachers concluded their lessons by asking the children to copy the notes written on the board.

5.5: Description of the 2-days workshop procedure and tools used.

5.5.1: Introduction

As discussed in chapter 5, the workshop was in two phases. The first phase lasted for two days while the second phase lasted for 1 day. In this section, the implementation of the 2-day workshop will be described but with an emphasis on issues of procedure and tools used. The analysis of the workshop data will be treated in the next chapter 6. There were three identical but consecutive 2-day and 1-day workshops which were conducted at different dates for different groups of teachers. (See Appendix E for details of the 2-day workshop programme).

The aims of the workshop include the following:

- To enable the teachers widen and deepen their knowledge of magnetism and at the same time be exposed to some practical activities they would need to teach this topic.
- to expose the teachers to strategies that could help them teach primary science in such a manner that both teachers and pupils simultaneously participate in the teaching and learning process;
- to help the teachers to teach primary science in an interesting way and thus to make it enjoyable to the primary school child;
- to make the teachers appreciate the value of using materials within the environment in teaching science in the classroom;
- to discover if resource materials could help to reduce the perception of difficulty in teaching magnetism by the teachers and to help them to gain confidence in teaching science.

5.5.2: First Day

The workshop started as early as 9.30a.m. with all the participants present. The workshop was formally declared open with a welcome address by an LGEA official. The LGEA also sent a number of officials from their offices as observers. The essence of the speeches made by the LGEA's representative, was that the participants were reminded about the objectives of the training workshop, such as the need to help them update their knowledge and to expose them to new experiences. They were also reminded of the need to make the most of an opportunity for the in-service training workshop geared to equip themselves with the knowledge and skills for teaching primary science topics.

The participants were then divided into groups of three, such that no group contained more than one participant from any one school. Each group was then directed to discuss freely, starting with such issues as the following:-

- whether science is being taught in their various schools as a single primary science course or as an integrated science course, etc.;
- whether a teacher assigned to a class is expected to teach all subjects on the time-table or whether a specialist teacher is assigned to teach only science;
- whether the head teacher is co-operative or well disposed to the teaching of science;
- whether the time allocated to science in the school timetable is considered adequate;
- whether there were any particular constraints encountered in teaching science, which did not apply to other subjects;
- the mode of assessment which the teacher uses to assess the pupils;
- the particular teaching strategies or mode of instruction which the teacher uses to teach science.

The above discussion was basically an icebreaker activity to enable the teachers familiarise themselves with one another and enable them to work in as friendly an atmosphere as possible.

At the end, of the above discussion a designated member of the group presented the summary of the group's discussion at a plenary meeting of all the participants (See Appendix Ei for examples of the 2-day workshop outcomes)

The teachers subsequently reported that they found the session very useful since it exposed them to what was being done in other schools. In fact, some teachers expressed surprise on hearing that some schools in one Local Government Area (i.e. Awka South) were equipped with science laboratories and that specialist teachers handled primary science in the senior classes.

This initial discussion was then followed by an exercise titled 'Magnetism story' (see Appendix I) which was supposed to last for 20 minutes. However, it took some of teachers more than 40 minutes to complete and submit their work. It was observed however, that the 'Magnetism Story' task appeared a bit difficult for the teachers to tackle. (An experience that was common in all the three workshops).

a). ***Description of the 'magnetism story' questionnaire.***

- From the analysis of data from the questionnaires, magnetism was identified as the most difficult topic in the Primary Science Core Curriculum for teachers to teach. Based on this finding, a questionnaire (see Appendix I for details) in the form of a story was developed by Mrs Jenny Frost of the Institute of Education, London University, and myself, with a view to exploring indirectly the primary teachers' concept of magnetism as well as to identify patterns of progress made by teachers in handling practical activities in science after developing adequate practical skills as a result of further training. The story was then used to obtain information about:
- primary teachers' ideas on magnetism
- how primary teachers could explain some aspects of magnetism to the primary school pupil
- the aspects of magnetism the teachers found most difficult to understand and to teach.

The story was also used to acquaint the teachers with those activities and practical exercises that could be carried out during a magnetism lesson in order to make it more interesting to the child.

The story is supposed to evolve from an initial discussion between the teacher and his/her hypothetical pupils. In the discussion developed in the story, the teacher is expected to present some materials for practical activities, and then to ask pupils questions as the story unfolds. The pupils were also at the same time expected to ask questions.

The story contains tasks at various places designated A,B,C.....H. These letters represent points at which responses were expected. Detailed instructions about each response are given at the end of the story.
Teachers were instructed not to consult textbooks for answers to the questions as this would not reflect their true knowledge of the correct answers. The returns of the individual teachers were made anonymous so that each teacher would be able to participate without any fear of the study exposing his/her individual professional inadequacy. They were also asked to comment on whether this tool could also be used to test their colleagues' ideas on magnetism.

The following are the problem set on the questionnaire story:
A: Teachers are asked to comment on what a pupil (named Sam) would observe if he tried to see the effect of a magnet on other materials.
B: A list of materials that are metals are given and teachers are asked to underline the materials that will be attracted to the magnet. (see Appendix I)

C: The teacher is asked to attempt to explain the terms 'attract' and 'repel' in magnetism in the words of a primary school pupil who had never met such words as 'attraction' and 'repulsion'. (The teacher is expected to take into account that pupils sometimes express themselves using everyday knowledge of science). This question should enable the teacher to assess how much a child would know about certain natural phenomena before being exposed to it in a science class.

D: Here the objective is to design an investigation to show how the polarity of a magnet may be determined. Teachers are expected to exhibit their design in the form they expect to use in the classroom.

E: A set of wide ranging questions are provided and teachers are asked to generate a set of corresponding questions that could be raised by pupils during a lesson on magnets. (see Appendix I). This exercise should enable the teacher to determine the state of the pupils conceptual knowledge about the topic. This feedback from the pupils should give the teacher some clues as to what activities could be organised to answer the children's questions.

F: In this section the teachers are asked to select from a list of questions in the questionnaire those that could be answered by carrying out practical activities in the classroom. In selecting those questions that could be answered through investigation, it is expected that the teachers would then be able to plan activities to provide the actual answers.

G: Here the teachers are asked to suggest a method of determining whether a magnet could operate through paper or other materials as an intervening medium, and also to determine if the quantity of paper present would affect the result.

H: Here, teachers are asked to suggest answers to questions 4, 7 and 9 on the questionnaire, the questions being:

> Q4: How do magnets manage to attract things when they are not touching them?
>
> Q7: Why are Compasses often called 'magnetic compasses', Give reasons.
>
> Q9: A textbook talks about magnets that attract and repel, what do you understand by this?

b) ***The construction of concept maps at the workshop.***

The concept mapping strategy was introduced after the completion of the 'magnetism story'. Concept mapping was one of the new strategies introduced at the workshop. The object of this strategy had been discussed earlier in chapter 2. It was to help the teachers improve their primary science teaching, and at the same time enable them involve the children more effectively in science lessons. This it is hoped would facilitate an effective assessment of the children's conceptual knowledge of science.

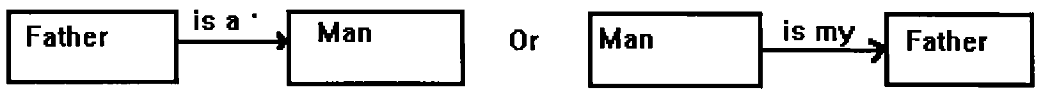
Concept mapping was also used to ascertain the primary teachers' understanding of some magnetism concepts at the start of the workshop. The maps also helped to assess what the teachers had learnt during the workshop, based on their own practical construction of concept maps.

The teachers were introduced to concept mapping method starting with some brain-storming activities. They were first asked to close their eyes and to think of any word that might come to their minds. Such a word could be an event, a noun, a process, etc. They were then asked to open their eyes and utter the first word that came to their minds. The words offered by the teachers were then collected and written on the blackboard by the co-ordinator who then classified them into groups according to their relatedness. Following this, the co-ordinator then wrote two sets of words on the blackboard and asked the teachers to state both the differences or similarities between the two sets. It was noted that the three teams of workshop participants were able to indicate that the first set of words were different from the second, on the basis that while the second set consisted of words which could be used to make sentences (e.g. is, are, study of, attracts, etc.,.), the first set consisted of names of things (e.g. boy, river, man, farm, father, magnet, etc.,.). The co-ordinator then informed the participants that the second set of words are called 'link words'. The understanding of the participants of this new idea was then tested by asking them to give other examples of 'link words'. This having been done, the workshop participants were guided to realize that the word 'join' was another meaning of the word 'link'.

At this stage, the co-ordinator encouraged the participants to devise ways of linking the two words : 'man' and 'father'. These two words were circled (or put in a rectangular enclosure) and denoted as nodes. It was then explained that nodes could be objects, people, events, concepts, etc. while links are in the nature of words used to link the nodes. Such links could be relational, or causal , or could take the form of activity. In Relational links, the link words join the two nodes showing only the relationships that exist between the nodes.

Causal or activity link words, on the other hand, are those link words used to join two nodes showing not only the relationships but also the action of one node on the other. Examples of relational link words are: 'is', 'are', 'has', 'study of', etc. Examples of causal or activity link words include 'attract', 'magnetised', 'produced', 'prepared' etc. The diagram below shows that in a concept map an arrow is always used to join two nodes.

Figure 5.1: Illustrating the concepts of nodes and links.



As an exercise, the teams or groups of teacher - participants were given different sets of words from which to generate concept maps by providing appropriate link words between the given words. Care was taken to ensure that most of the words given to the teachers were familiar to them (e.g. man, father, river, land, etc.,.). It was then found that the teams produced different types of maps. Indeed some of the maps produced showed more than one link from any given concept. These maps were subsequently exchanged among the teams of participants for discussion and for mutual criticism.

The next stage of the exercise involved the application of the knowledge of concept mapping to the topic of magnetism. In this, the co-ordinator asked the teams to choose at least ten concepts words on magnetism and then proceed to produce the concept maps of the chosen words using appropriate link words. The maps produced by each team of participants were then mounted on a large blackboard, where they were exhibited until the next day, when they were taken down and exchanged among the teams and again discussed and criticised as before. (see Appendix J for concept maps from 15 groups of workshop participants).

It may be reported here that towards the end of the second day of the workshop, the participants were asked to produce further concept maps on magnetism, except that this time, they were not given any concepts nor relevant link words. Moreover, they were instructed, not to consult any textbooks on magnetism. However, they were allowed to discuss among themselves within a team, before proceeding to construct the maps on paper, for which a maximum time of 30 minutes was allotted for the process. At the end, of the exercise, the teams efforts were again discussed and evaluated before being collected by the co-ordinator. At the end, the teachers were given handouts detailing different teaching strategies, including some guide-lines on concept mapping, as aid to the teachers in their future efforts at primary science teaching.

c) 'Ask the Object' Activity.

This exercise was again carried out by groups or teams of participants. The exercise involved giving the groups a magnet each and then asking the teams to list at least ten questions they would like to ask on the topic: magnetism, or magnets. In addition, they were also asked to classify these questions using any criteria they wished. This strategy was introduced to the teachers to enable them think through their own questions as well as help them to plan activities around the questions they raised in the class. In addition, 'Ask the Object' strategy could help the teacher to discover what the children may desire to know about a particular topic. These questions could then be used by the teacher to plan activities to answer any questions the children may raise. It is hoped that during the process of finding answers to the questions raised both the teachers and children would be enabled to restructure their concept and thus build their own concepts of the topic.

It was observed that nearly all the teams were able to use the following headings to classify the questions which they raised:

- questions which can be answered by consulting a textbook. (Ask the authority)

- questions which lead to further investigations
- questions which could be answered from common observation.

Examples of the questions raised by the individual teams as well as their classifications are summarized in Appendix Ei.

5.5.3: Second Day

The day started as usual with the review of the concept maps produced the previous day. The participants were again grouped into their previous teams. The concept maps produced by the different teams were again exchanged between the teams for discussion and constructive criticism. The comments made on the concept maps by the teams were later collected by the co-ordinator who then discussed the concept maps with each team with a view to helping them identify patterns.

The practical activity aspect of the workshop was then commenced. Altogether, six types of activity were mounted , with each lasting 30 minutes. For this purpose, the co-ordinator had earlier on set up six work places for the use of the participants in these activities in order to facilitate their smooth conduct. Copies of activity guide-lines were placed in each work place. The guidelines covered the following instructions:

- The number of activities to be carried out was indicated.
- Instructions for carrying out each of the activities were provided.
- Introduction on what participants should look out for during and after carrying out the activities.
- Questions arising from the activities requiring answers from the participants were also provided.

Finally, groups were instructed to start with any of the activities from any of the work places and to transfer to other work places in rotation until all the six activities were completed.

A description of these activities which have been numbered serially from 1 to 6 are given below. (Details of the activities are shown in Appendix K).

i) *Activity 1*

Magnets of different shapes and sizes were provided. The participants were asked to manipulate the bar magnets to enable them look at their shapes, colour, strength and by following the instructions given to record their observations. (See Appendix K)

ii) *Activity 2*

The activity materials included two bar magnets, some iron filings and a sheet of thick paper. The activity involved placing the bar magnets on the thick paper and spraying the iron filings in the vicinity of the magnets with a view to revealing the magnetic lines of force around each magnet. The participants were also instructed to note the pattern of the iron filings when the two magnets point in the same direction as well as when they point in the opposite direction. They were required to trace the field patterns on the paper in these cases.

iii) *Activity 3*

The activity materials included, a horse shoe magnet, a test-tube holder, a test-tube clamp holder as well as paper 'fishes' floating in a cylindrical pond made with cardboard paper. The 'fish' had attached to it either iron chips, brass paper clips or nothing . The participants were instructed to try to pull out the paper 'fishes' using the horse shoe magnet and their to explain why it was impossible to pull out some of the 'fishes' in this manner.

iv) *Activity 4*

The activity materials included, steel needles, a bar magnet, some cork stoppers and a cylindrical vessel containing water. The participants were first instructed to magnetise the steel needles by stroking them along their length with the bar magnet. They were then to pass the needle through the cork stoppers and to float the combination and then use a compass to identify the polarity of the magnetized needles.

v) *Activity 5*

This activity was designed to simulate the so-called 'Indian rope trick'[13]. The materials included a stand, a bar magnet, an iron paper clip, and a piece of cotton thread. The apparatus was mounted by the co-ordinator using a retort stand to support the magnet.

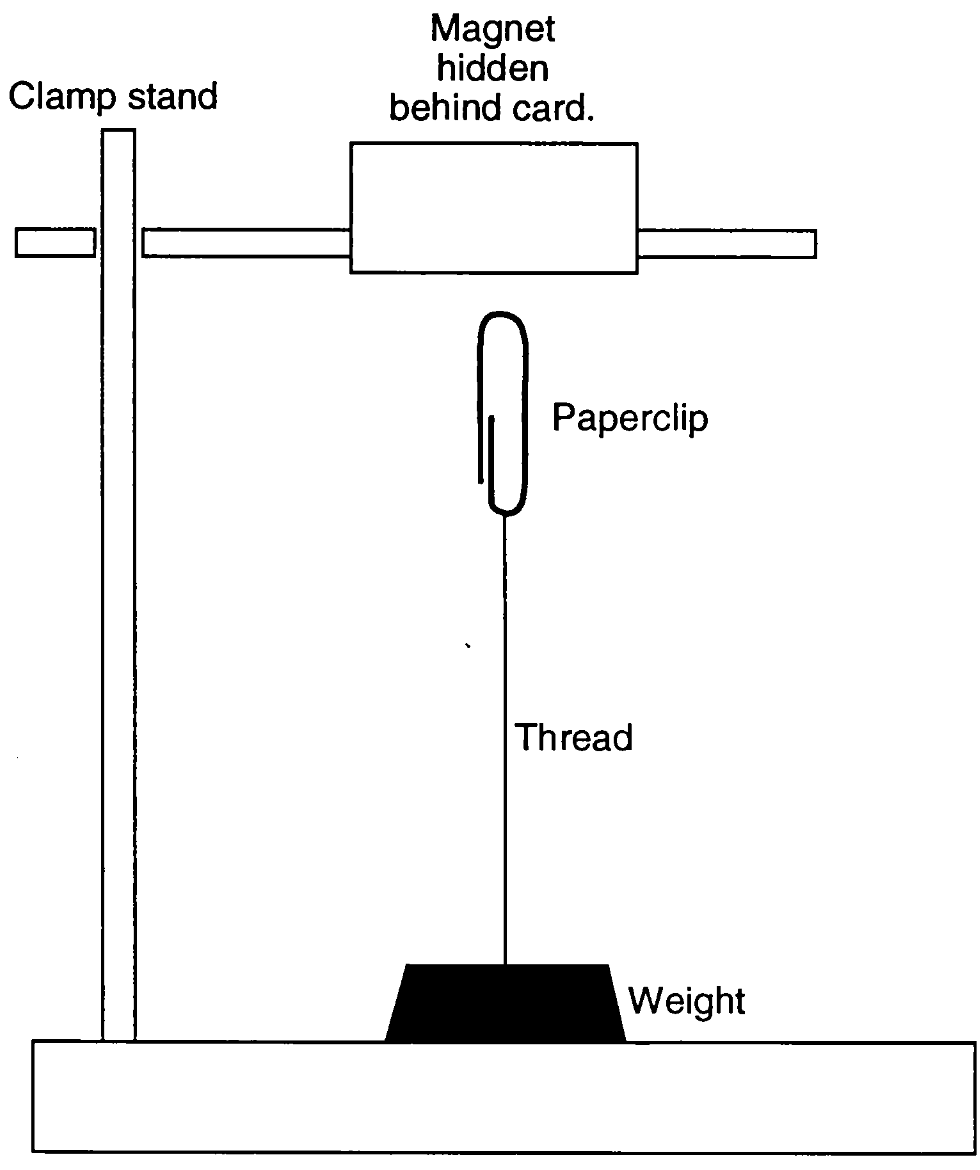


Figure 5.2 Illustration of the 'Indian rope trick'

[13] This is a name given to an experiment which illustrates the effect of the magnetic feild on a magnetic material.

A piece of cotton thread which was attached to an iron paper clip was attached to the base of a retort stand carrying the magnet as shown in figure 5.2. The participants were then required to observe the set-up and to explain why the paper clip although pulled towards the magnet , did not touch it.

•

vi) *Activity 6*

This activity called the 'Magnetism Game' activity. (details of which are given in Appendix L).

The teachers were asked to play the game and indicate the possible advantages and disadvantages of using the game in their science lessons. They were also asked to suggest when best the game should be used for science lessons as well as how it could be used to yield maximum positive effect on the pupils.

This game (which was modelled after the popular game called 'Monopoly') was designed by the co-ordinator as an aid for teaching magnetism. It involved the use of a rectangular shaped game board on which demarcated spaces were created along a thin **periphery** of the board and the spaces were given such names as 'Bank', 'chance', 'Questions'.

To play the game, a dice is thrown by players in turn and they move their 'tokens' in the form of a short bar magnet according to the number obtained by them in each throw. The outermost periphery of the board is divided into squares, with each square carrying a statement directing the players on the next action to take when the magnet, (moved round the bound a number of steps dictated by the dice), stops at any given square. In the course of the motion of a magnet round the board, points (negative or positive) are earned. The points are given monetary value in terms of the local currency - Naira. The winner of the game is the player who manages to accumulate the maximum amount of cash. To facilitate these business-like transitions, the game maintains a bank with a supply of artificial paper currency. Some of the squares are labelled 'chance' meaning that a player landing there must consult the topmost card in the deck of 'chance' cards to determine a penalty or a reward has been earned by the player. There are also certain squares on the game board boarder which are marked 'Question' each of which has a question about magnetism, such as: Who discovered the magnet?;

A set of 'Questions' cards, are kept in the space marked 'Question' located at the centre of the game board just as in the case for 'Bank' and 'Chance' cards. If a player lands on a position marked 'Question', a question from the question deck is picked and read to the player, who must then answer it. If the answer given is correct, the player is entitled to draw 100 Naira from the 'Bank' , otherwise, a 100 Naira fine must be paid into the 'Bank' .

The two 'tokens' are placed in the square marked 'START' before the game starts. An arrow on the game board shows the direction in which a player can move.

The 'Magnetism game' may be used in order to achieve the following results in the course of teaching magnetism:

- to demystify the concept of magnetism
- to familiarise the children with the scientific language/terms associated with magnetism by their repeated use during the game
- to assess how much knowledge the children had gained during the course of a lesson in magnetism and to make necessary adjustments in teaching strategy especially where misconceptions were observed.

The workshop participants were advised not to attempt activity 6 until they had finished the preceding five activities.

It was observed that in the course of these activities that thirteen out of fifteen teams of participants were able to set up the magnetism game as instructed without much difficulty, while the other two teams needed some assistance from the co-ordinator.

As an evaluation of activity No 6 , the following observations are ventured. First, the requirement that the player who first succeeds to accumulate earnings of N1000 be declared the winner did not often produce a technical winner, as more of the players accumulated that much money. Nevertheless, the participants felt it was the best activity in the workshop, and indeed wanted to take the game back to their various schools. This was not possible as the game still required some refinements. Nevertheless, the participants believed that the game would act as a vital aid in their teaching of magnetism since it would help their children to learn and remember magnetism concepts and jargons. In addition, the game would help to clarify misconceptions made during the teaching of the topic. The co-ordinator in the end promised to send game sets to the participants as soon as they were refined and assembled.

It may also be observed that the interest and motivation aroused by the game was such that the teachers did not mind working beyond the allotted time such that break time was delayed by 30 minutes.
Because of the great interest shown in the game during the workshop, the co-ordinator considered it a good idea to use the game again, during her follow-up visits to the teachers in their schools to assess the impact of the 2-day workshop on the teaching effort of the participants.

The plenary session, involving reports of the activities and discussions within the individual teams were presented by nominated team members to the general plenary of all participants. The suggestions made by the participants are summarized in Appendix Ei·At the end of the plenary session, the 'magnetism story' questionnaire was repeated and this time the groups were again asked to prepare another concept map on magnetism as in the earlier exercise. This was to enable the researcher to make comparisons between their learning outcomes before and after the workshop.

The workshop was formally closed at the Awka venue by an Education officer from the Awka South Local Government, and in the case of the Nnewi venue, by an Education Officer from the Nnewi Local Government. The closing remarks of these two officials included expressions of gratitude to the co-ordinator for providing some Anambra State primary teachers with the opportunity to update their knowledge and skills particularly in the teaching of magnetism. The hope was also expressed that the same opportunity would be extended to teachers not selected for the workshop. The addresses also touched positively on the issues of government policy raised by the participants in their remarks during the closing plenary. One of the participants speaking on behalf of the participating teachers enumerated some of the benefits they gained through the workshops especially their exposure to uncommon textbooks, interesting teaching strategies and the practice of team work. She hoped that their non-participating colleagues would in turn be afforded the same opportunity to improve their science teaching.

The co-ordinator finally thanked all the participants for their co-operation in the running of the workshops and urged them to try to implement the new strategies. They were given some questions on magnetism (see Appendix M) to help them probe the children's ideas on the topic. Each teacher was given ten copies of the questions to be administered to ten pupils before the teaching of magnetism and ten copies for use after the teaching.

CHAPTER 6

ANALYSIS OF DATA FROM THE 2-DAY WORKSHOP

Section 6.0: Introduction:

The workshop organised in the course of this investigation is a follow-up to the survey, reported in chapters 3 and 4 which sought to identify the teacher's inadequacies in the teaching of primary science in selected parts of Nigeria. In this chapter, the data obtained from the activities undertaken by a sample of fifty primary school teachers during the 2-day workshop will be analysed with a view to providing information about the following:

a) The level of the teachers understanding of the physical phenomenon of magnetism.

b) The teaching skills of the teachers in terms of their ability to devise and organise practical activities as part of a general strategies for teaching primary science.

c) The pedagogical approach of the teachers to the handling of such an abstract topic as magnetism.

The analysis will focus on data obtained from activities undertaken during the 2-day workshop, such as the 'magnetism story', concept mapping, and 'Ask the Object' exercise.

6.1: Data relating to teachers' understanding of magnetism

Information about the teachers' understanding of magnetism is drawn from the following workshop activities:

a) questions 1, 2, 8, and 9 of the magnetism story, (see Appendix I)

b) concept mapping, and

c) practical workshop activities

The following areas of the teachers' understanding of magnetism were explored:

- The distinction between magnetic and non-magnetic materials;
- An explanation of the action of a magnet in attracting magnetic materials separated from it;
- An explanation of why compasses are sometimes called magnetic compasses;
- The meaningful representation of concepts or concept terms on magnetism concept maps;
- An explanation of some phenomena observed during the practical investigations in magnetism.

6.1.1: The teachers' ability to distinguish between magnetic and non-magnetic materials

The teachers' understanding of magnetic materials was investigated using questions 1 and 2 of the magnetism story (see Appendix I). Question 1 did so indirectly, by asking the teacher to suggest what a child would describe as magnetic materials. This question has the obvious limitation that although the teacher would probably know the correct answer, yet s/he might feel obliged to give an incorrect answer based on his/her perception of what the pupil is expected to know. On the other hand, a correct answer, may merely reflect the teacher's own knowledge. Question 2 in contrast was more demanding, and direct in asking teachers to identify the magnetic and non magnetic materials themselves from a given list.

The analysis of data resulting from this part of the study will rely on the degree of difference between a teacher's response to the questions before and after the workshop. If all other factors are held constant, it may be assumed that a change in the teacher's response is attributable to the workshop. An incorrect response before the workshop followed by a correct one after the workshop would indicate a definite improvement in the teacher's knowledge as a result of the workshop. On the other hand, a correct response obtained before the workshop which is followed by an incorrect response after the workshop will be taken to mean that the workshop may have had a negative influence on the particular teacher in question.

The responses were categorized into four groups as follows:

Category 1: The teacher's responses to questions 1 and 2 are correct both before and after the workshop.

Category 2: The teacher's response to question 1 before and after the workshop is correct while the response to question 2 is incorrect before the workshop but correct after the workshop.

Category 3 : The teacher's responses to both question 1 and 2 are incorrect before and after the workshop.

Category 4: The teacher's responses before and after indicates an irrelevant 'scientific' view in response to question 1 and incorrect to question 2 before and after the workshop.

Table 6.1: Summary of categories of teachers' responses and the percentage of teachers in each category.

Categories of response	Number of teachers n = 50	% of teachers
1	1	2
2	35	70
3	6	12
4	8	16

From Table 6.1 it can be seen that the majority of answers to questions 1 and 2 fell into a simple pattern. 35 teachers (70%) replied correctly to the first question both before and after the workshop, and replied incorrectly to question 2 before the workshop but not afterwards. This result suggests that these teachers had some, but incomplete, knowledge of magnetic materials prior to the workshop, and that this knowledge was improved or extended by the workshop experience. Only one teacher gave correct answer to both question 1 and 2 before and after the workshop. This teacher's results obviously cannot show any improvement, being and remaining correct.

The remaining 14 teachers gave incorrect or not relevant answers to question 1 both before and after the workshop, and also gave wrong answers to question 2 on both occasions. Of these 14, 6 gave answers to question 1 which were relevant but contained mistakes, while 8 gave answers to question 1 which tended not even to be relevant.

The outcome seems clear. A majority of the teachers had some prior knowledge and were helped by the workshop. A minority had little or no prior understanding. This evidence, if taken alone, points to some positive effect of the workshop. No teacher's performance deteriorated as a result of the workshop, suggesting that the activities were not unhelpful. No teacher replied 'incorrectly' to question 1 but correctly to question 2, suggesting that the fear that they might report children's ideas which they knew to be wrong on question 1, is unfounded.

Examples of responses from the four categories:

The teacher (T10) who was correct all the time answered as follows:

> *"Sam might have said, that the metal things stick to the magnet, the paper clips stick to the magnet while the brass and aluminium will not".*

After the workshop, the same teacher suggested in response to question 1 that:

"Sam must have said that some metals stick or are attracted to the magnet especially the paper clips, the brass and aluminium will not".

The teacher's response before the workshop can be described as correct in that it appears to make a distinction between magnetic and non-magnetic materials i.e. materials that are attracted by the magnet and those that are not- which would have been a perfectly acceptable distinction. However, her statement that :

"the metal things stick to the magnet"

can be interpreted to mean that all metals are attracted by the magnet, which is incorrect.

However, this ambiguity is not evident in the teacher's response after the workshop when she said:

" .... that some metals stick or are attracted to the magnet "

Here there is a qualification suggesting that not all metals "stick to the magnet" as indicated in the earlier response.

With respect to question 2, the teacher coded T10 underlined correctly the magnetic materials in the list provided before the workshop. When the teacher's response to question 2 is combined with her response to question 1, it may safely be concluded that from the beginning she possessed a good understanding of magnetic and non-magnetic materials.

Altogether, 35 teachers were found to have improved in their understanding of magnetism after the workshop. One of them coded T35, suggested the following before the workshop;

"Sam might have observed that the magnet can attract metal materials like paper clips but does not attract brass paper fasteners and not saucepan which is made of aluminium ."

This represents a correct response according to our scheme in that it distinguishes between magnetic and non-magnetic materials and gives examples of each.

After the workshop, T35 suggested that:

"Sam will discover that among the metals given to him, only the paper clips can be magnetised while brass paper fasteners and saucepan are non magnetic substances."

Looking at the two responses (before and after the workshop), it might seem that there was no difference in the responses, but the response after the workshop provided evidence of more awareness of the concepts of magnetic and non-magnetic materials. However, both responses can be described as correct.

Before the workshop, T35 in question 2, underlined the following as being attracted to a magnet from the given list of magnetic and non-magnetic materials.

"A pair of Geometry compasses, iron hair clip, brass paper clips, steel drawing pins".

The inclusion of brass paper clips was interesting in view of the response given to question 1.

After the workshop, T35 underlined the following items:

A pair of Geometry compasses, iron hair clip, steel drawing pins.

The teacher appears to have had some understanding of magnetism before the workshop and to have benefited from the workshop.

An example of a teacher who made no improvement is T26 who, before the workshop, responded as follows to question 1:

> *"Sam said that the paper clips and the brass paper did not stick to the magnet even the saucepan made of aluminium. But it used to stick to the cars and fridge doors".*

After the workshop, T26 had this to say with respect to question 1:

> *"Sam might have said that when he placed a magnet on the materials it attracted the paper clips and the brass paper fasteners but the saucepan was not attracted to the magnet".*

The teacher's response before and after the workshop illustrates a case of someone who is not very familiar with magnetic materials; her description fails to distinguish correctly between magnetic and non-magnetic materials and therefore is incorrect.

With respect to question 2, the teacher [T26] could not identify correctly the magnetic materials in the tray before the workshop and she could not do so after the workshop.

The following is a list of the materials which T26 underlined as magnetic materials before the workshop:

> *"pair of geometry compasses, gold ring, gold earclips, golden latch and handle on the door, steel drawing pins.*

After the workshop, she underlined the following:

> *A pair of geometry compasses, brass paper clips, steel drawing pins.*

The above teacher obviously has a problem in identifying whether brass is magnetic or not, especially because she did not suggest in her response to question 1 that brass will be attracted to the magnet before the workshop but changed her view after the workshop.

Another example of a teacher who made no improvement is T43 who before the workshop said the following:

> *"Sam might have said that what happens to magnets as the forces between the magnets had been easily felt; like that of pushing (attraction) and drawing away (repulsion) and that the magnets stick together".*

After the workshop, the same teacher suggested in her response to question 1 again that:

> *"Sam could have said that magnets attract metals and repel non-metals".*

The above responses illustrate a case where the teacher gave a response which can be regarded as irrelevant to the question. The teacher's response before the workshop was not only incorrect but also irrelevant to the question because, the teacher failed to identify the magnetic and non-magnetic materials in her response but focused solely on attraction and repulsion. The teacher's response after the workshop was also irrelevant and, additionally, indicated some element of misconception of the word 'repulsion' in her response. This misconception, although interesting, does not affect the categorisation of the response.

However, with respect to question 2, the teacher [T43] could not correctly identify the magnetic and non-magnetic materials either before or after the workshop. This shows again a lack of knowledge before and after the workshop and the teacher could not be said to have gained much knowledge about this aspect of magnetism from the workshop.

6.1.2: Teachers' Explanation of the action of a magnet in attracting magnetic materials separated from it.

This analysis covers one of the questions that form part of question 'H' of the 'magnetism story' (see Appendix I) which sought the teachers' explanation as to why magnets manage to attract things separated from them. This question was intended to discover whether teachers understood that a magnetic force produced by a magnet enables it to pull things to itself without touching them.

The question sought to find out:

a) The ideas teachers use to explain their understanding of the action of a magnet.

b) The difference in the teacher's understanding of the action of a magnet before and after the workshop.

In this regard, four categories of responses were obtained from the teachers as follows:

Category 1: 'Technically correct': A good description is given which is correct in the sense that the explanation uses such scientific terms as magnetic force, etc. The teacher thus shows that the magnet attracts objects to itself as a result of its magnetic force.

Category 2: Essentially correct: Here, the teacher uses non-scientific or everyday language to describe the phenomenon. Also, included here are answers describing an experiment to show the effect of the magnetic force on a magnetic material without the magnet touching the material.

Category 3: Incorrect response.

Category 4: No response.

Table 6.2: Showing the categories of responses and the number of teachers responding to why magnet pulls objects to itself without touching them.

Categories of responses	Number of teachers responding before the workshop	% of teachers responding	Number of teachers responding after the workshop	% of teachers responding
1	21	42	28	56
2	1	2	3	9
3	16	32	19	38
4	12	24	0	0
	50	100	50	100

The result of analysis showed that 21 teachers (42%) were able to give a good description of the action of a magnet in attracting magnetic objects by means of an intrinsic attractive force. Twelve teachers (24%) prior to the workshop could not give any response to this question. Since this question is one of the last questions in the 'magnetism story' this lack of response could be taken to mean that the teacher did not know how to respond. It could also mean that the teachers were unable to complete the questions within the allotted time.

Example of a case in category 1 : Technically correct.

An example is T1 who before the workshop suggested the following:

> *"The magnetic force within the magnet will attract these things to the magnet".*

The teacher in this case had explained that a magnet attracts things to itself by means of an intrinsic force. It must be in this regard noted that the teacher had not indicated the importance of the distance between the magnet and the object being attracted.

Example of a case in category 2: Essentially correct.

Only one teacher (T19) before the workshop was able to give a description with the a use of a metaphor as follows:

> *" They manage to pull things because of the capacity of the magnet"*

In the above statement, the teacher has suggested that the magnet has a capacity to pull things to itself. Here the noun capacity is used to describe the force of a magnet in this case. There is no doubt that the above teacher had an idea of the extraordinary force (power) within the magnet that enables it to pull things to itself.

An example of a teacher in category 3 Incorrect response.

Seventeen teachers (34%) gave responses in this category before the workshop. For example, the teacher coded T22, gave the following response:

> *" The magnet manage to pull things when they are not touching them because it is the law of a magnet".*

An individual shift analysis was carried out after the workshop to find out how many of the teachers improved in their ability to explain the action of the magnet in attracting materials separated from it. The results of this analysis are shown in Figure 6.1. Figures 6.1, 6.2, 6.3, 6.4, 6.13 and 6.14 are illustrations of shifts of teachers' responses to different questions on the magnetism story. In these figures, 1, 2, 3, and 4 represent the categories of responses made by the teachers on a particular question. The number on the rows are the total number of teachers whose responses have fallen under different categories of responses before and after the workshop. However, the numbers which are circled and are placed on the arrows represent the number of teachers moving from one category to the other. In all the figures, category 1 signifies a scientific answer to the question. With the exception of figures 6.3 and 6.4 where the maximum categories generated for the analysis is 3, category 2 in others is also an acceptable correct answer to the question put in a common language. In addition, in all the figures, categories 3 and 4 are regarded as incorrect response (in most cases category 3) or no response (in most cases category 4) to the question. A shift from category 4 or 3 to categories 1 shows a positive influence of the workshop on the individual teacher. In a similar way, a shift from category 3 or 4 to category 2 show improvement. However, where there is a shift from category 1 or 2 to categories 3 and 4, a negative influence of the workshop on the teacher is observed. On the other hand, where the response given before and after the workshop fall under the same category, (e.g. where the two responses fall under category 1, before and after the workshop), it shows that the workshop did not actually influence the individual to improve nor help to worsen the situation. But where the responses given prior and after the workshop remained in category 3 or 4, it is assumed that the individual did not gain from the workshop.

From figure 6.1, it may be observed that only three (6%) teachers gave answers which were worse after the workshop than before. By contrast, 19 teachers improved, though 7 of these were only in the sense of going from no answer at all to giving an incorrect answer (category 3). 18 teachers gave good answers (category 1) before and after the workshop. A further 10 continued to give rather poor answers (category 3) despite the workshop activities.

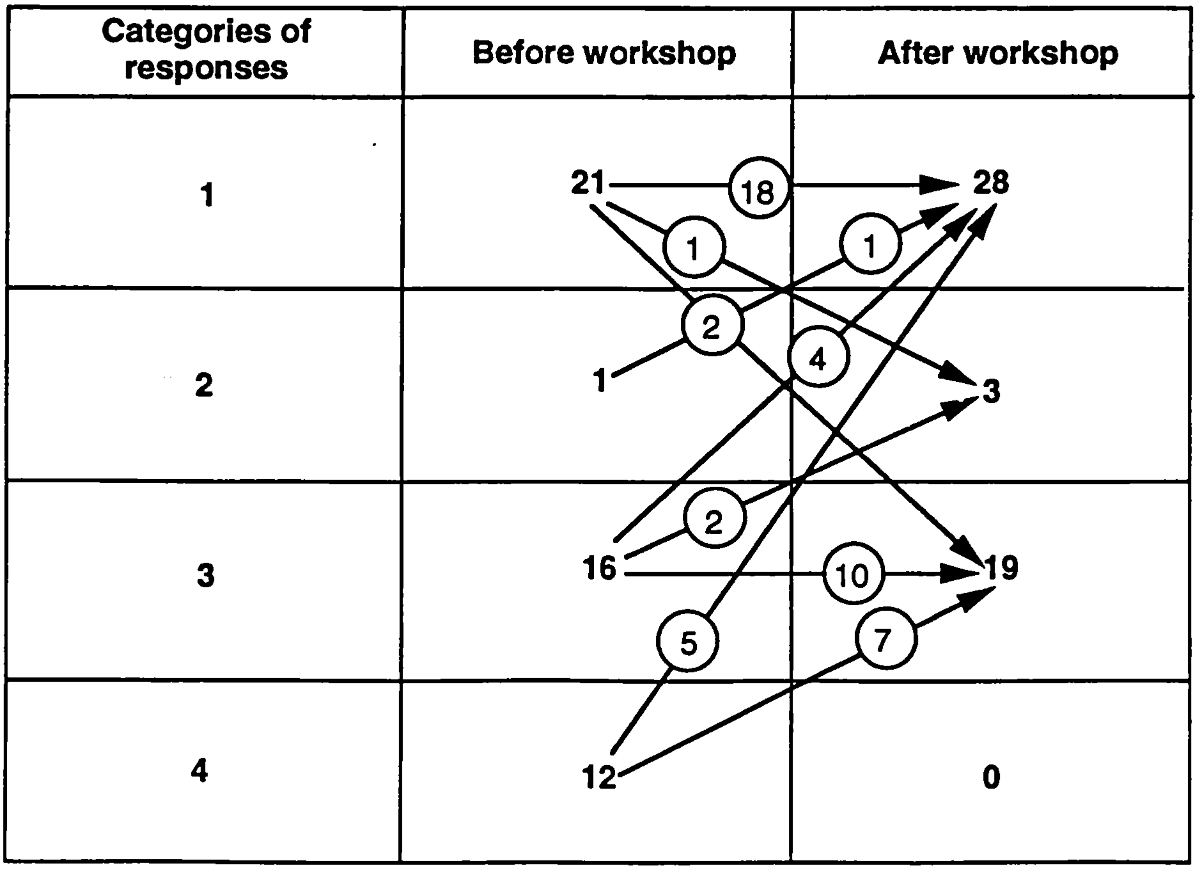


Figure 6.1 Illustrates the categories of responses (before and after the workshop) from primary teachers on why a magnet pulls objects to itself without touching them

From figure 6.1, it could be deduced that the workshop helped some teachers, but was not able to help a significant minority. A substantial number showed no improvement only because they gave good answers before the workshop (and after).

There is little evidence that the workshop confused anybody. The fact that no teacher gave no response after the workshop suggests that the workshop at least encouraged them to make attempts to answer the question.

The shifts to lower categories of response by three teachers are not as serious as they seem. One of the teachers in category 1 who moved to category 2 after the workshop has described the phenomenon using the description of an experiment carried out during the workshop as well as describing the magnetic force as a 'power'. Thus according to the teacher coded T21:

> *"Clip a magnet and tie a rope to a paper clip with something holding it on the base. The magnet keeps the pin and rope straight without touching it using the power in it."*

What this teacher has done is to describe the experiment and tried to link it to this question in order to describe the phenomenon. The fact that the teacher had moved from the 'scientific explanation' to 'everyday knowledge' to explain this phenomenon does not make the teacher 'wrong', instead it has shown that the teacher could use other ways of describing the magnetic force.

Two of the teachers who were in category 1 before the workshop moved to category 3 after the workshop. An example of this case is T45, thus:

> *Before workshop: "Magnet pulls things to itself by using its magnetic force which it contained"*
>
> *After workshop: "Question 4 will be answered by using different magnets with different ends or poles.*

The suggestion made by the teacher after the workshop should not be seen as an alternative way of explaining the idea the teacher held before the workshop, instead, it should be seen as a mix up of ideas. Here perhaps, the workshop activities were in effect not helpful.

An example of a response given by one of the 10 teachers who remained in category 3 after the workshop is the teacher coded T41; thus:

Before workshop: "The attraction pulls it"

After workshop: "The question 4 should be answered by experiment through research or resource person"

The number of the teachers who remained in category 3 after the workshop made similar statements. It is understandable that teachers state that the question can be answered by experiment. However, the question requires the teacher to explain the phenomenon observed. The above suggestion after the workshop, has not given any clue as to whether the teacher is aware of the experimental procedure or the cause of the action.

It was also found that 5 out of the 12 teachers who prior to the workshop were in category 4 (no response) moved to category 1 after the workshop, and were able to give correct explanations as to why magnets attract magnetic materials separated from them.

An example of this is the response of the teacher coded T40, thus:

Before workshop: "No response"

After workshop: "Magnet uses magnetic force to pull things to itself."

The statement made by the teacher before the workshop is a clear case of a teacher who appeared not to know what to write before the workshop and was able to give some meaningful response after the workshop. Similar responses were given by the other four teachers. All of these five teachers appear to have been helped by the workshop.

It was also, found that 7 out of the 12 teachers who gave no response before the workshop, moved to category 3. An example to show a case of no response before the workshop and a shift to category 3 is shown by the response of the teacher coded T43, thus:

Before workshop: "No response."

After workshop: "It is by practical"
The teacher may well know that the above question could easily be explained when an experiment is carried out, but she has not shown how the experiment will be carried out. Since she was not able to suggest either the material to be used for the practical activity or the way the experiment should be carried out, it was difficult to establish the teacher's understanding of the phenomenon in question. Similar responses were given by the other 6 teachers in this group.

6.1.3: Explanation of why magnets are sometimes called 'Magnetic compasses'

Question 9 or the second question under the item 'H' of the 'magnetism story' (see Appendix I) required the teachers to explain why compasses are sometimes called 'magnetic compasses'. Hence the teachers in this question are expected to show that they understand why a compass is able to locate the direction of the earth's magnetic North pole. Consequently, the questions addressed by the analysis include the following:

- What reasons can teachers possibly give as to why compasses are sometimes called magnetic compasses?
- What understanding do teachers show of the use of compasses for direction finding?
- Compare responses of the teachers to the above question before and after the workshop.

Four categories emerged from the responses to the above as follows:

Category 1: A good explanation about the magnetic or geographic North pole seeking characteristic of the compass is given. An explanation which indicates that compass needles show direction or point towards the geographic North direction is accepted.

Category 2: Everyday language is used to describe the magnetic compass. e.g. use of words such as 'follow the north', 'like the north' in which the compass is described as something that can do things for itself.

Category 3: No acceptable explanation is given about the magnetic compass.

Category 4: No response.

Table 6.3: Showing the primary teachers responses to why compasses are often called 'Magnetic compass'.

Categories of responses	Number of teachers responding before the workshop	% of teachers responding	Number of teachers responding after the workshop	% of teachers responding
1	11	22	28	56
2	0	0	1	2
3	16	32	19	38
4	23	46	2	4
Total	50	100	50	100

Prior to the workshop, eleven teachers (22%) were able to explain why a compass needle seeks the Magnetic North pole. 16 teachers (32%) were found in category 3 prior to the workshop, while 23 teachers (46%) were found in category 4 prior to the workshop.

Examples of categories:

Category 1: A good explanation: An example of a response belonging to this category is that of the teacher coded T2, who before the workshop, responded as follows:

"They refuse to point to other direction except North direction."

Although the statement has not demonstrated an understanding of the underlying principles involved when a compass points always to the Earth's magnetic North pole, the statement is acceptable because it shows that the teacher, at least, appreciates that a magnetic compass tends to point towards the earth's magnetic north pole. This statement, of course, could easily have been remembered from a textbook by the teacher. On the other hand, it is also possible that the teacher may not have understood the principle involved, as can be judged from the statement, that compasses *"refuse to point to any other direction except the north"*. Indeed, the use of the words 'refuse' and 'north', is an indication that the teacher understood that the compass needle will always point to the north. The language used by teachers in answering the question may be accepted as a simple way of bringing the concept down to the level of understanding of a child.

Category 3: No acceptable explanation was given.

The responses made by some of the teachers in this category are meaningful though not acceptable as answers to the question. The responses by two teachers coded T10 and T9 provide good examples as follows:

> *Before T10: "Magnetic compasses have magnetic force and are magnetic materials"*
>
> *Before T9: "A compass is called magnetic compass because it has pointed ends."*

These statements give no indication as to whether the teachers understood the relationship of the compass to the earth's magnetic field.

Figure 6.2 shows individual teacher's shift of categories from before to after the workshop.

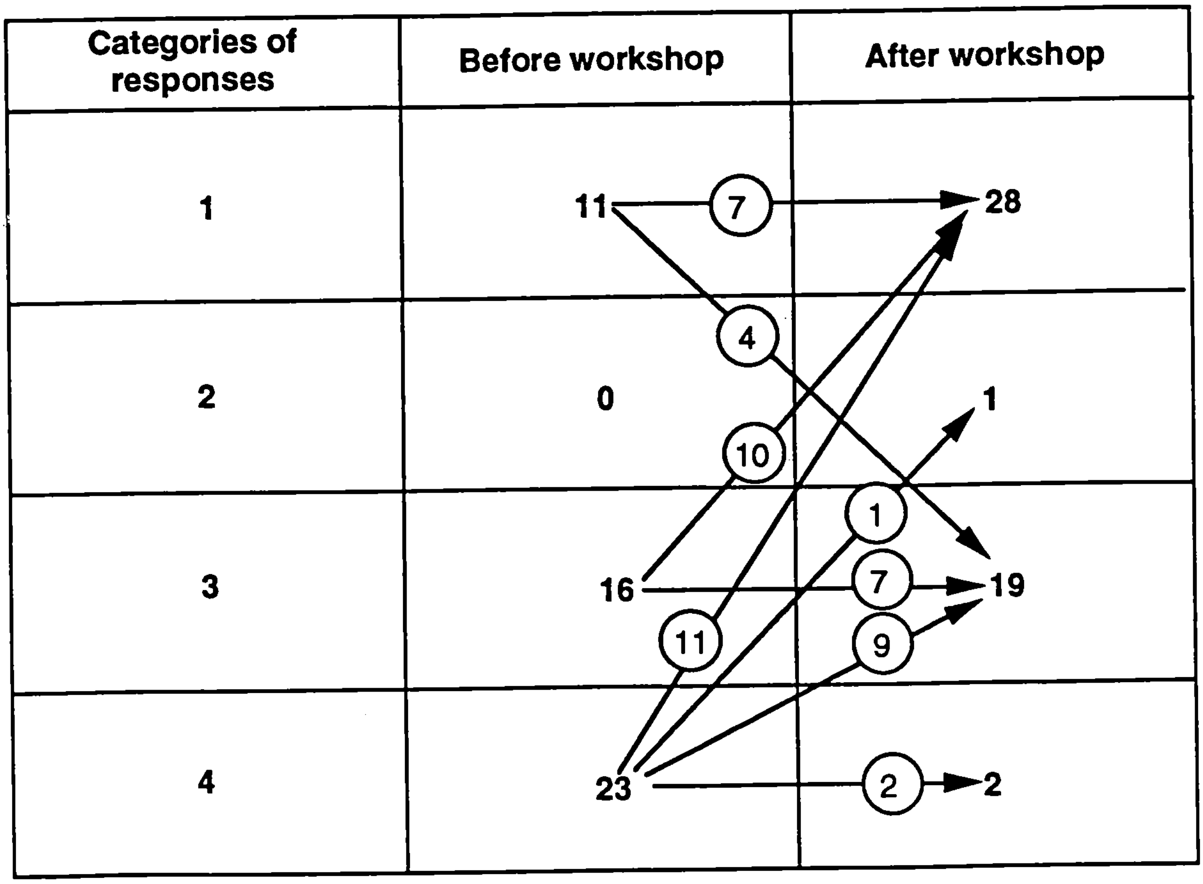


Figure 6.2: showing the categories of responses from teachers as to why compasses are often called 'magnetic compasses' before and after the workshop.

The results shown in figure 6.2 are encouraging as they suggest that the workshop was of benefit to many teachers. 39 teachers (78%) gave either incorrect (category 3) or no responses (category 4) prior to the workshop, while after the workshop, all but 8 of them had improved in their explanation of why compasses are sometimes called magnetic compasses. 21 teachers shifted from categories 3 and 4 to the highest category (1 and 2). All but 2 of the 23 who before the workshop, gave no response gave some response afterwards. However, 4 of the 11 teachers who gave good responses before the workshop gave non satisfactory answers after the workshop. A further 8 teachers who gave either non satisfactory or no response before and after the workshop, showed no improvement.

An example of a teacher who improved from an incorrect response to a correct one is the teacher coded T14, as shown from her response before and after the workshop as follows:

Before: "Compasses are called magnetic compasses because they can be magnetised."

After: "The compasses are called magnetic compasses because they show the North direction."

Although the statement after the workshop does not indicate clearly the teacher's awareness of the existent of the earth's magnetic north poles which the compass always point to, nevertheless, the statement shows a shift towards a correct explanation. Moreover, the teacher has been able to indicate a possible use of the compass for direction finding.

Almost half the 23 teachers who could not give any response before the workshop were able to give a good response after the workshop . The response by the teacher coded T31, before and after the workshop is a good example of this. Thus, the responses before and after were as follows:

Before: "No response"

After: "The compass is called a magnetic compass because it is always showing the north direction."

Again, the above statement has not shown that the teacher properly understood why a compass 'seeks' the north direction but it does give an indication of the use of the compass in relation to the explanation in the discourse.

The only teacher who moved from category 4 to 1 is the one coded T35, who before the workshop gave no response to the question but after the workshop suggested as follows:

> *"They are called magnetic compasses because they are used by sailors to find their way in the sea".*

Again, the above statement tries to portray the use of the compass in everyday life. However, the use mentioned here is in direction finding without any mention of how this is done.

6 out of the 16 teachers who were in category 3 before the workshop remained the same after the workshop.

An example is that of the teacher coded T30 whose responses before and after the workshop were as follows:

> *Before: "Keep the compass and hang the magnet in the air and allow it to settle. See if the direction corresponds to that of the compass."*
>
> *After: "Research."*

This response suggests that the teacher thought the answer could be found, but does not know how.

An example of the four teachers who were in category 1 before the workshop but moved to category 3 after is T45, who before the workshop suggested as follows :

> *"Compasses are often called magnetic compasses because they have point ends that always seek the North"*
>
> After*: "By experimentation"*

6.1.4: Explanation of the terms: 'attraction' and 'repulsion'.

Question 3 (or question 'C') of the 'magnetism story' and question 10 (or the third question of question 'H') of the 'magnetism story' were used to probe the teachers' understanding of the meaning of the terms, 'attraction' and 'repulsion'. In question 3, the teachers were asked to suggest what a child called Patience could have responded when playing with magnet for the first time, assuming that the child would respond correctly, and assuming that magnetism concept terms such as 'attraction' and 'repulsion' were beyond the child's vocabulary. The teachers, nevertheless, were expected to show an understanding of the two terms, 'attraction and 'repulsion'.

The analysis of the teachers responses were thus geared to the following questions:

- What alternative terms can teachers use to express concepts 'attraction' and repulsion?
- Did the teachers respond in everyday language or scientific language when describing the observations made by a child when playing with a magnet?

The following four categories emerged from an analysis of the teacher's responses as follows:

Category 1: Everyday words such as 'stick to' or 'marry' are used to describe 'attraction' while 'push away', or 'reject', are used to describe 'repulsion' .In addition, scientific terms, such as 'north and south poles', are used to describe the ends of the magnets.

Category 2: Everyday language was used to describe the terms attraction and repulsion as listed above while everyday language such as 'ends' was used to describe the poles of the magnet.

Category 3: Incorrect response to the question.

Category 4: No response given to the question.

Table 6.4: Showing primary teachers' explanations to magnetism concept terms: 'Attraction' and 'Repulsion'

Categories of responses	Number of teachers responding before the workshop	% of teachers responding	Number of teachers responding after the workshop	% of teachers responding
1	16	32	28	56
2	31	62	22	44
3	3	6	0	0
4	0	0	0	0
Total	50	100	50	100

The result of the analysis showed that before the workshop, 47 teachers (94%) could explain the terms 'attraction' and 'repulsion' (category 1) . Only 3 of the teachers (6%) could neither give other everyday words for the terms nor describe the processes involved. This result indicates that the teachers were familiar with the terms 'repulsion' and 'attraction'. After the workshop, all the 3 teachers who could not give good explanations moved to category 1 indicating that the workshop had a positive effect on them. As can be seen from Figure 6.3,16 teachers gave responses that were in category 1 while 31 teachers gave responses that were in category 2 after the workshop. Although a good number of the teachers (21) who were in category 2 remained in the same category after the workshop, it is nevertheless regarded as a good result since the teachers expressed the process in a language a child is expected to be familiar with. All of the teachers were able to suggest an answer to this question before and after the workshop.

Examples of categories:

Category 1: As an example, the teacher coded T23 gave the following responses before and after the workshop:

Before*: If the North and North of magnet are put together, they will not stick together but when North and South pole of a magnet are put together, they will stick together.*

After : *"That like terms do not stick together i.e. North and North poles, they do not stick together- they push apart. Unlike terms stick together- that is, North and South poles stick together".*

Category 2: Use of everyday language to describe the ends of a magnet as well as the terms 'attraction' and 'repulsion'. Before the workshop, 31 teachers (62%) were in this category.
An example of this category is given by the teacher T30's responses as follows:

Before: *When the two ends that are not similar come together, they stick each other but when the other two sides which are similar come together they push apart".*

The response by T30 after the workshop is same, thus;

After: " Uniform poles push away, each other while opposite poles stick and come together.

Category 3: Incorrect response: Before the workshop, only 3 teachers (6%) were in this category. An example of this category in the responses given before and after the workshop by the teacher coded T5 as follows:

Before: "It means that some magnets attract while some do not".

After the workshop, this teacher gave a response that fitted in category 1.

After *: "Patience will say that like poles will not stick together while unlike poles stick together. North pole will not stick to north pole, rather, North pole will stick to South pole.*

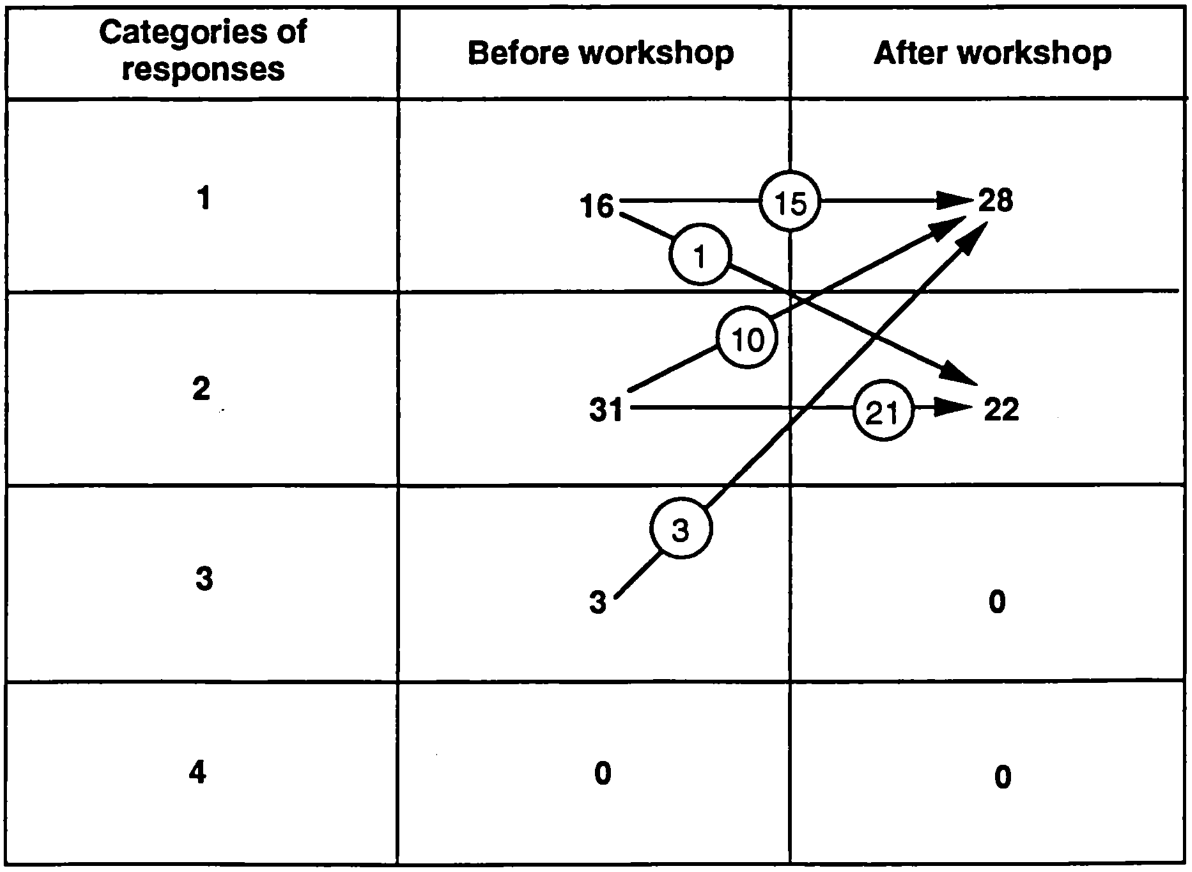


Figure 6.3: Illustrating categories of responses from teachers on the explanation of the terms: 'Attraction and repulsion to a primary six child.

As was mentioned earlier the majority of teachers had no problem with explanation of these terms.

However, the workshop can not be said to have influenced the responses given to the question by the majority of teachers (36) nor has it done any harm either. In fact, a few of the teachers who were not sure of the correct explanation at the start of the workshop were able to do so after the workshop. A total of 10 teachers who used everyday language in their explanation before the workshop, started to use scientific terms such as poles, in describing their magnets after the workshop. It could of course be argued that these teachers did not use these words before the workshop because they did not know them but could use them only after their exposure to the workshop.

In question 10, the teachers were asked to explain the terms: 'attraction' and 'repulsion'. In this question, teachers were expected to show an understanding of the two terms but were not necessarily expected to use everyday language or scientific language in their explanation. What mattered in this question was their understanding of the terms rather than the language of description.

Thus, the question states:

The terms 'attraction' and 'repulsion' are used in a book? What do these two terms mean?

The teachers were expected to use alternative words like 'pull to', 'pull together' , 'stick to' to describe such terms, as 'attract', and the words 'reject', 'push away' to describe the term, 'repulsion'. A description of the effect of attraction and repulsion was also expected.

Three categories of responses arise from these analysis, namely:

Category 1: Correct response: This is where the response given by the teacher explained the terms irrespective of the language used.

Category 2: Incorrect response: This is where the response given did not explain the terms.

Category 3: No response.

Table 6.5: Primary teachers' explanation of the terms 'Attraction' and 'repulsion'.

Categories of responses	Number of teachers responding before the workshop	% of teachers responding	Number of teachers responding after the workshop	% of teachers responding
1	22	44	28	56
2	12	24	20	40
3	16	32	2	4
Total	50	100	50	100

The result of the analysis of the teachers responses shown in Table 6.5. indicated that before the workshop, 22 of the teachers (44%) were able to give correct explanations of the terms 'attraction' and 'repulsion', 12 of the teachers (24%) gave incorrect responses while 16(32%) teachers gave no response at all to question 10. On the other hand, after the workshop, 28 (56%) teachers could give good explanations to the terms, 20 (40%) teachers did not give reasonable explanation, while only 2 (4%)] did not give any response. The changes in individual teacher's responses after the workshop are shown in figure 6.4

Examples of categories of responses.

An example of teachers' responses which were in Category 1 and remained in the same category after the workshop was given by the teacher coded T19 whose responses before and after the workshop were as follows:

Before: "Magnets are said to attract things when they stick to the things while when they push away the things, they are said to repel them"

After: "Magnets that attract things means they stick to the objects, repel objects means push them out".

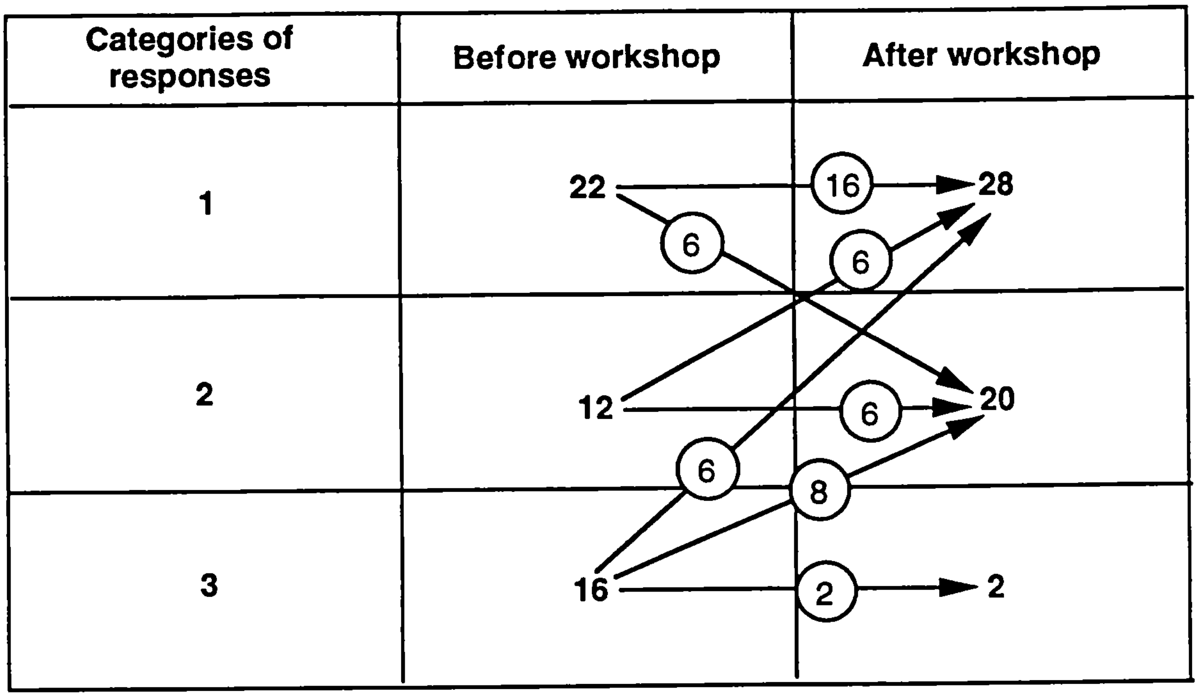


Figure 6.4: Illustrating categories of responses given by teachers as other words to explain the terms 'Attraction and Repulsion' before and after the workshop.

An example of responses which were in Category 2 before the workshop and remained in the same category after the workshop was given by the teacher coded T38 whose responses before and after the workshop were as follows:

Before: "Question 4,7, and 9 would be answered through experiment.

After: These would be answered through investigation.

An example of the teachers' responses which before the workshop were in category 1 but after the workshop their responses were placed in category 2 was given by the teacher coded T22 whose responses before and after the workshop were as follows:

Before: "Attract means pulls to while repel means push away".

After: "Question 9 will be answered by research".

An example of the teachers' responses which before the workshop were in category 3 but after the workshop their responses were placed in category 1 was given in the teacher coded T1 whose responses before and after the workshop were as follows:

Before: "No response".

After: "The poles of magnets when similar, push each other away (repel), but when not similar, pull each other together (attract)".

An example of the teachers' responses which before the workshop were in category 3 but after the workshop their responses were placed in category 2 was given by the teacher coded T34 whose responses before and after the workshop were as follows:

Before: "No response".

After: "It could be answered by research from book".

The reason why so many teachers did not give any response to question 10 before the workshop is probably not due to a lack of understanding of the terms. However, the evidence from question three, showed that the teachers in their responses to question three showed that they were familiar with the terms 'attraction and repulsion' and were also able to give reasonable explanations both before and after the workshop. Since the question was the last in the series, it is also possible that the teachers were tired by this time or that they did not have the time to deal with the question.

6.1.5: Generating meaningful representations of concepts as well as magnetism concept terms on the Concept maps

Introduction: The concept map task was designed to further consolidate the primary teachers knowledge of magnetism as well as magnetism concept terms. The strategy was introduced to the teachers to help them vary their teaching methods as well as making the learning of science interesting. The construction of the map was a new activity. The task of drawing the concept map was carried out in groups of a maximum of four teachers each (details described later in section 5.5). Altogether, fifteen groups of teachers were involved in the three workshops organised. The task was organised in such a way that every member of the group was encouraged to join in the group discussions and to contribute ideas for making the concept maps. The aim is also for teachers to gain from each others experience. As indicated earlier, concept maps were drawn by the teachers before and after the workshop activities. Although this strategy was new to the teachers, all the same, it was the aim of the study to use this strategy to determine the following:

a. evidence of teachers' understanding of magnetism

b. teachers ability to use the strategy in teaching science in their classrooms

However, the analysis of the concept maps focused on the following questions:

- What words are used as nodes?
- How many words are used as nodes?
- What types of links are made between nodes
- What differences are there in the maps drawn at the start and at the end of the workshop

The concept maps drawn by the teachers were analysed in terms of the learning changes that occurred as well as the types of link words used. Teachers were asked to use not less than ten nodes in the maps. However, they were not given any information about the different ways of drawing a concept map, or

even what makes a proper concept map. This factor has been taken into consideration when analysing the maps constructed during the workshop.
The following questions come to mind when assessing the efforts of the teachers in drawing concept maps:

In analysing the maps drawn by teachers before and after the workshop, it was observed that common nodes such as magnet, magnetism, iron filings, magnetic and non-magnetic materials, were seen in the maps drawn by the majority of the groups were acceptable (see Appendix J). Similarly, the common link words found in the maps such as : is a, has, etc. (see table 6.2) are also acceptable. In most cases, the joining of the concepts are linear both before and after the workshop. There are very few inter concept linkages[14] in most of the maps.
Below is a list of number of nodes and type of link words that were used the groups of teachers in drawing the concept maps before and after the workshop.

Table 6.6 summarises the total number of nodes and link words as well as the type of link words used by different teams of teachers in drawing the concept maps before and after the workshop. The table shows that there is a slight difference in the number of nodes and link words as well as the type of link words used by these groups of teachers. The concept maps drawn before and after the workshop by the 15 different groups of teachers are shown in Appendix J.

It is found that most of the maps drawn by different groups of teachers before the workshop have at least 10 nodes, (range 4 to 14) with the exception of concept maps drawn by 5 different groups. The map drawn by group 10 has exceptionally few nodes (4) (see Table 6.6).
After the workshop, all except two groups (groups 8 and 10) produced maps with a larger number of nodes.

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[14] This is where links are made from one node to other nodes and vice versa.

Table 6.6 : Showing the total number of nodes, and links used in the concept maps drawn by different teams of teachers.

Groups' maps	No of nodes		No of links		Type of link Relational		Type of link Activity	
	B	A	B	A	B	A	B	A
1	14	14	12	17	12	15	0	2
2	10	15	8	15	9	15	1	0
3	14	15	10	13	10	12	0	1
4	7	17	4	16	4	13	1	3
5	13	12	12	10	10	8	2	2
6	8	15	8	12	7	8	1	4
7	9	11	6	12	5	7	1	5
8	12	9	11	9	6	5	5	4
9	6	15	5	9	4	7	1	2
10	4	8	4	6	4	6	0	-
11	10	21	9	15	8	12	1	3
12	12	13	9	13	6	11	3	2
13	10	14	10	16	7	11	3	5
14	13	13	12	14	8	10	4	4
15	10	12	11	10	8	8	3	2

Key to the above table:B = Before workshop
A= After workshop

From Table 6.6 it can be seen that the number of links used by different groups of teachers also increased. Prior to the workshop, the number of link words used by different groups of teachers ranged from 4 to 12 while after the workshop the number of link words used ranged from 6 to 17. More links were used on maps drawn after the workshop.

With the exception of three maps (i.e. maps by groups 1, 3, 10) drawn by three groups all those drawn before the workshop have at least one 'Activity' link, while after the workshop, all but 2 (maps drawn by groups 2 and 10) had 'activity' links.

Some changes observed in the maps drawn before and after the workshop include:

Map drawn by group 11 had one 'activity link' before workshop but three 'activity links' after.

Map drawn by group 13 had three activity links' before, but five 'activity links' after.

It was observed that some of the maps drawn before the workshop activities had fewer nodes and links. In some cases, the link words were not properly used. Example could be seen in map drawn by group 4 before the workshop. (see map in Appendix J)

After the workshop, there were a number of changes in the concept maps drawn by the same group 4. From the first map drawn by the group, it could be observed that the information given on the map was based on uses and types of magnets. The map drawn after the workshop possessed a lot of information ranging from, uses of magnet, properties, production of magnet, to characteristics of magnet. The link words used on the map before the workshop is not well represented probably because the teachers were not familiar with the strategy. It could probably be as a result of lack of enough information to be used on the map.

There are some concept maps whose elements are arranged in a hierarchical manner while some use magnet as the centre from which the links radiate outward.

Comparing the map drawn by group 5 with the map drawn by group 15, for example, one finds that the structure starts from the lodestone before the workshop while after the workshop, the map drawn showed that the key word was 'magnetism'. In the case of group 15, it was found that the map drawn after the workshop it may be observed that magnet is the central concept and every link is drawn from it. There is no interlinking between the concepts, although in the first map drawn before the workshop, links were made from the second concept but not many links were present. (See group 15 concept maps before and after the workshop in Appendix J).

Learning changes in the map drawn after the workshop.

The analysis has also looked into the aspect of the concept maps which showed that the teachers have acquired some new magnetism concepts or concept terms after the workshop. The concept map strategy also aims to reveal possible misconceptions which the teachers may have had about some of the magnetism concepts as well as identified some of the misconceptions that were corrected at some stage during the workshop. Figures 6.5 to 6.12 show different learning changes observed from the concepts maps drawn by the teachers before and after the workshop.

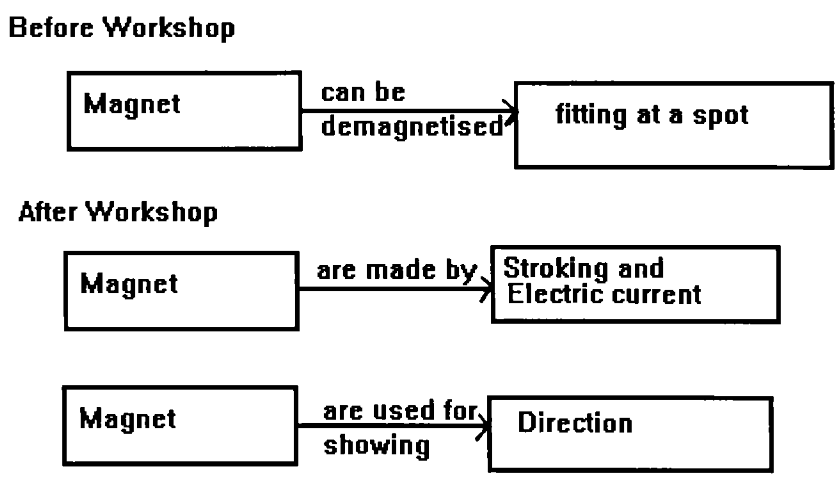


Figure 6.5

The map drawn after the workshop by group 4 teachers depicted a organisation and proper use of 'activity link' words than the map drawn before the workshop . In more specific terms, the following nodes were better linked to each other on the map drawn after the workshop than that drawn before the workshop:

The second map shows a clarification of some concepts raised in the first maps which were not well represented.

Another map which shows some degree of shift in the understanding of the magnetism concepts after the workshop is the map by group 11. Before the workshop, the map drawn by this group has very few nodes compared to the second map drawn after the workshop. Although most of the link words used in the second map are relational, the later map clarifies some misconceptions which appeared in the first map as can be seen in figures 6.6.

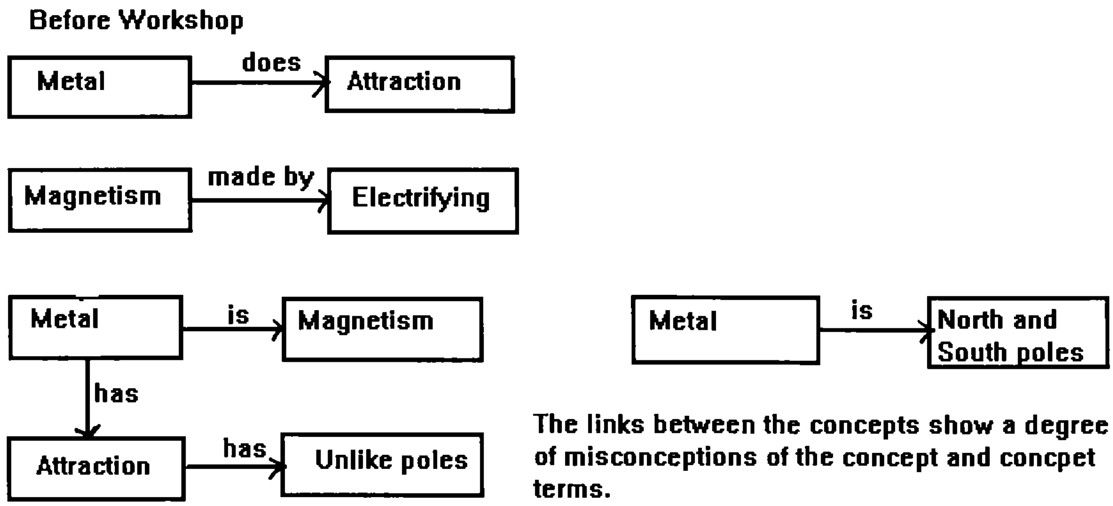
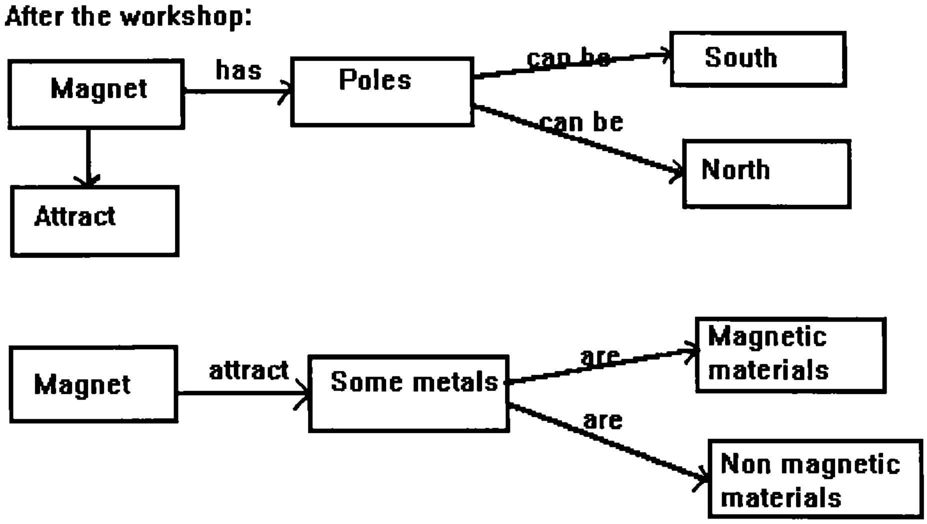


Figure 6.6

After the workshop, the map drawn by the same group shows that some of these misconceptions are corrected. Thus:

After the workshop:



Although the links above are more of relational, they are used properly in joining the concepts and concept terms. The later links show a better understanding of the concepts and concept terms than the former.

Figure 6.7

Such a characteristic like attract is properly represented in the figure 6.6 but showed some misconceptions in the former map (see figures 6.6 and 6.7). It should be noted that although the map drawn first by this group possessed many relational links , it demonstrates a good deal of understanding of magnetism concepts after the workshop.

In some of the maps, there were obvious cases of concepts learnt during the workshop being included into the maps. This feature is shown clearly in map drawn by group 13. Concepts such as needle, iron filings, compass, traveller, sounds, magnetic and non-magnetic materials, attracts, magnetises, demagnetises, paper clips, telecommunication were seen in the second maps which were completely lacking in the map drawn before the activities. (see concept maps drawn by group 13 in Appendix J).

There are some maps which do not show any major difference between that drawn before and after the workshop. For example, with the exception of arrows showing the direction of the sentences which are properly represented in the map drawn after the workshop, most of the nodes and links used in map 12 were repeated in the second map.

In some cases, the teachers could not depict some concepts in the map. They therefore decided to include additional forms of representation in the map. An example is group 5 concept maps.

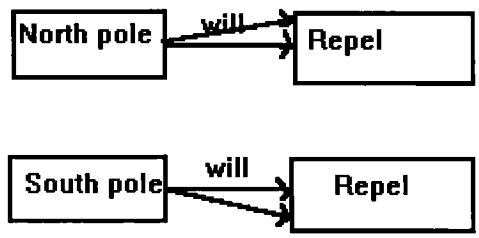


Figure 6.8

In their map, before the workshop, the arrow from north pole to repel as shown below, is paired probably to show that when two north poles come together, they repel each other. A similar strategy was used for the south pole (see figure 6.8). In their description of the attraction in figure 6.9, an arrow from the north pole and south pole go to make up the attract box with the link words in between the two arrows. Thus:

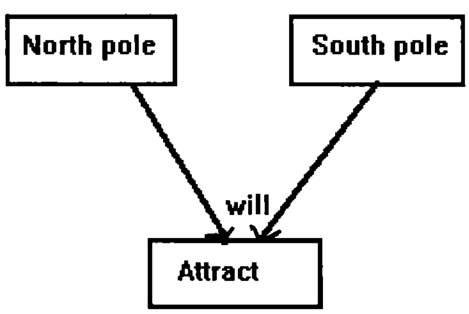


Figure 6.9

The problem with the above diagram is that they have activity links (attract, repel) in nodes.

In the second map drawn by the group after the workshop, the group decided to use another means to represent some of the above terms. For example, the group decided to place all the concepts , concept terms or events in a box in the second map instead of spreading them apart. This reflected the teachers' difficulties in representing some of their information on the map. There were also indications that the teachers had acquired a comprehensive knowledge of the magnetism concepts and concept terms in the maps drawn after the workshop. However, the problem which remained was that the teachers inability to represent these concepts on the map with appropriate link words. This is shown in figure 6.10.(see Appendix J for details).

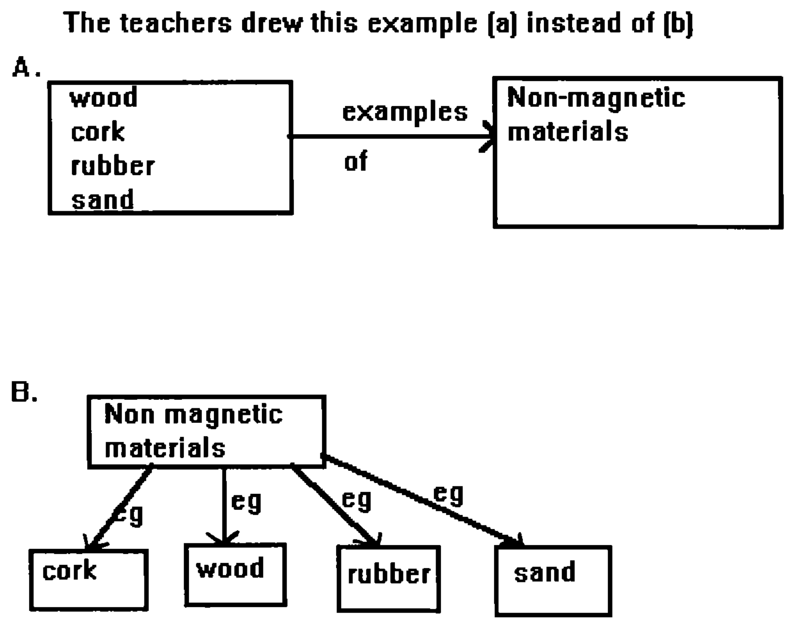


Figure 6.10

Certain features in the concept maps drawn by group 15 showed that the teachers had used the relational links to describe abstract phenomenon. For instance, in Figure 6.11, the links between the magnet and repulsion or attraction, and the links between magnet and the magnetic North and South poles are good examples of such cases; Thus:

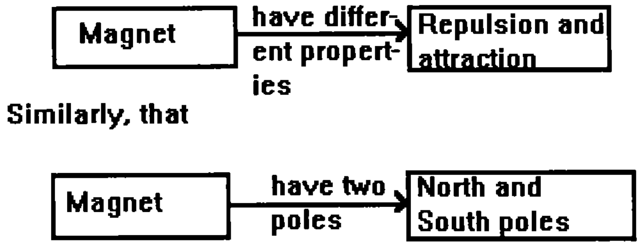


Figure 6.11

However, the problem here is that they have put 'activity' links in nodes. There were cases where the concept 'repel' was wrongly represented as a result of misunderstanding of the concept. This may be seen in the maps drawn by group 14 where the error occurred both before and after the workshop as shown in figure 6.12.

Figure 6.12

In the above case, the word 'repel' is used in the sense of the opposite of 'attract'. There were other cases where the maps drawn before the workshop showed that the teachers found it difficult to link the concepts to one another and therefore had resorted to drawing smaller different maps to show their understanding of the concepts. The map drawn by group 14 was not improved after the workshop as many of the arrows in it have no link words on them. In fact, these arrows are drawn from two nodes to another node to represent an information without any link words. Another example of the above case is seen in the map drawn by group 10 before the workshop.

As mentioned before, maps drawn after the workshop, tend to have a general increase in the number of nodes and links. There were 2 thus maps with less than 10 nodes drawn after the workshop compared with 5 before the workshop.

Generally speaking, most of the maps drawn by the teachers did show proper representation of concept maps but reflect some misconceptions about some of the magnetism concepts. These misconceptions were generally observed in the maps drawn before the workshop. There was some evidence of the correction of these misconceptions in the maps drawn after the workshop.

6.1.6: Explaining observations and findings from workshop practical activities

The aims of the activities during the workshop are the following:

- to expose the teachers to materials which can be used in teaching magnetism concepts.
- to design and carry out some practical tasks on magnetism
- to acquire confidence in carrying out practical investigations
- to investigate possible ways of improvising local materials for teaching magnetism topic
- to deduce explanations for some observed phenomena.

Altogether, there were six practical activities of which four asked teachers as follows:

Activity 1: The teachers were asked to observe some magnets and then determine which magnets were stronger than others.

Activity 2: The teachers were asked to explain why the iron filings were concentrated in the region of the poles of the magnet.

Activity 3: The teachers were asked to explain why some paper fishes were attracted to the magnet while some were not.

Activity 4: The teachers were asked to prepare a magnet and determine the poles using a compass.

Activity 5: The teachers were required to explain why magnets exert a force on magnetic objects separated from them.

Activity 6: The teachers were asked to play the magnetism game and make suggestions on how they think it could be used in their classrooms, as well as their perception of the game as an instructional material.

Activities 4 and 6 are to be discussed under the teachers' skills to teach science in section 6.2.

Some of the activities involved initial observation, and the explanations or interpretation of the observed phenomena, in addition to the actual organisation and carrying out of the experiment. The teachers were given about two hours to carry out the above activities in all the workshops. The activities were carried out in groups with maximum of four teachers. Every member of the group was expected to be involved in the activities. The group's observations, explanations and interpretations were compiled by all the members of the group. The activities are discussed in detail in chapter 5.

As noted in chapter 5, the teachers were then asked to explain some of the observed phenomena during the practical activities, such as the following:

- why some magnets are stronger than the others
- why the iron filings are arranged around the poles of the magnet
- whether magnets work through wood and paper.
- why some 'fishes' were 'caught' while others were not.
- why the paper clip was standing on the thread.

Activity 1: Explanations as to why some magnets are stronger than the others
The teachers were provided with magnets of different sizes, shapes and makes. They were then asked to try the magnets and compare the strengths of the magnets provided. All the teachers observed that some of the magnets were

strong and some were weak. The reasons suggested by the teachers for differences in the strengths of the magnets are shown in Table 6.7 in decreasing order of frequency.

Table 6.7: Groups of teachers suggestions as to why some magnets are weak and some are strong.

Suggestions made by groups of teachers	Number of groups
1. the size of the magnet: A bigger magnet is supposed to be stronger than a smaller magnet.	15
2. the age of the magnet: some of the magnets in schools are old and have begun to lose their magnetic properties.	4
3. The physical composition of the magnet.	2

From Table 6.7 it may be observed that all the groups suggested that a particular magnet is stronger than all the others because it is bigger than others, while a few groups (4) suggested that the age of the magnet could affect its strength. Only two (2) groups suggested that the strength of the magnet depended on its physical composition.

The first reason is considered a plausible explanation as to why some magnets are weaker than others. This is because a bigger magnet, of the same material, is 'stronger' than a smaller one in that it will hold up a bigger weight. The other two reasons for the difference in the strength of a magnet are the age and physical composition of the magnet as stated in numbers 2 and 3 of table 6.7 above. Some magnets are stronger than the others depending on the type of elements or physical substance used in its manufacture. Interestingly, only 2 groups made both of these points.

Activity 2a: Explanations about the arrangement of iron filings around the magnets:

In this activity, the teachers were asked to place two magnets on a straight line with the North pole of one magnet pointing towards the South pole of the other. A piece of plain paper was then placed on the magnets and some iron filings sprinkled on the paper. The distribution of the iron filings was then observed.

Except for group 12, all the groups showed from their diagrams that the iron filings concentrated on the poles or ends of the magnet. From their diagrams, it was observed that the concentration of the iron filings reduced in direction away from the poles. Based on the explanation given by the 14 groups, it was established that the distribution of the iron filings was more concentrated around the poles and as the concentration iron filings thinned at greater distances from the magnet, and this was ascribed to facts that the forces holding the iron filings got weaker with nearing distance. In the words of group 8:

> *"It was observed that the magnetic force was greater at the poles that is why the iron filings are concentrated more at the poles."*

Similarly, group 1 and 9 reported as follows :

> *Group 1:" The iron filings are not uniformly clustered. The strength or bulk of the iron filings are more concentrated or clustered at the ends of the magnet, that is at the poles of the magnet."*
>
> *Group 9: "There are certain areas of the magnet where the forces are more which attract the iron filings and therefore the concentration of the iron filings are more at those areas- basically the poles."*

It can therefore be concluded that these teachers understood that the magnetic force (or field) produced by a magnet is strongest at the poles and that the presence of the magnetic field leads to the iron filings exhibiting the spatial distribution of this field.

Activity 2b: Teachers' explanation as to why magnets act through paper and wood.

In this activity, the teachers were asked to place a piece of paper between a magnet and some magnetic material such as steel pins. They were then to observe what happened as the thickness of paper was increased.

All the groups were found able to give a reasonable explanation of what they observed. Their explanation showed that magnets act through non-magnetic materials like paper and wood and that the distance between the magnetic material and the magnet affected the strength of attraction. According to the teachers, the attraction of some pins by a magnet acting through some pieces of paper could be explained on the basis of the action of a magnetic force produced by the magnet. This magnetic force field was seen to decline as the magnet was moved away from the magnetic substance. The explanation was reported in the words of group 15 members as follows:

> *"On continuous addition of paper, it happened that the more the paper, the more the magnet loses its magnetic power within the magnetic field"*

Activity 3: Explanation of why the magnet could only pick up some paper fishes.

In this activity, the teachers were asked to use a magnet attached to a stick to pick up some paper 'fishes' in a paper 'pond'. Some of the 'fishes' were attached to paper clips, some to brass paper fasteners, while others had nothing attached to them.

It was found that all the groups i.e. 1 to 15, were able to explain why some fishes were caught and others were not. The reasons given by all the groups may be summarized as follows:

a) The paper clips attached to the paper fishes allowed them to be caught with the magnet because a paper clip is a magnetic material.

b) The fishes which were attached to the brass paper fasteners were not caught because brass is not a magnetic material.

c) The fishes which did not have either paper clips or the brass paper fasteners could not be caught because the magnet did not attract the paper since paper is a non-magnetic material.

An example of the above explanation as reported groups 8 and 11 are as follows:

Group 8: "The reason why some fishes were not caught was that some of the fishes contained brass paper clips which is non-magnetic materials and some without any clip at all were not caught because the paper is a non-magnetic material. The ones caught were with iron paper clips."

Group 11: "They contained some iron around them. Some couldn't be caught because they were not attached to any iron clips. The brass paper clips is not a magnetic material"

This activity was easy enough, and all groups were able to provide correct explanations.

Activity 5: Explanation of why a magnet exerts a force on magnetic objects separated from it.

In this activity, described in Chapter 5 and on Appendix K, a paper clip was attached to a cotton thread and the thread held with some blue-tak. A magnet was then attached to a retort stand and a distance was created between the paper clip hanging by the thread, and the magnet. The teachers were then asked to explain why the paper clip could hang on a thread irrespective of the differences in their weights.

Fourteen groups were able to provide acceptable explanations for their observation; only one group (15) was unable to do so. Fourteen different groups suggested that the iron clip could stand upright because the force of the magnet was pulling it up. They also explained that the iron clip was within the magnetic field. A typical example of this response was that given by group 2:

> *Group 2:*
>
> *"The paper clip is standing on its own because it is within the magnetic field. This happened because the pin itself is a magnetic material. But the force of gravity on the ground is pulling it down."*

The only group which did not give a reasonable explanation to the effect was group 15 who suggested the following:

> *"We noticed that the clip was able to stand on its own because the clip is smaller than the magnet.*
>
> *b. Then when the object is smaller than the magnet, the magnet has to be taken nearer to the metal object.*
>
> *c. And the bigger the metal object, the nearer it sticks to the magnet.*
>
> *d. Again, we noticed that the clip was unable to reach the magnet, because a heavier object than the clip is holding the clip through the 'Indian Rope".*

None of the four statements by group 15, indicated above, constitute reasonable explanation why the iron paper clip stood on top of the thread without touching the magnet. These observations were thus regarded as incorrect.

6.2: Data relating to the development of teachers' skills in teaching magnetism

6.2.1: Introduction

In this section, the teachers' ability to organize practical tasks in their science lessons is assessed from their responses to questions 4, and 7, of the 'magnetism story' as well as from practical activity 4 of the 2-day workshop.
In this regard, the following aspects of the teachers ability to organize practical tasks and activities in their magnetism lesson were explored.

- The provision of practical instructions to the children on how to determine the poles of a magnet (Question 4 of the magnetism story).
- The provision of instructions to enable the children investigate the properties of magnets (Question 6 of the magnetism story).
- The ability to prepare a magnet and determine its magnetic poles (Activity 4 of the workshop activity, Appendix K).

6.2.2: The provision of practical instructions on how to determine the poles of a magnet

In the response to question 4, the teachers are required to provide appropriate instructions to children to enable them determine the poles of a given bar magnet. The teachers were also required to indicate the materials that would be required for this purpose.
Based on this, the responses from the teachers have been classified into the following categories according to their correctness:

Category 1: Acceptable Instruction and materials were identified.

Category 2: Acceptable instruction provided but materials required not indicated.

Category 3: No acceptable instruction and materials provided: The teachers could neither give a clear description of the instruction required nor were they able to list the materials required for the practical.

Category 4: No response.

Table 6.8: Showing the primary teachers ability to provide acceptable instruction to determine the poles of a magnet. (n = 50)

Categories of responses	Number of teachers responding before the workshop	% of teachers responding	Number of teachers responding after the workshop	% of teachers responding
1	1	2	28	56
2	10	20	2	4
3	38	76	20	40
4	1	2	0	0
Total	50	100	50	100

Before the workshop, Only one teacher could provide an acceptable instruction plus the materials to be used in this experiment . 10 teachers (20%) were able to give a clear description of the procedure but were not able to list the instrument used in determining the polarity of the magnet (category 2). A majority [38(76%)] of the teachers were in category 3 before the workshop. However, only one teacher gave no response to this question prior to the workshop.

Examples of categories of responses:

Category 1: Acceptable instruction and materials provided: Only one teacher was in category 1 before the workshop. This was the teacher coded T8 who suggested that:

> *"Lead the children to hang a magnet or each of them to hang his/her magnet freely with a rope or a thread. Allow the magnet to swing and come to a stop on its own. Check the positions assumed by the different ends of the magnet on stopping using a compass".*

This response shows that the teacher understood the correct instruction, and that the teacher was quite familiar with this activity. This teacher also made the same/similar suggestions after the workshop.

Category 2: Acceptable instruction, no mention of material.

An example of this category is the response of the teacher coded, T20, who suggested before the workshop:

"Tell the pupils to tie the bar magnet with a string or thread; hang it somewhere and then determine where North and South poles are facing".

From the above statement, the teacher knew of the instruction required to carry out this activity. However, the teacher did not realise that an instrument was needed for determining the polarity of the magnet, or that she omitted this additional information for some other reason.

Category 3: No acceptable instruction or material provided: .

A typical example of a teacher's response in this category is that of teacher coded T6 who reported as follows:

"The teacher will then tell the children that one end of the magnet is the North pole and it is noted with the letter N in the end and another end is South pole and is noted with the letter S".

The above statement from the teacher indicated that the teacher did not know how to determine the poles of the magnet.

Another example is the response given by a teacher coded T16 as follows:

"1. All of you must have a magnet

2. Paint the ends with different colours.

3. Indicate the side that is the North pole and the side that is the South pole"

The two teachers (quoted above), seem to have no idea on how to determine the polarity of a magnet.

Figure 6.13 shows that the responses by a good number of teachers improved after the workshop, but there was a minority who were unaffected. This findings is consistent with earlier results (for example, the teachers' understanding of magnetism analysed in the earlier section of this chapter). 8 out of 10 teachers in category 2 improved to category 1. Almost half (18/38) in category 3 also improved to category 1. However, 19/38 (half) of those in category 3 remained there, giving no reasonable account before or after the workshop.

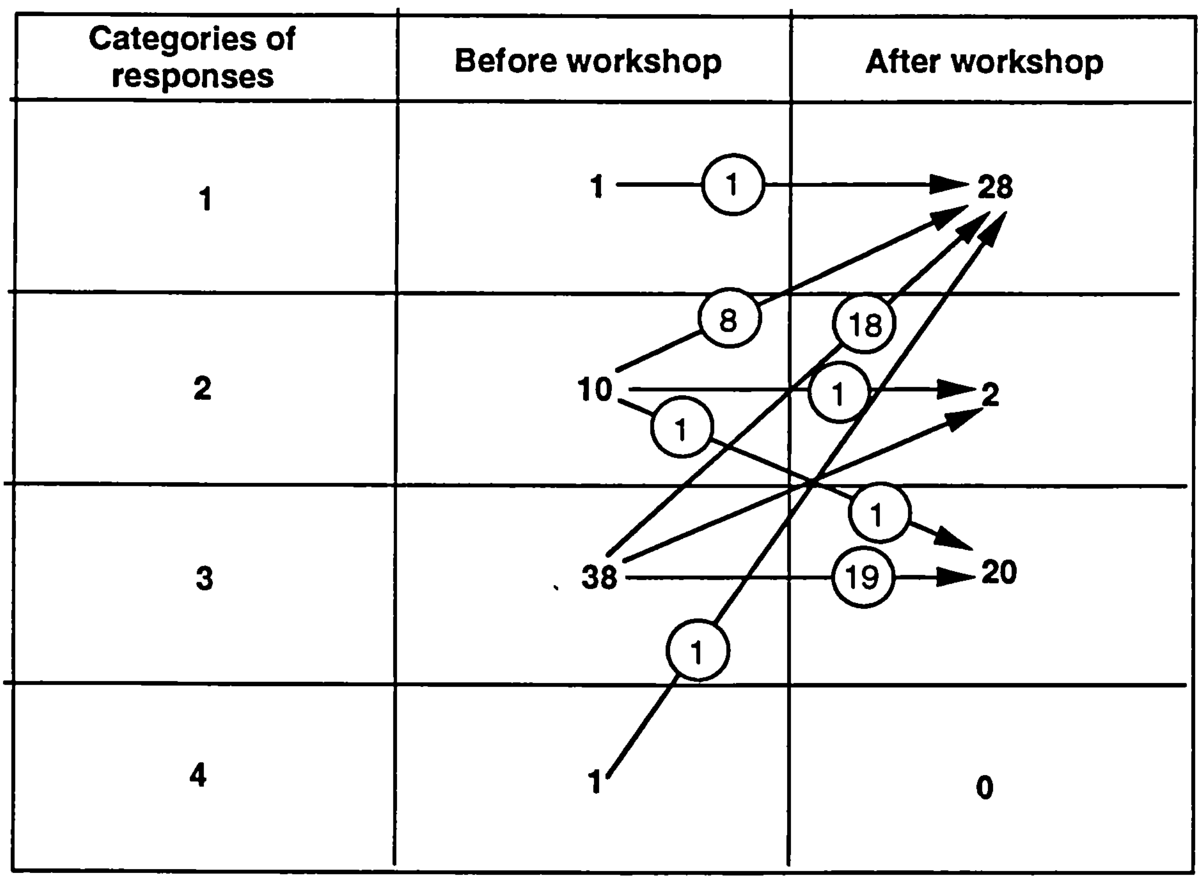


Figure 6.13 showing categories of responses from the teachers on their ability to give instructions to determine the poles of a magnet before and after the workshop.

Overall, where 39 (78%) gave no reasonable answer, or no response before the workshop, 30 (60%) gave a good or reasonable (category 1 or 2) response afterwards. There was only one person whose response deteriorated in performance.

The teacher (T8) who was on category 1 remained in the same category after the workshop. This teacher after the workshop showed that in answering this question, the following steps will be taken into account:

"1. Stroke a needle with a magnet. Pass it through a cork and float in a container filled with water.

2. Tie a thread to a bar magnet, allow to hang and swing until it stops on its own.

3. Use a compass, read the arrow and know the direction".

Comparing the above statement with the earlier response given by this teacher before the workshop, some differences may be observed as follows:

1. An additional procedure/instruction has been included in the instruction after the workshop i.e. the stroking of a needle with a magnet. Thus, the teacher gave an instruction to prepare a magnet and at the same time determine its polarity.

2. The emphasis in the instruction after the workshop on the use of a compass can be taken as an improvement over the first statement. Moreover, an emphasis on the use of the compass to determine the polarity of the magnetic poles was a clear indication that the teacher had a better idea after the workshop about what should be done than before the workshop.

Eight of the teachers who were in category 2 before the workshop had moved to category 1 after. A good example is the response before the workshop given above of a teacher coded T20. After the workshop this teacher responded as follows:

"Bring a Bar magnet and tie it with 50cm thread.

2. Hang it until it stands still

3. Place a magnetic compass near the hanging magnet

4. Find out which is the North and South pole".

The teacher in this case has clearly given a step by step procedure for carrying out the practical activity. the teacher also included the materials required for the determination of the polarity of the magnet using a compass. Compared with the response prior to the workshop, the instruction after was more explicit and detailed and demonstrated a better knowledge of the various items of equipment and their uses.

18 out of 38 teachers who were in category 3 moved to category 1. With teacher coded T6 giving typical responses as follows:

After : "Tie a thread or rope on the centre of a bar magnet with the rope about 50cm long. Hold it until the magnet is ready. Then you will notice where each end is directing using the compass. Note, the one that is directing to the North is the North pole, and the one directing to the South is the South pole".

The above instruction is an improvement over that given by the teacher prior to the workshop. The teacher in this case was able to provide an instruction which also indicated a step by step procedure to enable pupils to determine the poles of a magnet.

After: "Use rope about 50cm, tie it to the bar magnet suspend it and allow to stop dangling, then put down a compass and determine the North and South poles of the magnet using the compass".

In both of the above responses there is clear evidence of the teacher's ability to provide clear instructions for pupils.

6.2.3: The ability to provide instructions to enable the children investigate some properties of magnets

Question 'G' of the magnetism story (Appendix I) required the teachers to propose an experiment to demonstrate the ability of a magnet to act through a non-magnetic material like paper or wood. In doing this, teachers were also expected to demonstrate that the effect of the magnetic field decreased as the amount of the paper or wood is increased.

In analysing the responses, the following were looked for:

- Were the teachers able to propose an experiment to demonstrate that a magnet can act through a piece of paper or wood?
- Could the teachers specify the experimental procedures involved in carrying out this investigation?
- Could the teachers specify the right experimental set-up or conditions to ensure that of the experiment succeeded?
- Was there any difference in the teachers' responses before and after the workshop?

Four major categories emerged from the responses of the teachers to this question as follows:

Category 1: Acceptable explanation and experimental procedures and conditions given.

Category 2: Acceptable explanation but no experimental conditions given: The experiment is described but no experimental conditions were added. That is, the teacher could show that magnet would be placed under a paper or wood and a magnetic material placed on top of paper or wood. The teacher made no mention of increasing the number of sheet of papers or thickness of wood, indicating that the teacher does not know that the result of the experiment could change as a result of these varying conditions.

Category 3: No acceptable experimental procedure or condition was given by the teacher.

Category 4: No response

Table 6.9: Showing primary teachers responses to possible description of an experiment to show how magnet work through paper or wood. (n = 50)

Categories of responses	Number of teachers responding before the workshop	% of teachers responding	Number of teachers responding after the workshop	% of teachers responding
1	6	12	32	62
2	0	0	3	6
3	35	70	15	30
4	9	18	0	0
Total	50	100	50	100

Table 6.9 summarizes the teachers' responses to question 6 of the magnetism story before and after the workshop. Prior to the workshop, 6 of the teachers (12%) were able to give a good description of the experimental set-up and variable conditions (category 1). No teacher's responses were in category 2 prior to the workshop; however, 35 teachers (70%) were in category 3 before the workshop, while 9 teachers could not give any response to the question before the workshop.

Examples of categories of responses.

Category 1: Acceptable experimental procedure and condition given.

A typical example of this case is illustrated in the response by teacher T1 as follows:

> *"You place a piece of paper over the magnet and place some magnetic materials over the paper or wood. You will notice some form of*

movement or attraction. The extent of attraction is reduced if the paper or wood is much."

The above statement suggests that the teacher understood the experiment and was aware of the procedure involved in the experiment. Also shown in the statement is that the addition of more paper would affect the extent of attraction of the magnet to the magnetic material. The addition of more papers or wood in this case is an experimental condition observed by the teacher. However, the statement has not indicated why the magnetic attraction is reduced with the addition of more pieces of paper or wood.

Category 3: No acceptable experimental procedure and condition provided:
An example of this case is illustrated in the response of teacher T13 before the workshop as follows:

"We have to get iron fillings in a sheet of paper and hold it with a piece of magnet. The children will see that the magnet will attract the iron together. With the wood, we have to make strokes on the wood."

The above statement does not however, show that the teacher understood the purpose of the question. Even if she did understand the question, she nevertheless, has not mentioned the use of paper and how it would affect the result of this experiment. In the case where the wood was mentioned, the teacher's phrase could not be interpreted as anything other than one who did not know how to respond to the question.
Another example of an instance where the teacher showed no knowledge of how to respond to this question was shown in the response of teacher T36 before the workshop, as follows:

Before: " the teacher will demonstrate with magnetic and non-magnetic materials like, iron, nails, coin, wood, plastic cup, paper etc. The magnet will attract magnetic materials while non-magnetic materials will not be attracted."

This response again indicates that the teacher did not understand what to do. The statement reveals some misunderstanding of the question, and gave the impression that the teacher would not be able to carry out the experiment.

After the workshop, a measure of the individual teacher's improvement was taken. A positive shift was found overall as can be seen in figure 6.14 below .

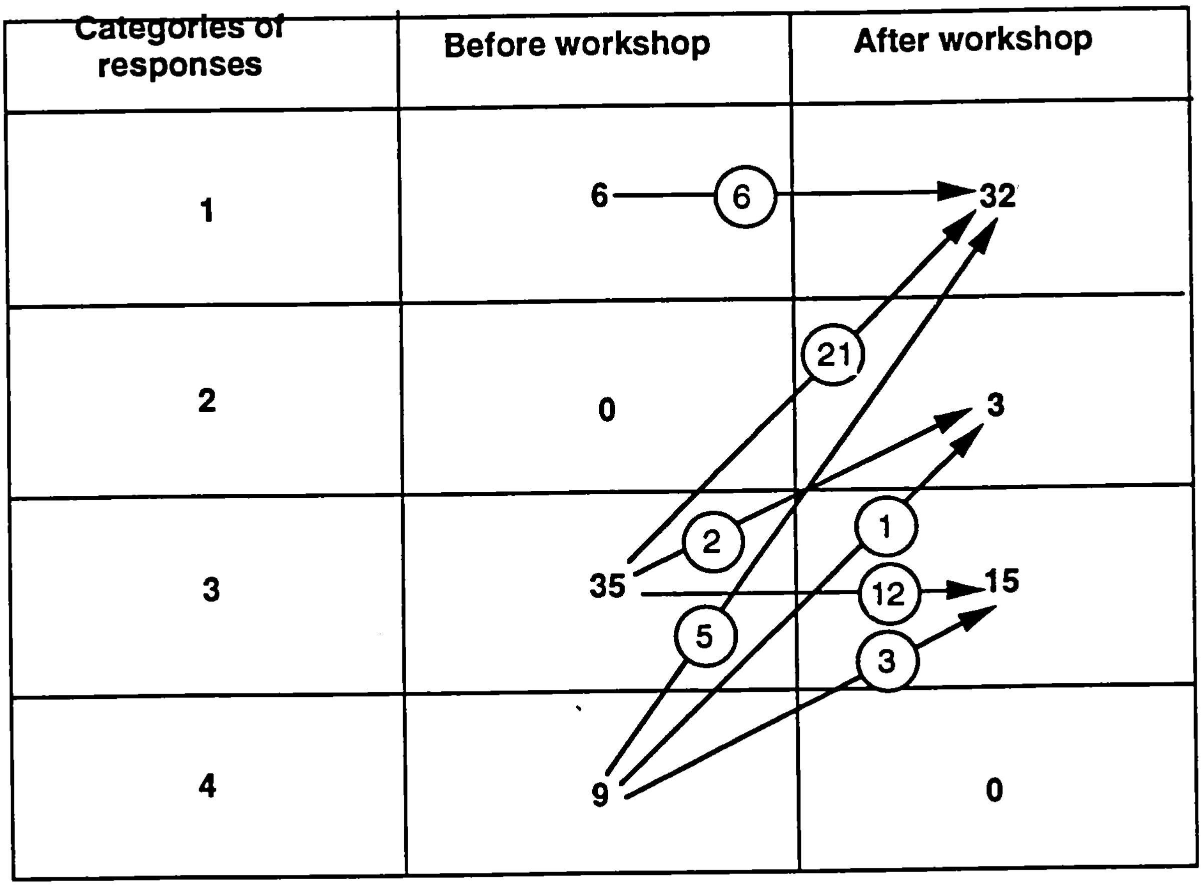


Figure 6.14: Categories of responses from teachers on possible instructions to experiment on whether a magnet works through wood or paper before and after the workshop

The 6 teachers who were in category 1 before the workshop, remained in the same category after the workshop; however, a difference in the details of their description of the experiment was observed. An example is the response of the teacher T1 before the workshop which was quoted. After the workshop, her response was as follows:

1. "You need a magnet , paper and pins.

2. Place a piece of magnet on the table and a piece of paper on the top of the magnet.

3. Place some needles on top of the paper.

Observation: The pins are attracted to the magnet through the paper, the attraction decreases with thickness of paper or wood."

The above are clear step by step instructions. She also noted the materials to be used for the experiment. The teacher has also observed the effect in any variation of the experimental conditions i.e. an increase in the thickness of the paper while an increase of wood decreases the attraction.

21 teachers (42%) who were in category 3 before the workshop moved to category 1.

An example is the report of teacher T14 who before the workshop was as follows :

" First and foremost, bring the materials involved i.e. wood, paper and magnet. Secondly, get the magnet close to the materials. If the magnet reacts on them you know then that magnet work on wood and paper"

After the workshop, the same teacher made the following proposal:

After T14: "Placing a magnetic object on the table or paper and move a magnet beneath it, it is noticed that the object moves e.g. needle but when the paper is many, the magnet will no longer have any effect."

The latter response shows a clear understanding and a clear description of the procedure and experimental conditions.

The two teachers from category thus 3 moved to category 2. One of these teachers (T46) after the workshop proposed the following:

Before workshop: " Bring out papers and woods of different types, use a magnet to see if it attracts them".

After workshop: "Place a magnet on top of the table or paper, place another under the paper or table to see what takes place."

She also showed how the experiment could be carried out but did not go further to explain what would happen if more papers or wood was added.

As in previous cases, there is a minority who were not helped by the workshop, despite its beneficial effect on many. 12 out of the 35 teachers who were in category 3 remained in the same category after the workshop. There could be a number of possible reasons for this one could be that the teachers found it difficult to change their original framework.

All of the 9 teachers who could not give any response to this question before the workshop were able to give a response after the workshop. 5 were able to provide a good description of the experiment after the workshop. One teacher gave a response in category 2, and 3 teachers in category 3. These responses may be regarded as a substantial improvement from the condition before the workshop except for those teachers who gave responses in category 3. An example of a teacher who could not give any response before the workshop but provided a reasonable one afterwards is illustrated in T18 who after the workshop, wrote that:

"You will cut the paper and the wood and then bring the magnet and perform the experiment. Put magnet under the paper and then pins on top of the paper. Try and move the pins with the magnet. Then collect more papers and put under the pins. Try the experiment again and see what happens when big papers are added"

The above statement indicates that after the workshop the teacher could describe the experiment and vary the experimental conditions.

6.2.4: Analysis of teachers' ability to ask 'good' questions in their science lessons and devise questions that could lead to practical activities:

As discussed earlier in this chapter, information about teachers' ability to raise 'good' questions as well as to devise questions that could lead to practical activities were drawn from the following sources :

- questions 5 and 6 of the or questions E and F of the 'magnetism story , and
- 'Ask the Object' activity from the workshop.

The areas covered were in this analysis include the following:

- Teachers' ability to generate question which they think children could raise on magnetism (question E of the 'magnetism story')
- Teachers' ability to raise their own questions (from ' Ask the Object' activity)
- Teachers' ability to identify the questions that can lead to practical investigations. (from question F of the 'magnetism story')

6.2.5: Teachers' ability to anticipate questions children could have asked during their lessons on magnetism.

Question 'E' (in Appendix I) of the 'magnetism story' required the teacher to suggest questions which the children might ask on magnetism during a lesson on magnetism. The purpose was to establish whether the teachers could anticipate questions children might ask during magnetism lessons. In this regard, it is assumed that one of the problems facing science teaching in Nigerian primary schools is the teachers' inability to raise appropriate questions in such lessons. However, as discussed in chapter 2, the majority of the questions Nigerian primary teachers ask in their science lessons are straight forward, requiring only simple, direct, answers. Open-ended questions tend not to be encouraged because the teachers believe that there is no time or materials to carry out any useful investigations.

Again, the teacher could face a problem with this question since s/he is being asked to anticipate the questions the child might ask in a magnetism lesson rather than state his/her own questions. All the same, the questions provided by the teachers were analysed in terms of their individual merit.

These questions were then compared with the questions raised by the teachers during one of the 2-day workshop activities called 'Ask the Object' which aimed at helping the teachers to assess the type of questions they would ask during their science lesson. The analysis of these questions are described in section 6.2.6 below.

6.2.6: Teachers' ability to raise questions of their own

In 'Ask the Object' activity, the teachers were asked to raise at least ten questions on magnetism to which they would like to find answers. It was useful to compare the two sets of questions in order to appreciate the type of questions teachers could raise in their science lessons. It must be noted that while the questions raised on the 'magnetism story' were collected from individual teachers, the questions collected from the 'Ask the Object' represent the group effort of a number of teachers. The analysis is therefore conducted along the following lines:

- What kind of questions leading to investigation do teachers believe pupils might ask?
- Were there any differences in these questions as provided by teachers before and after the workshop?
- Was there any difference between children's questions as anticipated by the teachers and those questions which the teachers themselves had raised during the 'Ask the Object' activity?

The analysis of the written responses in the magnetism story showed that in general, all the teachers could anticipate questions which children might ask during a science lesson. Because the present study is interested in the questions that could lead to practical investigations in the classroom the analysis is focused on issues which meet the above requirement.

The summary of the questions raised by teachers in response to questions in the magnetism story before and after the workshop as well as during the 'Ask the Object' activity, is given in Table 6.10.

The practical questions which the teachers raised after the workshop but not raised before were as follows:

In which parts of the magnet are the (magnets) forces strongest?

Can a magnet be melted?

Can magnets be used in a radio?

Can wood stick to a magnet when it is stroked by a magnet?

Can we use a magnet to find the direction of the wind?

How can we measure the distance (extent) of a magnetic field?

It may be noted from Table 6.10 that more teachers raised more investigative questions after the workshop than was the case before the workshop.

For instance, the following questions identified in table 6.10:

" Can we make a magnet"

was raised before the workshop by four teachers and by eight teachers after the workshop.

While the question:

"How do we find the North and South poles of a magnet"

was raised by four teachers before the workshop and seven teachers after the workshop.

On the other hand the question:

"How can we demagnetise a magnet or can a magnet lose its magnetic properties or powers"

was raised by four teachers before the workshop and by eleven teachers after the workshop.

Table 6.10: Comparison of the open-ended questions raised before and after the workshop and also during the 'Ask the Object' activity.

Questions	Number of teachers raising question before workshop	Number of teachers raising question after workshop.	'Questions raised during the 'Ask the Object' by different groups.
How can one demagnetise a magnet?	4	11	4
How does one know if a magnet possessed a North and a South pole?	4	7	8
Can a magnet stick to our one Naira coin?	4	3	1
How can one make a magnet?	4	8	2
Can a magnet stick on the wall	3	0	0
What is the colour of a magnet	3	4	3
How can we separate pieces of iron and pieces of wood from a mixture?	2	1	10
How many types of magnet do we have?	2	6	2
Can magnets be prepared or manufactured industrially?	2	3	0
If a magnet is dropped into water, would it lose its magnetism?	1	0	0

An interesting question which was raised by three teachers before the workshop but not repeated after the workshop was:

"If a magnet is dropped in water, does it lose its magnetism?"

Perhaps the workshop activities directed attention away from such a question or helped teachers to answer the question. Some questions raised by the teachers required information obtainable from textbooks or other authority rather than by experiment. Such questions evidence of the fact that the teachers had given further thought to their previous activities during the workshop. A questions such as *"Why do magnets attract magnetic objects from a small distance without touching them"* could represent the thinking of those teachers who wondered why certain things happened. On the other hand, activities during the workshop could have provided opportunities for a teacher to work on the materials during the practical session and to come up with an explanation as to why things happened the way they did. In any case, the teacher having observed a phenomenon, or having carried out the activity, might still remain unclear about the correct explanation and consequently may feel that a child in similar situation may have his/her curiosity raised and hence would ask such as a question.

6.2.7: Teachers' ability to identify questions that can lead to practical investigations on magnetism.

Question 'F' of the 'magnetism story' (in Appendix I) was designed to discover the questions the teachers could raise in science lessons that could lead to practical investigations. Fifteen questions were thus identified in the magnetism story and the teachers were then asked to suggest which of these questions could lead to practical investigations in the classroom.

An analysis of the response to this question revealed the number of teachers who chose each of the questions that led to practical investigation. Indeed, all the questions could lead to practical investigations with the exception of questions 8 10, 11 and 12 which may be answered using library resources. The following representing in manner in which the questions before and after the workshop were categorized:

- How many teachers identified the same questions before and after the workshop?
- How many teachers identified a different set of questions before and after the workshop?
- How many teachers identified additional questions in addition to the same questions identified before and after the workshop.?
- What is the frequency of teachers identifying each of the questions?
- What is the average number of question(s) identified by each teacher before and after the workshop?

The Table 6.11 and figure 6.15 show the number of teachers identifying each of the questions (1-15) as leading to practical investigations. Thus:

Table 6.11: Number of teachers identifying different questions as leading to practical investigations.

	Questions 1 - 15														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Number of teachers listing each of the questions before the workshop														
	35	25	12	27	21	32	15	11	19	2	4	2	12	11	20
	Number of teachers listing each of the questions after the workshop														
	44	40	30	38	31	40	17	15	22	2	8	3	14	24	33

At the start of the workshop, all teachers were able to identify at least two questions that could lead to investigation. The number of teachers identifying individual questions is shown in Table 6.11. After the workshop, the number of teachers identifying these questions increased. The number of teachers identifying other questions amenable to investigation also increased; this was particularly evident for questions 3, 5, and 15. Over half of the teachers identified questions 1, 2, 4 and 6 as ones that could be answered by means of investigation. The following categories of questions are identified for the purposes of the analysis.

Category 1: Some questions identified before and after the workshop

Category 2: Different questions identified before and after

Category 3: Some questions plus additional after the workshop.

Category 4: No questions identified before: appropriate questions identified after.

Overall, there was an increase in the number of questions identified by individual teachers(average number before = 4 , after = 7). This finding suggests that the workshop had helped the teachers to become more aware of the types of questions that can lead to practical investigations with pupils.

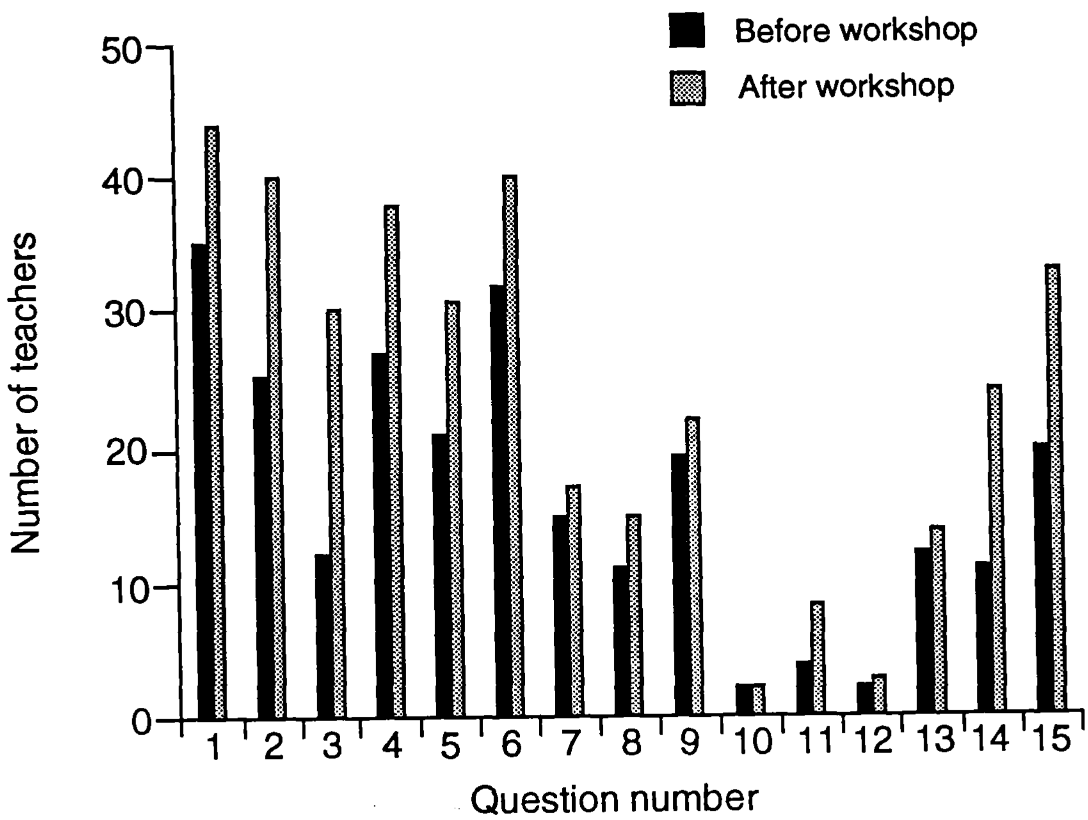


Figure 6.15: Number of teachers listing questions that can lead to practical investigations in the classrrom.

The responses from teachers could be grouped into 4 categories

Examples of categories:

Category 1: Individual improvement were also taken into account since 9 teachers (18%) identified the same questions which they identified before the workshop.

Category 2: 8 teachers (16%) identified completely different questions which were not among those that were identified before the workshop. An example is the response given in the teacher coded T11; prior to the workshop, she identified questions 1 and 7. as leading to investigation.

After the workshop, the same teacher identified questions 14 and 15 as leading to investigation.
In this case, there is also no change in the number of questions identified.

Category 3: 32 teachers (64%) identified some questions other than the ones identified before the workshop. An example is the teacher coded T3 who prior to the workshop identified questions 1,2,5,6,7 as leading to investigation, while after the workshop, identified questions 1, 2, 4, 5, 6, 7, 8, 9, 10, 12, 13 as leading to investigations.

Category 4: Another case is that in which the teachers gave no response before the workshop but were able to identify some questions that could lead to practical activities after the workshop. An example is the response given by the teacher coded T47 who prior to the workshop gave no response to this question (question F) but after the workshop, she identified the following eight questions as leading to practical activities..
Questions *1,2,3,4,6,7,14, and 15.*

There is a general increase of teachers in this analysis identifying nearly all the questions. Before the workshop, a minority of the teachers identified questions 8, 10 ,11 and 12, the 'library' questions, as leading to practical investigations. After the workshop, though a minority of the teachers still identified these questions as leading to practical investigations, but there was an increase in the number of teachers identifying questions 8, 11, and 12 compared with the number before the workshop. The fact that a good number of the teachers did not identify the above questions as leading to practical investigation shows that most teachers could distinguish between questions leading to practical investigations and those that do not.

It may be observed that before the workshop, the average number of questions that could lead to practical investigation identified was 4 per teacher, while after the workshop, the average number of questions identified had risen to 7.

Summary:

All the teachers were able to suggest questions that children could ask during their lesson on magnetism. There was also, a general increase of the number of questions teachers identified which they think can lead to practical activities after the workshop than before. A minority of the teachers identified questions 8, 10, 11, and 12 as being answerable through practical investigations but that was not the case. The fact that not many of the teachers did identify them as leading to practical investigations showed that majority of the teachers could still distinguish between questions that can lead to investigations and those that can not. It appears that the workshop has a positive effect on the teachers' ability to identify questions that can lead to practical investigations in their science lesson. This would help the teachers in their choice of appropriate strategies in the teaching of science. This ability to raise appropriate questions in science lessons, would enhance understanding as well as achievement in science as a whole.

6.3: Findings:

6.3.1: Teachers' understanding of magnetism.

a) ***Teachers' ability to distinguish between magnetic and non-magnetic materials.***

Before the workshop, only one teacher (1) representing 2% of the teachers possessed a good knowledge of magnetic materials. Forty-nine (49) representing 98% of the teachers did not possess adequate understanding of this task before the workshop. After the workshop, an extra 35 teachers, (representing 70% of these teachers), could distinguish between magnetic and non-magnetic materials. This may be interpreted as a positive influence of the workshop on the teachers ability to distinguish between magnetic and non-magnetic materials.

The task of distinguishing between magnetic and non-magnetic materials is a direct one. There is a direct relationship between the workshop activities in this area and the task which the teachers performed. The practical activity which involved distinguishing between magnetic and non-magnetic materials required the teachers to bring the materials near the magnet and thus identify the ones attracted to and those not attracted to the magnet. This entailed direct observation and could be said to have had some effect on the teachers' ability to retain what has been learnt. A direct transfer of the knowledge and skills gained at the workshop to answering the above questions could have contributed to positive influence the workshop had had on the teachers in this domain.

b) Teachers explanation as to why a magnets exert a force on things separated from it.

Before the workshop, only 21 teachers representing 42% of the teachers were able to give a acceptable scientific explanation as to why magnets are able to attract magnetic objects separated from them. After the workshop , 31 teachers representing 62% of the teachers, were able to give an acceptable explanation (in either scientific or everyday terms). Only 10 teachers could be clearly said to have benefited from the workshop in understanding this aspect of magnetism. Here, the effect of the workshop is positive, but perhaps limited.

The task here required the teachers to give an explanation as to why certain processes occurred. It required the teacher to think beyond what was observed. A workshop activity designed in this domain did not directly answer this question in contrast to the task of distinguishing between magnetic and non-magnetic materials, which required the teacher to apply directly what is observed to the task. The task of explanation/interpretation on the other hand requires an in depth understanding of the phenomenon to be discussed. In the scientific domain, this requires a good understanding of phenomena. This understanding may have proved difficult for many teachers.

c) Teachers' description of what is meant by the term: 'Magnetic compass'.

Before the workshop, eleven teachers (11) or (22% of the teachers) could give an acceptable explanation of what is meant by the term, compass. After the workshop however, 29 of the teachers (or 58%) could do so. Here 18 teachers clearly benefited from the workshop, but 21 teachers representing 42% of the teachers still could not perform this task. Again, the workshop had a limited but positive effect.

A possible reason for this result could be seen as being similar to the reason given for the teachers being able to explain why a magnet could attract magnetic objects separated from it. An explanation as to why compasses are sometimes called magnetic compasses requires some knowledge about the composition of compasses as well as, the use and characteristics of a compass. This result suggests the need for the teacher to consider the practical activities which could assist the children to draw useful inferences in scientific investigations.

Another reason could be seen as merely a reflection of the co-ordinator's yardstick for a 'good' or judging what made a good or bad explanation. In the end, the criteria adopted may have been too stringent.

d) Teachers' ability to delineate or elaborate magnetic concepts on concept maps.

The work on concept maps showed that before the workshop, most groups' concept maps (ten groups) possessed at least 10 nodes. After the workshop, all but two of the groups' maps had at least 10 nodes. After the workshop, the number of link words used by most groups also increased as opposed to the links used prior to the workshop. Moreover, after the workshop, the maps drawn by most groups showed some changes in their knowledge, such as ability to represent processes on the maps, correction of some misconceptions held prior to the workshop. These results obtained from concept mapping may be interpreted to mean that the workshop has had a positive influence on the teachers' ability to elaborate concepts on the magnetism concept maps.

There is also some evidence that the teachers have acquired more magnetism concepts as a result of exposure to the workshop activities. Similarly, more links (in the range 6-17) were made on the maps drawn after the workshop than on the maps drawn before the workshop (range 4-12). A few (5) maps drawn before the workshop had up to 3 'activity links', but more (7) maps drawn after the workshop possess up to 3 'activity links'. An increase in the use of 'activity links' in the maps after the workshop is an indication of the positive effect of the workshop on the teachers.

There were misconceptions shown on the maps drawn before the workshop which were corrected on the maps drawn by the same group after the workshop. Again, this is a measure of the positive effect of the workshop on the teachers' understanding of the magnetism concepts and concept terms. The reason for this effect could be understood in terms of the teachers' practical experience with some of the materials on magnetism during the workshop. The teachers may have performed well because at the workshop, they were involved in practical activities which focused on magnetism which was intended to help them to understand some concepts, or phenomena on magnetism. The positive effect could also result from practice. Before the workshop, the teachers were not familiar with the construction of maps. This skill improved in the second maps as a result of a second attempt at the same task.

Nevertheless, it is necessary to point out that the effective use of this strategy is highly dependent upon so many factors, such as the proper understanding of the concepts (nodes) to be linked as well as, a good command of English (the medium of communication), and adequate time for practice.

e) Teachers' ability to explain observations and findings from practical activities.

The teachers were able to show some degree of understanding of magnetism concepts through the explanations they gave to questions raised during the workshop on some of the activities provided.

Although few of the groups of teachers could give acceptable reasons why some magnets are weaker than others, yet most (14) groups gave acceptable explanations as to why the iron filings were arranged around the poles of the magnet. All the groups of teachers were able to give an acceptable explanation why the magnet picked some paper fishes but not all. Similarly, the teachers' gave acceptable reasons as to why a paper clip was pulled up and stood on top of on a thread without touching a magnet.

From the explanations given by the teachers, one may say that the workshop had had a positive effect on the teachers. This claim is based on the teachers' ability to distinguish between magnetic and non-magnetic materials, as well as their ability to show an understanding of some of the magnetic concepts on the maps drawn after the workshop. However, the teachers were found wanting in being able to explain why magnets are able to attract objects separated from them. To this extent the workshop failed to produce a positive influence on the teachers.

Nevertheless, this result could be understood in terms of the constraint of using group work to make inferences about individual ability within a group. Of course it is possible that some members of the group may still have benefited from the workshop in this domain, and indeed such members may have influenced the responses for the group, since 'two heads are better than one'. In any case where some of the teachers may have lacked the scientific language to express their responses, it is to be expected that those members with a command of the scientific language would influence the group's responses.

f) Teachers ability to explain scientific terms 'attraction' and 'repulsion':

Before the workshop 47 of the teachers (94%) were able to explain the terms 'attraction' and 'repulsion' in both scientific and common everyday languages. However, after the workshop, all the 50 teachers (or 100%) were able to do so. This may be interpreted as a positive effect of the workshop on the teachers ability to explain the terms 'attraction' and 'repulsion. Indeed, the teachers on the whole seemed to be familiar with these terms and were able to describe them using the scientific and common everyday language. The activity involving playing with magnets carried out during the workshop was observed to have helped the teachers learn from first hand experience. A direct application of these practical activities (similar ends of two magnets repelling each other or dissimilar ends of two magnets attracting each other) experienced during this exercise contributed to this positive effect.

In question 10(the third question of question H in Appendix I), 22 of the teachers (44%) gave correct scientific explanation of 'attraction' and 'repulsion' prior to the workshop. After the workshop 28 of the teachers (56%) were able to give correct explanation of the terms. Thus, only 6 teachers showed some improvement in their knowledge. This result could be interpreted to mean that the workshop had had no positive effect on the teachers' ability to give correct scientific explanations to these terms. However, since these teachers were able to give good explanations to these terms using scientific and everyday common language in question 3, it is reasonable to assume that their inability to answer a similar question was not due to their unfamiliarity or a lack of understanding with the terms. Instead, it may be assumed that there may have been other factors, that influenced the above result.

6.3.2: Development of teaching skill on magnetism :

a) Teachers' ability to provide acceptable instructions to determine the poles of a magnet.

Prior to the workshop only one teacher could provide an acceptable set of instructions on how to determine the poles of a magnet and at the same time give a list of the materials that would be needed for this activity. On the other hand, after the workshop, 30 teachers representing 60% of the total number of teachers were able to give acceptable instructions needed to carry out the task. However, 2 out of the 30 teachers could still not list the materials required for the experiment. Thus, 29 teachers could be said to have benefited from the workshop in this area.

A possible explanation for this result may derive from the nature of the task. This, involved a direct application of the practical activity carried out at the workshop (activity 4). Activity 4 was designed to develop the teachers in this area. This required the teachers to carry out the practical tasks at the workshop and subsequently, use the acquired knowledge to answer the question. This made it possible for the relationship between practical activities in science to the teachers' ability to organise and design practical activities in science lessons to be deduced.

b) ***Teachers' ability to provide instructions to guide children investigating some properties of magnets.***

Before the workshop, only 6 teachers (12%) were able to design an experiment to show that a magnet could operate through wood and paper as well as indicate the necessary experimental set-up. After the workshop, 35 teachers (70%) could do so, thus showing an increase of 29 teachers. The workshop thus had a positive effect on the teachers in this area.

One may suggest that an explanation for this positive effect may derive from ascribed to the activity at the workshop which dealt directly with the task. Again, there was a direct use of the knowledge gained in the workshop in responding to the question. The task in this case did not require the teacher to draw inferences beyond what was observed.

c) ***Teachers' ability to anticipate questions which children could have asked in their science lessons as well as teachers ability to raise their own questions leading to practical investigations***

All the teachers could anticipate questions that children could have asked in their lessons. After the workshop, teachers on their part raised more open-ended questions that could lead to investigation than before. There was no difference between children's questions as anticipated by teachers and those which the teachers themselves had raised as science teachers. Before the workshop, an average of 4 investigative questions were selected by each teacher but after the workshop, an average of 7 questions that could lead to practical investigations were selected per teacher. This shows that the workshop had had a positive effect on the teachers.

A possible explanation for these outcomes could be ascribed to the teachers' exposure to the practice of raising questions as well as criticising their own questions during the workshop.

In this regard, the 'Ask the Object' strategy was introduced to the teachers during the workshop. During the session on this strategy, the teachers were asked to raise at least 10 questions on magnetism and then classify these questions into those that would lead to investigations and those that would not. This exercise gave the teachers the opportunity to criticise and think through the questions they raised after the workshop on the 'story'. It is also possible that since questions which were raised during the 'Ask the Object' exercise were on magnetism, it was easier for the teachers to repeat or transfer this exercise directly to the task on the 'magnetism story' after the workshop.

Chapter 7

EVALUATION OF THE WORKSHOP OUTCOMES

7.0: Introduction

The present chapter will look at the evaluation of the overall workshop programme. This will involve the assessment of the ability and confidence of the teachers to teach primary school science based mainly on the outcomes of the workshop, reported by the teachers as well as their observed ability to apply the strategies learnt to teaching science as well as other subjects in their classroom environment. The assessment of the impact of the strategies learnt in the workshop on the performance of the teachers in their schools, as assessed by their headteachers, will also be taken into account.

In this exercise, a number of tools were used to obtain the required information, and these include the following:

- post-workshop interview,
- post-workshop observation of the teachers ,
- the benefits derived from the workshop as judged by the teachers, their headteachers.

7.1: Post workshop interview of the participating teachers and the presentation of data.

Introduction: A second interview of the teachers that participated in the training workshop was carried out as part of the follow-up exercise. The purpose of this interview was to ascertain the extent of the change in the teachers' teaching as a result of their participation in the workshop. In addition, the exercise enabled the level of confidence of the teachers to teach magnetism (already deemed difficult) , to be determined. Other objectives of the follow-up exercise included the following:

- To determine whether the teachers had gained enough practical experience from the workshop which could help them in teaching primary school science.
- To discover whether some of the strategies introduced during the workshop had helped the teachers to make their science teaching more lively.
- To determine whether pupils' response to the learning of science had changed as a result of the strategies employed by the teachers.
- To discover whether the teachers who participated in the workshop have been able to influence colleagues (who did not attend the workshop) and their schools generally.
- To discover if the teachers participating in the workshop have been able to apply their newly acquired knowledge and skills to other topics in science as well as other subject areas (see follow-up interview proforma, in Appendix N).

The data collected were analysed in such a way as to answer the following questions:

- What were the teachers' views about the possible application of the learnt strategies to other topics in science as well as other subjects?
- If the answer to question 1 above was positive, what were the problems encountered during the application of the learnt strategies?
- What were the teachers' observation of the pupils' response to the strategies?
- What did the teachers report about the observation of their other colleagues regarding the learnt strategies?
- What benefits of the workshops did the teachers, head teachers and groups of other teachers report.

In dealing with the above questions, relevant information was obtained from such sources as the following:

- The accounts by groups provided at the end of the 2-day workshop on the benefits of the workshop
- The head teachers' account of the benefits provided during the researcher's second visit to schools
- The individual teacher's account of the benefits which was collected during the follow-up visit to schools.

The analyses of the responses from the above mentioned sources are now presented in the following sections.

7.1.1: Other topics in science and other subject areas that can be taught using the strategies learnt during the workshop

All the teachers sampled suggested that they could and had indeed used the strategies to teach other aspect of science. For example, the teachers reported that they had already used concept mapping strategy in teaching the following topics(see Table 7.1).

- The circulation of blood in man.
- Friction and force,
- Life cycle of a house-fly,
- Digestive system,
- Our environment.
-

Table 7.1 summaries the science topics to which the new teaching strategies had been applied by the teachers. This table shows that a good number of teachers used concept mapping and 'Ask the Object' strategies in teaching science topics which come under physics rather than biology. Not many of the teachers used the strategies to teach science topics such as circulation of blood, digestive system, etc.

Table 7.1: Showing the science topics as well as the strategies used to teach them.

Science Topics	Strategy used	Number of teachers reporting use of strategy
Our environment, etc.	Concept mapping	26
Friction and force	Concept mapping, Activity method, 'Ask the Object'	26
Growing better crops	Concept mapping	12
Life cycle of a house-fly,	Concept mapping/'Ask the object'	6
Pulleys	Concept mapping	6
The circulation of Blood in man.	Concept mapping	2
Digestive system	Concept mapping	2

This results makes one wonder if the teachers experienced problems representing some biological concepts on the concept maps but could easily do so when it is a physical science concept. On the other hand, it could mean that the topics which they used the strategies to teach had something to do with the topics in the scheme of work at the level taught. It was further observed that some of the teachers had also applied the learnt strategies to other subjects other than primary science (see Table 7.2).

Table 7.2: Teachers list of other subjects where the learnt strategies could be used.

Subject or Topic	Strategy used	Number of teachers reporting use of strategy.
Health Education.	'Ask the object' and concept mapping.	23
English Language	Concept mapping	22
Agricultural science	'Ask' the object', Concept mapping	21
Social studies	Ask the object and concept mapping	12
Mathematics	concept mapping	3

Although it was observed that some of the teachers used practical activities in their teaching of science after the workshop, the teachers appeared to have commented only on the impact of concept mapping and 'Ask the Object' strategies on their teaching as shown in Table 7.2. This may be because, the teachers seemed to be excited about the novelty of these strategies (concept mapping and Ask the Object). However, since the teachers had obviously been exposed to practical strategies during the workshop, they would not have considered it necessary to report its effect on their teaching.

It should be noted from the teachers' responses shown in Table 7.2 that more teachers applied the strategies for subjects such as Health Education, English Language and Agricultural Science than in other subjects such as Mathematics and Social Studies. It seems possible that the ready use of the strategies by nearly half (23) of the teachers to teach Health Education could be due to its relatedness to primary science on which the workshop programme was based. On the other hand, the fact that about the same number of teachers (22) also used the strategies to teach English Language is probably due to the use of words common and familiar to both the teachers and the pupils. It is rather surprising that not many of the teachers applied the use of concept maps in teaching Social Studies inspite of the use of common words as in English. In addition, it was observed that only a few (3) teachers used the strategies in teaching Mathematics. This also could be as a result of the difficulty in their ability to represent the concepts as well as choice of appropriate linking words to join them on the map. Mathematics concepts are more abstract than scientific concepts. Since the teachers were new to these strategies, there was limit to the extent they would be expected to apply them in their teaching.

7.1.2: Pupils response to the strategies introduced by the teachers.

The teachers reported that there was a marked increase in enthusiasm of the pupils' attendance and participation in science lessons resulting from the use of such strategies as, concept mapping, 'Ask the object', and other practical activity methods. According to the reports of the teachers, this change in science learning was expressed in the following ways:

- the pupils were eager to come to science lessons,
- the children were equally eager and inquisitive about the topic for the next science lesson,
- the children appeared more in the mood to work, as confirmed by the fact that , they did not even want to return to their homes after the lessons because of their group interests in science projects,
- the children were more active and ready to answer questions in the class,
- the children appeared more involved in either the drawing of maps or in carrying out practical activities in the classrooms.

Table 7.3 summarises the above attributes of the children as identified by the teachers.

Table 7.3: Reasons given by teachers as evidence of their measure of development of positive attitude in their pupils.

Attributes reflecting positive response in children as reported by teachers.	**Number of teachers reporting each attribute.**
Children showed interest in drawing of concept maps.	43
The children's involvement in class and attention span increased.	23
Children showed interest in carrying out practical work	19
The children's enthusiasm to answer questions in the class increased.	13
Children's showed improved ability to carry out investigations on their own as they were allowed to do them by themselves.	12

It may be observed from table 7.3 that the most frequently reported attribute shown by the children was their interest in drawing concept maps. This is an important finding as this indicates that the concept mapping strategy did involve the children's active participation in the lessons and this could have helped to improved their interest to learn science. Such a strategy, if used in teaching science, is expected to help the classroom teacher make his/her lesson more interesting to the children. In addition, a little less than half (46%) of the teachers reported that the strategies introduced to them during the workshop had also helped increase the attention span of the children. However, a few (24%) of the teachers had reported some improvement in the children's ability to carry out practical investigations on their own. This information is considered vital as it revealed the strategies the teachers and the children used most effectively. There is no doubt that the teachers frequent use of a concept mapping strategy and the children high interest to use it, could be because of its being new to them or because they find the strategy interesting and probably easier than practical activity while still making children involved in the lesson like the practical activity method.

For illustrative purposes examples to represent each of the categories of attributes are given below.

Examples of some of the attributes as illustrated by the teachers:

a) Interest in drawing concept mapping in the classroom.

An example of the above statement was given by the teacher coded T13 who commented as follows:

> *"The children liked the strategies a lot and obviously have developed positive attitude because of the interest they show in drawing the maps and being active in the class always ready to carry out the activities quickly ".*

Some of the teachers also described their perception of children's interest to learn science as evidenced by children's approach to the drawing of the concept maps as well as their exhibition of enthusiasm to study science and their general interest in their science lessons. This is further attested to by the teacher coded T39 who reported as follows:

"Yes there is positive attitude to science developed in these children because they are eager to come to science lesson and want to know what is next to be done which is unusual"

There is no doubt that the children's attitude changed because their teachers' attitude also changed. The teachers must have shown interest in their teaching by introducing other strategies which they had never used before. This, of course, changed the learning atmosphere for the children.

b) Class Involvement and attention span:

The teachers have commented on the children's involvement and attention span which increased as a result of the use of some strategies such as concept mapping, 'Ask the Object', for example, the teacher coded T10 commented as follows:

"The pupils attitudes are changed because of the length of the attention they give during science lessons as well as the extent of their involvement in class activities throughout the lesson"

This attitude was further illustrated by the teacher coded T23 who commented as follows:

" I think that they have positive attitude because children are eager to come to science lessons and want to know what we will do next and like drawing concept maps a lot".

c) Interest/Ability to carry out investigation:

The teachers observed that the children had began to show interest in carrying out practical activities as a consequence of their being allowed to do things on their own. This observation may be illustrated by the comments of the teachers coded T24 and T21 respectively; as follows:

T24: Yes, a positive attitude is developed a lot in the children because the children work on their own during practical activities, and are drawing maps with high interest. There is an obvious difference with what they do now compared to what they had been doing before".

T21: "There is development of positive attitude on the children. They enjoyed the lesson and could perform the activities by themselves".

<u>*d) Positive attitude deduced as children's interest in answering questions in the class increased:*</u>

An example of this may be taken from the comment of the teacher coded T17 as follows:

"Yes, a big positive attitude as they all struggle to answer the questions during science lessons".

The above comment was also corroborated by the investigator during her visits to schools. This positive attitude was observed mostly in classrooms where the children carried out practical activities. In this regard the children were observed to exhibit high enthusiasm to answer questions especially when they had something to do with observations made during classroom activities.

The teachers were able to assess in different ways the degree of the development of positive attitude empowered towards science teaching. Indeed, the teachers had observed that this change of attitude in the children had in turn reacted positively on their teaching of science in many ways for a possibility for future high achievement in the study of science.

7.1.3: The teachers' observations of their colleagues attitudes to the strategies learnt during the workshop

90% of the teachers reported that they were able to organize independently a similar workshop or seminar in their schools. Some of the teachers however, complained that they did not have adequate materials to organize the activities similar to those obtained in the workshop. Nevertheless, the teachers observed that some of their colleagues liked the new strategies. This may be illustrated from the comments of the teachers coded T21 and T50 as follows:

> *T21: "I have already run a similar workshop for the teachers in my school and they enjoyed it a lot. We did it in one day. I taught them concept mapping, 'Ask the object' strategies and they equally carried out activities on Magnetism as done during your workshop, although we lacked some of the materials you used like the 'Magnetism game".*

> *T50: "My colleagues liked the strategies. They feel that it will help them to make the children more involved in their lesson".*

Some teachers suggested that their colleagues while acknowledging that the strategies were good for teaching science and other subjects, expressed some reservations about the use of concept maps. Such reservations derive from the link words which may cause problems for the pupils. The above views may be illustrated with the comment made by the teacher coded T11 as follows:

> *"They liked the strategies but feel that concept mapping may be a bit difficult for the children to use in some topics".*

An interesting conclusion of this analysis is the finding that the teachers were able to disseminate information and skills learnt from the workshop. In fact, during my follow-up visits to schools, some of the teachers who did not participate in the workshop, appeared quite keen to hear more about the strategies and their applications. As a result, some head-teachers were obliged to send more teachers to attend the 1-day workshop on their own. It was understood from the Education Officers from all the eight LGEAs involved in the workshop, that the feedback from the workshop was also disseminated at that level. In fact, some of the LGEAs collected the reports of the workshop and handouts given to the participants from their LGEA and instructed them to organise a similar workshop for the whole LGEA (example of such LGEAs being Nnewi North, and South, Anaocha, Onitsha South, Aguata, Awka South and Njikoka.).

Nevertheless, a few teachers (10%) were not able to organize workshops in their own schools due to their lack of self-confidence. This may be illustrated by the comment of the teacher coded T29 as follows:

> *" Yes I think that I need to relate to other colleagues through a seminar or workshop. It is worthwhile to do so, but I think that it will be tedious for me alone to run such a workshop. I will need the assistance of the researcher since I don't think I am perfect to run the workshop on my own".*

Other reasons given by the teachers for their inability to organise a workshop afterwards was ascribed to lack of funding. The teacher coded T15, has reported this in the following words:

> *" I spoke to my other colleagues and they were willing to and interested to have that experience but I need money to buy some materials for the workshop. Our Local Government told us that they have no money to give to us now".*

Other teachers who also expressed the need for the workshop co-ordinator to be present during their workshop appeared to be more interested in the co-ordinator's physical presence, to avail themselves of her guidance.

7.1.4: Problems encountered during the introduction of the workshop strategies

All the fifty (50) teachers who participated in the workshop reported that after the workshop they had used the learnt strategies in their science lessons. However, some of the teachers had reported experiencing problems with some of these strategies. These problems will now be discussed in the following paragraphs.

a: Problems encountered in the use of such strategies as, concept mapping, 'Ask the Object', and investigation in science lessons.

A number of problems were experienced by the teachers in the course of their using the strategies introduced at the workshop. Some of these problems were associated with novelty of the strategies while others involved the applications of the strategies to science teaching.

i) Problem associated with the introduction of concept maps:

Results show that 31 teachers (62%) reported that they had experienced problems in the introduction of concept mapping to the pupils. The remaining 19 teachers (38%) did not find it difficult to introduce the concept mapping to the pupils.

ii) Problems associated with the use of link words :

The major problem highlighted by the teachers on the use of concept mapping concerned the selection of appropriate link words used to join concepts or nodes. However, some of these teachers claimed that they were able to overcome this difficulty through constant practice. Indeed, out of the 31 teachers who had problems with introducing concept mapping, 22 reported problems with the use of the link words, while 9 felt that it was not a problem, but that representing some of the processes (such as , drawing a concept map showing North and North poles of a magnet repel while, North and South poles attract) on the map was the most difficult. However, some of these teachers blamed their poor command of English as one of the major draw backs to the success of this strategy.

The teachers' difficulty in the selection of appropriate link words may be illustrated by the comments of teacher coded T50 who noted as follows:

> *"The strategies were used in the science lessons and the children liked them especially the concept map but can not make meaningful links between the concepts because of the language barrier".*

Similarly the teacher coded T17 while acknowledging that the concept mapping strategy had helped the children become more involved in the lesson, nevertheless was dissatisfied with its use, for reasons adverted to earlier. This teacher noted during the interview as follows:

> *" Not really; but the concept mapping increased the children's interest in science because of their involvement in the activities and development of the maps, but the problem is the link words which are actually posing problems to the pupils".*

iii) Problems associated with representing processes on the map:

Some of the teachers whose problems arose from their difficulty with representing some processes on the map reported that while the strategy was good and interesting to the children, they (the teachers) however, noticed some limitations as regards the use of the strategy. According to the teachers this short coming is associated with the difficulty of representing some processes on the map as earlier discussed. This problem which was first found in the concept mapping analysis in chapter 6, was reported by only a small minority of teachers (i.e. 9 or 18%).

The teachers did not report having any difficulties with the use of strategies 'Ask the Object' or the activity method, except in the case in which a teacher had reported difficulties in her ability to raise 'good' questions that could lead to practical investigations in her science lessons. This was illustrated in the comment made by the teacher coded T14 as follows:

> *T14: "The difficulties I encountered was in the introduction of concept mapping and also being able to frame good questions that can lead to investigation although I am beginning to get used to it by constant practice".*

There were also teachers who had experienced the two problems highlighted above. Such teachers claimed that they were able to overcome the problems encountered. However, some of these teachers still experienced difficulties in the use of the concept mapping. This was observed particularly when the teachers tried to use the strategy to teach a topic. Some of the teachers were quite comfortable using concept mapping for assessing the pupils' performance in science. In some cases, the strategies did not serve the purpose for which it was introduced. This is illustrated by the teacher coded T2 (who in trying to use the strategy to teach 'Circulation of Blood in Man', got stuck in the middle of the lesson). No wonder not many of the teachers used this strategy in teaching this topic as shown in the earlier section of this chapter. Nevertheless, the teachers found it easier to use the strategy to teach subjects such as, Languages and social sciences, involving use of everyday common words as also shown from Table 7.2.

b) Ways in which teachers overcame the problems.

2 out of the 31 teachers who reported encountering some difficulties in using the concept mapping strategy also reported that they were able to overcome the problems by constant practice. According to the teachers, the pupils were

not able to make good links between the concepts the first time round but with constant practice, they began to make progress. The teachers also noted that the children did not have any problems in using appropriate link words to join common words in English language or social studies but expressed difficulties in finding appropriate words in joining nodes involving scientific words. A good illustration of this was given by the teacher coded T18 who commented as follows:

"At first the children did not cope especially with the linking words but with constant use, they started to overcome the problem".

Another, teacher (T34) simply commented;

" By continuous trial".

The above examples of comments from the teachers showed that they persevered in the use of the strategy inspite of the problems they encountered during their use. This may indicate the interest and willingness of the teachers, to bring science to the level of the children and in that way make science interesting and less boring.

7.1.5 : The actual benefits of the workshop as reported by the teachers.

a. The evaluation of the workshop outcomes by teachers in groups:

It should be recalled that the data for this analysis came from three different sources, namely; group responses of the teachers, (obtained during the 2-day workshop) head-teachers responses and individual teacher's account of the benefit of the workshop (obtained during the follow-up visits to schools). As discussed in chapter 5, there were 15 groups of teachers from all the workshops.

i) *Group Analysis of the benefit of the Workshop:*

Table 7.4 summarizes the benefits of the workshop as reported by the groups of teachers at the end of the 2-day workshop.

Table 7.4: Showing the benefit of the workshop as reported by the groups of teachers.

Benefits as reported by the teachers	Number of groups of teachers reporting each benefit. (n = 15)
i) Strategies learnt during the workshop could help the teachers to teach pupils to learn science in a fun way and develop positive attitude in children	13
ii) Exposure to practical investigation at the workshop could help the teachers retain the learnt concepts	13
iii) Strategies learnt could be used to identify children's ideas.	11
iv) Teachers exposure to some science materials could help them learn more magnetism concepts	10
v) The strategies learnt could be used to teach subject areas other than science	8
vi) The workshop encouraged the spirit of team work	4
vii) Workshop provided an opportunity for the teachers to read other textbooks in primary science.	3
viii) The workshop helped the teachers to become aware of some local materials that could be improvised to teach primary science.	3

It may be observed from table 7.4, that five important benefits emerged as reported by more than half of the groups of teachers. The most important benefit claimed by the groups of teachers include the following (a) the strategies learnt during the workshop were seen as a way of making science interesting to the children, (b) The exposure of the teachers to practical activities on magnetism had helped them to retain better the concepts learnt during the workshop. From this result, it is easy to see that the main problem which the teachers had had with the teaching of magnetism was their inability to make the topic interesting to the children as well as a lack of understanding which resulting from a lack of retention of what they learnt. This issue of making science learning interesting had already been discussed in the earlier section of this chapter where the teachers claimed that the children's response to science learning reflected their high enthusiasm to learn science in general. The teachers' appreciation of the fact that their exposure to practical activities would help them to retain more of the concepts learnt, shows that the teachers had earlier lacked this practical exposure. Nevertheless, very few (3) groups claimed that the workshop enabled them to be aware of the possible use of local materials to teach science. It is rather surprising that although the teachers rated the importance of practical activities high, not many of them realised the aspect of improvisation of local materials to the teaching which was one of the problems militating against the progress of teaching of science by discovery. In fact, teachers tended to blame inadequate resources for their inability to teach science using the discovery method as reported in this work and other earlier studies. A recognition of this benefit by the teachers could imply that teachers could make use of the materials in their local environment in designing practical activities which obviously would make more sense to the children.

For illustrative purposes, the following sections are presented as examples each of the benefits as claimed by the teachers.

i) Example of where the strategies learnt helped the teachers to teach children to learn science in a fun way and develop positive attitudes:

An example of the above benefit of the workshop was made by group 1 teachers who emphasised that activities provided during the workshop enabled them to be aware of other ways of making the teaching of science interesting. On this note they observed as follows:

> *" From the series of activities carried out on magnetism , we realised that science is discovery and should be done through playway method . This way of teaching help children learn science in a more relaxed manner and also have positive attitude towards science teaching".*

Similarly group 4 members reported as follows:

" The magnetism game introduced during the workshop could help the children to check what they know on magnetism as well as help them to learn and retain some of the magnetism concept terms in a playway method which is the major problems in the learning of magnetism. It makes learning in science interesting and less boring".

ii) Example of where the workshop helped the teachers to be exposed to materials and learning more magnetism concepts and concept terms:

An illustration of the above benefit can be found in the report of group 3 teachers as follows:

" We were exposed to all kinds of magnets which we never saw before. We discovered that with a strong magnet, repulsion could be felt by playing with the magnets and this has helped in understanding these terms better and hope that it will help the children to understand the concept terms easily".

iii) Example of where the benefits are perceived in terms of strategies used for assessing pupils work in science:

The above example was reported by members in group 3 who reported as follows:

" The strategies introduced e.g.: concept mapping, 'Ask the Object' , and Magnetism Game were found to be the ways of making the science teaching and the learning of science interesting. For example, concept mapping, was seen to be effective in checking the starting point of the child as well as used to find out if there is any misconceptions the child has about a particular topic before and after teaching the topic".

iv) Example of where the benefit is seen as the use of strategies to teach other subject areas that are not primary science:

This aspect of the benefit was noted by many groups but was represented in groups 1 report as follows:

> *"Concept mapping and 'Ask the Object' strategies can be used to teach other subject areas and also in assessment of learning outcomes".*

v) Example of where the benefit was perceived in terms of providing opportunity for the teachers to be exposed to practical investigations which helped them in the retention of learnt concepts:

The above example was reported in group 2's report as follows:

> *" We were exposed to the practical knowledge of the topic which we have been reading theoretically and this has helped us to understand more of magnetism and also will help us to remember them".*

vi) Example of where the benefit of the workshop was seen as an opportunity for the teachers to interact with each other and work as a team:

Example of this was illustrated in group 3's report as follows:

> *"We discovered that working in a team helps in gaining more experience by exchanging views with other colleagues".*

This aspect of the workshop benefit is important as the teachers appreciated the need for mutual exchange of views and learning through such interactions. Hopefully, such contacts between the teachers will continue even after the workshop and can lead to interschool exchange of views.

vii) Example of where the benefit of the workshop was perceived as an opportunity to be exposed to other science texts:

The teachers reported that the workshop offered them the opportunity to become aware of other primary science texts in use in other parts of Nigeria as well as other texts which are related to the teaching of science. This may be illustrated from the report of group 3 members who commented as follows:

> *"Our exposure to other textbooks on primary science enabled us to know that there are other better textbooks on magnetism and other topics in science which are not treated well in the recommended text we use".*

viii) Example of benefit as providing skills for Improvisation of local materials to teach primary science:

A few groups observed that the workshop experience provided them with skills to improvise local materials that could be used in running science practical activities within their local environment. An example of this was illustrated in group 2's report as follows:

> *"We always blame the lack of materials on our inability to teach science in a proper way. From this research, we have come to realise that any material can be used for science teaching as long as they are organised, meaningfully. In this workshop we have used materials ranging from cardboard papers, pen and pencils, magnets of different shapes and sizes, compasses, needle etc. These are all from the market in Awka. Science materials must not come from overseas".*

b) Evaluation of the workshop outcomes by the head-teachers of participated schools.

The headteachers of the schools which participated in the workshop were interviewed during the co-ordinator's follow-up visits to schools. Responses were received from (41) head teachers of forty-one primary schools from which the 50 primary six teachers who participated in the workshop were drawn. The follow-up visits to schools revealed that all the fifty teachers reported to their head teachers about their experiences at the workshop. All the head teachers subsequently interviewed reported the outcomes of the workshop as beneficial to their schools. Table 7.5 summarizes the head teachers perception of the workshop outcomes.

Table 7.5: showing the head teachers' evaluation of the outcomes of the workshop.

Benefit of the workshop as reported by the head teachers of schools.	Number of head teachers reporting each benefit.
i) More confidence demonstrating by the teachers	37
ii) Knowledge updated and desirable skills for science teaching acquired.	31
iii) Change in the teachers choice of pedagogy in science teaching	31
iv) Helping the teacher and the pupils to develop greater interest in science.	20
v) Helping other colleagues to develop interest in science.	3

The two most outstanding benefits of the workshop as reported by the headteachers include the facts that the teachers acquired the ability to demonstrate greater confidence in teaching science as well as their ability to demonstrate their acquisition of desirable strategies for science teaching. This is similar to the earlier benefit of the workshop reported by the groups of teachers. The headteachers report on the benefits of the workshop could reflect the fact that the teachers had actually been able to demonstrate these earlier claimed attributes in the classroom. The teachers had earlier reported of understanding magnetism concepts and thus teaching them effectively in their classrooms. It may therefore be concluded from the observations of the headteachers, that the teachers did benefit from the workshop.

A few of the headteachers reported that the workshop had enabled the teachers who participated to train their colleagues. The fact that this was reported by only a small minority is rather unfortunate as this was an important objective of a training workshop in which a teacher from one school is trained in order to train others in his/her school. However, it may well be that the teachers who participated in the workshop had laid more emphasis on the teaching strategies learnt rather than the subject content which could have produced well rounded teachers rather than one steeped in pedagogy. However, it needs to be said that although some of the teachers' colleagues liked the strategies, nevertheless, they had some reservations on their application in the classroom. This would probably affect the impact of the workshop outcomes to these teachers. Hence, more effort to make an expected impact on their other colleagues was expected of the teachers that participated in the workshop.

In the following sections examples of each benefits listed in table 7.5 are discussed.

i) Example of where the headteachers perceived the workshop as having helped the teachers to be more confident in their teaching:

The different headteachers were required to describe the extent of involvement, confidence and change of attitude in science developed by the teachers who participated in the workshop. Their responses were similar and may be illustrated by the headteacher of the teacher coded T21 who commented as follows:

> *" The teacher seemed to be happy and more confident in teaching Magnetism and other topics in science after the workshop. I noticed the interest in her".*

ii) Example of benefit of workshop participation expressed the acquisition of desirable new skills for science teaching as well as knowledge update:

A good number (73%) of the headteachers observed that their teachers improved in their ability to explain some of the magnetism concepts to the pupils. This indicated better understanding of the concepts. In particular, the headteacher of the teacher T16, reported the following on this issue:

" The teacher briefed me on the workshop. I feel that this type of opportunity will benefit my school because it will help the teacher to update her knowledge as well as provide skills for the teachers who did not have such opportunity during their training days".

The above comment shows that the headteacher believed the teacher who must have reported to her what she learnt from the workshop. It also shows the ability of the teacher to share newly acquired skills and information with other teachers who did not attend the workshop.

iii) Example of a benefit of the workshop in terms of the teachers change in their choice of pedagogy in science teaching:

Some of the teachers had shown that the strategies learnt during the workshop had enabled them to use other strategies in teaching science. This may be illustrated from the comments of the headteacher of the teacher coded T27 who commented as follows:

" The teacher has improved in the ways of teaching science especially topic like 'Magnetism' which poses a lot of difficulties for both the teacher and the pupils".

iv) An example of the benefit of the workshop expressed as helping for teacher and the pupils to develop greater interest in science :

The headteachers also commented on the value of the workshop as providing opportunities that enabled their teachers to make their science teaching more interesting. On this point, the headteacher of the teacher coded T12 specifically commented as follows:

"From the briefing with the teacher who attended the workshop, it showed that there is progress and interest on the part of the pupils and the teacher".

v) Example of workshop benefit expressed as enabling teachers help other colleagues to develop greater interest in science in other colleagues:

The head-teachers, noted that the workshop experience did not only develop the teachers skills in science teaching but also their ability to transfer the teaching skills to their other colleagues who had not participated in the workshop. In this regard, the headteacher of the teacher coded T45 commented as follows:

> *" Very good workshop! We have done a similar one in my school for the senior teachers. We like the strategies but still need you to come and help us organise a similar workshop on other science topics. I think that the teachers will be more confident in teaching the topics in science with this type of training given on them".*

The headteacher reported that she would want these strategies tried in other science topics but would however, require some external assistance (from the co-ordinator). However, it was rather surprising that only three of the head-teachers had reported this benefit since more of the headteachers were expected to realize the need for more workshops to be organized on other topics. Nevertheless, most comments of the head-teachers as regards the positive effect of the workshop were geared towards promoting a greater interest in science among the teachers and children alike.

Generally speaking, all the head-teachers found the workshop beneficial to their teachers and schools. They also appreciated the exposure of their teachers to different strategies and activities in science, as well as the update in their knowledge. they also noted the improved confidence in the teachers while carrying out practical investigations in the course of their science teaching.

c) ***Benefit of the workshop as reported by the teachers who attended the workshop.***

The teachers who participated in the workshop were visited during the follow-up exercise and interviewed in order to debrief them on their workshop experiences, their perceived benefits, as well as problems which they encountered using some of the strategies in their post-workshop teaching practice.

The analysis of the data has shown that all the fifty teachers perceived the workshop as useful to them. However, there were variations in aspects of professional skills which they believed were improved as a result of participating in the workshop. Table 7.6 provides a summary of the various aspects of the areas of professional development that are believed to have been affected as a result of the teachers' exposure to the workshop.

Table 7.6: Showing teachers' perception of the benefit of the workshop

Benefits of the workshop as reported by individual teachers.	Number of teachers reporting each workshop benefit attribute. (n = 50)
1. The workshop exposure helped the teachers to be more confident in carrying out practical tasks.	43
2. the workshop had helped the teachers to learn more about Magnetism.	29
3. The workshop provided an opportunity to the teachers to learn about other strategies used in teaching and assessing primary science.	24
4. the strategies helped the teachers to get children more involving in class activities and make science teaching interesting.	21

In Table 7.6, two major benefits were highlighted by more than half the teachers who participated in the workshop, as follows: (a) workshop exposure helping them to be more confident in carrying practical activities in science, and (b) learning more about magnetism as a result of their exposure to the workshop. Again, the benefits of the workshop as highlighted by the headteachers are also reflected by the majority of the teachers in their individual capacities. Since the teachers were not adequately trained to teach science, they faced difficulties in teaching science to their children. These inadequacies were tackled through their workshop exposure and appeared to have restored their confidence to teach science. Indeed, there is no doubt that as observed by these teachers and their headteachers, the aims of the present workshop were achieved. Although less than half (42%) of the teachers who participated in the workshop had reported that the strategies learnt during the workshop had helped them to involve children to participate actively in the lesson, as well as helped them to learn more about other strategies needed to teach and assess primary science (48%), the number that reported these benefits are considered substantial enough for one to conclude that the teachers had benefited well from those aspects of the workshop.

Examples of benefit of the workshop reported by the teachers are illustrated in the following sections as follows:

i. The workshop enabled the teachers to develop more confidence to carry out practical tasks in science:

Some of the teachers had reported that the workshop helped them to be more confident in carrying out practical activities in science. This benefit in the comments made by the teacher coded T29 as follows:

> *"The workshop helped me a lot. I have been teaching Magnetism but it was abstract, but with the workshop, I was exposed to some of the activities and I was confident in what I was doing like doing experiments and the children were happy with the whole activities".*

ii. The workshop provided opportunity for the better understanding of magnetism concepts:

Some of the teachers who participated at the workshop reported that their exposure to the workshop had helped them in understanding some of the magnetism concepts not understood before the workshop. For example, reports from some of the teachers such as the one coded T27 suggested that such magnetism concepts as the polarity of the magnet, magnetic force, etc., were better conceptualized and this led to an enhanced ability to teach the topic more confidently. This was expressed by the teacher coded T27 as follows:

> *" I can now identify the poles of the magnet and saw that there are weaker and stronger magnets. I discover that magnetic power is stronger at the poles. Magnets can not attract all the metallic materials. The strategies used helped me to evaluate the pupils starting point and to check their knowledge after teaching. I can now carry out investigations on Magnetism confidently".*

iii. The workshop provided an opportunity to the teachers to learn about other strategies used in teaching and assessing primary science.

The teachers reported that the workshop provided them with an opportunity to learn other strategies used to teach as well as assess primary science topics. This is illustrated by the comment of the teacher coded T17, as follows:

> *"The workshop exposed me to other strategies to teach science and assess in science. I learnt more about Magnet".*

This is further amplified by the teacher (T14) who commented as follows:

> *" The use of different strategies in the teaching of science make learning and teaching more interesting. I was able to determine the poles of a magnet and had the opportunity to work with strong magnet to show the major characteristics of magnet which is repulsion. I have*

used concept mapping in my class, it made the class so lively. The children raised all sorts of questions in the class when I used 'Ask the Object' strategy. The children were quite involved in the lesson".

iv. the use of the strategies to help the teachers to get children to be more involving in class activities and make science teaching interesting

The teachers also reported that the workshop strategies such as concept mapping, 'Ask the Object', practical activities, had helped the children in active participation in classroom activities which helps them in becoming interested and as such help them to make sense of what they learnt. This may be illustrated by the response of the teacher coded T13 who commented as follows :

T13: "With the exposure to several activities, I realised that carrying out investigations in science make science more interesting and help children to be more involved and make sense of what they have learnt".

7.2: Post workshop observation of teachers.

7.2.1: Description of post workshop observation of teachers' lessons.

It may be recalled that the first observation of the teachers' while teaching their science lessons was carried out before the 2-day workshop was organised. The second observation of the teachers on the other hand, was carried out 1 to 2 weeks after the 2-day workshop. The teachers at the workshop were exposed to various kinds of experience ranging from

- varying teaching strategies
- exposure to series of investigations in magnetism
- possible sources of local materials to use in teaching magnetism and other aspects of science.

The purpose of the second observation was to find out the following:-

- How activities were carried out by teachers who participated in the workshop, on their return to their normal teaching duties in primary science.

- The extent to which the teachers were able to incorporate the new strategies in their teaching effort.
- To determine the difference, if any, occurring between the first and second observations in terms of the criteria mentioned above.
- To ascertain whether any change in the time allocated to science activities had occurred as a result of the workshop .
- To ascertain whether there was any change in the pupils' involvement in the classroom.
- To assess the general attitude of the pupils to the new skills employed by the teachers.
- To assess how the teachers carried out assessments in science after the workshop.

7.2.2: Presentation and analysis of the data from the follow-up (First post workshop observation) observation of the teachers

The following attributes were recorded from the 50 teachers in their normal classrooms. Similar to the first observation, the behavioural attributes were observed as they occurred within a single lesson of 35 minutes. Table 7.7 summarizes the trend of events as they occurred in the 50 teachers lessons as follows:

Table 7.7: Number of teachers who engaged in a particular activity at different stages of the science lessons observed during the second observation of teachers

Behavioural Attributes by teachers	Time Intervals within a single lesson of 35 minutes						
	0-5	**5-10**	**10-15**	**15-20**	**20-25**	**25-30**	**30-35**
Teacher talking	50	50	49	46	45	50	50
Questions asked Closed-type	49	40	8	4	14	30	38
Questions asked Open type.	9	5	3	-	-	-	2
Teacher performing practical activity	-	1	17	17	17	12	2
Teacher writing on board.	41	43	12	11	12	40	40
Pupils Answer question.	38	32	2	1	-	7	41
Pupils' ask question.	-	2	-	2	1	1	-
Pupils' perform activity.	-	1	15	17	17	12	2
Pupils' draw concept mapping or other type of diagrams.	-	-	16	18	18	16	18
Pupils' copy notes.	-	-	-	-	-	-	6
Pupils' seek assistance from teacher.	2	-	13	13	14	11	3
Chart used.	1	-	-	-	-	1	1
Science Equipment used.	-	-	-	-	-	-	-
Local materials used.	-	1	17	17	17	12	2
Lesson concluded.	-	-	-	-	-	-	6

Analysis of Second Observation of the teachers lessons.

The result of the observations which are summarised in Table 7.7 shows that all the teachers continued to give information to the pupils through out the duration of the lesson. There were, however, only a few teachers who did not talk to the class during the middle part of the lesson. The observations were very similar to those recorded during the pre-workshop visit. (see Table 7.7).

Nevertheless, it was noted that the type of talk was different with teachers raising questions, helping pupils to clarify a view, or giving more information on the activities to be carried out during the lesson. Over 80% of the teachers raised questions during the first ten minutes (time interval of 0-5 and 5-10), as well as at the end of the lesson (30-35 interval). A minority of teachers (less than a quarter) questioned pupils within the time interval of (10-15) and (15-

20). A few (9) of the teachers used open-ended questions in their science lessons mostly at the beginning of the lessons. This is an improvement over the first observation where no teacher raised a single open-ended question. The teachers were mostly involved in assisting the children in the drawing of concept maps during this observation. The blackboard was used frequently, particularly at the beginning (0-10) and at the end of the lesson (25-35). The teachers during this observation were observed writing on the blackboard more often.

Over 80% of the teachers used the blackboard within the time intervals (0-10), as well as (25-35). Again, it must be pointed out that this observation refers to a different kind of writing on the blackboard. This type of writing included; drawing of concept maps and drawing of structures.

An interesting observation, was made to the effect that most of the teachers used brainstorming in introducing concept maps in their classrooms. These brainstorming exercises were usually in English in the course of which the children were asked to make sentences using the words they provided and written on the blackboard by the teacher. (This exercise was carried out during the workshop and was given as a way of introducing concept maps in the classroom). An example of teachers who used the brainstorming strategy is the teacher coded T2 who used the brainstorming technique quite successfully, but who unfortunately faced a minor problem with the use of the link words (e.g. is, are, has, etc.). However, when the teacher applied the concept mapping on her science topic (Human circulatory system) it was observed that in most of the maps drawn by both the teacher and her pupils, nodes were joined mostly with link words which are relational (e.g. is, has, study of, etc.,). The choice of appropriate link words as well as the position of the arrow posed a great problem for this teacher and her pupils. This problem was further illustrated by the teachers coded T13 whose children found it difficult to fix the position of arrows (representing processes) in their concept map diagrams of pulleys.

However, there were cases where concept mapping was used to assess the lesson taught. For example, the teacher coded T35 used concept mapping to consolidate a lesson on the digestive system as well as to assess the lesson. The exercise was interesting as the children drew diagrams to depict how food taken in the mouth could be digested.

It was also observed that on two occasions children asked teachers questions but these questions were mostly closed but challenged the teacher to help them clarify their understanding about concepts or instructions given by the teacher. A good example of this is illustrated in the teacher coded T1's lesson where a child asked a question relating to the attraction of a magnet to the iron pins on the teacher's table. This question required the teacher to indicate what the pin was made of and why the pin was attracted to the magnet, while his school box, which was also a metal, was not attracted.

During the observation, children were involved in activities of different types, involving the performance of practical activities in their classrooms. It was also observed that, about 30% of the teachers performed activities as well as involved children in activities in their lessons. These activities were carried out within a time interval of (10-15) to (25-30) minutes. Some of the materials used for the activities were brought to the lessons by the children. In some cases, activities were stretched over to the end of the lesson. However, a good proportion of the teachers did not perform any activities in their lesson.

In contrast to the initial observation, the activities above prevented the children from having to sit passively to listen to the teacher all through the lesson and thus break the monotony. These children were also observed answering or asking questions as mentioned earlier which helped to make the atmosphere lively. The concept mapping activity involved the children having to sort out the right words to use for linking the concepts on their maps. This type of activity helped the children to gain an understanding of what they were doing. As a result, children began to ask questions and to seek for help from the teacher. This could be seen from the table 7.7 as a little below 30% of the children were seen seeking for assistance especially when drawing the maps or during the activity section.

Finally, we consider the important issue of the teachers' use of locally made resource materials to teach science. It was observed that about 30% of the teachers used local materials in their science lessons. Only one teacher used a chart, which was presented at the beginning of the lesson as well as towards the end. Six of the teachers concluded their lessons after the activities. However, most of the teachers were also observed using questions (of the closed-type) to check learnt materials after the lesson.

7.3: The 1-day Reflection workshop

7.3.1: Introduction:

After the follow-up exercise, discussed above, it was found necessary that the participants come together again to discuss how they managed with the new strategies introduced during the first workshop. A description of the 1-day (Reflection) workshop organised for the teachers after the second visits to their schools is given below (see Appendix F for details of the three 1-day workshop).

7.3.2: The Description of the 1-day workshop:

The aim of this workshop was to enable the teachers to reflect on their total interaction with the workshop co-ordinator. This involved discussing with their colleagues how they were able to apply the new strategies in their post-workshop teaching practice. They also considered any other problems encountered during their use as well as how these problems were tackled. In addition, the reflection workshop was designed to enable the teachers learn how to plan activities on topics in science other than magnetism. Initial discussions were therefore carried out along the following lines:

•To examine their pupils' reaction to the use of the strategies.

• To examine their head-teachers reactions to the use of the strategies.

• To consider the reactions of other colleagues to the use of the strategies.

• To ascertain what the teachers intended to do in future.

The teachers also carried out some exercises on how to plan investigations in other topics in science as well as how to develop an assessment tool for measuring the outcomes of their planned activities. As in the 2-day workshop, in which the teachers were subdivided into three batches or groups, the 1-day workshop was carried out in a similar way. (see Appendix F for details of the three workshops).

The reflection workshops, on which other ones were modelled took the following form:

The workshop generally started at 9.00 am with all the 50 teachers. who participated in the 2-day workshop being present. Five additional teachers who were sent by their individual headteachers as already indicated earlier, were also present.

In all the workshops, the teachers were asked to remain in their former groups (formed earlier during the 2-day workshop) to discuss the following issues:-

• The head-teachers view on the benefit of the workshop.

• Any impact made, or intended, in their various schools.

• The teachers' perceptions of the strategies which they learnt during the workshop.

Although the above issues were discussed during the follow-up visits to their schools, it was nevertheless necessary that the teachers shared their experiences in these group discussions. Each group was subsequently given 3 minutes to present its discussion. (Details of the discussions are given in Appendix F1)

After the discussion, the groups were asked to present magnetism concept maps produced by their children before and after teaching the topic to check for any change in the maps drawn as well as the answers to questions testing their ideas on magnetism. The groups presented comments on the maps drawn by the children. Because some of the teachers did not bring the concept maps drawn by their children before and after the activities on magnetism, it was difficult to assess their corresponding children's knowledge before and after, in order to make comparisons. Nonetheless, the maps collected by those teachers who carried out their tasks properly were used for this exercise.

The groups were also asked to discuss the peculiar problems each teacher encountered when applying the strategies. This discussion on the difficulties showed that concept mapping was, for the teachers , the most difficult strategy to introduce to the children. Although all the teachers agreed that concept mapping was an interesting strategy for teaching not only primary science but also other subjects, nonetheless, it was difficult to introduce, because of the children's poor repertoire of English words needed to link nodes. Generally speaking, the teachers acknowledged that both the concept mapping strategy as well as the practical activities increased the children's interest and motivation to learn science. This also helped them to develop a positive attitude to the subject. This outcome was similar to the benefit of the workshop reported by the individual teachers from their own perspective. It was also observed that many of the children showed marked interest and involvement in their learning of science and were thus willing to carry out activities in the class.

Following the discussions on the children's concept maps, the teachers were asked to pick a topic from the primary six science curriculum and develop workshop activities that could help the children understand the topic better. This activity was also carried out in groups. The specific instruction to them was to use the 'Ask the Object' tool to raise questions on the topics chosen and hence develop activities for any one question that they thought would lead to further practical investigations. The topics chosen by the groups were as follows, Group 1 - Simple Machines

Group 2 - Environment

Group 3 - Minerals

Group 4 - Minerals

Group 5 - Simple Machines

(Details of the activities prepared may be found in Appendix Fi)

The various groups also planned practical activities that could be carried out in the classrooms in other to answer the questions raised during the session.

The planning of activities was followed by the development of a 'story'. This was a very difficult task as the majority of the teachers were not familiar with this type of activity. The 'story' was expected to be written around the topic chosen above. The purpose of this exercise was to expose teachers to other ways of posing 'good' questions in a science lesson. It was also meant to diversify the teachers' skill in asking questions.

The teachers appeared to have made some efforts but tended to raise rather straight-forward questions during this exercise. The most difficult aspect of this exercise was to construct a question that should not give clues to another questions that could be raised in the story. The five groups having presented their stories, the teachers then discussed and presented the outcomes of the workshop group by group. This part consumed time and made the workshop unduly long.

7.3.3: Presentation and analysis of data collected from the 1-day (reflection) workshop.

Here, activities were planned on seven different science topics by the 15 different teams or groups of teachers employing strategies which were learnt in the 2-day workshop. The teachers raised questions on the topics chosen and then planned activities to answer at least one of the questions raised. The 15 groups of teachers showed ability to raise both productive (i.e. questions that could lead to investigation) and unproductive (questions that can not lead to investigations) questions in science as evidenced by the questions they raised during this session. The use of 'Ask the Object' strategy created a forum for the teachers to raise as many questions as needed to be answered on the topic chosen. The questions raised as well as the activities planned to answer them, are presented in Appendix F. Although it was observed that teachers were able to raise productive questions on the selected topic, still there were still a large number of productive questions raised by these groups of teachers.

Table 7. 8: Number of groups of teachers that planned activities on each science topic.

Topics	**Number of Groups planning activity.**
Simple machine	3
Environment	2
Minerals	3
Air	2
Digestion	1
Measurement	1
Earth and Sky	1

The following sections are the descriptions of the activities planned on different science topics.

<u>Simple Machine.</u>

The activities which were planned under this broad topic by group 1 included, identification of simple machines, survey of types of levers, review of the causes of friction as well as the reduction of frictional forces in objects . The activities which the team planned required the children to carry out work on their own so as to appreciate the terms as they carried out their practical activities. For example, the activity on friction which involved the children to rub their palms together or to rub two pieces of toasted bread together, led to direct experiences by the children and at the same time enabled them to be involved in the class. Such activities are expected not only to involve the active participation of the children in the lessons but also helped them understand some of the terms used in the lessons.

Similarly, groups 5 and 12 planned activities on the topic of simple machines but they however, concentrated on the lever, as a part of the main topic. Activities which they planned (see Appendix Fi) involved not only the use of local materials but also involved the children in simple practical activities guaranteed to promote their active participation in the lesson.

Environment: This topic was chosen by groups 2 and 10. The questions raised by the two groups of teachers were mostly unproductive but included a few productive ones which required simple observation. The only questions which required simple observation were raised by group 10. These involved examining changes in the environment, the effect of humans on the environment as well as ways of ameliorating the affected environment in order to prevent further environmental disasters.

Mineral: Three groups namely groups 3, 4, 9, worked on this topic. The groups, as usual, raised mostly straight-forward questions that required simple straight-forward answers and their uses. However, in some groups activities (such as in group 9), the teachers proposed other strategies including drawing and use of field trips for the active participation of the children. The group however, failed to show how the field trip should be carried out and what the children should look out for on arrival at their destination. However, group 4 attempted do this. Further, group 4 planned a practical activity which was demonstrated by the classroom teacher.

Air: Activities on this topic were planned by groups 6 and 14. The questions raised by the two groups were not only straightforward but not well focused.

For example group 4, raised questions which required the children to show a knowledge of what the teacher had in mind but failed to make clear that the topic addressed is "air. For example, the question, " Supposing I pump a balloon and leave it on the grass, what would happen? apart from the fact that it was not well framed but lacked focus. Moreover, there was a mix up of the concepts of air and oxygen in the planned activity. However, the teachers demonstrated some understanding of the importance of oxygen in combustion.

Earth and Sky: Only one group (7) worked on this topic. Again, most of the questions raised on the topic were straight-forward and led to straightforward answers. However, a few of the questions could have helped the children to think. There were also no questions or activities on the rotation or revolution of the earth.

Digestion: The only group that worked on this topic was group 11. Both productive and unproductive questions were raised by this group. An example of unproductive question raised by this group on this topic was one on the definition of digestion. However, in this connection, an interesting question which required a child to explain several processes involved in the digestion of a morsel of yam (food) was raised. This allowed a child (in primary six) to explain to a primary 2 child what would happen to a piece of yam after it is eaten.

Measurement: Only one group worked on this topic. The questions raised were however, quite productive and well framed. The questions involved measurements and comparisons of different materials and the subsequent use of the results to compare densities.

Generally, teachers in the above exercise, were able to raise questions and were able to reflect on these questions. There is no doubt that the majority (13) of the groups placed more emphasis on raising productive rather than unproductive questions. Obviously, the use of 'Ask the Object' strategy had helped the teachers to gain a better appreciation of the necessary questions to be used in science lessons. With this method, the teachers are able to raise as many questions as could help them exhaust the various aspects of the topic they proposed to teach. These questions would later be tabulated and organized for effective planning against future use. The teachers were also able to suggest ways of carrying out practical activities associated with the questions raised in order to provide ready solutions to them. In addition, processes and materials required for the proper execution of the practical activities were suggested. Furthermore, the teachers were able to reflect on their practice and thus were able to make meaningful suggestions to this effect. One may thus conclude that the demonstrated ability to plan science activities during the workshop was enhanced from their reflections.

7.4: Post workshop observation of teachers after a three months interval.

The observation of teachers lessons was carried out three months after the 1-day workshop. This observation made use of the same schedule described in the initial observation of the teachers' lessons in chapter 5.

7.4.1: Description of the three months post workshop observation of teachers' lessons.

The third phase of the observation was carried out three months after the second workshop to ascertain the extent to which the new strategies acquired through exposure at the workshop were still in use by the teachers. The purpose of the third observation was to establish whether:

- the teachers were still using the strategies learnt during the workshop.
- the teachers had gained more experience in using the strategies.
- the teachers were using the skill they acquired during the workshop to teach other science topics as well as other subjects.

7.4.2: Presentation and analysis of three months post workshop observation.

The table below (Table 7.9) summarizes the behavioural attributes of workshop participated teachers during the third observation of their science lessons. As in the earlier descriptions (first and second observations of the teachers lessons) the columns represent the behavioural attributes of the teachers as well as the different time intervals within a single lesson of 35 minutes. The rows on the other hand, represent the number of teachers performing each of the attributes per different time interval of 5 minutes.

Analysis of three months post workshop observation.

As in the cases of the two observations carried out, the teachers were found talking to the pupils most of the time in their lessons. Most of the lessons observed reverted to the use of didactic method by the teachers but overall, teachers were still asking more questions and using a greater variety of strategies.

Most of the teachers (46) raised closed type of questions between the time intervals of (0-5) and (30-35) minutes respectively. Less than half the teachers raised closed questions between (5-10) and (20-25) minutes interval. Unlike the follow-up observation, a minority (2) of the teachers used open-ended type of questions in the science lessons.

Table 7.9: Number of teachers who engaged in a particular activity at different stages of the science lessons observed during the third observation of teachers

Behavioural Attributes by the teachers	Time Intervals within a single lesson of 35 minutes						
	0-5	5-10	10-15	15-20	20-25	25-30	30-35
Teacher talk	50	48	49	49	50	50	50
Questions: Closed-type	45	35	3	2	7	28	42
Questions: Open type.	1	2	1	-	-	1	2
Teacher perform activity	-	-	8	8	8	8	-
Teacher write on board.	47	43	17	34	16	41	48
Pupils Answer question.	45	25	1	-	3	25	33
Pupils' ask question.	-	-	-	-	-	-	-
Pupils' perform activity.	-	-	8	8	8	8	-
Pupils' draw concept mapping or other type of diagrams.			13	13	14	14	2
Pupils' copy notes.	-	-	-	-	3	33	33
Pupils' seek assistance from teacher.	-	-	7	10	7	7	-
Chart used.	1	1	2	2	2	2	-
Science Equipment used.	-	1	1	1	1	-	-
Local materials used.	-	-	7	7	7	7	-
Lesson concluded.	-	-	-	-	-	-	7

It was also observed that more than half of the teachers sampled used the blackboard more often between (0-5) and (30 - 35) minutes interval. Similarly, the response to questions by the pupils were more during the time (0 - 5) and (30 - 35) minutes interval than between (5 - 10) and (25 - 30) minutes interval. It is interesting to observe that only a few of the teachers (8) were found using activity method during their teaching. Similarly, less than half of the teachers used concept mapping in their lesson. In fact, there was a case of a teacher coded T21 who combined both activity method and concept mapping in her teaching. Children sought assistance from the teachers mostly in the drawing of their concept maps. It was observed that the concept mapping strategy was adopted in other science topics and other subjects other than science.

Science topics which were found to be treated using concept mapping include, simple machines, pulleys, farm tools, and environment. Teachers mostly used this method for assessment rather than for instructions.

7.5: Summary of the chapter:

Primary teachers have shown the ability to apply new strategies on the teaching of other topics in science as well as subjects other than science. A number of these teachers expressed having difficulties in the use of the strategies, although, a good number of them were able to overcome them through continued practice. Nevertheless, both pupils and other colleagues showed a positive attitude to the use of the strategies as reported by the teachers. In fact, some of the teachers' colleagues had tried the use of the strategies in their science lessons as also reported by the teachers.

The value of the workshop as perceived by the head teachers of the schools, the teachers participating in the workshops and the teachers' colleagues (who did not take part in the workshop) could be said to be substantial. Both the head teachers, and the teachers had perceived the workshop as enabling the participating teachers to gain greater confidence, knowledge and skills needed to teach Magnetism and other aspect of science. Some implications of these results to the teaching of magnetism were discussed in the preceding sections. One important aspect of the benefit gained from the workshop is that of the greater confidence which the teachers claimed to have achieved through their exposure to the workshops which implies that the teachers would be in a better position to carry out their duties. Indeed, some of these teachers had confessed holding certain misconceptions on concepts of magnetism which they were able to correct during the workshop. Thus, the teachers who had been passing wrong information to the children could now improve their performance or conceptions. A problem that could emerge from the teachers lack of knowledge on a given topic could be appreciated since teachers teaching a topic try to do so in a way that they do not expose their ignorance. This is illustrated by the case of the teacher T21 who before the workshop, felt that magnetism could only be taught by the didactic method. Teachers, it is known tend to use such strategies when they want to hide their ignorance (Harlen, 1987).

The question of the teachers organising similar workshops in their schools may be seen as a means of providing the teachers with an opportunity to try out the new skills and hence assess their performance at the workshop.

Chapter 8

GENERAL DISCUSSION

8.0: Introduction:

The object of the present chapter is to evaluate the entire phases of this study vis-à-vis the background study, research methodology, collection and analysis of the data, as well as the findings and their reliability. In addition, a critical review of the outcomes of the study and their implications for the classroom teacher, teacher educators, as well as curriculum planners would be undertaken. The discussion will also provide evaluation criteria for determining the effectiveness of the project in terms of the achievement of its stated objectives.

8.1: A review of the methodology used in the study.

The basic tool used for the surveys was the questionnaire. A number of considerations went into the design of this tool. In particular, a question used for the main study had made it possible for the reasons why teachers found certain topics difficult to teach to be easily identified. This question which was omitted in the questionnaire for the pilot study, was however taken care of in the design of the supplementary questionnaire, subsequently sent to those teachers that completed the questionnaire for the pilot study. Although not all the teachers who participated in the pilot survey completed the supplementary questionnaire (because some of them had transferred to other stations while others had left their jobs) , the number (41) of teachers who completed the supplementary questionnaire was considered a good representation of the number (50) that completed the pilot questionnaire.

Originally, the plan was for the teachers to be sampled within their school environment. Unfortunately, on arriving in Nigeria, it was found that all primary teachers in the country had embarked on a nation-wide strike action. In this circumstance, the teachers were chosen on the basis of the class they taught and also taking account of the need for not more than three primary six teachers to be selected from one school. This decision was made to enable teachers to be selected from different schools for a good representation of the sample.

Owing to the constraints of finance, the survey and workshop were limited to only 180 and 50 primary six teachers respectively. The choice of only primary six teachers, naturally limited the number of science topics to be considered as well as the number of teachers to be used in the study. This is so, because it was considered that since primary six is the last year of the primary education and since teachers who teach in the primary schools are likely to remain there for some time, they were likely to be acquainted with all the topics taught at that level and thus would be able to indicate which subjects they found most difficult to teach. In addition, since it was necessary to visit the teachers and work with the pupils in their natural environment, primary six was considered the most suitable level for easier communication in English language.

Turning now to the modalities of retraining the teachers, one may recall that there are a number of possible methods for retraining science teachers, as highlighted in chapter 5. Considering that the reasons given by the teachers for their difficulty in teaching some science topics, including the fact that they were inadequately trained in science teaching, the workshop approach was then considered a useful and valid method for retraining them. Moreover, this approach would enable them to have a first hand experience with the materials with which they were expected to teach, while at the same time providing them with the opportunity to carry out some practical activities on their own in an atmosphere that enabled them share their views with other colleagues within their team. This approach has the advantage that it allowed the teachers to gain or regain their lost confidence in carrying out their teaching duties.

It was found that the teachers performed better after their exposure to the workshop in some tasks, especially on the questions outlined on the 'magnetism story' and representing the concepts on the concept maps. The 'magnetism story' itself was jointly prepared at the Institute of Education, University of London, by Jenny Frost and myself following some initial discussions on magnetism. The purpose of the 'magnetism story' as a tool was to provide a mechanism for testing the teachers' knowledge of magnetism in a subtle and non-threatening manner.

It was also observed that some of the questions (in the 'magnetism story') did not meet the objectives of this study and moreover were found misleading. For instance, consider question 1 which required the teacher to react to a question directed to a child called, Sam. It later became clear that the teachers could react in a way that Sam (the child) would be expected to respond under normal circumstances, but this would depend on what type of child the teacher would have had in mind when reacting to the question. This problem was subsequently neutralized during the analysis by pairing the teachers responses to question 1 with their responses to question 2, which was asked directly to the teacher. Hence in analyzing the teachers' responses to the two questions, question 2 became the determining factor rather than question 1.

On the issue of the construction of the concept maps, it was observed that although the concept maps produced by the teachers after the workshop displayed a better understanding of some concepts of magnetism, nevertheless it was clear that in most cases, the teachers, did not appreciate what made a proper concept map. In fact, some of the teachers drew concept maps with either magnetism or magnet as a central concept and then proceeded to draw other concepts from the centre. Thus, these maps did not show any hierarchy of concepts or inter-concept linkages. This shortcoming was also found in the concept maps produced by the children in their lessons (see Appendix O). This is not surprising, considering the method used in introducing this strategy to the teachers. It was not found necessary to mention the different types of concept maps when introducing this teaching strategy to the teachers. Since the aim of introducing this strategy was to enable them teach and assess primary science while also helping them to consolidate their own learning, this strategy was considered useful and valid for this purpose irrespective of its incompleteness during its introduction.

8.2: Reliability of the tools used and the findings of the study.

In any study carried out, a measure of the reliability of the findings is always necessary if only to enable the claims to be validated. In this study, some statistical tools were used. The analysis of the data from the surveys were carried out using the SPSS computer programme. This programme is particularly useful as it enables the user to define variables, as well as to determine information across variables. The results of the surveys of the present study were not , however, subjected to any statistical tests. Nevertheless, the findings were considered useful for the purpose they were meant to serve. Indeed, the consistency in the results of the pilot and main surveys pointed to the general reliability of these results. The survey was carried out in three states of Nigeria: namely Anambra, Kaduna and Plateau. Since all primary school teachers in Nigeria are deemed to undergo similar initial training and since they use the same National curriculum, one may posit that a teacher in any other state in Nigeria would be expected to face similar problems as those exhibited by the teachers sampled in the three chosen states.

The 'magnetism story' which was used to assess the teachers' understanding of some aspects of magnetism is not a standardised test, however, it has been used in Britain[15] and was found useful and valid. Although the analysis of this tool was mainly subjective, its subjectivity was taken into account by giving the parallel responses to other teachers which thus enabled the response to be categorized correctly.

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[15] The magnetism story was used in the 20 days primary science workshop group, (12 primary teachers) at the Institute of Education, University of London in the 1992/93 session.

The science observation schedule (described in Chapter 5) constructed for this study was again not a standardised one. It was however, constructed borrowing ideas from established science observation schedules prepared by known educators(see e.g. Eggleston et al 1976; Flanders in Robson, 1995). It was observed that the schedule did not allow the recording of some of the behavioural attributes of the teachers and pupils in their classroom. However, this gap was plugged by using diaries of visits made to individual schools in the course of this study.

It must also be borne in mind that there were only fifty teachers involved in the workshop study. Although in statistical terms this number may be seen as not being a very large number considering the total population of primary school teachers in Nigeria, the results obtained from this study are considered acceptable as they provide a good illustration of what may be applicable in Nigerian primary schools generally.

8.3: The problem of the limited time and funds for the study.

There are many ways one could have approached this study. For instance, it would have been useful to have had a control group in order to measure the extent of the impact of the workshop on the teachers as well as determine other intervening variables that could affect the teachers progress on some of the tasks given to them at the workshop. However, establishing a control group or comparing various methods of retraining teachers would have taken far too long a time to complete; certainly outside the acceptable time limits of a doctoral study.

Since there was only one day between the first and the second completion of the magnetism activity, it was therefore concluded that the teachers' progress on the 'magnetism story' and the concept mapping was as a result of the activities which they were exposed to during the workshop. This view is supported by the fact that, the result of the initial and post workshop observations showed a clear difference in the teachers ability to teach as well as use other strategies in their lessons.

The problem of not having a control group was taken care of by carrying out the workshops with three different groups at different times. The consistency in the teachers performances suggest that they were being influenced by their exposure to the workshop. However, owing to the constraint of time, it was not possible for other methods of teacher training remediation to be used. But, since the main objective in the remediation plan adopted was to help the teachers to understand as well as teach magnetism, the workshop approach may be considered a very useful and valid method for this purpose.

Availability of adequate funds was also an important factor in the successful execution of this study. In this regard, money was needed for the purchase of workshop materials as well as for paying the teachers' travelling costs between their stations and the workshop venue. Funds were also required to cover the travel costs of the investigator between London and Nigeria, as well as her local costs of board and lodging. The funding constraints are now discussed below in some detail.

8.3.1: The resource materials:

The resource materials required for the workshop were easily obtained from the local markets. These materials included magnets, iron filings, hair clips, paper clips, silver ear-rings, gold ear-ring, cardboard papers, plain papers, pens, and pencils. Some of the unavailable resource books (for example, 'Learning how to learn' by Novak and Gowin (1984) were bought in the United Kingdom, while some were borrowed from the libraries of local universities. Other resource books used at the workshop (including relevant textbooks such as the primary six science textbooks), were readily purchased from local bookshops in Nigeria. Some were also collected from the book holdings in Local Government headquarters.

8.3.2: Travel costs:

Considering the fact that teachers in Nigeria were not paid regularly, it was necessary for the teachers to be financially sponsored to the workshop if they were to attend. Ideally, the cost of running this workshop should have been borne by the LGEA where the workshop venue was located. Alternatively, these costs could have been underwritten by the Federal Ministry of Education and/or the Federal Ministry of Science and Technology. However, with the depressed state of the Nigerian national economy, resulting in the government bodies mentioned above not being able to play their part, the only alternative was to appeal to my post-graduate sponsor - ARIMAK NIGERIA LTD - for assistance. Luckily, this appeal was successful which greatly facilitated the field work.

8.4: The teachers background information from the survey.

It was found that majority of teachers who were involved in the survey had NCE as their minimum academic qualification, about one third (31%) of them were still with Teacher Grade II Certificate while a minority (8.1%) of them had the B.Ed degree as their minimum academic qualification. While a majority (70.8%) of these teachers had no form of training in science, and less than one third of the teachers had science training from either the Teachers' Training College or through INSET attended after their initial training.

The above finding falls below the expectation of the projections made on the new National Policy on Education. It should be recalled that the NPE proposed that by 1991, all the teachers in the primary school should possess at least an NCE qualification. This policy, requires each teacher to be specialized in at least two teaching subjects during the course of training. Following upon this, each primary school is expected to have at least a specialist teacher in each subject (including science) who should take charge of teaching that particular subject at all levels. Unfortunately, this ideal has not been achieved as could be verified from the result of the teachers' background in science collected from the surveys as well as those that participated in the workshop. Although most of these teachers possessed the NCE as their minimum academic qualification, a good number of them had specialised in other subjects such as Psychology of Education, Principles and Practice of Education, Education Evaluation, rather than science. In addition, some teachers who had offered arts related subjects had found themselves being required to teach science in the primary schools. This prevailing situation could, however, be understood in the light of the following:

a. Before the inclusion of science as one of the compulsory subjects in the primary school core curriculum, science was not one of the compulsory subjects in the teacher education curriculum. For this reason, student-teachers were allowed to select science as one of the optional subjects in the Grade II Teachers Colleges. However, not many of these teachers opted to do science during their training.

b. Even when the new NPE was introduced, there was little or no time for the teachers already in the field to be adequately trained in science to equip them for the task ahead of them.

c. When the minimum academic teaching qualification was upgraded to NCE, the structure of the training was such that it did not allow the student teachers to obtain adequate training in those subjects they were expected to teach in the primary school.

d. Although the NPE required that NCE primary school teachers specialize in one or two subjects; the policy was not matched by an administrative requirement for a teacher to teach not more than one or more subjects to different classes at all levels. Indeed, most schools continued with the practice of each teacher being 'jack of all trades'!

Based on the above, one may observe that the acquisition of the NCE as a minimum academic teaching qualification at the primary school level appears not to do much for the teachers' needs and professional development.

8.5: The teaching and assessment of primary science.

The post workshop interview with teachers and their heads provided an insight into ways in which teachers had tried to use the newly learnt strategies in their teaching as well as assessment of their pupils' learning outcomes. It was found that all the teachers taught magnetism in their classrooms using the strategies (e.g., concept mapping, 'Ask the Object' and practical activities) learnt during the workshop. Most of the teachers had also used the strategies in teaching other science topics as well as subjects other than science. For example, some of the teachers had used the 'Ask the Object' strategies to discover what their pupils knew about a topic prior to its being taught and then they built their activities on the pupils previous knowledge and what they wished to learn.

Subsequent reports from the teachers who again taught magnetism after the workshop showed ways in which their perception of the topic had changed as a result of their being exposed to new insights to topics and teaching strategies during the workshop. Indeed, the majority of the teachers were able to demonstrate the new strategies in their classroom (see Appendix O for pupils' concept maps on different topics in science and other subjects).

However, there is no doubt that the provision of the In-service Training (INSET) to these teachers had helped a great deal in dispelling certain doubts which they (the teachers) had had about some issues on magnetism. The teachers had earlier blamed their poor or inadequate training for not preparing them to cope adequately with the task they faced in the field. Clearly, if teachers are not trained properly, they were bound to find it difficult to teach and consequently, the children would also find it difficult to follow. The poor foundation given to primary pupils by such unqualified science teachers would no doubt contribute to the children's poor development in science and technology as well as their lack of interest in taking up careers in science or its related disciplines in future. Unfortunately, this process tends to be propagated from one generation to another thus rendering it endemic.

There is no doubt that because these teachers perceive some of these science topics as being too difficult to teach, they tend to resort to such choice of teaching methods as the lecture/didactic method rather than the recommended discovery/inquiry strategy. In this connection, Bajah (1984) noted that although these teachers claimed that their inability to adopt the recommended method (discover/inquiry) in their science teaching, was due to the insufficiency of the resource materials, that the actual reason was because these teachers lacked the requisite knowledge to impart to the pupils. This situation was noted by Ameh and Gunstone (1985; 1992) where they observed some misconceptions of some selected science concepts amongst some Nigerian science teachers. Indeed, the issue of teachers' misconceptions of some scientific concepts was not peculiar to Nigeria alone as Kruger and Summers (1988) also noted that some physical science teachers in United Kingdom held some views about some scientific concepts which were not in accord with the usually accepted scientific viewpoints.

Harlen (1985) had in fact noted earlier that teachers tended to teach science in the didactic manner because it tended to help them hide their ignorance since they lack knowledge. Even though the majority of the teachers in this study have been teaching for at least 10 years, very few of them had studied science during their pre-service years or have been exposed to any form of in-service training in science. However, it was found that while the teachers claimed to have adopted the discovery/inquiry method in their science teaching, nevertheless they had lacked the practical experience to see them through necessary investigations in science. Indeed, the quality of their initial experience in science teaching seems to support this view. While the consequences of a lack of adequate knowledge of the subject matter on the part of the teachers need not be overemphasized, it is equally important to note that the teachers approach to teaching in a manner that obscures their ignorance could encourage the pupils to learn by rote which eventually would lead to a forgetfulness of the learnt materials after a short period.

Indeed, a design of the teachers' training course which allows the content of the curriculum to speak to the teachers' natural environment and experience and which allows them teach children to work on their own and to process their own information, would no doubt help the children to improve their understanding while enabling the teachers to be both resourceful and interested in what they do.

Since the problem does not lie with the teachers' willingness to change or learn, this situation could be remedied through the provision of an INSET programme to the primary teachers in all the science topics (particularly those identified as being difficult to teach). This would allow them to be exposed to the contents of the curriculum especially with regard to what they are required to teach. It is of course necessary to provide the teachers with an in depth knowledge of the subject content in order to give them enough room for manoeuvre.

The teachers sampled in this study have also shown that they could plan science activities in other science topics. The practical activities which teachers planned during the 1-day workshop showed that these skills were indeed acquired. For example, in the planning of activities on 'Simple machines' by group 1 teachers, they raised appropriate questions on the topic and then chose from the pool of questions those that could lead to practical investigation. The necessary steps or procedures to follow as well as materials required were clearly set out by these teachers.

Such level of confidence demonstrated by the teachers was also exhibited during the post workshop visits. As one of the teachers, coded T1 commented (or reported) during her interview regarding her teaching of magnetism to her class after the 2-day workshop:

> *"I thought that to teach magnetism is abstract but now, I realise that you can teach it using all sorts of materials. I can carry out practical activities confidently."*

Although the new science curriculum encouraged critical thinking in the children, the type of questions raised by teachers on the 'magnetism story' as well as during their science teaching (both during the initial and the post workshop observations) do not promote the development of such objectives. In addition, it was also found that before the workshop, more of the simple recall questions were asked on the 'magnetism story' as opposed to after the workshop. All the teachers were found to have used mostly the closed-type of questions during the first observation of their science lessons. However, some teachers tried to use more open-ended questions during the second observation of their lessons than in the initial observation of their science lessons. These findings were in line with that of Oguniyi (1981), and Gyuse (1982). These researchers found that some science teachers in Nigeria tend to use more of memory questions in their science lessons rather than task-provoking ones owing to the teachers' inadequate training as well as their perceived difficulty of the teaching materials.

Since the quality of the teaching of the teachers depended so much on both the individual teacher's conceptions of the nature of science and his knowledge of science (Abah, 1982a; 1982b) as well as the quality of the questions asked on the topic, it may be concluded that the children operated at the level of the teachers' questions and knowledge of the concept. Clearly, if teachers asked thought provoking questions, the pupils were bound to become not only more creative but will build their concept of the materials during the process of finding answers to the questions.

On the issue of the assessment of primary science, one may observe that although this was not the focus of this study, it seems sensible for one to take stock of what is learnt after every teaching activity. Otherwise, nothing could surely be claimed to have been achieved. The assessment of science, particularly the practical aspects of it, was earlier reported by teachers to be posing difficulties to them. This was partly due to the fact that these teachers were not conversant with the practical aspects nor did they have the skill to demonstrate them much less assess them. However, reports from the sampled teachers showed that they had begun to use the concept mapping strategy as well as 'Ask the Object' to assess learning outcomes from their pupils in science. According to these reports, concept mapping, in particular, enabled the teachers to identify readily any misconceptions occurring in the children whereupon the problem could be addressed immediately. The concept mapping strategy further enables the teacher to follow a child's progress and thus assist the child individually. It was found useful especially in a Nigerian situation where the teachers faced the problem of large classes.

8.6: The role of the teacher as a key teacher.

The hope for teachers in terms of the remediation programme described in this study is that innovations introduced during the workshop could lead to a change in the teachers' conceptions of magnetism as well as the way they teach science generally. Indeed, reports from the teachers during the 1-day workshop as well as during the follow-up exercise revealed that the teachers stimulated change in their schools through running similar workshops for their colleagues. In fact, all the teachers who participated in the workshop had taught primary science in their schools with the majority of them having no science background at all. The role of the key teachers therefore was to act as local (science) co-ordinators in their schools with the task of helping to train their school colleagues in a manner reminiscent of the workshop, and subsequently to give continuos support to these teachers trained by them.
In support of the above, the teacher coded T1 had commented as follows:

'I never believed I could do all these; Honestly, if teachers are trained in this way, there should not be any problem in teaching what we are asked to teach. Even when we go to seminars, conference or the so-called workshop, it is never like this'.

Another teacher coded T43, commenting on her ability to run a similar workshop had said;

'Yes, I can why not? I now know how to carry out some of the activities on magnetism except for the materials you used. I know that they would cost money but they can be purchased in the local market'.

The aim of selecting teachers from different schools was to enable them to discuss their experiences in their training as well as in their various schools. These teachers, it was hoped would serve as key teachers whose work would help to disseminate the information they gained during the workshop. It was found that most of the teachers who participated in the workshop not only reported back to their headteachers (who of course were highly interested in the workshop outcomes) but also tried to run similar workshops for colleagues in their schools. This result is encouraging and held interesting possibilities.

The processes involved in the development of key science teachers in schools is summarized in figure 8.1. This has earlier been discussed in the model proposed by Harlen (1985), Turner (1992), and Jenkinson et al (1994). These three authors had also proposed ways in which links could be maintained amongst the teachers after an INSET programme. The flow chart in figure 8.1 summarizes the nature and processes involved in an INSET programme which could be valuable in Nigeria. The flow-chart shows how a wider population of primary school teachers could be trained with less money being involved. Indeed, it was intended that the LGEAs would use such teachers to run similar workshops within the LGEAs and their individual schools, and this could be extended to even the state level. In this way, workshop information could easily be disseminated to every classroom teacher. In this regard, most of the teachers who participated in the workshop had reported back to their headteachers, who subsequently provided them the opportunity to talk to other teachers in their schools. In this way, the skills learnt were being transferred to those colleagues who did not attend the workshop but were willing to accept change. In this regard, Newton (1987) had reported that the support of the headteachers could be seen as a major catalyst for disseminating materials learnt during the workshop to other teachers within the schools.

It is necessary to point out at this stage that one of the aims of running a workshop, especially of the type, involving the selection of teachers from different schools is to establish a network between schools for exchange of ideas between teachers who attended the workshop programme. A further reason why teachers were brought together during the 1-day reflection workshop was to enable them exchange views as well as discuss problems encountered during the implementation of the acquired workshop teaching strategies in their schools. Such an exercise was meant to help them to learn from each other's experience as well as enable them grow professionally.

8.7: The practical constraints of running the designed INSET programme in Nigeria.

It is difficult to anticipate the amount of difficulty one may encounter in implementing an INSET programme especially at the planning stage. In fact, a number of problems were encountered in the course of this study. These are now reviewed one by one.

8.7.1: Instability in the Nigerian political situation:

There was a lot of political uncertainty in Nigeria during the period when this study was carried out. This affected the study in many ways. As mentioned earlier, the pilot survey itself faced a lot of problems in the sampling of the teachers who completed the questionnaire in December 1992, owing to the national strike action embarked by the teachers during this period. As a result, of the strike, a lot of changes were effected in the governance of primary schools which affected the ease of selection of the teachers for the workshop. The involvement of the LGEAs in the selection of the teachers did not help matters. For example, it was necessary for all the LGEAs involved in the workshop to be visited in person to discuss the proposed INSET programme. The fact that the selected teachers could not attend the workshop without the prior permission of their Chief Education Officers was another reason for the investigator to visit each LGEA, sometimes several times, to ease the way for the teachers. Moreover, since this project was based on the findings of the initial survey, it was hoped that the LGEA would further support the workshop by assisting in the selection of the schools to participate in the workshop. Nevertheless, the official bureaucracy involved in the selection of teachers through the LGEA Chief Education Officer can be quite frustrating. In fact, it required some familiarity with the operations of the local governments, which took some time to master.

8.7.2: The problem of funding the teachers to the workshop:

Another problem confronting this study is that of finance which has already been touched upon earlier. The first 2-day workshop lasted for two days and required that the expenses of the teachers be covered for the two days. The required funds were made available by the investigator, who sent the money to the teachers through their LGEAs on the basis of which the letters inviting the teachers to participate in the workshop were subsequently sent to their individual schools. The amount of money involved in all the phases of the study was quite substantial considering that the investigator herself was being funded privately. Altogether, a total of N133,545.00 (approximately £1000.00) was spent for the entire phases of the workshop (see Appendix Eiv for details of expenditure).

8.7.3: The availability of a venue for the workshop:

An accommodation/facility considered suitable for the workshop was adjudged to possess the following features:

- It should easy accessible by road.
- It should provide such vital physical infrastructures as electricity, water, furniture, etc.
- It should be centrally located within the general area where the participants are to be drawn.

The Awka-South and Nnewi-North LGEAs were approached to provide suitable venues for the workshop which possessed facilities such as enumerated above. Indeed, some secondary schools and primary schools in Anambra State, appeared readily to qualify as suitable venues. In the end, the Government Technical College, Awka was chosen as the venue for the Awka zone while the Model Primary School, Nnewi was chosen as the venue for the Nnewi zone. The Principal and headteacher of these schools respectively were then requested to get the chairs and tables ready for the workshop. Again, official bureaucracy reared its ugly head once more and it required several visits and consultations for bookings to be made against the date of the INSET.

8.7.4: The problem of providing support to the teachers after the workshop:

The teachers were visited before and after the 2-day workshop as well as after the 1-day workshop. Owing to the time constraint, it was not possible for each teacher to be visited at equal intervals after the workshop. Indeed, some of the teachers were visited less than two weeks after the workshops while others were visited well after one month. In some cases, the investigator visited a school more than three times especially where the teacher was absent during an earlier visit. The fact of the matter is that the investigation ideally required a team to run the INSET. This would have provided enough capacity for the

team to provide adequate support to the teachers who participated in the workshop. The handling of fifty teachers by only one person within such a limited period as this study allowed was indeed a tedious task. The problem of inadequate personnel arising from the limited time and funds available to process the teachers after the workshop (especially after the 1-day reflection workshop) probably affected the result of the third observation of their lessons. This view is reinforced by the fact that many of the teachers observed failed to use the strategies learnt during the workshop. This failure by the teachers to use the workshop materials may be ascribed to the fact that the teachers probably thought that these strategies unlike their usual didactic method could not give them enough room to cover as much content in the syllabus as possible. The tendency was that some of them reverted to their old methods.
On the other hand, given enough time and funds to carry out this type of project, the problem of personnel would have been taken care of by recruiting university lecturers or students to help in the running of the workshop for many more teachers (than used in the project) as well as giving enough support to the teachers. Again, this has its own down side as it would have required time and money to train the lecturers or the undergraduates who would have acted as resource persons for the INSET programme. Otherwise, there inconsistencies were bound to occur in the results of their observation as well as the type of support they could give to the teachers. The training of such additional personnels would have required time and money, and in the end may have been counter productive.

8.7.5: The issue of the timing and duration of the workshop:

Since the workshop in its initial design was based on the fact that the teachers would come from different parts of Anambra state, the issue of the travelling times of individual teachers to the workshop venue was considered important. This is so, when it is remembered that a teacher attending the workshop, say at Awka, from Onitsha, might need up to one hour of public travel to make the journey, especially as most of the teachers did not possess their own private cars. Since the commencement time for the workshop was usually 9.00 am, (considered reasonable for beginning each day's workshop activity) with closing time at 4.00 p.m., a participating teacher was in such circumstance deemed able to get home before dusk at the end of each day's workshop. However, although the workshop generally started at 9.00 am, the closing time was in fact never 4.00 p.m. As a result, some of the teachers were obliged to rush their work towards the end. This in particular affected the 'magnetism story' which was completed at the end of every 2-day workshop. Hence, the teachers did not respond as expected to some of the questions on the 'magnetism story'.

8.8: Implications of findings for curriculum change.

As was indicated in chapter 2, the teaching of primary science as a compulsory subject is now over three decades old in Nigeria. The subjects covered in the national primary science curriculum include , physics, chemistry, biology, astronomy, technology, etc. The National Curriculum Committee (NCC) has also recommended certain strategies in order to usher in effective science teaching in Nigeria. These strategies were recommended with an eye to take into account the nationally perceived demands of this group of children as articulated in the National Policy on Education (NPE) document. This national policy demands that children in the Nigerian primary school system should be encouraged to develop the power of critical and scientific thinking at this stage of their lives. Indeed, up till now, according to available information, no evaluation of the outcome of the introduction of the teaching of science as a primary school subject has been carried out in Nigeria. Indeed, as one saw in chapter 2, not all the science subjects listed above appear in every level of primary school teaching. In view of this, it has become the practice that schools and teachers tend to work out their own strategies for teaching particular topics in science in order to suit their own purposes bearing in mind the requirements of the science curriculum.

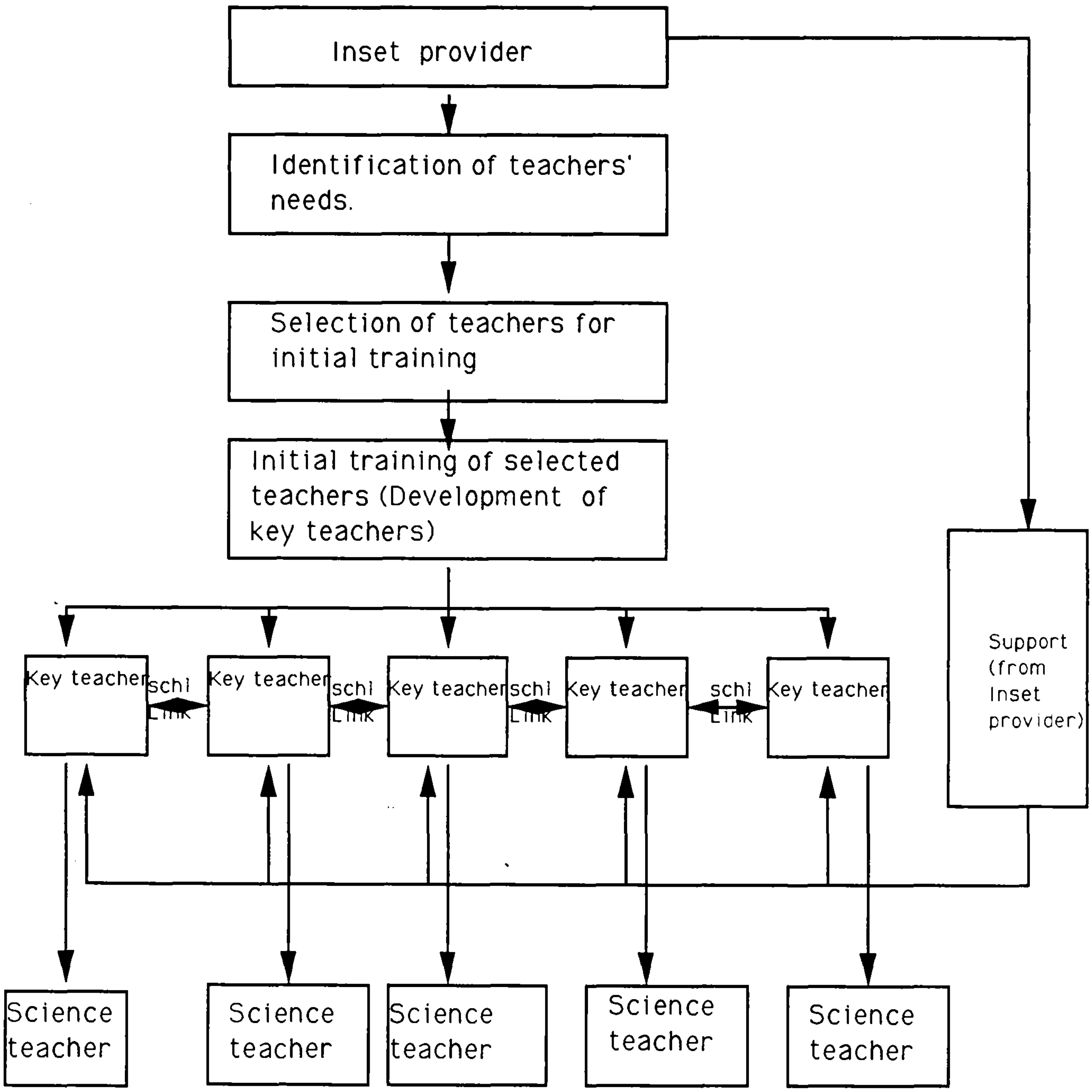

Figure 8.1: The processes involved in the proposed INSET programme for Nigerian primary school science teachers.

Chapter 9

CONCLUSIONS AND RECOMMENDATIONS

9.0: Introduction

This final chapter looks critically at the findings of the research study described in the previous chapters and considers the implications of the findings for teacher education in Nigeria.

The study had two major aims:

1. To identify the topics in the Nigerian National core curriculum in science which teachers in primary schools find difficult to teach.
2. To develop an in-service programme for primary teachers to support the teaching of specific topics in science.

During the first phase of the study a questionnaire was sent to a sample of 180 primary school teachers of Primary 6 classes in three states in Nigeria. The responses to the questionnaire indicated that the majority of the teachers thought that Relevant Technology and Magnetism were the most difficult topics to teach in the primary science syllabus. Inadequate practical experience of science during their initial teacher education courses, limited opportunities for in-service programmes and the lack of adequate resource materials for teaching science were commonly cited reasons for the difficulties that teachers identified in teaching science. Further evidence about the views of teachers about science teaching came from visits to fifty schools where primary six teachers and their headteachers were interviewed and teachers were observed in the classroom setting. The teachers in these schools subsequently participated in the workshop programme.

The in-service programme described in Chapter 3 was developed to address the difficulties that teachers had identified in teaching about magnetism. The programme consisted of a two-day initial workshop followed four weeks later by a further one-day workshop (see Figure 1.5) The outcomes of the workshops are reviewed in the first part of this chapter. The evidence from the two post-workshop visits to schools, which included further interviews and classroom observations of teachers, suggests that the programme of in-service training that was developed had some positive effects. Many of the teachers acquired further knowledge about magnetism and some additional skills. Many teachers stated that they were more confident about carrying out practical activities in their science lessons. This increased confidence was particularly noticeable in those teachers who were able to apply the skills acquired in their training when teaching other topics in science.

In discussing the findings from the study it is recognised that whilst the methods used could be applied in other situations the results obtained are dependent on the specific sample population and the conditions in which the study was made, including the interviews and observations of teachers in their classrooms. However, the findings are consistent with those of earlier studies in the same field (see for example, Harlen, 1985; Harlen, Holroyd and Byrne (1995)). The findings therefore provide a reliable basis for the suggestions for the development of INSET programmes in Nigeria that are outlined in the final section of the chapter.

9.1: Teachers' perceptions about teaching science topics

The responses to the questionnaire, which were discussed in detail in Chapter 4, indicated that the majority (63.1%) of the 130 responding teachers found the teaching of Relevant Technology most difficult to teach while about a half (52.3%) of them found magnetism difficult to teach. Topics such as Animals, Water, were less problematic. The responses given by teachers of different ages, sex, experience or qualification or between those working in rural or urban locations appeared to be similar. No statistical analysis was undertaken as the number of teachers in each state and each sub-group was small as can be seen from Tables 4.1a,b and 4.2a,b.

The questionnaire survey in the three states, and subsequent interviews with teachers in Anambra State, indicated that teachers attributed their perceived difficulty in teaching these topics as being the result of the following:

- the content of the topics was difficult to understand,
- adequate resource materials were not available for teaching the topics,
- lack of adequate practical training during initial teacher training programmes,
- limited opportunities for in-service programmes.

These findings are based on a small sample of primary teachers (130) in three states in Nigeria. However, these teachers represented a cross section of primary teachers in terms of their age, experience, qualification and school location. Furthermore, analysis of the data indicates that there were no differences in the reasons given by teachers of different ages, years of experience or qualifications. It is therefore reasonable to suggest that the views of these teachers will be similar to those of their colleagues in other parts of Nigeria. The findings have implications for both pre- and in-service education and resource provision.

The provision of resource materials is amenable to solution as low-cost materials can be developed readily for teaching science in primary schools (see for example, UNESCO Harlen (ed) (1983); Young (1979) and Kenya SPRED materials (1994)).

During the past decade, the government of Nigeria has sought to address the other problems identified by teachers. The government has recently begun to address issues of science pre-service education (Wuyep and Turner 1994; 1995) by redesigning the pre-service training of teachers and upgrading the minimum academic qualification of primary teachers to NCE.

The reaction of the Federal Ministry of Education to the perceived problem of poor primary science teaching was to organise the Teachers Vocational Training Courses (TVTC) for the serving teachers within the state universities during the long vacation for a period of three to six weeks. The purpose of these courses has been discussed in chapter 2. However, personal communications with a University Head of science department during 1994 indicated that these courses achieved only limited success, and in fact did not seem to have reached all the teachers who required this in-service training. The comments made by a few of the teachers (4) during the workshops in the present study indicated that these teachers had not gained much from TVTC. According to these teachers, they were not taught in the way that they were expected to teach the children. In addition, the teachers felt that there was a mismatch between their training and the expected practice in their classrooms.

Professional training and retraining programmes are also offered by the Science Teacher Association on Nigeria (STAN). However, such courses are only available for teachers who are members of STAN; many teachers cannot afford the membership fees.

In the author's view, the main problem is not with the curriculum itself *per se*, nor with the amenability of the teachers to self-improvement, but the limited provision of suitable INSET for teachers. The findings of the author's study point to the importance of continuing professional development. The evidence from the study suggests that there is a need for INSET programmes that provide teachers with support in developing appropriate teaching and learning strategies. Such courses need also to focus on helping primary school teachers to understand scientific concepts. Teachers who were involved in workshops in this study were keen to attend and their evaluation of the workshop programme indicates how much they valued the experience. However, incentives may be needed to persuade some teachers of the value of INSET programmes. Government sponsorship of teachers to enable them to attend workshops and seminars for training and retraining is an ideal to be pursued.

9.2. Teachers' understanding of magnetism concepts.

The workshop programme developed during the study focused on the teaching of magnetism, a topic that had been identified as particularly problematic by teachers who responded to the questionnaire. The views of teachers who participated in the workshop, the majority of whom were teachers who had responded to the questionnaire, were ascertained prior to the workshop during preparatory visits to their schools. These teachers agreed that magnetism was a difficult topic to teach and that the focus of the workshop was appropriate for their needs.

Evidence about teacher's understanding about magnetism came from activities undertaken during the workshop programme and from discussions with teachers on visits to schools prior to and after the workshops.

The 'magnetism story' was used at the start and the end of the first workshop and provided evidence about individual teacher's understanding and of their learning during the workshop. The analysis of the data from the 'magnetism story', which was discussed in Chapter 6 , indicates that the understanding of the majority of the teachers was improved following exposure to the workshop activities. Those teachers who already had a good understanding of the concepts also derived some benefit.

Further evidence about what the teachers had learnt about magnetism came from concept maps produced by groups of teachers and from discussions during the workshops, which were recorded on videotape and by means of notes made during the discussions by the author. These discussions included teachers' explanations of phenomena observed during practical activities related to magnetism. One of the limitations of the study was the need for the researcher to act as organiser, teacher, researcher and evaluator during the workshops. Systematic collection of qualitative data based on discussions by groups of teachers was therefore problematic. The videotapes were used to provide supporting evidence to augment notes made by the researcher during the workshops. Groups of teachers were also asked to provide summary notes on their discussions. The videotapes were viewed and analysed as soon after the workshops as possible. The data from the videotapes were then used in conjunction with the notes made by teachers and the researcher to develop detailed reports of the workshop outcomes. These records were then compared with the data from concept maps and the 'magnetism story'.

The evidence from the study indicates that the majority of teachers who participated in the workshops had a better understanding of magnetism concepts following the workshops. The workshops can therefore be said to have had a positive effect. These learning outcomes from the workshops are consistent with those described by other authors, including Harlen, *et al* (1995) and Neale *et al* (1990), which indicate that primary teachers with limited experience of science seem most likely to show better understanding of science concepts after participating in practically focused workshops that use strategies that can be applied in the classroom.

Further indirect evidence about teachers' understanding of magnetism concepts came from their increased confidence in teaching this topic after the workshop. This confidence was apparent from classroom observations, comments made by teachers themselves and from appraisals by headteachers.

9.3: Application of workshop strategies to the teaching of science.

The first workshop had a number of purposes, which were identified in Chapter 5. During the workshops teachers were provided with opportunities to explore ideas about magnetism and to try out practical activities that could be used in the classroom with primary six pupils. The workshop activities, which are described in detail in Chapter 5 included simple practical activities involving magnets, for example using magnets to make a compass, and more widely applicable teaching strategies, such as concept mapping

Evidence about how teachers used practical activities in the classroom came from observations of teachers made between the first and second elements of the workshop and approximately three months after the completion of the workshop programme. Evidence came also from work produced by pupils and from comments made by headteachers who were interviewed during visits to schools.

The initial observations of teachers, that are discussed in detail in Chapter 5, indicated that the majority (96%) of the fifty teachers who participated in the workshop used a didactic, lecture approach. Teachers rarely asked pupils questions. For children in the majority of classes observed the only active participation in the lesson was in terms of copying notes.

Evidence from observations made during visits to schools after the 2-day workshop showed that over a third (36%) of the participating teachers were using a greater variety of strategies when teaching science. These strategies included greater use of questioning techniques, the use of concept mapping and, importantly, practical activities with pupils. The use of practical activities in science lessons was observed in about a third of lessons (30%).

Three months after the completion of the workshop programme a third visit was made to schools to observe teachers. This visit was made without prior warning to try to ensure that the lesson being observed was not one planned to impress the researcher. The observations indicated that fewer teachers were using practical activities in science lessons than had been observed during the third visit. However, just over a quarter of the teachers (28%) were still using the concept mapping strategy in their teaching. Many teachers were also using a less didactic approach and engaging pupils more actively in lessons through, for example, greater use of questioning.

There was a marked difference in the use of strategies by rural and urban teachers, with rural teachers using the strategies used in the workshops more frequently. Discussions with teachers suggested that urban teachers were more reluctant to try out practical activities; the reasons cited included:

"I do not have resource materials to carry out practical activities in my classroom."

"The science resource materials are taken to someone's house for safety because the school offices are sometimes burgled by thieves."

Some urban teachers placed the blame for employing a limited number of teaching strategies on the pupils:

"the children are not interested in education and therefore may find it difficult to understand the strategies."

"..if it was in Enugu ... you could bet that the children would be better off and more interested."

The differences between the willingness of rural and urban teachers to apply new techniques is interesting. Urban teachers generally appeared less well motivated. The profiles of rural and urban teachers appear to be similar in terms of their ages, experience or qualifications. The similarities in the profiles is not surprising given the relocation of teachers from one area to another during past five/ten years. Thus the observed differences in the application of new strategies by urban and rural teachers appear to be the result of other factors which need further investigation. No statistical analysis was carried out as the number of teachers who participated in the workshop was small.

The evidence from the classroom observations of teachers suggests that the workshops had some success in changing or extending the strategies used by about one third of the teachers, particularly those in rural areas. However, single observations of lessons provide only a partial picture of what teachers are doing and the observations need to be considered alongside evidence from other sources. In this study evidence came from discussions with headteachers and from work undertaken by pupils, as well as from discussions with teachers during visits to schools allied to their own written appraisal of lessons. This evidence suggests that the workshops had a more positive long term effect on teaching strategies in science than the data from the classroom observations indicate.

One positive outcome of the workshops was that many teachers were willing to try out new ideas. Some of these teachers demonstrated that they were able to use the strategies learnt during the workshop in their lessons. These teachers used strategies such as concept mapping and 'Ask the object' in science lessons and in their teaching of other subjects. The concept mapping strategy was mostly used by the teachers to gain insight into their pupils' understanding of specific concepts as well as to help pupils to participate more actively in lessons. Teachers also indicated that they found 'Ask the Object' strategy a useful tool for discovering what the children wanted to know about a topic. This information was used by teachers to plan future activities in science.

The classroom observations indicate that teachers were less successful in implementing practical activities work in science than other strategies such as concept mapping. There are probably a number of reasons for these findings. One is the lack of resources that was identified earlier. A further reason may be the duration and nature of the workshops. During the workshops the time available for practical activities, and for discussion about how such activities might be managed in the classroom, was very limited. There was some evidence that further support in the classroom might have helped teachers who were reluctant to try out new ideas. After the completion of the study the researcher was able to demonstrate the use of practical activities in the classroom to some of the urban teachers. These demonstrations helped to convince these teachers that their pupils could carry out practical science tasks on their own and a number of these teachers subsequently used similar strategies themselves.

Single lesson observations, as was noted earlier, provide only limited evidence of actual classroom practice. Furthermore, the collection of data by one person acting as observer and evaluator, provides less reliable data than the use of an independent evaluator working alongside the observer in the classroom. More reliable results therefore would have been obtained by training evaluators to observe lessons, with the researcher acting as moderator and analyst. Videotapes of lessons could also have provided further evidence, although the use of videos in rural schools in Nigeria is not easy. In the present study further evidence to support the observations of classroom practice came from teachers' own lesson notes and evaluations, headteachers' appraisals and evidence from work by children.

9.4: An assessment of the teachers' interest in teaching science

Information obtained from interviews in schools and discussions during the workshops indicated that many of the teachers who participated in the workshop were interested in teaching science. This interest was not dependent on whether they had studied science during their pre-service courses.

Many of the teachers indicated that the workshop had heightened their interest in teaching science. Moreover, these teachers considered that the workshops had helped them to recognise that many aspects of science could be taught in primary schools through practical activities and experience of phenomena, such as the 'pull' exerted by strong magnets. Some teachers commented that the experience of doing practical activities had made them more confident about using such activities with pupils.

Those teachers who used practical activities in the classroom observed that the children were positively involved in science lessons and were able to carry out some science activities on their own. They also considered that learning outcomes and motivation were increased when pupils were able to engage in practical work.

Teachers were particularly interested in the use of concept maps in their classrooms, seeing concept mapping as a useful strategy for obtaining information about children's ideas about science concepts. They also recognised the potential applications for other subject areas and as a means of motivating pupils. This view is supported by work by Anamuah-Mensah *et al* (1995), who observed that the use of the concept mapping technique in teaching biological sciences in secondary schools in Ghana sustained the students interest and enhanced better understanding of science topics.

The headteachers' views on the outcomes of the workshop also indicated that the teachers who participated in the workshop were more interested in teaching science than they had been before. This interest and increased motivation were also conveyed to their colleagues, many of whom tried out strategies such as concept mapping, and their pupils. The interest developed by these groups of people was one of the positive outcomes of the workshops.

9.5: Implications of the findings for teacher education.

Some of the findings from this study have implications which could be of interest to the Federal Ministry of Education (under whose governance all decisions about education are made), as well as to teacher educators involved in the training of teachers in Nigeria. These implications are discussed in the context of teacher education at both the pre-service and in-service levels.

Teacher education can be viewed as one of ongoing professional development that begins with pre-service teacher education. The importance of in-service education has been identified clearly by UNESCO (1975):

" *In view of the continuous renovation and development of general and pedagogic knowledge, and of the constant change taking place in education systems and the increasingly creative character of pedagogical activities, it does not seem possible to equip the student teacher with knowledge and skills which would be sufficient for his(sic) whole professional life.."*

"Hence a comprehensive policy is needed to ensure that teacher education is reorganised as a continuous co-ordinated process which begins with pre-service preparation and continues throughout the teacher's professional career. In such a system, pre-service education should be integrated, fostering the concept of life-long learning and the need for recurrent education.

The suggestions about continuing professional development outlined by UNESCO are ones that have been endorsed by educators throughout the world, including Thomas (1995). Thomas views teacher education as a process of life-long training and personal development, during which teachers and teacher educators are exposed to new ideas and practices with the ultimate aim of improving their self esteem and professional competence. As discussed in the earlier chapters of this thesis, both pre-service and in-service teacher education can follow different patterns and can be run for varying duration depending on the purpose and the target population for whom the courses are designed.

In most cases, in-service teacher education is provided as a means of professional development or to correct limitations of pre-service teacher education. It could be argued that in-service teacher education is particularly important in subjects like science where changes in knowledge and understanding have implications for curriculum development. The importance of these changes for teacher education have been acknowledged by UNESCO (1970):

"A single course of teacher training, however long it lasts and however excellent it may be,no longer suffices in view of the radical changes which may intervene. ....There are also technical innovations in regard to the way the curriculum is presented. This can be seen from the spectacular changes that have characterised mathematics and science teaching in primary schools. Even the most highly qualified teachers therefore have to be helped to adapt to these changes either through refresher courses to bring knowledge up to date to fit new circumstances or by actual further training" p25.

An in-service programme for teachers could also be used as a medium to introduce innovations to practising teachers which may be the result of socio-political or economic factors. A country may decide to change their school curriculum if they feel that the old curriculum no longer meets the demands of their society. For example, the Universal Primary Education (UPE) Crash Programme for teachers which was introduced in Nigeria in the 1970s in order to meet the increased demand for teachers as a result of the large number of children who registered for the Universal Free Primary Education Scheme (Lassa, 1983) that was introduced in 1974. Another example of this type of programme was the ZINTEC (Zimbabwe Integrated Teacher Education Course) which was introduced in 1981 to cater for the acute shortage of qualified teachers in Zimbabwe (Sibanda, 1982; Ncube, 1983).

A further reason for INSET is to address issues caused by the mismatch between teacher training and the task (curriculum) to be faced by teachers in the field that has been reported by a number of authors including Matahelemual (1991), Ameh, (1990), Russell, (1994), and Wuyep (1994). These authors reported that the education provided for teachers during their pre-service years had little or no relevance to the curriculum that they were expected to teach in their classrooms. Russell (1994), in particular noted that most primary school teachers in developing countries were ill-equipped to teach science. He further added that many of these teachers operate in a traditionally authoritarian society where a good teacher remains the one who 'spoonfeeds her class by filling the blackboard with facts to be copied by the children'. Ameh (1990) in more specific terms, noted that the science taught in the teachers' colleges in Nigeria did not have any relevance to the curriculum the teachers were to face after training. She further added that not many of these teachers studied science and even those who did were not prepared adequately for the task they were to face after training. Wuyep (1994) in addition, observed that most Nigerian integrated science teachers who were to teach the Junior Secondary School (JSS) integrated science curriculum were not only unqualified to teach Integrated science but also lacked the skills to teach topics in science in a way that actually portrays the philosophy behind the subject matter. According to Wuyep, teachers taught the science topics within the curriculum as separate entities and sometimes avoided the topics which were not directly related to their specialised subject disciplines. Matahelemual (1991) in a study of the problems faced by primary school teachers in Indonesia who were expected to use problem solving techniques, noted that the majority of primary teachers in Indonesia were not trained to teach science using this approach. According to her, these teachers faced a lot of difficulties implementing such innovations in their classrooms.

One of the outcomes identified by the teachers in the author's study was the value placed by teachers on the opportunities that the in-service workshops provided for them to share ideas with colleagues and the researcher. The workshops also provided opportunities for teachers to reflect on their own practice in ways that were identified by Schön (1983; 1987). The term 'the reflective practitioner', was adopted by Schön to describe the type of reflection that characterises the work of professionals , such as engineers, who need to learn from experience in order to further develop their professional expertise; it is a term now widely used in education. The ways in which professional reflection can be encouraged through in-service programmes have been described in other studies involving primary teachers, see for example, Turner

(1992). The implication is that opportunities need to be provided for teachers to reflect on their practice and that INSET programmes can provide opportunities for such reflection to take place.

The issue of finance has always been an issue in the training of teachers and directly affects the teaching of science. Lack of adequate resource materials have always been blamed for the teachers' inability to teach science in an acceptable way. Teachers who responded to the questionnaire in the study identified the lack of adequate resources as one of the problems that they faced in teaching science. Some of the teachers felt that they could have done better given adequate funding. This problem is not peculiar to Nigeria. Peacock (1989), reporting on a case study in Namibia, identified the problems faced by highly resourceful and enthusiastic teachers who attended an INSET programme. He noted that these teachers though interested in carrying out similar workshops for their colleagues and pupils in their schools were handicapped owing to lack of simple materials to teach science.

Molomo (1982) and Thomas (1995) noted that unless attendance at in-service training is linked to rewards there will be little or no motivation for teachers to improve themselves. Such rewards could be increase in teachers' salaries, or providing them with certificates of attendance, which could be a factor in gaining their promotion. For example, in Singapore, Thomas noted that such incentives were based on performance objectives that were assessed mainly by heads of Institution and senior departmental staff as well as through staff self appraisal.

In Nigeria, the STAN issues certificates of attendance to candidates who have attended INSET programmes but these certificates are seen as providing the candidates with intrinsic motivation rather than extrinsic. Considering that Nigerian teachers are poorly paid, a remedial programme would be most effective and useful to all concerned if carried out under direct government auspices. Attendance on INSET courses could be recognised as part of teachers' remuneration and a factor in gaining promotion.

Another issue which is of great importance in developing appropriate and effective INSET programmes is the monitoring and evaluation of the programme. Osibodu (1983) observed that systematic evaluation of INSET activities is not common in many countries in Africa. Where the INSET activity was evaluated, it was done mainly through questionnaire, usually completed by participants at the end of the activity. Osibodu could find no instance where the INSET participants were monitored in their schools as a follow-up some months after the INSET course. He further noted that even when such plans were made, the organisers of the INSET often seemed to find follow-up impracticable due to shortage of staff, funds and time. Trevaskis (1969) and Jones (1979) have earlier highlighted ways of evaluating in-service programmes. They suggest that evaluation should include, asking teachers themselves, collecting the trainer's opinion, follow-up visits to observe the teachers, academic examination, evaluation of skills of participants, evaluation of course progress and objectives and possibly, checking the outcomes through how much children's learning improved as a result of the teachers' exposure to the INSET programme. Jones in particular warned that it may be subjective to judge the outcomes of the INSET based merely on teachers' enthusiasm during a workshop.

In the present study the evaluation included discussions with teachers, a written evaluation, evaluation by headteachers and teachers' colleagues plus a follow up visit to schools three months after the workshop. The visits to schools and classroom observations provided further evidence of the effect of the workshop on the teaching strategies used by teachers.

9.5.1: Models of In-service teacher Education

Different models of in-service teacher education have been identified by several authors . (See for example, Trevaskis, 1969; Unesco, 1970; Jones, 1979; Udo and Greenland, 1983; Greenland, 1983; Peacock, 1994; Thomas, 1995). Peacock and Thomas in particular, have identified the models of in-service teacher education training that are commonly used presently. Some of these methods of training could also be adopted during pre-service education. There are a number of factors or criteria which need to be considered before planning a programme of in-service training for teachers (Russell, 1994; UNESCO, 1970). Russell in particular, noted that culture affects science teaching and should therefore be taken seriously when choosing a programme of teacher training for teachers. He argued that since both the teachers and the children tend to come from the same culture, they both experience certain features in common.

UNESCO (1970) in general terms stipulates that the training, further training and retraining of primary school teachers should be seen as one which must comprise the following:

- *A well-balanced general training, including a methodical knowledge, the power of analysis and means of expression, each teacher must want to be responsible for his/her own cultural enlightenment.*

- *Pedagogical training based on a practical and well planned approach to conducting a class.*

- *Civic, economic and social instruction, thus stimulating a desire to take part in the national development and introductory study on the social environment with particular regard to the desirability of how to play an active part.*

Some of the models of in-service teacher training as identified by Trevaskis (1979), Peacock (1994), Thomas (1995) and others are as follows:

College-based teacher training : This type of teachers' training involves a situation where the trainees are trained within the college and is common in most developing countries such as Nigeria and Uganda. According to Thomas (1995), the training often lacks articulation between the theory and practice as well as being very costly to provide a 4-year programme for each teacher. Some college based teacher training does include some experience of teaching in school.

Cascade model: Thomas (1990) and Peacock (1994) described this model as one where an 'expert' teacher educator(s) trains a small group of teachers who in turn replicate the training they received to other groups of teachers. This model has been used in Bangladesh, Malaysia, Botswana, Namibia, and Kenya and was found to be a useful means of retraining teachers who are already teaching in the field. Dove (in Thomas 1995) draws attention to the fact that this model is essentially a 'top down' approach and thus will be most suitable when uncomplicated information is being transmitted. Problems associated with this model include the dilution and distortion effect and the need for sustained follow-up to reinforce the initial training at all the levels. Githui (1994) reported that this model of training teachers was used to train the primary teachers in Kenya in order to adapt to the new methods of teaching included in the curriculum. These methods of teaching which were introduced to the teachers include, the enquiry approach, the learner-centred method and the discovery technique, among others.

The mobile teacher education model . This model involves a situation whereby some selected teachers are trained to train others on a selected programme. Peacock (1994) referred to this as 'Training of trainers' which according to him, involves a situation where some teachers are selected for their good work and are trained in order to become 'Teacher Advisers' or 'Mentor Teachers'.

These teachers can be deployed to work from teachers' centres or used as mobile teachers. This model, according to Dove, (in Thomas, 1995) has its problems regarding the training personnel who may not be competent enough to undertake this type of training, or motivated to travel to remote areas. This model has been tried out in countries such as Uganda, Zimbabwe and Nigeria. Gyuse (1982) noted that good resourcing , training of trainers and monitoring which are important ingredients for successful implementation of this model were lacking when it was adopted to train primary teachers in the Northern states of Nigeria to use the Primary Education Improvement Programme (PEIP) materials.

Sandwich Course Model : This model of teachers' in-service training was launched in 1972 in Nigeria as an alternative approach by which the teachers could be retrained in their schools during term time and undergo their professional training during the long school summer holidays (Jones, 1979; Stanley, 1979). This model is used in Malawi and Nigeria and involves the teacher on a full time teaching employment spending part of their vacation in the university attending some taught courses for upgrading of the teacher's subject specialisation. This model is acknowledged to be a good way of training teachers by authors such as Stanley (1979) and Osibodu, (1983) as it saves both time and money. Osibodu argues that there is benefit in cost terms of the Associateship Certificate in Education (ACE) (which was adopted in some universities in Nigeria) to schools in that the teachers are on the job still and there is no need to pay substitute teachers salaries. He explained that the teachers on the other hand receive their salary increase at the end of the programme, even although they had earlier added to the investment by paying fees for the programme.

In-service teacher education as earlier mentioned is usually provided to help teachers adapt to innovation or as part of ongoing professional development. Since it is necessary to review a school curriculum as years roll by, it is apparent that the training of the teachers whose tasks lie in implementing the curriculum should be a continuous process (UNESCO, 1975).

Turning now to the issue of retraining primary teachers in Nigeria, some of the approaches to teachers' training mentioned above have been adopted in teacher education in Nigeria. For example, the full-time degree course in education is adopted by almost all the universities in Nigeria while the Mobile teacher approach was adopted by the PEIP in the northern states of Nigeria to disseminate ideas and run courses at local level based on the original courses. The scheme used Teacher Inspectors who were used as 'Mobile teachers' to go round the primary schools to train the primary teachers on the PEIP materials which these teachers needed to adopt in their classrooms. However, some of these approaches faced problem(s) at the implementation level. Gyuse (1982) noted that the 'Mobile teachers' used in the PEIP project experienced problems which originated from the inspectors inability to visit the teachers regularly to provide support where necessary. On the other hand, the full-time degree or diploma courses for teachers in the universities are not easy either. These require that the teachers have to resign their appointments to be enrolled in full-time study. Since it was almost impossible for most of these teachers to leave their jobs (their only source of income as the government could not afford to give a study leave with pay) and enrol in full-time study, and of course were expected to pay fees, (as was also in the case of Swaziland (Stanley, 1979)) some of them decided to undertake the same courses on part-time basis (Sandwich Scheme). Even then, it is not very easy for some of these teachers to leave their families for a 2-3 months course that is some distance from their place of domicile. Evidence from the present study indicated that even the training the teachers obtained from these sandwich courses had little or no relevance to their teaching of science.

The cascade model is one that has been widely used in many parts of the world as noted earlier. This model of in-service education has a number of advantages. Cascade models are claimed to be cost effective as many teachers can benefit from a training given to very few teachers at the beginning. The overall net effect is cheap considering the chain effect of the training given. For these reasons the author suggests that a cascade model could provide one way of solving some of the difficulties faced by Nigerian primary school teachers when teaching science. The in-service programme described in the present study was not designed as a cascade model. However, it was observed that the teachers who participated in the workshop were able to disseminate the information and skills acquired during the workshop to their colleagues and pupils. In the longer term similar workshops could be developed that would enable participants to disseminate ideas in a more systematic way.

Nevertheless, as was noted earlier, there are issues to be addressed in developing in-service programmes based on the cascade model. These issues include the way in which information is diluted, changed or misunderstood. Wrong conceptions, as Kinder and Harland (1991) indicate can be carried along the line. Other issues have been identified by Peacock (1994), who observed that this model of in-service training was not effective in the training of primary teachers in Namibia where majority of the teachers were not only unqualified but also could not speak English, which was the medium of communication.

The problem of passing wrong information to colleagues could be tackled by providing support to the teachers after a workshop or by having a series of workshops spread over a period of time. These strategies would also ensure that enthusiasm, interest and confidence were maintained. In the present study it was found during the third observation[16] that only a few of the teachers had continued to use the INSET materials with the same enthusiasm

[16] The third observation of teachers in this context means the observation of teachers' lessons carried out after the 1-day workshop.

that had been noted during the second observation[17]. Of course, teachers tend to revert to their old methods after any training, but not necessarily because they lack the interest. The evidence from the present study suggested that some teachers were reluctant to adopt new strategies because of lack of confidence or because they had not fully understood new strategies promoted during the workshop.

The importance of monitoring the outcomes of in-service programmes and providing ongoing support after in-service training has been noted in a number of studies. Supporting teachers after in-service programmes can be done in a number of ways. Support could be actual instruction or help given to teachers in their classroom work. This support should of course be provided by the INSET organiser/provider, such as selected government officials, or university lecturers. The author suggests that such support should be offered for a given period of time, over a period of at least six months, after an INSET programme. Trevaskis (1969) argues that follow-up work should be seen as an essential part of in-service training, and should involve staff going into classrooms to work with teachers and pupils. It may also be found necessary for teachers to be brought together again to encourage exchange of experiences with the new materials. In this way, the teachers learn from their other colleagues through sharing their experiences.

Matahelemual (1991) noted that on-going support helped teachers to use skills which they learnt during the workshop with their colleagues. In particular, Matahelemual noted that the support provided for the teachers to carry out the innovation of problem solving approach in Indonesia primary schools was through regular meetings of the teachers with their headteachers and supervisors in a teachers' club where they all gathered to discuss their problems, to share and develop new ideas among their colleagues. These

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[17] The second observation of teachers in this context means the observation of teachers' lessons after the 2-day workshop.

regular meetings, according to Matahelemual, provided the teachers with support to bring about changes in their classrooms. In addition, the support after an in-service training could be provided through preparation of a teachers' handbook (as used in the Strengthening of Primary Education (SPRED) project in Kenya (Ministry of Education, Kenya, 1994)) with a focus on the content of the INSET materials which could be used by the teachers. The handbook could be used by other teachers who received their training from their colleagues. This type of support helps the teachers to develop their skills. It also helps in the diffusion effect so as to avoid a situation of the INSET being felt in one classroom with no effect on the rest of the school. In theory, with the use of the handbook, generations of teachers could be trained with little or no dilution effect.

9.6: Recommendations

The recommendations which are outlined in this section are based on the outcomes of the research described in this thesis. It is hoped that these recommendations, if carried out carefully, could help to acquaint primary teachers with relevant developments in science as well as aid their general professional development.

The majority of the teachers (70%) in the present study, had no form of training in science, even with the NCE minimum academic qualification. Even those teachers who had such training did not possess the knowledge and skills expected of them to teach science in the primary school. For these reasons it is therefore recommended that:

1. That science should be included as a core element of pre-service education courses for all primary teachers in Nigeria.

2. The science taught in pre- and in-service teacher education courses should reflect the science that teachers are expected to teach after training. This

training should include all the science topics included in the primary science core curriculum plus additional courses which should provide the teachers with an in-depth knowledge of the topics they are expected to teach.

3. It is recommended that discovery and inquiry methods be adopted in the teachers' colleges to equip new entrants to the profession with the skills and understanding of the methodology they are expected to use with the children. Such strategies should help to ensure more meaningful learning on the part of pupils in primary schools.

In addition, it is also suggested that teaching strategies are incorporated, such as concept mapping, 'Ask the Object', and simulations, which were found useful in the present study and known to encourage meaningful learning by children in other parts of the world. The hope is that the more the teachers are exposed to different strategies, the more versatile they will become in their choice of teaching approaches geared to make their science lessons interesting and at the same time involve the active participation of the children.

4. Teachers' colleges should be provided with laboratories which should have simple science materials and science corners which student teachers, or teachers on in-service programmes, are expected to have in their own classrooms after training.

5. Working in groups and reflection on practice should be encouraged in the new teachers to help them to appreciate the need to learn from their own and colleagues' experiences and from INSET programmes.

6. The teaching practice should be prolonged and an in-school training be encouraged in the Nigerian teacher education programme. This in-school training should involve the would-be teachers being sent into primary schools after their first year in the teachers' college. During this period (in the school), the would-be teachers are to work together with experienced teachers within

their classrooms and support is to be provided to the new teachers by all concerned which includes, the experienced teachers, headteachers as well as the teacher educators. This in-school training of teachers is noted to be common in the U.K and Australia at present.

It should be noted that experienced teachers will need to provided with mentor training if this model of teacher education is adopted.

7. Teacher educators who teach in the teachers' colleges should teach in the manner they expect the trainees to work after their training. The trainers should see themselves as 'mentors' for the new teachers and provide examples worthy of emulation.

8. That on-going INSET programmes in science should be implemented for Nigerian teachers in primary schools.

The Nigerian National Policy on Education recommends that there should be specialist subject teachers in all the primary schools in the country. Nevertheless, the policy makers have so far not made adequate efforts to help those teachers who were trained prior to the introduction of the new policy, cope with the new system. As a result, only very few primary schools in the country could be claimed to be operating the prescribed system. It is therefore recommended that the cascade model be adopted in Nigerian primary schools to facilitate the retraining of the primary school teacher population in science, although it is recognised that the model has limitations. This strategy in effect would amount to a system whereby a teacher trained from each school would subsequently function as the science co-ordinator for that school. S/he would thus have to attend all INSET programmes in science and thereafter undertake to train his/her colleagues using the same techniques learnt during the INSET course. It would also be necessary for the key teacher to develop communication links with other key teachers selected and trained within the LGEA. Through such inter-school exchanges the teachers are bound to learn from their colleagues and at the same time become aware of what goes on in other schools. Such programmes should be carefully monitored and evaluated.

9. In-service programmes should provide opportunities for teachers to improve their qualifications.

10. It is also recommended that government should sponsor most in-service teachers' training programmes.

11. In addition, INSET programmes such as the one proposed in figure 8.1 is highly recommended in Nigerian schools.

It is necessary to stress that in the present study, it was found that most teachers and their headteachers were happy with the outcomes of the workshop and found the INSET useful to their schools.

Government provision of cash incentives for remedial programmes for teachers is very necessary. As was seen in this study, the provision of direct financial support to the teachers was found very effective. Indeed, the teachers undoubtedly showed much interest and devotion to their work. The support probably must have helped in the long term application of the results of the workshop programme as the teachers felt obliged to give a feedback at the end of the day. The federal and state governments should therefore provide INSET for the primary teachers through their LGEAs by organising and funding regular workshops, utilising government institutions based in their states. At present, available training in the form of Teacher Vocation Training Courses unfortunately do not reach as many teachers as need such training.

9.7: Suggestions for further study

The study described in this thesis was small scale and limited by constraints of time and funding. Therefore there is a need for studies that will build on and extend the present study and which would rectify the limitations identified earlier, including the need for independent observers and evaluators during in-service workshops. In the light of these observations, it is therefore suggested that future studies should address the following:

1. There is a need for a nation-wide survey of the background of primary science teachers. Such a survey would provide useful information about the extent and the difficulties faced by teachers, as well as provide an estimate of the number of teachers requiring retraining in science teaching.

2. An in-depth study to provide information about the deficiencies in primary science in the context of the national science curriculum in Nigeria This study could lead to a proper appreciation of where remediation is required.

3. An evaluation of the content of the present science core curriculum in order to ascertain if the Nigerian primary children's ability to learn science is in line with the demands of the prescribed primary science curriculum.

4. Development and long term evaluation of INSET programmes for science that are based on the cascade model.

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APPENDIX A

FEDERAL MINISTRY OF EDUCATION, LAGOS. CORE CURRICULUM FOR PRIMARY SCIENCE (1980)

FEDERAL MINISTRY OF EDUCATION
LAGOS

CORE CURRICULUM
FOR
PRIMARY SCIENCE

1980

PRIMARY CLASS SIX

TOPIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT AND MATERIALS	EVALUATION
SIMPLE MACHINES (a) LEVERS	Children will be able to (i) Collect and identify common simple lever machines. (ii) Identify components in any given simple lever machine. (iii) Group a collection of simple lever machines. (iv) List common uses of levers.	(i) Things that make work easier around us. (ii) Components of a simple lever. (iii) Classes of levers (iv) Common uses of levers.	(i) Collect some samples of simple lever machines for children to identify and name. (ii) With the aid of a suitable chart/drawing, discuss the components of a typical lever machine – (fulcrum/pivot, effort and load arm) and the characteristics of different classes of lever machines. (iii) identify these components on some given simple lever machines. (iv) Prepare a char showing types of leve machines, (by name). Their uses and location of fulcrum, load/resistance and effort arm. Indicate the class of lever for each machine.	Scissors, bottle opener, wheel barrow, plier, fishing rod, crow-bar, charts showing types of simple lever machines.	(i) Are children able to identify at least four lever machines? (ii) Are children able to locate efforts and load arms and pivot in each of these four machines? (iii) Are the children able to classify the collected lever machines into 1st, 2nd and 3rd classes of lever? (iv) Are the children able to list at least four common uses of simple lever machines
(b) PULLEYS	Children will be able to: (i) recognise and identify simple pulley machines. (ii) identify and describe from a given chart, different uses of pulley, machines in everyday life. (iii) improvise and use simple pulleys.	(i) Simple pulleys – fixed and moveable. (ii) Common uses of simple pulleys.	(i) Collect some standard and improvised simple pulley machines for recognition and identification in class. (ii) With the aid of a suitable chart identify and describe different uses of pulley machines in every day life.	simple pulleys, strings plane glass, sand paper Charts showing uses of simple pulley machines	(i) Are children able to identify simple pulley machines? (ii). How many uses of simple pulley machines are children able to list? (iii) Are children able to make and use a simple fixed pulley?

TOPIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT AND MATERIALS	EVALUATION
			(iii) Improvise and use in class a simple fixed pulley and a moveable pulley.		
(c) FRICTION	Children will be able to: (i) define and give some instances and natural application of friction in everyday life. (ii) produce and reduce frictional effect through simple activities. (iii) List useful and harmful effect of friction in everyday life.	(i) Friction:- Resistance that occurs when two surfaces are in contact. (ii) Observing frictional effect. (iii) Reducing friction (iv) Useful and harmful effect of friction in everyday life.	(i) Rub two surfaces together. (a) Rough against rough as in sandpaper. (b) Rough against smooth. (c) Smooth against smooth Pupils to narrate their experiences. (ii) Rub the following surfaces together. (a) two slices of dry/toasted bread - friction wears away surfaces. (b) a large pebble on a cemented surface - friction produces heat. (c) Strike the sharp edge of a cutlass against a stone/cemented floor - friction produces light effect. (ii) Use different types of lubricant, rollers, ball-bearings to reduce frictional effect. (iv) Discuss and list useful and harmful effect of friction in everyday life.	Toasted bread, large pebble. cutlass, big stone or cemented floor. Lubricating oil, rollers, ballbearings.	(i) Are children able to state four natural instances of application of friction? e.g. walking on a rough/smooth surface Writing on a waxed/rough paper Riding bicycle on a sand/tarred road. (ii) Are children able to use lubricant, rollers, ballbearings to reduce friction? (iii) Are children able to list at least four useful and four harmful effects of friction in everyday life?

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TOPIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT AND MATERIALS	EVALUATION
2. GROWING BETTER CROPS	Children will be able to: Observe and describe the effect of using compost and fertilizers in growing common crops.	Class project (i) Comparison of (a) Growing crops without fertilizers or compost (b) Growing crops with compost (c) Growing crops with fertilizers	(i) Project work on the use of compost and fertilizers in growing common crops e.g. maize, groundnut, beans and lettuce/ spinach/tomatoes. (ii) A visit to a nearby agric. farm to observe how crops are being grown and cultivated.	Pot, soil, compost and fertilizers, maize, groundnut, beans and lettuce.	Are children able to list the essential differences between the effect of compost and fertilizers on the growth of two selected crops:-
3. MAGNETISM	Children will be able to: (i) Collect and identify different types of magnets (ii) Differentiate between magnetic and non-magnetic materials. (iii) List the properties of a magnet. (iv) make and use temporary magnet. (v) List common uses of magnets.	(i) Magnet, magnetic and non-magnetic materials. (ii) Properties of a magnet. (iii) Making magnets (iv) Uses of magnets. (v) Producing electric current using a magnet.	(i) Collect various types of man-made magnets from old radio, loudspeakers, telephone receivers and speedometer of vehicles. (i) Identify them by shapes (iii) Collect common materials and with help of a magnet group them into magnetic and non-magnetic materials. (iv) By means of simple activities find out if: (a) magnet can act through non-magnetic materials. (b) magnet will attract or repel another magnet. (c) certain part of a magnet attracts iron dust more than other parts. (d) magnet can lose its magnetic property (e.g. by heating etc.) (v) Make temporary magnets by using:	Different types of magnets, iron nails, office pins, iron filings, paper clips, steel pins, drawing pins, needles, coins, rubber band, pebbles, pieces of chalk, cork, pieces of copper wire, cotton thread, Galvano-meter, flex wire and a solenoid.	(i) How many types of magnets are children able to name? (ii) Are children able to list at least three properties of a magnet? (iii) Are children able to make temporary magnets by stroking and by electrical methods? (iv) Are they able to list at least three uses of magnet? (v) Are children able to demonstrate production of electric current using a magnet?

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TOPIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT AND MATERIALS	EVALUATION
			(a) stroking and (b) Electrical method. (vi) Use your temporary magnet to pick up magnetic objects. (vii) Discuss and list common uses of magnets. (viii) Examine sample magnetic toys. (ix) Demonstrate production of electric current using a magnet.		
4 MINERALS	Children will be able to: (i) recognise minerals in solid or liquid forms and differentiate them from non-minerals. (ii) List common sources of minerals. (iii) Identify minerals by their properties. (iv) List important uses of some common minerals (e.g. coal, iron-ore, crude - petroleum).	(i) Types of minerals. (ii) Sources of minerals. (iii) Characteristics of minerals (iv) Uses of minerals	(i) Collect or bring sample minerals for class activities e.g. tin-ore, alum, iron-ore, coal, crude oil (petroleum) in a bottle, epsom salt (magnesium sulphate), common salt, marble, bauxite (aluminium ore) also use pictures and charts of oil refinery and a petrol tanker. (ii) With the aid of a hand lens let them look closely at the specimens and feel them. (iii) Let them also examine the crystals of selected minerals and make sketches of what they see. (iv) Show children that petroleum is a mineral that occurs naturally in the liquid state.	tin ore, alum, iron-ore, coal, crude oil, (petroleum) in a bottle, epsom salt (magnesium sulphate), common salt, marble, bauxite (aluminum ore). Pictures and charts of oil exploration, oil refinery and a petrol tanker, hand lenses.	(i) from a collection of liquids and solids, are children able to tell which are non-minerals? (ii) Which sources of these minerals, coal, iron-ore, and petroleum are children able to list?

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TOPIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT AND MATERIALS	EVALUATION
			(v) With the aid of relevant pictures or charts explain the sources of three important minerals – petroleum, coal and iron-ore. (vi) Examine the solid minerals listed earlier and let children narrate experience of characteristic colour, lustre and hardness of these minerals (vii) Examine a sample of crude oil (petroleum) and compare it with such valuable products as petrol, kerosine, engine oil, grease and wax (liquid paraffin etc.) (viii) Let children identify these products by their smell and colour. (ix) With the aid of a suitable chart, during class discussion guide children to suggest some everyday uses of selected minerals. Excursion to relevant establishment will aid in reinforcing this introductory work on minerals.	charts illustrating sources of petroleum, coal and iron-ore.	(ii) Given a list of characteristics for each mineral, are children able to identify the minerals? (iv) Can children list at least one use of every mineral identified?

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TOPIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT AND MATERIALS	EVALUATION
5. OUR ARTH AND 'UR SKY	Children will be able to· (i) recognise by name natural objects/ bodies below the earth's surface, on the earth's surface and above the earth's surface. (ii) Show through simple experiment that the Earth exerts gravitational pull on objects/bodies. (iii) describe through simulation activities two important movements of the Earth and their effects. (iv) Recognise the sun as an important star which acts as an important source of energy (heat and light) for other planets including our earth. (v) Through necessary exposure to the major characteristics of, and differences between planets, children will be able to guess at what life will be like on such planets. (vi) Using the observed position of the sun at sun set and sun rise, children will be able to establish the four cardinal points. (East, West, North, and South).	(i) A closer look at our Earth. (ii) Simple experiment involving Earth's gravitational pull. (iii) Earth's movement (a) Rotation (b) Revolution Day and Night. (iv) A closer look at the solar system: sun and planets (v) General characteristics of planets. (vi) Major differences between planets. (vii) The four cardinal points. (viii) Eclipses of (a) the sun (b) the moon.	(i) With the aid of suitable charts, discuss and let children narrate experience on different natural objects below, on and above the earth's surface. (ii) With the aid of appropriate simple illustrations show that the pull of gravity is always towards the centre of the earth. (iii) With the aid of 0-100g elastic/spring balance show the measure of gravitational pull on an object is its weight. (iv) Discuss with reference to recent space exploration that the gravitational pull (weight) on an object on the moon is less than that of the earth (e.g. men walking in space on the moon). (v) Discuss the idea of the Earth's movement and show by simple experiment that (a) the Earth rotates on an imaginary axis – (rotation) causing day and night and (b) that the earth revolves round the sun once in approximately one year (revolution) (c) using a home -made planetarium or other methods demonstrate the formation of lunar and solar eclipses.	Suitable charts showing objects/bodies below, or above the earth's surface. String, stone or any solid object. elastic/spring balance, stone or any solid object and thread.	(i) How many natural objects/ bodies are children able torecognise and name? (ii) Are children able to realise that the Earth rotates on its axis and revolves round the sun? (iii) Are children able to recognise that sun is an important source of energy (heat and light)? (iv) Are children able to predict the nature of life on other planets? (v) Are children able to indicate the four cardinal points? (vi) Are children able to realise the causes of solar and lunar eclipses?

TOPIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT AND MATERIALS	EVALUATION
	(vii) Through simple experiments, children will be able to explain the causes of solar and lunar eclipses.		(vi) (a) With the aid of suitable pictures and charts, discuss the important role played by the sun in the solar system, emphasising in particular the energy supplying function. (d) Demonstrate the heating effect of the sun on object by using a convex lens to focus the rays of the sun on to a piece of dry paper. (vii) With the aid of a suitable chart and home-made planetarium discuss major characteristics of planets such as (a) average distances from the sun (b) time it takes to revolve round the sun (c) period of rotation on its axis. (d) its diameter (e) the number of moons if any. (viii) Use a pocket compass to fix the four cardinal points or achieve the same as follows: Indicate first the direction of sun rise and that of sun set. Point your left hand in the direction of sun set, and your right hand in the direction of sun rise.	suitable charts showing (i) rotation of the earth on its axis. (ii) the earth revolving round the sun. Home-made planetarium convex lens, thin sheet of paper or dry leaves. magnetic compass	(vii) Are children able to understand and tell why we have day and night? (viii) Are children able to realise that sun is a source of energy (heat and light)? (ix) Are children able to know and be aware of: (i) the period of rotation of the earth on its axis? (ii) the time it takes the earth to revolve round the sun? (x) Are children able to indicate the four cardinal points (E,W,N,S,)?

TOPIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT AND MATERIALS	EVALUATION
			As you stand in this position you are facing the North and have your back to the South.		
6. US AND WHERE WE LIVE	Children will be able to- (i) define erosion (ii) name the causes of erosion and factors that contribute to erosion. (iii) explore the environment and locate eroded areas. (iv) discuss ways of controlling erosion. (v) participate in a class activity that aims to control erosion.	(i) changes in environment (a) erosion	(i) Visit an eroded section near the school compound to explore its causes. (ii) Demonstrate with a pan of pebbles, sand and soil the factors that influence erosion. (iii) Students work on projects i.e. terracing, mulching, grass and tree planting, to prevent or control erosion.	eroded area. Pan of pebbles, sand and soil, water hose or sprinkler. school yard, machetes, spade, hoe, bermuda grass, tree saplings.	(i) are the children able to write a test on causes and effects of erosion? (ii) Are they able to locate and participate in an activity that concerns erosion?
	Children will be able to– (i) define pollution (ii) list agents of pollution (pollutants environment). (iii) locate areas in the community that are polluted or are sources of pollution. (iv) discuss the role of the community in contributing to pollution. (v) recognise effects of water and air pollution. (iv) describe the effects of an oil spill.	(b) Pollution	(i) Show posters, pictures or film strips showing pollution of air, water and land. (ii) Visit or identify areas which are polluted in the community. (iii) Plan a school campaign for awareness of pollution in the environment i.e. exhibits, resource speakers, clean–up week, etc.	Pictures, posters, film strips on pollution market place, garbage in the dump, river bed that is polluted. trash cans, brushes, spades.	(i) Are the children able to list pollutants of air and water? (ii) Are they able to name their effects upon man? (iii) Are they involved in an activity that prevents or controls pollution ?

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TOPIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT AND MATERIALS	EVALUATION
	(vii) participate in a class programme that prevents pollution. Children will be able to:– (i) explain how man uses natural resources; i.e. forests, water, minerals, oil etc. for his needs. (ii) demonstrate the effects of man's excessive use of the natural resources. (iii) define desertification.	(ii) Exploitation of resources.	(i) class debate on exploitation of natural resources versus conservation of naturalresources.	posters, charts, or figures about use of natural resources (trees, oil, minerals etc.)	(i) Are the pupils able to discuss the effects of man's uses of resources upon the environment? (ii) Are they able to describe desertification ?
	Children will be able to: (i) discuss the meaning of conservation. (ii) identify government agencies involved in conservation practices. (iii) differentiate between replaceable and irreplaceable resources. (iv) list ways by which natural resources are conserved. (v) describe sources of energy. (vi) name ways by which energy is conserved at home. (vii) define recycling. (viii) explain how materials in the environment are recycled, i.e. water, air, and soil. (xi) demonstrate ways by which objects in the environment can be recycled.	(iii) Conservation practices. (a) natural resources i.e. soil, water, minerals, etc. (b) energy use. (c) recycling.	(i) Visit a government office and hear a resource person discuss government programmes on conservation. (ii) Develop a picture wall display on sources of energy. (iii) Make a material display of replaceable and irreplaceable resources, and of recycled materials from the environment	posters, pictures, plastic bottles, glass bottles, old newspapers, scrap textiles, rubber tubings etc.	(i) Are the pupils able to define conservation. (ii) Can they name ways by which natural resources are conserved. (iii) Are they able to discuss the importance of conserving energy? (iv) Are they able to show projects that are recycled objects?

APPENDIX B
NIGERIA EDUCATIONAL RESEARCH COUNCIL. INTEGRATED SCIENCE FOR PRIMARY SCHOOLS (A TEACHING CURRICULUM DEVELOPED FROM THE FEDERAL MINISTRY OF EDUCATION CORE CURRICULUM FOR PRIMARY SCIENCE) (1982).

NIGERIA EDUCATIONAL RESEARCH COUNCIL

INTEGRATED SCIENCE FOR PRIMARY SCHOOLS

(A Teaching Curriculum Developed From The Federal Ministry of Education Core Curriculum For Primary Science. 1980)

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TOPIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT & MATERIALS	ASSESS
ANIMALS	Pupils will be able to show: (i) by simple activities the need for breathing in air. (ii) the effect of exercise on rate of breathing. (iii) that it is not good to breathe in already breathed out air. Pupils will be able to: (iv) name and identify the type of teeth in the mouth. (v) say the uses of each type in connection with eating. (vi) say what happens to food in the mouth before it is swallowed.	Treat the following for animals and human body: (i) Breathing System (ii) Feeding System	(i) Hold your breath by plugging your nostrils for a while and describe how you feel. (ii) Take the breathing rate before and after taking a rigorous exercise and compare. (iii) Check the types of teeth of children. (iv) Let pupils chew a piece of bread or any suitable piece of food for a given time.	Stop watch bread or any suitable piece of food.	Are the p able to: (i) expla they chok chok brea stop (ii) say t diffe betw the r brea befo and a exer (iii) ident locat types teeth mout (iv) say are func each

YEAR 6

TOPIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT & MATERIALS	ASSESSM
ENVI- RON- MENT-	Pupils should be able to observe and identify: (i) the influence of environment on man. (ii) the influence of man on environment (iii) the influence of environment on other types of animals and plants	(i) Influence of environment on man. (ii) influence of man on environment. (iii) influence of environment on living things.	(i) Observe types of farming (food), houses, clothing of the people. (ii) Observe various means of transport e.g. canoe, donkey, bicycle, cattle, lorries/trucks, trains, etc. (iii) Observe bush/forest clearing, forest fires, gulleys, dams, irrigated farms, new highways, new housing estates/sites, rural electric poles. (iv) List some of the influences of environment on man, plants and animals e.g. sun rain, land, ocean (sea, river).	Means of transportation — canoes, bicycles, cars, lorries, boats, aeroplanes Charts, diagrams, pictures of villages, towns before and after recent extensive house/road construction. (e.g. a new school, or church, or market, or hotel or a place previously bushy). Refuse dumps by the road side. (pictures of these).	Are the able to: (i) identi various ronme influe effect enviro on ma effect on enviro (ii) recogn how pollut enviro and th sequen effects polluti (iii) recogn how manip the en ment suit purpos

TOPIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT & MATERIALS	ASSESSMENT
ENVIRONMENT	(iv) how man controls some of the problems in the environment and some of the problems created by man on the environment e.g erosion, dam construction, irrigation, pollution.	(iv) Controlling the environment.	(v) Outline some of the man's efforts to control influences on environment e.g Sun Shelter Rain clothing land-farming and transport. Ocean – fishing transportation, generation of power. (vi) List influences of man on environment e.g. farming, road-making, mining, pollution of: – land; dumping of refuse. – Water disposal; of domestic and industrial sewage. – Air; gaseous exhaust of burning from cars, lorries and industries. (vii) Outline efforts made to control pollution. – burning of refuse – refilling of pits. – recycling of some materials. – manufacture of new cars that can use another source of energy apart from petrol.		(iv) suggest wa of contr ing poll ion? (v) appreciate the magni tude of t problem pollution?

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YEAR 6.

TOPIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT & MATERIALS	ASSESSMENT
HEALTH AND SAFETY	Pupils should be able to: (i) cross road properly (and use zebra crossing where applicable) (ii) obey traffic signs (including traffic lights, police at road junctions) (iii) guard against fire outbreak. (iv) store drugs and dangerous chemicals away from children.	(i) Safety measures at home, school, and outdoor. — Road crossing - Traffic signs (ii) Hazards of fires in the home and school (iii) Proper storages of drugs, farm tools etc.	(i) Practise proper crossing of roads. (including zebra crossing) (ii) Study traffic sign such as "stop", "Go", "Do not enter", "School children crossing", "cattle" etc. (iii) Practise fire drill (iv) Rehearse other methods of preventing fire outbreak. (v) See that farm tools are properly stored at home/schools. (vi) A visit to a fire Station where applicable.	Charts and diagrams to illustrate zebra crossing and other traffic signs. Storage/first aids kits at home or school, Rat poisons, insecticides, izal/dettol Farm tools-matchets, hoes, shovels, forks, etc.	(i) Can th[e] pupils observe road safet[y] procedure[s] or rules? (ii) Do the[y] know wha[t] to do i[n] case o[f] fire out break a[t] home o[r] school? (iii) Do the[y] know ho[w] to handl[e] and/or store drug[s] and chemicals?

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TOPIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT & MATERIALS	ASSESSMENT
MAGNET	Pupils will be able to:				
	(i) collect and identify different types of magnets.	(i) Properties of a magnet.	(i) Collect various types of man-made magnets from old radio loud speakers, telephone receivers and speedometer of vehicles.	Pieces of chalk, corks pieces of copper wire, cotton thread, galvanometer, solenoid.	(i) How many types of magnets are pupils able to name?
	(ii) differentiate between magnetic materials.	(ii) Magnets: magnetic and non-magnetic materials.	(ii) Identify them by shapes.		(ii) Are pupils able to list at least three properties of a magnet?
	(iii) list the properties of a magnet.	(iii) Uses of magnets.	(iii) Collect common materials and with help of a magnet group them into magnetic and non-magnetic materials		(iii) Are pupils able to make temporary magnets by stroking and by electrical methods?
	(iv) make and use temporary magnet.	(iv) Making magnets.	(iv) By means of simple activities find out if – magnet can act through non-magnetic materials. – Magnet will attract or repel other magnet. – certain part of a magnet attract iron dust more than other parts. – Magnet can lose their magnetic property (e.g by heating etc.)		(iv) Are they able to list at least three uses of magnet
	(v) list common uses of magnets	(v) Producing electric current using a magnet.	(v) Make temporary magnets by using the: – stroking and electrical methods		(v) Are pupils able to demonstrate production of electric current using a magnet?

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PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT & MATERIALS	ASSESSMENT
Children will be able to observe and list things that will dissolve in water and which do not dissolve.	Water as a solvent	Using various materials, stirred into jars of water, describe and list in tabular form which material "disappeared partially" and did not disappear (Note to teacher) The word, dissolve could later be introduced.	Water, beakers, test tubes, jam jars, spoon, garri, saw dust, salt, sugar, stone, sand.	Can the pupils differentiate between solvent (water) and solute (sugar, salt etc)?

›PIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT & MATERIALS	ASSESSMENT
A- IRE- NT	Pupils should be able to: (i) identify commonly used metric unit. (ii) recognize materials and equipment used for measurement. (iii) determine the volume of various amount of liquid by using a container marked in metric units. (iv) use a balance and standard weight to determine the mass of various objects. (v) identify application of measurement in relevant technology. (vi) determine and compare the volume, mass relationship of different metals or solids.	Applications in relevant technology simple treatment of mass, volume relationships of different metals. or solids	(i) Outline and list commonly used metric units. (ii) Distinguish the metric units used in linear, volume and mass measurements. (iii) determine length of various objects and distances. (iv) determine the volume of various amount of liquid using different standard units. (v) outline the application of measurement in relevant technology. (vi) Visit. — motor mechanic workshop — a petrol station — a carpentry workshop — a brewery — a produce station to get familiar with the units of measurement.	Metre rules, strings, balance, graduated cylinders, standard measures, metals or solids.	(i) How many ways of measurement can the pupils name? (ii) Can the pupils appreciate the relevance in technology?

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IC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT & MATERIALS	ASSESSMENT
·l- nd	Pupils should be able to				
	(i) observe parts of machines eg. bicycle, table clock, sewing machine, cars, electric fans, motor-rized childrens' toys	(i) Observation of parts of simple machines.	(i) By use of old machine and equipment, ask pupils to observe and identify the parts.	Old machines, tools, equipments eg. clock, electric fans, electric switches, bicycle, motorized children toys etc.	(i) How many parts: of the machines do the pupils know?
y	(ii) identify and know the functions of parts of the machines.	(ii) identifying parts of machines.	(ii) Ask the pupils to dismantle any old machine and re-assemble it.		(ii) Can they re-assemble the dismantled machines?
	(iii) dismantle and reassemble some machines.	(iii) dismantling and re-assembling of simple machines.	(iii) Let the pupils undertake a project work involving the use of metal or wood. They can make wooden money box, metal ash tray, office file tray, carvings etc. or any project of their choice.		(iii) Are they able to perform the projects?
	(iv) undertake individual approved work involving wood or metal.	(iv) approved project work involving wood or metal.			

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)PIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT & MATERIALS	ASSESSMENT
ks	Pupils will be able to				
erals	(i) recognize minerals in solid or liquid forms and differentiate them from non-minerals.	1. Types of minerals.	(i) Collect or bring sample minerals for class activities eg. tin ore, alum, iron-ore coal, crude oil (petroleum) in a bottle, epsom salt (magnesium sulphate). common salt, marble, bauxite (aluminium ore) also use pictures and charts of oil exploration, oil refinery and a petrol tanker.	tin ore, alum, iron-ore, coal, crude oil (petroleum) in a bottle, epsom salt (magnesium sulphate) common salt, marble bauxite (aluminium ore). Pictures and charts of oil exploration oil refinery and a petrol tanker, hand lens	(i) from a collection of liquids and solids, are children able to tell which are non-minerals?
	(ii) List common sources of minerals.	2. Sources of minerals	(ii) With the aid of a hand lens, let them look closely at the specimens and feel them.		(ii) which sources of these minerals, coal, iron-ore, and petroleum are children able to list?
	(iii) Identify minerals by their properties.	(iii) Characteristic of minerals.	(iii) Let them also examine the crystals of selected minerals and make sketches of what they see.		(iii) Given a list of characteristics for each minerals, are pupils able to identify the minerals?
	(iv) List important uses of some common minerals (e.g. coal, iron-ore, crude - petroleum).	(iv) Uses of minerals. emphasis on coal, petroleum, iron and tin.	(iv) With the aid of relevant pictures or charts explain the sources of three important minerals - petroleum, coal and iron-ore.		(iv) Can pupils list at least one use of every mineral identified?
			(v) Examine the solid minerals listed earlier and let pupils narrate experience of characteristic colour, lustre and hardness of these minerals.	charts illustrating sources of petroleum, coal and iron-ore.	
			(vi) Let the pupils know that petroleum is a mineral that occur naturally in the liquid state.		
			(vii) Examine a sample of crude oil, if it is readily available (petroleum) and compare it with such valuable products as petrol, kerosene, engine oil, grease and wax (liquid parafin etc)		

OPIC	PERFORMANCE OBJECTIVES	CONTENT	ACTIVITIES	EQUIPMENT & MATERIALS	ASSESSMENT
'ater	Children will be able to observe and list things that will dissolve in water and which do not dissolve.	Water as a solvent	Using various materials, stirred into jars of water, describe and list in tabular form which material "disappeared partially" and did not disappear (Note to teacher) The word, dissolve could later be introduced.	Water, beakers, test tubes, jam jars, spoon, garri, saw dust, salt, sugar, stone, sand.	Can the pupils differentiate between solvent (water) and solute (sugar, salt etc)?

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APPENDIX Bi
A SAMPLE OF CONTINUOUS ASSESSMENT SCORES FOR PRIMARY SCHOOLS IN ANAMBRA STATE

MINISTRY OF EDUCATION
EXAMINATION DEVELOPMENT CENTRE

CONTINUOUS ASSESSMENT SCORES FOR PRIMARY SCHOOLS

SCHOOL: .... LOCAL GOVERNMENT AREA: .... ZONE: ....

/N	CODE NUMBER	NAME	CONTINUOUS ASSESSMENT SCORES FOR SUBJECTS																								GRA TOT OF SCO
			ENGLISH						MATHS						IGBO						GENERAL PAPER						
			Yr 3 (10)	Yr 4 (20)	Yr 5 (30)	Yr 6 (40)	Total (100)	Std. Score	Yr 3 (10)	Yr 4 (20)	Yr 5 (30)	Yr 6 (40)	Total (100)	Std. Score	Yr 3 (10)	Yr 4 (20)	Yr 5 (30)	Yr 6 (40)	Total (100)	Std. Score	Yr 3 (10)	Yr 4 (20)	Yr 5 (30)	Yr 6 (40)	Total (100)	Std. Score	

APPENDIX C
TEACHERS QUESTIONNAIRE USED FOR THE SURVEY(MAY - JULY 1993)

Dear Colleague,

TEACHING PRIMARY SCIENCE IN SCHOOLS.

I am currently doing a research at the Institute of Education in London to find out more about science topics which pupils in primary six find difficult to learn. I should be most grateful if you could complete this questionnaire for me. I am also enclosing a short questionnaire for pupils in your class. I should be most grateful if you could ask ten pupils in your class to complete the questionnaire. Please could you choose the pupils at random e.g. every third child on the register.

I wish to assure you that any information provided on this questionnaire is treated as strictly confidential and will be used only for the purpose of this research.

If you have any problem about the questionnaire, please contact Mrs Gladys Aniedu, % Department of Parasitology, Nnamdi Azikiwe University, Awka. Anambra State. Nigeria.

Please return the completed questionnaire to Mrs C. Anosike, % Mrs Gladys Aniedu in the above stated adress.

I should like to thank you in advance for your help. When the responses to the questionnaire are analysed, I would send you the summary of the results.

Yours Sincerely,

Cordelia Anosike (Mrs).

SECTION A: BACKGROUND INFORMATION.

1. Name of your school...

2. State of your school...

3. Where is your school located?

Rural ❑ Urban ❑ *(tick as applicable)*

4. Number of years of experience in teaching:

0-4yrs ❑ 5-9yrs ❑ 10yrs or >❑

5. Sex. Male ❑ Female ❑

6. Academic qualification:

Grade 11 ❑

Grade 1 or N.C.E. or Grade 11+ N.C.E. ❑

Grade 11 + B.Ed or Grade 11+N.C.E. + B.Ed. ❑

Others...

7. Did you do any science subject during training?

Yes ❑ No ❑ *(tick as applicable)*

8. Have you attended any inservice training in science in your career?

Yes ❑ No ❑ *(tick as applicable)*

9. What year was your last inservice training in science?................................

SECTION B: TEACHING SCIENCE IN PRIMARY SCHOOLS.

10. Are you familiar with the National Core Curriculum?
Yes ❑ No ❑ *(tick as applicable)*

11. Do you teach science as seperate subject in your school?
Yes ❑ No ❑ *(tick as applicable)*

12. How many lessons of science do children have each week in your school time table?

....

13. Please tick from the list of topics provided below in order of your perceived difficulty to teach them. (5 = very difficult, 4 = difficult, 3 = neutral, 2 = easy, 1 = very easy).

Primaryscience(6) topics	Level of difficulties				
	1	2	3	4	5
Animals					
Earth and Sky					
Environment					
Health and Safety					
Heat					
Magnet					
Measurement					
Modelling and Relevant Technology					
Rocks and Minerals					
Water					

14. Which topic (from(13) above) do you find most difficult to teach?

....

15. From your experience, why do you think the topic is difficult to teach?

a. because the ideas are difficult to conceptualize

b. because the language used in the textbooks is complex

c. the resources available for teaching the topic are not sufficient

d. the objectives set out for the pupils are not appropriate for their age

e. materials to be learnt are not relevant to the child's need

f. lack of practical skill during your training

g. others..

(You can tick as many as are applicable to you.)

16. From the list of concepts provided, please tick in order of the pupils perceived difficulty in understanding the topics.

Primary science(6)topics	Level of difficulties				
	1	2	3	4	5
Animals					
Earth and Sky					
Environment					
Health and Safety					
Heat					
Magnet					
Measurement					
Modelling and Relevant Technology					
Rocks and Minerals					
Water					

17. From your experience which topic from (16) above do pupils find most difficult?

....

18. Why in your opinion do pupils perceive the topic in (17) difficult to learn.

....

....

(if your reason is as stated above in (15) indicate by writing *'SAME')*

19. Are there concepts under the difficult topic which pup nd interesting to learn?

....

....

20. Please show from the table below the way you assess your learning outcomes in science. (tick as appropriate).

Methods of assessment	Always	Sometimes	Never
End of Module examination			
Mid year examination			
End of year examination			
Cloze tests			
Drawing			
Discussion with pupils			
Written work			
Verbal feedback			
Weekly tests			

Others.*(please give details)*..

....

21.The National Curriculum for Education in Nigeria has emphasised that reflective
thinking should be encouraged in primary school pupils.
Show how often you employ the following strategies to help pupils reflect in

your science lessons by ticking each strategy as it is applicable to you.

Methods of teaching science	Always	Sometimes	Never
Imagining			
Enquiry			
Problem Solving			
Discussion with pupils			
Hypothesising			

Others (*please give details)*...

....

APPENDIX Ci
PILOT QUESTIONNAIRE: CODING FOR BACKGROUND INFORMATION AND DIFFICULT TOPIC TO TEACH

	state	location	code	sex	qual	science	animals	earth	environ
1	1	1	1	1	1	3	2	5	2
2	1	1	1	2	1	3	2	3	3
3	1	1	2	1	3	3	2	5	3
4	1	1	3	1	1	3	1	2	2
5	1	1	3	1	1	1	2	2	2
6	1	1	4	1	2	3	2	3	3
7	1	1	5	1	3	3	2	2	2
8	1	1	5	1	3	2	1	1	1
9	1	2	6	1	2	1	1	1	2
10	1	2	6	1	2	3	1	3	2
11	1	2	7	1	3	3	1	2	2
12	1	2	8	1	3	1	1	5	3
13	1	2	8	1	1	3	2	2	1
14	1	2	8	1	3	3	2	2	3
15	1	2	9	1	3	3	1	2	1
16	1	2	9	1	3	3	1	3	2
17	1	2	10	2	3	3	1	3	4
18	2	1	11	2	3	3	2	4	1
19	2	1	11	1	3	3	2	4	2
20	2	1	12	2	3	3	2	4	1
21	2	1	13	2	1	3	3	5	5
22	2	2	14	1	1	3	2	3	1
23	2	1	15	2	1	3	3	5	2
24	2	1	16	2	1	3	2	2	2
25	2	2	17	1	1	3	3	3	3
26	2	2	17	1	1	3	3	4	3
27	2	1	18	1	2	3	3	3	2
28	3	1	19	1	2	3	3	2	2
29	3	1	20	1	1	1	2	2	2
30	3	1	21	1	3	3	1	2	2
31	3	1	22	1	2	1	2	3	2
32	3	1	23	2	3	1	1	2	2
33	3	1	24	1	2	3	2	3	2
34	3	1	25	1	3	3	2	2	2

	health	magnet	measure	techy	rocks	water	reasons
1	1	2	3	3	1	2	13
2	2	5	4	4	3	3	.
3	2	5	3	5	3	2	135
4	2	4	1	4	2	1	13
5	1	3	2	4	3	2	.
6	2	4	3	4	4	3	135
7	2	4	3	4	4	2	13
8	2	4	3	5	2	2	.
9	5	4	4	5	4	2	13
10	1	1	4	5	2	1	.
11	1	4	2	5	3	1	25
12	2	1	2	4	4	1	145
13	2	3	2	5	2	1	135
14	2	3	3	4	3	2	.
15	1	4	4	5	5	1	135
16	2	3	2	3	3	2	135
17	2	2	4	5	4	1	.
18	3	2	1	3	3	1	135
19	3	4	2	2	3	2	5
20	2	5	1	4	1	1	135
21	3	5	3	4	3	2	15
22	1	3	2	3	3	2	5
23	2	5	2	2	4	1	5
24	1	5	3	2	3	2	.
25	1	5	3	4	3	1	134
26	1	5	4	4	3	1	14
27	1	5	3	4	3	2	124
28	2	2	2	3	3	2	135
29	3	4	3	5	5	3	5
30	4	5	4	5	1	1	125
31	2	4	2	5	4	2	35
32	2	2	2	4	2	2	35
33	3	3	5	4	4	2	135
34	4	4	4	4	2	2	134

	state	location	code	sex	qual	science	animals	earth	environ
35	3	1	26	1	2	3	2	3	3
36	3	1	26	1	3	3	2	4	3
37	3	2	27	1	3	3	2	2	2
38	3	2	28	1	3	1	1	2	3
39	3	2	29	2	3	1	2	2	2
40	3	2	29	2	3	1	2	2	2
41	3	2	30	1	1	1	2	2	1
42	3	2	30	2	3	1	2	4	3
43	3	2	31	1	2	3	1	4	1
44	3	2	32	1	3	1	1	3	4
45	3	2	32	1	3	1	2	4	3
46	3	2	33	2	3	3	1	1	2
47	3	2	33	1	1	3	4	2	1
48	3	2	34	1	3	3	2	3	2
49	3	2	35	1	1	3	1	2	2
50	3	2	36	1	2	3	1	5	2

	health	magnet	measure	techy	rocks	water	reasons
35	4	4	3	3	4	2	35
36	2	5	3	2	5	2	134
37	1	1	2	3	4	1	124
38	1	1	2	4	4	2	15
39	2	2	3	3	3	2	135
40	2	2	3	3	3	2	13
41	2	3	1	4	3	3	13
42	3	3	3	4	5	2	135
43	2	2	3	5	4	1	15
44	2	3	2	3	4	2	.
45	2	4	2	5	3	2	135
46	2	3	3	3	2	1	.
47	1	4	4	4	4	1	13
48	2	4	3	3	3	2	15
49	4	4	3	3	4	3	135
50	2	2	2	5	2	1	135

APPENDIX Cii
PILOT QUESTIONNAIRE: CODING FOR TEACHING STRATEGIES IN TEACHING SCIENCE

	state	location	code	sex	qual	science	imaginat	enq_dis	probsolv	discuss	others
1	1	1	1	1	1	3	2	2	1	1	0
2	1	1	1	2	1	3	3	1	1	2	0
3	1	1	2	1	3	3	2	2	1	1	0
4	1	1	3	1	1	3	2	1	1	1	0
5	1	1	3	1	1	1	2	1	1	1	0
6	1	1	4	1	2	3	2	1	1	1	0
7	1	1	5	1	3	3	2	1	1	1	0
8	1	2	5	1	3	2	3	1	1	1	0
9	1	2	6	1	2	1	2	1	2	1	0
10	1	2	6	1	2	3	2	1	1	1	0
11	1	2	7	1	3	3	1	1	2	2	0
12	1	2	8	1	3	1	2	1	1	1	0
13	1	2	8	1	1	3	1	1	1	1	0
14	1	2	8	1	3	3	2	1	2	1	0
15	1	2	9	1	3	3	1	1	2	1	0
16	1	2	9	1	3	3	3	2	1	2	0
17	1	2	10	2	3	3	3	2	1	1	0
18	2	1	11	2	3	3	3	1	1	1	0
19	2	1	11	1	3	3	3	2	1	1	0
20	2	1	12	2	3	3	3	2	1	1	0
21	2	1	13	2	1	3	3	3	1	1	0
22	2	2	14	1	1	3	1	2	1	1	0

	state	location	code	sex	qual	science	imaginat	enq_dis	probsolv	discuss	others
23	2	1	15	2	1	3	3	1	1	2	0
24	2	1	16	2	1	3	2	3	2	1	0
25	2	2	17	1	1	3	2	3	2	1	0
26	2	2	17	1	1	3	2	3	2	1	0
27	2	1	18	1	2	3	2	2	2	2	0
28	3	1	19	1	2	3	3	2	1	2	0
29	3	1	20	1	1	1	3	2	2	1	0
30	3	1	21	1	3	3	1	2	2	1	0
31	3	1	22	1	2	1	2	2	2	1	0
32	3	1	23	2	3	1	1	1	2	2	0
33	3	1	24	1	2	3	2	2	2	1	0
34	3	1	25	1	3	3	2	1	1	1	0
35	3	1	26	1	2	3	3	2	2	1	0
36	3	1	26	1	3	3	1	1	1	1	0
37	3	2	27	1	3	3	2	1	1	1	0
38	3	2	28	1	3	1	1	2	2	1	0
39	3	2	29	2	3	1	1	1	1	1	0
40	3	2	29	2	3	1	1	1	1	1	0
41	3	2	30	1	1	1	2	1	2	2	0
42	3	1	30	2	3	1	2	1	2	1	0
43	3	2	31	1	2	3	1	2	2	2	0
44	3	2	32	1	3	1	2	1	2	1	0

	state	location	code	sex	qual	science	imaginat	enq_dis	probsolv	discuss	others
45	3	2	32	1	3	1	2	2	2	1	0
46	3	2	33	2	3	3	1	1	2	1	0
47	3	2	33	1	1	3	2	2	1	1	0
48	3	2	34	1	3	3	1	2	2	1	0
49	3	2	35	1	1	3	3	2	2	1	0
50	3	2	36	1	2	3	1	2	2	1	0

APPENDIX Ciii
PILOT QUESTIONNAIRE: CODING FOR ASSESSMENT STRATEGIES USED IN ASSESSING PRIMARY SCIENCE

	state	location	code	sex	qual	science	weektest	modul_ex	year_ex	drawing	oral_ex	others
1	1	1	1	1	1	3	1	3	2	2	1	0
2	1	1	1	2	1	3	1	2	1	2	2	0
3	1	1	2	1	3	3	2	2	1	2	3	0
4	1	1	3	1	1	3	2	2	1	1	2	0
5	1	1	3	1	1	1	1	1	1	2	2	0
6	1	1	4	1	2	3	1	3	2	2	2	0
7	1	1	5	1	3	3	1	1	1	2	2	0
8	1	2	5	1	3	2	1	2	1	2	1	0
9	1	2	6	1	2	1	1	1	1	2	2	0
10	1	2	6	1	2	3	1	1	1	2	2	0
11	1	2	7	1	3	3	2	2	1	3	3	0
12	1	2	8	1	3	1	1	1	1	3	2	0
13	1	2	8	1	1	3	1	1	1	3	2	0
14	1	2	8	1	3	3	1	2	2	1	2	0
15	1	2	9	1	3	3	1	2	1	2	2	0
16	1	2	9	1	3	3	1	2	1	2	2	0
17	1	2	10	2	3	3	1	2	1	1	2	0
18	2	1	11	2	3	3	1	2	1	3	2	0
19	2	1	11	1	3	3	1	2	1	2	1	0
20	2	1	12	2	3	3	1	1	1	3	2	0
21	2	1	13	2	1	3	1	1	1	3	2	0
22	2	2	14	1	1	3	1	1	2	2	2	0

	state	location	code	sex	qual	science	weektest	modul_ex	year_ex	drawing	oral_ex	others
23	2	1	15	2	1	3	1	2	1	1	1	0
24	2	1	16	2	1	3	2	2	2	3	2	0
25	2	2	17	1	1	3	1	2	1	3	2	0
26	2	2	17	1	1	3	2	2	1	2	1	0
27	2	1	18	1	2	3	1	2	1	1	2	0
28	3	1	19	1	2	3	1	2	2	2	2	0
29	3	1	20	1	1	1	1	1	1	2	3	0
30	3	1	21	1	3	3	1	1	2	1	2	0
31	3	1	22	1	2	1	1	1	1	1	1	0
32	3	1	23	2	3	1	2	2	2	2	2	0
33	3	1	24	1	2	3	2	2	1	1	2	0
34	3	1	25	1	3	3	1	1	2	2	2	0
35	3	1	26	1	2	3	1	1	1	2	1	0
36	3	1	26	1	3	3	1	2	1	2	1	0
37	3	2	27	1	3	3	1	2	1	2	2	0
38	3	2	28	1	3	1	1	1	1	2	2	0
39	3	2	29	2	3	1	1	1	1	3	2	0
40	3	2	29	2	3	1	1	1	1	3	1	0
41	3	2	30	1	1	1	1	1	2	3	2	0
42	3	1	30	2	3	1	2	2	1	3	1	0
43	3	2	31	1	2	3	1	2	2	2	2	0
44	3	2	32	1	3	1	1	3	1	1	2	0

	state	location	code	sex	qual	science	weektest	modul_ex	year_ex	drawing	oral_ex	others
45	3	2	32	1	3	1	1	1	1	1	2	0
46	3	2	33	2	3	3	1	2	1	3	1	0
47	3	2	33	1	1	3	1	1	1	3	1	0
48	3	2	34	1	3	3	1	3	1	3	2	0
49	3	2	35	1	1	3	1	2	1	1	2	0
50	3	2	36	1	2	3	2	1	1	1	2	0

APPENDIX Civ
MAIN QUESTIONNAIRE : CODING FOR BACKGROUND OF TEACHERS

	state	location	code	sex	qual	science	experien	animals	earth
1	1	2	1	1	1	3	3	1	1
2	1	2	1	1	2	3	3	2	4
3	1	2	2	1	2	3	1	1	2
4	1	2	2	1	1	3	1	1	2
5	1	2	2	2	2	3	2	1	4
6	1	2	3	1	2	3	1	1	2
7	1	2	3	2	2	3	2	1	4
8	1	2	3	2	2	3	2	1	3
9	1	2	4	1	2	3	3	2	2
10	1	2	4	2	1	3	1	1	2
11	1	2	4	1	2	3	2	1	2
12	1	2	5	1	2	1	3	1	4
13	1	2	5	2	1	3	2	2	4
14	1	2	5	1	2	1	2	1	5
15	1	1	6	2	2	3	2	1	4
16	1	1	6	1	2	3	2	1	3
17	1	1	6	1	2	3	2	2	3
18	1	1	7	1	2	3	1	2	4
19	1	1	7	1	1	3	3	2	3
20	1	1	8	2	2	3	3	2	4
21	1	1	8	1	1	3	3	3	3
22	1	1	8	2	1	3	2	2	3
23	1	1	9	2	1	3	3	1	4
24	1	1	9	1	1	3	2	2	3
25	2	2	10	2	2	3	3	2	1
26	2	2	10	2	2	2	2	2	2
27	2	2	11	2	2	1	3	2	2
28	2	2	12	1	2	2	2	2	2
29	2	2	13	2	2	2	2	2	2
30	2	2	14	2	1	1	2	2	2
31	2	2	15	2	2	1	3	2	4
32	2	2	16	1	2	2	2	2	5
33	2	2	17	2	3	1	3	2	2
34	2	2	18	2	2	2	3	2	2

	environ	health	magnet	measure	tech	rocks	water	reasons
1	2	1	4	1	1	1	1	5
2	2	2	4	4	3	2	2	134
3	2	1	3	2	3	3	1	1
4	2	2	5	3	5	5	2	4
5	2	1	4	1	3	2	1	135
6	1	1	2	3	3	2	1	135
7	2	2	3	3	4	3	1	135
8	2	2	3	2	4	2	2	3
9	2	2	3	3	3	2	1	235
10	2	1	2	3	3	2	1	35
11	1	1	2	3	5	5	1	3
12	2	1	5	1	2	5	1	1
13	3	2	4	2	3	3	2	135
14	1	1	3	2	4	4	1	35
15	2	1	4	1	3	2	1	135
16	3	1	4	4	4	4	1	1
17	3	2	4	3	3	4	2	13
18	2	4	3	3	3	3	2	15
19	2	3	4	3	2	3	1	1
20	1	2	3	2	3	4	1	1
21	2	3	3	3	4	3	2	15
22	2	2	3	4	4	2	3	1
23	1	3	2	2	3	4	2	14
24	2	1	4	3	3	5	2	1
25	2	5	4	2	3	2	1	35
26	2	2	4	2	4	2	2	13
27	2	2	2	2	4	2	2	13
28	2	2	2	2	4	2	2	13
29	2	2	2	2	4	2	2	13
30	2	2	2	2	4	2	2	13
31	2	2	2	2	4	2	2	13
32	1	1	2	2	3	4	5	135
33	2	2	4	3	4	3	2	13
34	2	2	2	4	4	2	2	13

	state	location	code	sex	qual	science	experien	animals	earth
35	2	2	19	1	1	1	2	2	2
36	2	2	20	2	1	2	2	2	2
37	2	2	21	2	2	1	2	1	2
38	2	2	22	2	2	1	3	2	2
39	2	2	23	2	1	1	3	2	2
40	2	2	24	2	2	1	2	2	2
41	2	2	25	2	1	1	2	2	2
42	2	1	26	1	2	3	2	1	3
43	2	1	27	1	1	3	3	1	4
44	2	1	28	1	1	3	3	1	2
45	2	1	28	1	2	1	2	1	2
46	2	1	29	1	1	3	1	1	1
47	2	2	30	1	1	3	3	3	3
48	2	1	31	2	3	1	2	2	4
49	2	2	32	2	2	3	2	1	2
50	2	2	32	1	2	3	3	1	3
51	2	2	33	2	1	3	1	3	3
52	2	2	33	2	2	3	2	1	2
53	2	2	33	1	1	3	3	1	3
54	2	1	34	1	1	3	3	2	1
55	2	1	34	1	1	3	2	1	2
56	2	1	35	2	1	3	3	1	2
57	2	1	35	1	2	3	3	1	3
58	2	1	36	2	1	3	2	1	1
59	2	1	36	2	2	3	2	3	3
60	2	1	37	1	1	3	2	1	4
61	2	1	37	1	1	3	2	1	2
62	2	1	37	1	1	3	1	1	1
63	3	1	38	1	2	3	3	4	4
64	3	1	38	1	2	3	3	1	2
65	3	1	38	1	2	3	2	2	2
66	3	1	39	1	2	3	1	2	2
67	3	1	39	1	1	1	1	1	4
68	3	1	39	1	1	3	3	4	3

	environ	health	magnet	measure	tech	rocks	water	reasons
35	2	2	2	2	4	2	2	13
36	2	2	2	2	4	2	2	13
37	2	4	4	2	5	1	2	13
38	2	2	2	2	4	2	2	13
39	2	2	2	2	4	2	2	13
40	2	2	2	2	4	2	2	13
41	2	2	4	2	4	2	2	123
42	2	1	5	2	5	5	1	35
43	2	2	4	2	5	2	1	13
44	4	2	3	2	4	2	1	13
45	1	1	2	1	5	2	2	13
46	1	1	4	2	5	1	1	3
47	1	4	4	3	3	3	3	235
48	2	3	2	2	2	3	1	235
49	1	2	4	2	5	4	2	13
50	2	1	2	3	4	3	2	13
51	1	3	3	3	3	3	3	235
52	2	1	3	2	4	3	2	23
53	2	2	4	2	5	2	2	35
54	1	1	4	2	3	3	1	13
55	2	2	5	3	4	4	1	1
56	1	3	4	2	3	3	2	13
57	2	2	3	2	3	3	3	12
58	2	2	2	3	4	4	2	13
59	1	3	3	2	5	3	1	13
60	3	4	2	2	4	3	1	135
61	1	2	4	3	3	4	2	135
62	2	2	3	3	4	5	3	13
63	3	2	5	5	5	5	4	135
64	3	2	3	4	5	4	2	135
65	1	1	4	4	4	2	1	35
66	1	1	2	3	3	2	1	5
67	1	3	2	2	5	5	2	5
68	2	2	3	4	4	3	4	135

	state	location	code	sex	qual	science	experien	animals	earth
69	3	1	40	1	3	3	3	2	4
70	3	1	40	2	1	3	3	2	3
71	3	1	41	1	2	3	3	1	2
72	3	1	41	2	2	3	3	2	4
73	3	1	42	2	2	3	3	2	4
74	3	1	42	1	2	2	3	2	2
75	3	1	43	1	2	3	3	2	4
76	3	1	43	2	2	1	3	2	4
77	3	1	43	1	2	3	3	1	2
78	3	1	44	1	1	2	1	2	3
79	3	1	44	2	2	3	3	3	4
80	3	1	45	1	2	3	3	2	4
81	3	1	45	1	1	3	2	2	2
82	3	1	46	1	2	3	3	2	4
83	3	1	46	1	2	3	3	3	3
84	3	1	47	1	2	3	2	2	2
85	3	1	47	1	2	3	2	2	5
86	3	1	47	1	2	2	2	1	4
87	3	1	48	1	2	1	3	1	4
88	3	1	48	1	2	3	2	2	1
89	3	1	49	1	2	3	2	2	1
90	3	1	49	1	2	3	2	2	1
91	3	1	49	1	2	3	2	1	4
92	3	1	50	2	2	3	2	2	4
93	3	1	50	2	2	1	2	2	3
94	3	1	51	2	1	2	3	2	3
95	3	1	52	1	2	3	3	1	2
96	3	1	53	1	2	3	3	2	3
97	3	1	54	1	1	3	2	2	2
98	3	1	55	1	2	1	2	2	2
99	3	2	56	1	2	3	1	2	2
100	3	2	56	1	2	3	1	2	2
101	3	2	57	1	3	3	1	2	5
102	3	2	57	1	1	3	2	2	4

	environ	health	magnet	measure	tech	rocks	water	reasons
69	1	1	2	1	3	4	2	135
70	3	2	3	3	4	3	3	35
71	2	1	3	2	4	5	3	235
72	2	4	4	2	4	5	3	134
73	1	2	4	4	4	5	3	125
74	2	1	4	4	4	2	3	1
75	2	1	4	4	4	1	1	135
76	2	1	4	4	4	1	1	135
77	2	1	3	2	4	5	3	23
78	3	3	4	2	3	2	2	35
79	2	3	4	2	5	4	3	35
80	2	2	4	2	5	4	4	345
81	2	3	2	4	2	4	2	35
82	2	2	2	1	4	2	2	35
83	2	2	5	4	5	4	3	35
84	2	2	5	2	3	3	3	5
85	1	2	5	4	5	2	2	135
86	2	3	5	3	2	3	1	45
87	2	2	4	4	2	2	1	13
88	1	1	5	2	5	2	1	14
89	1	2	5	2	5	2	2	13
90	1	2	5	2	5	2	2	13
91	2	3	5	3	2	3	1	45
92	2	2	4	2	5	4	4	345
93	3	3	4	2	3	2	2	35
94	2	1	2	1	4	4	2	35
95	1	1	4	3	3	5	2	45
96	2	3	3	3	4	3	1	135
97	2	3	5	4	2	4	2	35
98	1	1	3	2	3	1	1	35
99	1	1	3	2	5	1	1	35
100	2	2	4	2	4	2	2	35
101	5	1	5	4	5	5	1	1
102	4	1	4	4	4	4	4	35

	state	location	code	sex	qual	science	experien	animals	earth
103	3	2	58	1	2	3	3	3	4
104	3	2	58	1	1	3	2	3	3
105	3	2	59	1	3	3	3	5	5
106	3	2	59	1	2	3	3	4	4
107	3	2	60	1	1	3	1	2	3
108	3	2	60	1	2	1	3	2	5
109	3	2	61	1	2	3	3	2	5
110	3	2	61	1	2	1	3	3	5
111	3	2	62	1	2	3	3	3	4
112	3	2	62	1	2	3	2	2	2
113	3	2	63	2	1	1	3	2	2
114	3	2	63	1	2	3	3	1	4
115	3	2	64	1	2	1	3	2	5
116	3	2	64	1	3	1	3	1	3
117	3	2	65	1	3	1	3	2	2
118	3	2	65	1	3	3	3	1	5
119	3	2	66	1	2	3	3	2	3
120	3	2	66	1	3	3	3	2	2
121	3	2	66	1	3	1	3	2	4
122	3	2	67	2	1	1	3	1	2
123	3	2	67	1	1	3	2	1	2
124	3	2	68	1	1	1	3	3	4
125	3	2	68	1	3	3	3	3	4
126	3	2	69	1	2	3	3	3	3
127	3	2	69	1	2	3	3	1	2
128	3	2	70	1	2	3	3	4	4
129	3	2	71	1	2	3	3	2	2
130	3	2	71	1	2	3	2	3	3
131	.	.	.	.	.	.	.	.	.
132	.	.	.	.	.	.	.	.	.

	environ	health	magnet	measure	tech	rocks	water	reasons
103	3	3	4	3	5	2	3	13
104	5	2	5	3	2	1	3	35
105	5	2	4	3	5	2	2	1
106	2	2	4	2	3	3	1	125
107	1	2	5	3	4	3	2	135
108	2	2	4	3	1	3	3	3
109	1	2	5	1	5	5	2	5
110	2	1	3	3	5	2	1	5
111	3	2	4	3	2	4	3	345
112	2	4	4	2	3	2	2	235
113	2	2	3	2	5	4	1	3
114	1	1	3	3	5	4	1	15
115	3	3	2	2	2	4	3	13
116	3	2	1	3	4	5	1	35
117	1	1	2	3	4	5	4	35
118	1	1	4	2	3	2	2	1
119	3	2	4	4	5	5	1	3
120	1	1	2	5	5	4	2	123
121	3	1	3	2	4	5	4	13
122	3	1	2	5	3	2	2	1
123	3	2	1	2	3	1	3	3
124	3	2	4	3	5	3	1	135
125	3	2	3	4	5	3	1	135
126	2	2	4	3	4	5	4	1
127	1	2	4	3	4	4	3	13
128	3	2	2	2	2	3	1	13
129	3	2	5	1	4	2	2	13
130	4	2	5	1	2	2	3	13
131	.	.	.	.	.	.	.	.
132	.	.	.	.	.	.	.	.

APPENDIX Cv

MAIN QUESTIONNAIRE CODING FOR TEACHING STRATEGIES

	state	location	code	sex	qual	science	imaginat	enq_dis	probsolv	discuss	others
1	1	2	1	1	1	3	1	2	2	2	0
2	1	2	1	1	2	3	2	2	2	1	0
3	1	2	2	1	2	3	2	2	1	1	0
4	1	2	2	1	1	3	2	2	2	1	0
5	1	2	2	2	2	3	2	1	1	1	0
6	1	2	3	1	2	3	2	2	1	1	0
7	1	2	3	2	2	3	1	3	1	1	0
8	1	2	3	2	2	3	2	3	1	1	0
9	1	2	4	1	2	3	2	2	2	1	0
10	1	2	4	2	1	3	2	2	1	1	0
11	1	2	4	1	2	3	2	2	1	1	0
12	1	2	5	1	2	1	1	1	2	1	0
13	1	2	5	2	1	3	1	3	2	2	0
14	1	2	5	1	2	1	2	2	2	1	0
15	1	1	6	2	2	3	2	1	1	1	0
16	1	1	6	1	2	3	2	3	1	1	0
17	1	1	6	1	2	3	2	3	1	1	0
18	1	1	7	1	2	3	2	2	1	1	0
19	1	1	7	1	1	3	2	2	1	2	0
20	1	1	8	2	2	3	2	2	1	1	0
21	1	1	8	1	1	3	1	1	2	1	0
22	1	1	8	2	1	3	2	1	2	1	0

	state	location	code	sex	qual	science	imaginat	enq_dis	probsolv	discuss	others
23	1	1	9	2	1	3	2	3	1	1	0
24	1	1	9	1	1	3	1	3	1	1	0
25	2	2	10	2	2	3	2	2	2	2	0
26	2	2	10	2	2	2	2	2	2	1	0
27	2	2	11	2	2	1	2	2	2	1	0
28	2	2	12	1	2	2	2	2	2	1	0
29	2	2	13	2	2	2	2	2	1	1	0
30	2	2	14	2	1	1	2	2	2	1	0
31	2	2	15	2	2	1	2	3	2	2	0
32	2	2	16	1	2	2	1	3	1	1	0
33	2	2	17	2	3	1	1	3	2	1	0
34	2	2	18	2	2	2	2	2	2	1	0
35	2	2	19	1	1	1	2	2	2	1	0
36	2	2	20	2	1	2	2	2	1	1	0
37	2	2	21	2	2	1	2	2	2	1	0
38	2	2	22	2	2	1	1	2	2	1	0
39	2	2	23	2	1	1	2	2	1	1	0
40	2	2	24	2	2	1	2	2	1	2	0
41	2	2	25	2	1	1	2	2	2	1	0
42	2	1	26	1	2	3	2	1	2	1	0
43	2	1	27	1	1	3	2	2	3	2	0
44	2	1	28	1	1	3	1	1	1	1	0

	state	location	code	sex	qual	science	imaginat	enq_dis	probsolv	discuss	others
45	2	1	28	1	2	1	2	2	1	2	0
46	2	1	29	1	1	3	2	3	1	2	0
47	2	2	30	1	1	3	1	2	1	2	0
48	2	1	31	2	3	1	2	1	1	1	0
49	2	2	32	2	2	3	3	2	2	1	0
50	2	2	32	1	2	3	1	1	1	1	0
51	2	2	33	2	1	3	2	1	1	2	0
52	2	2	33	2	2	3	2	1	2	1	0
53	2	2	33	1	1	3	3	3	1	2	0
54	2	1	34	1	1	3	3	1	1	1	0
55	2	1	34	1	1	3	3	1	1	2	0
56	2	1	35	2	1	3	3	2	2	2	0
57	2	1	35	1	2	3	3	2	1	1	0
58	2	1	36	2	1	3	3	1	2	1	0
59	2	1	36	2	2	3	2	3	1	1	0
60	2	1	37	1	1	3	1	2	1	2	0
61	2	1	37	1	1	3	2	3	2	2	0
62	2	1	37	1	1	3	1	1	1	1	0
63	3	1	38	1	2	3	2	3	1	1	0
64	3	1	38	1	2	3	2	1	2	1	0
65	3	1	38	1	2	3	2	1	1	1	0
66	3	1	39	1	2	3	2	3	1	2	0

	state	location	code	sex	qual	science	imaginat	enq_dis	probsolv	discuss	others
67	3	1	39	1	1	1	1	2	1	1	0
68	3	1	39	1	1	3	2	1	1	2	0
69	3	1	40	1	3	3	2	2	1	1	0
70	3	1	40	2	1	3	2	2	2	1	0
71	3	1	41	1	2	3	1	2	1	1	0
72	3	1	41	2	2	3	3	1	1	1	0
73	3	1	42	2	2	3	3	1	1	1	0
74	3	1	42	1	2	2	3	2	1	1	0
75	3	1	43	1	2	3	1	2	1	1	0
76	3	1	43	2	2	1	2	2	2	1	0
77	3	1	43	1	2	3	1	2	1	1	0
78	3	1	44	1	1	2	1	2	2	1	0
79	3	1	44	2	2	3	3	2	2	1	0
80	3	1	45	1	2	3	1	1	2	1	0
81	3	1	45	1	1	3	2	1	1	2	0
82	3	1	46	1	2	3	2	1	2	1	0
83	3	1	46	1	2	3	2	2	1	1	0
84	3	1	47	1	2	3	2	2	1	1	0
85	3	1	47	1	2	3	3	1	1	2	0
86	3	1	47	1	2	2	2	2	1	1	0
87	3	1	48	1	2	1	3	1	1	1	0
88	3	1	48	1	2	3	3	3	3	2	0

	state	location	code	sex	qual	science	imaginat	enq_dis	probsolv	discuss	others
89	3	1	49	1	2	3	3	2	2	1	0
90	3	1	49	1	2	3	3	2	3	2	0
91	3	1	49	1	2	3	3	2	1	1	0
92	3	1	50	2	2	3	1	1	1	1	0
93	3	1	50	2	2	1	1	2	2	1	0
94	3	1	51	2	1	2	2	2	1	2	0
95	3	1	52	1	2	3	2	2	1	2	0
96	3	1	53	1	2	3	2	2	2	1	0
97	3	1	54	1	1	3	2	1	1	2	0
98	3	1	55	1	2	1	1	2	2	2	0
99	3	2	56	1	2	3	3	1	1	1	0
100	3	2	56	1	2	3	3	2	1	2	0
101	3	2	57	1	3	3	3	2	2	1	0
102	3	2	57	1	1	3	2	2	1	2	0
103	3	2	58	1	2	3	2	2	1	1	0
104	3	2	58	1	1	3	2	1	1	1	0
105	3	2	59	1	3	3	1	1	1	1	0
106	3	2	59	1	2	3	2	1	1	1	0
107	3	2	60	1	1	3	2	2	2	2	0
108	3	2	60	1	2	1	2	2	2	2	0
109	3	2	61	1	2	3	2	3	1	1	0
110	3	2	61	1	2	1	2	1	1	2	0

	state	location	code	sex	qual	science	imaginat	enq_dis	probsolv	discuss	others
111	3	2	62	1	2	3	3	2	2	2	0
112	3	2	62	1	2	3	3	2	2	1	0
113	3	2	63	2	1	1	2	2	2	1	0
114	3	2	63	1	2	3	1	2	1	1	0
115	3	2	64	1	2	1	2	1	2	1	0
116	3	2	64	1	3	1	3	2	1	1	0
117	3	2	65	1	3	1	1	1	2	1	0
118	3	2	65	1	3	3	3	2	1	1	0
119	3	2	66	1	2	3	2	1	2	2	0
120	3	2	66	1	3	3	2	2	1	1	0
121	3	2	66	1	3	1	3	1	1	1	0
122	3	2	67	2	1	1	3	2	2	1	0
123	3	2	67	1	1	3	3	2	1	1	0
124	3	2	68	1	1	1	3	1	1	1	0
125	3	2	68	1	3	3	3	1	1	1	0
126	3	2	69	1	2	3	3	2	2	1	0
127	3	2	69	1	2	3	1	1	1	1	0
128	3	2	70	1	2	3	2	1	1	1	0
129	3	2	71	1	2	3	2	1	1	1	0
130	3	2	71	1	2	3	3	1	1	2	0

APPENDIX Cvi

MAIN QUESTIONNAIRE CODING FOR ASSESSMENT STRATEGIES

	state	location	code	sex	qual	science	weektest	modul_ex	year_ex	drawing	oral_ex	others
1	1	2	1	1	1	3	1	2	1	3	2	0
2	1	2	1	1	2	3	1	2	1	2	2	0
3	1	2	2	1	2	3	1	2	1	3	2	0
4	1	2	2	1	1	3	1	3	1	3	2	0
5	1	2	2	2	2	3	1	2	2	3	2	0
6	1	2	3	1	2	3	1	1	1	3	3	0
7	1	2	3	2	2	3	1	3	1	3	3	0
8	1	2	3	2	2	3	1	2	1	2	2	0
9	1	2	4	1	2	3	2	3	1	2	3	0
10	1	2	4	2	1	3	1	1	2	3	3	0
11	1	2	4	1	2	3	1	2	1	2	3	0
12	1	2	5	1	2	1	1	2	1	3	3	0
13	1	2	5	2	1	3	1	2	1	2	3	0
14	1	2	5	1	2	1	1	2	1	1	3	0
15	1	1	6	2	2	3	1	1	1	3	3	0
16	1	1	6	1	2	3	2	2	1	2	3	0
17	1	1	6	1	2	3	1	1	1	2	1	0
18	1	1	7	1	2	3	1	2	1	2	3	0
19	1	1	7	1	1	3	1	2	1	3	3	0
20	1	1	8	2	2	3	2	2	1	2	3	0
21	1	1	8	1	1	3	1	2	1	1	3	0
22	1	1	8	2	1	3	1	2	1	3	3	0

	state	location	code	sex	qual	science	weektest	modul_ex	year_ex	drawing	oral_ex	others
23	1	1	9	2	1	3	1	2	2	2	3	0
24	1	1	9	1	1	3	1	2	1	2	1	0
25	2	2	10	2	2	3	2	2	1	2	2	0
26	2	2	10	2	2	2	1	1	1	2	1	0
27	2	2	11	2	2	1	1	2	1	2	2	0
28	2	2	12	1	2	2	1	2	1	2	2	0
29	2	2	13	2	2	2	1	1	1	1	2	0
30	2	2	14	2	1	1	1	2	1	3	1	0
31	2	2	15	2	2	1	1	2	1	2	2	0
32	2	2	16	1	2	2	1	2	1	1	2	0
33	2	2	17	2	3	1	1	1	1	3	2	0
34	2	2	18	2	2	2	1	1	1	3	3	0
35	2	2	19	1	1	1	1	1	1	1	3	0
36	2	2	20	2	1	2	1	2	1	1	3	0
37	2	2	21	2	2	1	1	2	1	2	2	0
38	2	2	22	2	2	1	1	1	1	2	3	0
39	2	2	23	2	1	1	1	2	1	2	3	0
40	2	2	24	2	2	1	1	1	1	2	3	0
41	2	2	25	2	1	1	1	1	1	2	1	0
42	2	1	26	1	2	3	1	2	1	2	3	0
43	2	1	27	1	1	3	2	2	1	2	3	0
44	2	1	28	1	1	3	1	1	1	1	3	0

	state	location	code	sex	qual	science	weektest	modul_ex	year_ex	drawing	oral_ex	others
45	2	1	28	1	2	1	1	1	2	2	3	0
46	2	1	29	1	1	3	2	2	1	2	3	0
47	2	2	30	1	1	3	1	1	1	3	3	0
48	2	1	31	2	3	1	2	3	2	3	3	0
49	2	2	32	2	2	3	1	1	1	3	2	0
50	2	2	32	1	2	3	1	1	1	3	3	0
51	2	2	33	2	1	3	1	2	1	2	3	0
52	2	2	33	2	2	3	1	2	1	1	3	0
53	2	2	33	1	1	3	1	2	1	2	3	0
54	2	1	34	1	1	3	2	2	1	1	3	0
55	2	1	34	1	1	3	1	1	1	3	3	0
56	2	1	35	2	1	3	1	2	1	3	3	0
57	2	1	35	1	2	3	1	3	1	3	2	0
58	2	1	36	2	1	3	1	3	1	3	3	0
59	2	1	36	2	2	3	1	3	1	3	2	0
60	2	1	37	1	1	3	1	1	1	1	2	0
61	2	1	37	1	1	3	1	2	1	3	3	0
62	2	1	37	1	1	3	1	2	1	1	3	0
63	3	1	38	1	2	3	1	2	1	3	2	0
64	3	1	38	1	2	3	2	2	1	3	1	0
65	3	1	38	1	2	3	1	1	1	3	3	0
66	3	1	39	1	2	3	2	2	2	2	1	0

	state	location	code	sex	quai	science	weektest	modul_ex	year_ex	drawing	oral_ex	others
67	3	1	39	1	1	1	1	2	2	2	3	0
68	3	1	39	1	1	3	1	2	1	2	2	0
69	3	1	40	1	3	3	1	1	1	2	3	0
70	3	1	40	2	1	3	1	1	1	1	3	0
71	3	1	41	1	2	3	1	2	1	3	2	0
72	3	1	41	2	2	3	1	2	1	3	1	0
73	3	1	42	2	2	3	2	2	1	1	3	0
74	3	1	42	1	2	2	1	2	1	1	3	0
75	3	1	43	1	2	3	1	1	1	3	3	0
76	3	1	43	2	2	1	1	2	1	3	3	0
77	3	1	43	1	2	3	1	1	1	3	2	0
78	3	1	44	1	1	2	1	3	1	2	2	0
79	3	1	44	2	2	3	1	1	1	1	3	0
80	3	1	45	1	2	3	2	3	1	2	2	0
81	3	1	45	1	1	3	2	3	1	2	3	0
82	3	1	46	1	2	3	1	1	1	1	2	0
83	3	1	46	1	2	3	1	3	1	2	3	0
84	3	1	47	1	2	3	1	3	1	2	2	0
85	3	1	47	1	2	3	1	2	1	3	3	0
86	3	1	47	1	2	2	1	1	1	3	2	0
87	3	1	48	1	2	1	1	2	2	3	2	0
88	3	1	48	1	2	3	1	1	1	1	3	0

	state	location	code	sex	qual	science	weektest	modul_ex	year_ex	drawing	oral_ex	others
89	3	1	49	1	2	3	2	2	2	3	3	0
90	3	1	49	1	2	3	1	1	1	1	3	0
91	3	1	49	1	2	3	1	3	1	3	3	0
92	3	1	50	2	2	3	1	3	1	2	3	0
93	3	1	50	2	2	1	1	3	1	2	3	0
94	3	1	51	2	1	2	2	1	1	2	3	0
95	3	1	52	1	2	3	1	2	2	2	3	0
96	3	1	53	1	2	3	1	2	1	2	3	0
97	3	1	54	1	1	3	1	1	1	2	3	0
98	3	1	55	1	2	1	2	2	1	1	2	0
99	3	2	56	1	2	3	1	1	1	3	2	0
100	3	2	56	1	2	3	1	1	1	2	2	0
101	3	2	57	1	3	3	1	2	2	1	2	0
102	3	2	57	1	1	3	2	1	2	2	2	0
103	3	2	58	1	2	3	1	1	1	3	2	0
104	3	2	58	1	1	3	1	2	1	1	1	0
105	3	2	59	1	3	3	1	1	1	3	2	0
106	3	2	59	1	2	3	1	1	1	3	1	0
107	3	2	60	1	1	3	2	2	1	1	2	0
108	3	2	60	1	2	1	1	2	1	2	2	0
109	3	2	61	1	2	3	1	2	1	3	2	0
110	3	2	61	1	2	1	1	2	1	3	1	0

	state	location	code	sex	qual	science	weektest	modul_ex	year_ex	drawing	oral_ex	others
111	3	2	62	1	2	3	1	2	1	2	2	0
112	3	2	62	1	2	3	1	2	1	3	2	0
113	3	2	63	2	1	1	1	2	1	1	2	0
114	3	2	63	1	2	3	1	2	1	3	1	0
115	3	2	64	1	2	1	1	2	1	2	2	0
116	3	2	64	1	3	1	1	2	1	3	2	0
117	3	2	65	1	3	1	1	2	1	2	2	0
118	3	2	65	1	3	3	1	2	1	1	1	0
119	3	2	66	1	2	3	2	2	2	2	3	0
120	3	2	66	1	3	3	1	1	1	3	2	0
121	3	2	66	1	3	1	1	1	1	3	1	0
122	3	2	67	2	1	1	1	1	1	3	2	0
123	3	2	67	1	1	3	1	2	3	1	2	0
124	3	2	68	1	1	1	1	1	1	2	2	0
125	3	2	68	1	3	3	1	1	1	3	1	0
126	3	2	69	1	2	3	1	2	1	2	2	0
127	3	2	69	1	2	3	1	2	1	2	1	0
128	3	2	70	1	2	3	2	1	1	2	2	0
129	3	2	71	1	2	3	1	1	1	2	2	0
130	3	2	71	1	2	3	1	2	1	3	2	0

APPENDIX Cvii

Interpretation of the coding of the teachers' questionnaire.

Teachers' Questionnaire on background information, difficult topic, and reasons given.

As indicated above, the columns (in Appendices Ci and Cvi) are used to denote the variables. These variables have been assigned codes or names or numbers in the computer as follows:
'State': State of origin of the school. (state is coded as follows: 1 means Plateau; 2 means Kaduna; 3 means Anambra)

'Location' means the location of school: (location is coded as follows : 1 means rural ; 2 means urban).
'Code': School Code: (Each school is given a serial number n, ; where n is an integer 1, 2, 3...etc.). integers)
'Sex' means the Sex of the teachers (sex is coded as follows: 1 means female, 2 means male).
'Qual' means the Highest academic qualification of teachers (qualification is coded as follow: 1means Grade II Certificate holder; 2 means NCE holder; 3 means B.Ed holder.).
'Science' means the Background training or experience of the teachers in science (background in science is coded as for in-service training in science, 3 means None or no background at all). 1 means Yes, through TTC Certificate/higher, 2 means Yes, through in-service, 3 means none or no background at all.

The primary science core curriculum topics and the levels of difficulty found by teachers in their teaching of topics were also coded as follows:
'Animals' means Animals
'earth' means Earth and sky
'environ' means Environment
'health' means Health and Safety.
'magnet' means Magnet
'measure' means Measurement
'tech' means Modelling and Relevant technology.
'rocks' means Rocks and Minerals.
'water' means Water.

The level of ranking of difficulty of teaching the above topics which represents the characteristics of the above variable (science topic) were computer coded as follows:
5 means most difficult to teach.
4 means difficult to teach
3 means neither easy nor difficult to teach.
2 means easy to teach.
1 means quite easy to teach.

The reasons for the choice of a particular topic as being most difficult to teach were also coded as follows:
1 means the ideas are difficult to conceptualise.
2 means textbook language was found complex.
3 means the resources available for teaching a particular topic are insufficient.
4 means the set objectives are inappropriate to the age of the pupils (too abstract).
5 means teachers lacked practical skills that would have been required while in training.
6 = Any other reason.

Questionnaire on teaching strategies

As in the previous cases, the columns in Appendixes Cii and Cv denote variables and have been assigned computer codes as shown in the previous section. Background information on the teachers remain same as in the difficult topic.

In the case of the methods of teaching primary science, the methods have been coded as follows.
'imaginat' = Use of imagination.

'enq_dis' means teaching by enquiry and discovery (deductive)
'probsolv' means teaching through problem solving (Analytic)
'discuss' means discussion with pupils.
'others' means any other method of teaching other than above. Others.

The frequency of use of the above teaching methods , represent the characteristics of the above variable (teaching strategies) and is coded as follows:

1 means that the method was used *always*.
2 means that the method was used sometimes
3 means that the method was *never* used.

Questionnaire on the assessment of pupils' learning outcomes in primary science.
Here again, (Appendixes Ciii and Cvi) the column are used to denote variables. These variables have been assigned computer codes previous for background information of the teachers.
In the case of the methods of assessment of the pupils work in primary science.
Methods have been assigned the following computer codes;
'weektest' means Weekly test
'modul_ex' means end of module examination.
'year_ex' means end of year written examination.
'drawing' means drawing test
'oral_ex' means oral examination.
'others' means other methods other than above..

b) The frequency of tests which represents a characteristic of the above variable (Method of assessment) were computer coded as follows:.
1 means always.
2 means sometimes.
3 means never.

APPENDIX Cvii.

LIST OF SCHOOLS USED FOR THE SURVEY.

Anambra	Local Govt	Location	School Code
	Anambra	Rural	38
	Anambra	Rural	39
	Anaocha	Rural	40
	Anaocha	Rural	50
	Aguta	Rural	41
	Aguta	Rural	42
	Aguta	Rural	43
	Idemmili	Rural	44
	Idemmili	Rural	45
	,, ,,	,, ,,	62 63
	Njikoka	Rural	46
	Njikoka	Rural	49
	,,	Rural	52
	Orumba	Rural	47
	Orumba	,,	48
	,,	,,	55
	Oyi	,,	51
	,,	,,	53
	,,	,,	54
	,,	,,	56
	Awka	Urban	64
	,,	,,	65
	,,	,,	66
	,,	,,	67
	,, ,,	,, ,,	60 70
	Nnewi	,,	58
	,,	,,	61
	,,	,,	69
	Onitsha	,,	68
	,,	,,	57
	,,	,,	59
	,,	,,	71
Kaduna	Kaduna	Urban	11
	,,	,,	22
	,,	,,	12
	,,	,,	25
	,,	,,	10
	,,	,,	14
	,,	,,	21
	,,	,,	15
	,,	,,	16
	,,	,,	18
	,,	,,	19
	,,	,,	20

	,,	,,	23
	,,	,,	24
	,,	,,	17 13
	Rural	Rural	33
	,,	,,	28
	,,	,,	29
	,,	,,	30
	,,	,,	31
	Urban	urban	32
	Rural	rural	26
	,,	,,	27
	Urban	urban	34
	urban	urban	35
	,,	,	36
	,,	,,	37
Plateau	Jos	Urban	1
	,,	,,	2
	,,	,,	3
	,,	,,	4
	,,	,,	5
	Rural	R ural	6
	,,	,,	7
	,,	,,	8
	,,	,,	9

APPENDIX D
SUPPLEMENTARY QUESTIONNAIRE

Dear Colleague,

Thank you so much for completing the questionnaire on teaching science to primary six pupils last december/january. I have now analysed the responses. From the result of the analysis , it appears that the areas of the core curriculum content which most teachers find difficult to teach and the area which most pupils find difficult to understand are:-

a. modelling and relevant technology

b. magnetism

I should be grateful if you could give me a little more information about why you think technology and magnetism may be difficult to teach and for pupils to learn. If you did not complete the last questionnaire and your perception is different, please feel free to give your opinion.

The information which you will provide on this questionnaire will enable me to develop the next stage of this research which will be to develop support materials and inservice training programme which I hope will help you and other of our colleages to overcome these difficulties.

Attached herewith is a copy of a questionnaire and some statements about magnetism and technology for your reaction. Remember that this questionnaire is not intended to test your knowledge on these concepts but to help in identifying the area where help is most needed.

I still promise to give you feedback on the analysis of this questionnaire and general information on any arrangement made about the inservice training programme. I also want to assure you that any information given should be used for the purpose of this research and will be regarded as highly confidential.

Remember that your sincere and honest response will help in promoting primary science education in the country as a whole.

Thanking you for your usual maximum cooperation!

Yours Faithfully,

Cordelia Anosike (Mrs)

SECTION A:

BACKGROUND INFORMATION

1. Did you complete the first questionnaire in Dec-Jan 199

Yes ☐ No ☐

2 Name of your school.. ....

....

3. Number of years of experience in teaching.

0-4yrs ☐ 5-9yrs ☐ 10yrs ☐

4. Sex: Male ☐ Female ☐

5. Academic qualification:

Grade 11 ☐ Grade 1 ☐ N. ☐

Grade 11 + N.C.E. ☐ Grade11 + B.Ed

Grade 11 + N.C.E. + B.Ed ☐ Others........ (tick as app)

6. Where is your school located?

Rural ☐ Urban ☐ (tick as applicable)

7. Have you been on inservice in science before?

Yes ☐ No ☐

SECTION B:

TEACHING AND LEARNING PRIMARY SCIENCE CONCEPTS.

Please tick from the options provided, the best that describes your view about the problems facing the teaching and learning of Relevant technology and magnetism in the primary schools. You can choose more than one options.

8. Technology is difficult to teach because,

a. the ideas are difficult to conceptualize

b. the language used in the textbooks is complex

c. the resources available for teaching the concepts are not sufficient.

d.the objectives set out for the pupils are not suitable for their age.

e. materials to be learnt are not relevant to the child's need.

f.lack of practical skill during your training.

g others..

....

....

....

....

9. What areas of the technology do you think pupils find interesting?

....

....

....

....

....

10. Why do you think they find the area(s) interesting?

....

....

....

....

....

11. Magnetism is difficult to teach because,

a. ideas/concepts are diffcult .

b. the language used in the textbooks is complex

c. the resourses available in teaching the concepts are not sufficient

d. the objectives set out for the pupils are not suitable for their age

e. materials to be learnt are not relevant to the child's need.

f. others..

....

....

12. What area(s) of the magnetism do pupils find interesting?

....

....

....

....

....

Thank you once more for your cooperation!

APPENDIX E

The summary of the 2-day workshop design.

Time	Topic	Group Size	Activities	Purpose	Materials
9.00-9.30	CEO's Address.	Normal	Address from the Chief Education Officer to the workshopparticipants	To enforce the participants on the need and value of the workshop as well as what is expected of them and the the benefits they expect to get from the workshop.	Video recorded.
	Familiasation of one another. How is science taught in schools	3 or 4	Discussion in their various groups about their school, Headteacher's attitude to science, pupils' attitude to science ,materials used for science teaching, time allocated to science teaching, Strategies used for science teaching. A member of the group presented the group's discussion to the entire class.	This was planned to enable the participants to familiarise themselves with each other and also to enable them to know what goes on in other primary schools in Anambra State as regards science teaching and learning.	Paper and pen.
10- 10.30		Individual work as they remain in their various groups.	Administration of the 'Magnetism Story'.	To check how the participants make sense of certain concepts of magnetism as well as to find out how much the participantsare comfortable with organising practical investigations in Magnetism in their respective classroom.	'Magnetism Story' Pen and Pencil.
10-30-11.00am	**Tea Break**	**Tea Break**	**Tea Break**	**Tea Break**	**Tea Break**

11.00-12.30 am	Introduction to **Concept Mapping**	3 or 4 Researcher as the teacher.	Brainstorming. Use words provided by the researcher to produce concept maps making meaningful linking of the words/concepts provided . Also, choose ten different words or concept terms on Magnetism and map them using proper linking words.	The first exercise is to introduce the participants to concept mapping. The second exercise will enable the workshop coordinator to find out how much meaningful linkages the teachers can make using Magnetism and its concept terms. This is to be done in groups as well as individually.	Brainstorming words provided, each group having ten concepts each to map. Paper , pen, and pencil.
12.30-1.00pm.		3 or 4	Display each groups concept map on the Blackboard for others to see.	To criticise individual groups' concept map displayed.	Paper ,pen and concept maps.
1.00-2.00pm	**Lunch Break**	**Lunch Break**	**Lunch Break**	**Lunch Break**	**Lunch Break**
2.00 - 3.00pm.	**'Ask the Object'**	3 or 4	Raise as many questions as possible. Classify these question and apply any type of classification considered helpful	To find out the type of questions teachers ask in their primary science lessons. If teachers classify their own questions, they may start to realise the type of questions they tend to raise often in their science lesson. This may enable them change their mode of questioning.	Paper and pen.
3.00-3.30 pm.			One member of the group present their work to the entire class.	To enable members from all the groups hear their views particular views of the participants.	
3.30-3.45 pm			Coordinator make some annoucements for the next day's work and thank the participants for their cooperation.		

Second Day					
9.00-10.00 am	Display individual maps.	3or 4	To criticise each groups' concept map and to point out any misconceptions identified.	To see if theparticipants are able to make constructive criticism of their own concept maps	, paper and pen.
10.00-10.30 am.		3 or 4	Discussion with all the class.		
10.30-11.00 am.	**Tea Break**	**Tea Break**	**Tea Break**	**Tea Break**	**Tea Break**
11.00-1.30	Activities with magnet.	3 or 4	There are 6 activities on magnet provided. Each activity is marked. The groups are expected to move from one activity to the other. Any group can start with any activity except activity 6. Participants are advised to do activity 6 as their last activity. Participants are not expected to spend move than 30 mins on each activities. Instruction regarding the execution of the activities are handed out to participants should be read and the activities carried out following the instructions provided. o	These activities are planned to help expose the teachers to some important activities on Magnetism which they are to use with their children in their science lessons. Each of the activities should enable the participants to ask questions and to plan activities or investigation designed to answer some of the questions raised. It is expected that after these activities the teachers should be able to answer some of the questions raised on the 'Magnetism Story'	Bar magnet, Horse-shoe magnets, Round magnets, Cylindrical Magnets, Other pieces of magnets, Iron filings, Plain papers, paper clips, needles, corks, 'Magnetism Game board'
1.30-2.30	**Lunch Break**	**Lunch Break**	**Lunch Break**	**Lunch Break**	**Lunch Break**
2.30-3-15pm		3 or 4	In your individual groups say what you think that you have gained from the workshop. Draw another concept map for your group.	To check if the teachers have achieved what they planned to achieve when attending the workshop.	

3.15-4.15pm		Individually	Completion of another magnetism story plus individually draw another concept map on Magnetism.	To find out if there is any difference between the first and the second 'Story' completed, or Maps drawn	

APPENDIX Ei

Examples of the 2-day workshop outcomes

Examples of questions raised by different groups of teachers on the 'Ask the Object' Activity and their classifications:

GROUP I:

1. Who discovered the magnet?
2. What made him to discover it?
3. What is a magnet?
4. What objects are attracted to the magnet?
5. What makes an object a magnet?
6. What is a magnet used for?
7. How can magnet be made?
8. Why does a magnet repel some object and attract some?
9. How can a magnet loose its magnetic properties?

Classified into:

A.. Straight forward questions:
What is a magnet?
Who discovered the magnet?

B. Questions that can be answered by asking the Authority:
Who discovered the magnet?
What made him to discover the magnet?
What is a magnet made of?

C. Questions that can lead to Investigation:
What objects does a magnet attract to?
What makes an object a magnet?
What are magnets used for?
How can a magnet be made?
Why does a magnet repel some object and attract some?
How can a magnet loose its magnetic properties?

GROUP 8:

Questions that can be answered immediately	Through Practical means	From Textbooks.
- What does a magnet look like? - What is the colour? -Can magnets be domestically used ? - Do all magnets have the same shape?	How do we identify North and South Poles?	- What is a magnet? - What is it made of? - Why does it attract certain things and repel certain things? - Why is N and N poles and S and S poles repel each other? - How do we identify N and S poles? - Can magnet be manufactured or is it natural? - Is it a mineral in the soil? - What is magnetic field, Force or Pull? - What are the properties of a magnet? - What are the uses of magnet ? - What is magnetic induction?

Group 11

Questions that can be answered through Investigations	Questions that can be answered through textbook or authority	Straight forward answers required
1. What is magnet made of?	Who produced the first magnet?	What are the qualities of those objects that are magnetic?
2. Are there other uses of magnet other than attraction ?	Where do magnets get their force?	
3 Why are some magnets more powerful than others?		
4. Can a magnet attract in water?		
5. Why do magnets repel?		
6. How are N and S poles detected?		
7. How can one produce a magnet?		

BENEFIT OF THE WORKSHOP.

GROUP 1

From the series of activities carried out magnetism, we realised that science is discovery and should be done through a playway method. We discovered a lot of things on magnetism which we never knew e.g. that magnet does not attract gold eventhough gold is a metal. This way of teaching help children to learn in a more relaxed manner and have positive attitude towards science.

With a strong magnet, repulsion could be felt by playing with the magnets and this will help the children understand the concept terms easily.

The strategies which were introduced e.g. concept mapping , 'Ask the Object', Magnetism Game are found to be ways of making science teaching and learning interesting. Concept Mapping , for instance can be used to check the starting point of the child as well as find out any misconceptions before and after teaching the topic. It could be used in any subject area and can also be used for assessment of the learning outcomes.

'Ask the Object' enable the teachers to know what the child wants to know so that you can start with what the child likes to learn in introducing the lesson. Concept mapping can be used to teach other subject areas and also in assessment of learning outcomes.

GROUP 5.

One of the things we acquired during this workshop was that, most of the time we blame lack of science materials to the teaching of primary science. We noticed that the researcher has used only materials found in Nigeria e.g. Cardboard papers, pen and pencils, magnets of different shapes and sizes, compasses needle.

1 .Most of the time we think that science equipment must be from overseas, but the researcher has shown us that we can teach science with the materials we have.

2. It is very important and help in retention when we learn through the playway method e.g. the Magnetism Game.

3. It is very necessary that the State Education Commission organize this type of workshop for the teachers to train teachers who do not have the skill during training and update the ones who had the practical experience during their training. Majority of the teachers in the primary school do not have any form of training in the area of science and that is why they teach science is a way they understand it.

4. We worked as a group and learnt from each other.

5. The strategies learnt could help us in teaching science and other subjects to our pupils to make it interesting and help them retain what has been learnt.

GROUP 8

-The workshop created rooms for exchanging views concerning teaching of science in different schools.

- It helps each teacher to point out areas of weakness in their individual schools.
- It exposed us to identifying method of teaching science and other subjects to the primary school pupils.
- With the teaching of concept mapping, we found out that things can be associated in so many ways with different concepts.
- Playing the magnetism game helps us to check what was not quite understood when we carried out the activities.
- We were exposed to several activities that can be done with magnet.
- It exposes to certain science materials which we hear but never saw. e.g. compass.
- 'Ask the Object ' strategy was good and helped us to know what the children will like to know and start from that. It will encourage the children to ask questions in the classroom.

-The idea of group work was encouraged.

- We suggest that this type of workshop should be organised for other topics in science to help the teachers improve in the teaching of science in their classroom.
- The workshop does not provide only the skill but also the knowledge on the topic.
- We suggest that this type of workshop be included in the school curriculum for training primary teachers in Nigeria.

Group 11

1. It exposed the participants to other strategies that can make the teaching of science easy and interesting. e.g. magnetism game.

The strategies can be used in other topics in science as well as in teaching other subjects.

The opportunity of reading through many textbooks in primary science was good as this provides the teachers opportunity to read through and choose the text that best treats a particular topic in science better. The idea of using one text book all the time for all the topics in the curriculum is not advisable, because sometimes some of the textbooks do not treat all topics in depth.

The workshop provided the participants opportunity to carry out some investigations on magnetism which in most cases was their first time of carrying such investigations.

The workshop provided strategies to evaluate or assess learning outcomes in science which the 'magnetism game' and concept mapping can say to have provided.

The 'ask the object' strategy is an interesting way to introduce science topics as the method will enable the child to ask questions on the topic to be treated and this enables the teacher to know what the child wants to know about the topic and start from there to teach the child.

We therefore recommend that this type of workshop should be done or organise for the other colleagues to benefit from. This can be done at the state level as well as at the local government level.

This type of workshop should be organise on other topic.

APPENDIX Eii

LIST OF TEACHERS AND SCHOOLS USED FOR WORKSHOP.

Tr code	Location	Qualification	yrs. of Exp	Name of School	L.G.A.
1	U	3	3	Community P/S Umuokpu Awka	Awka South
2	U	3	3	Udeozo Memorial P/S Amawbia.	„
3	U	3	3	Central School Amawbia	„
4	U	3	3	Achalla Rd. P/S., Awka.	„
5	U	3	3	Amaenyi Comm. Sch. Awka.	„
6	U	2	3	Amaenyi Comm. Sch. Awka	„
7	U	2	3	Achalla Rd. P.S. Awka..	„
8	U	2	3	Central School, Amawbia	„
9	R	2	3	Union P/S. Nibo.	„
10	R	2	2	Union P/S. Nibo.	„
11	U	2	3	Udeozo Memorial P/S. Awka.	„
12	U	2	3	Udoka P/S. Awka	„
13	U	2	3	Community P/S, Umuokpu Awka.	
14	R	2	1	Central Sch. Isuofia	Aguata
15	U	2	2	Central Sch., Awka.	Awka South
16	U	3	3	Practising Sch. Agulu.	Anaocha
17	U	3	3	Practising Sch. Awka.	Awka South
18	U	2	3	Comm. P/S. Enugwu-Ukwu.	Njikoka
19	U	2	3	Amamife P/S. Awka.	Awka South.
20	R	2	3	Central Sch. Igbo Ukwu	Aguata
21	R	2	1	Ojiako Memorial P/S, Adazi-Nnukwu	Anaocha
22	U	2	3	Ozalla P/S, Abagana.	Njikoka
23	R	2	3	Central Sch. Ekwulobia	Aguata
24	R	3	2	Comm.P/S, Agulu	Anaocha
25	U	2	2	Ezi-Awka P/S, Awka	Awka South
26	U	3	3	Ezinato National Sch., Awka.	Awka South
27	R	3	3	Comm. Sch. Ekwulobia.	Aguata
28	R	2	3	Union P/S, Adazi-Nnukwu	Anaocha
29	U	2	3	Ojiako P/S, Nawfia	Njikoka
30	U	2	3	Central School, Abagana.	Njikoka
31	R	3	3	Unity P/S, Okpokolo- Amichi	Nnewi South
32	U	2	1	Model P/S, Nkwo Nnewi	Nnewi South
33	R	2	3	Central School, Nnobi	Idemili
34	U	1	2	Nupe Square P/S, Fegge-Onitsha.	Onitsha South
35	R	3	3	Community P/S, Awka Etiti.	Idemili.
36	R	2	3	Union P/S, Awka Etiti	Idemili
37	U	2	3	Agai P/S, Fegge Onitsha.	Onitsha South
38	U	1	1	Central School, Onitsha.	Onitsha South
39	R	2	3	Community P/S, Ichi.	Nnewi North

40	U	3	3	Central School, Odakpu Onitsha.	Onitsha South
41	R	1	1	Ebenesi P/S, Nnobi	Idemili
42	R	2	3	Union P/S, Awka Ekiti	Idemili
43	R	2	3	Central School, Nnobi	Idemili
44	U	2	3	Fegge 1 Comm. P/S. Onitsha	Onitsha South.
45	U	2	3	Ugbommili P/S 1,Fegge Onitsha.	Onitsha South
46	R	2	2	Central School, Ukpor	Nnewi South.
47	U	2	2	Umudim Central Schl, Nnewi.	Nnewi South
48	R	3	3	Unity P/S, Ukpor.	Nnewi South
49	U	3	3	Okwuani Central Sch., Nnewi.	Nnewi north.
50	R	2	3	Comm. Central Sch., Amichi.	Nnewi South

APPENDIX Eiii
LETTER OF PERMISSION TO LGEAs TO CARRY OUT THE STUDY

Department of Science
Education
Institute of Education
University of London
20 Bedford Way
London.WC1 HOAL

Deputy Director of Education
Anaocha Local Government Education
Authority. Neni.

Dear Sir/Madam,

Permission to carry out a workshop for teachers in your Local Government Area.

I am currently undertaking a research work on teaching and learning of primary science topics at the Institute of Education, University of London. From the analysis of previous surveys carried out in three different States namely, Anambra, Kaduna and Plateau in December 1992 and May/July 1994, primary six teachers and their pupils identified Magnetism and Relevant Technology as the most problematic topics for them (teachers) to teach and for their pupils to learn. These teachers had also blamed their inability to teach these science topics confidently as a result of their poor background in the course content as well as the lack of resource materials to teach them.

Based on the above outcomes, several strategies and materials have been suggested and prepared by the researcher in the United Kingdom to assist teachers and pupils in teaching and learning the topic Magnetism. These materials and strategies could easily be used in teaching not only magnetism but also other topics in primary science.

In the light of the above suggestions made by the researcher, it will be necessary to organise series of in-service workshops for primary teachers within the state. The in-service workshops involve the initial 2-day workshop for teachers, and a follow-up of the teachers after the workshop for sometime. The follow-up exercise will involve the researcher working with the teachers in their various schools to help (where necessary) in the implementation of the strategies and materials learnt during the workshop. Another workshop will be organised to enable the teachers come together again to reflect on the outcomes of the new materials and strategies being implemented. It may be necessary to revisit the teachers again after a period of three months and find out what impact the new strategies have made in the teaching and learning of science as a whole.
I plan that the whole exercise will take at least a period of six months since it involves training.

Since I can not cope with all the primary school teachers in the state, I have decided to select a few teachers within eight out of the sixteen local government areas of Anambra State of which yours is one of them to try out the materials developed. I need four teachers from different schools within your local Government Area to attend the workshops.

I do not need to over-emphasize the benefit of these materials and strategies as their acquisition would enable the primary teachers not only to teach primary science confidently but at the same time make them (teachers) and their pupils learn Magnetism concepts in a way that will enhance better understanding and help the teachers to allow children participate during the learning process. It is also hoped that the teachers who attended the workshop be used in training other teachers within their schools on magnetism.

I therefore ask your permission to carry out the workshops and also request for your assistance in selecting the schools that would be involved in the workshops bearing in mind the school location to the various workshop centres. Because these workshops involve teachers from different parts of Anambra State, Government Technical College, Awka and Model Primary School, Nnewi have been chosen as centres for the workshops.

Below is the list of Local Government Areas chosen randomly. These are:
Awka South Local Government Area; Anaocha LGA; Onitsha south LGA
Nnewi North LGA; Nnewi South LGA; Idemili LGA
Njikoka LGA; Aguta LGA.

Your urgent attention to the above request is highly needed since I have limited time to carry out this project.
Attached herewith is the 2-day workshop programme.

Thanking you in anticipation of your usual maximum co-operation.

Yours Faithfully,
Cordelia Anosike (Mrs)

APPENDIX Eiv
Summary of workshop cost

Phases of the research investigation	**Purpose of each phase**	**Total sum used to run the phase**
Phase One	First visit to all workshop participants before the 2-day workshop	N4,000
Phase Two	Running the 2-day workshop programme. This includes the materials for workshop activities as well as teachers' and co-ordinator's transport fares.	N23,450
Phase Three	Follow-up visits to workshop participated teachers by the co-ordinator for support.	N4,000
Phase Four	Running of the 1-day workshop for participated teachers for reflection on practice.	N9,095
Phase Five	Three months (after 1-day workshop) visit to the participated teachers for extra support by the co-ordinator.	N4,000
Accommodation (Co-ordinator) for 9 months at N1,000 per month -	This includes hotel lodging as the co-ordinator was not residing in Anambra State.	N9,000
Co-ordinator's transport to Nigeria and back		N80.000.00
GRAND TOTAL		N133,545.0

APPENDIX Ev.

LIST OF BOOKS USED FOR THE WORKSHOPS.

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24. Steve Fields (1987): "The measure of the Magnet" Science and Child. V25, no 3, p12-13. Nov-Dec.

25. Lloyd H. Barrow (1990): "Ceramic Magnets Pass The Bar."
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28. Science Support Group: A pack which was developed by a group of Teachers to help other colleagues to teach some topics in Science. One of the Authors is Angela Trend.

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APPENDIX F.
The summary of the 1-day workshop design.

Time	Topic	Group size	Activities	Purpose	Materials
9.00-9.30 am.	Plenary discussions on the use of the strategies in the science lessons	Same as in 2-day workshop. i.e. 3-4 teachers in a group.	Discussion in their groups about the introduction of the new strategies in their lessons, to their colleagues. Also, discuss the problems encountered and the way they handled the problems.	To enable the teachers to discuss and share their experiences with other of their colleagues.	Paper and pencils.
9.30-10.30 am.	Discussion on the pupils' concept maps.	Same as above.	Discuss the concept maps of children on magnetism in their groups. The concept maps from children which will be collected before and after the teaching of magnetism will be used for this exercise. The teachers will study the maps and identify patterns in terms of how maps are related, any misconception(s) observed, etc.	This is to help the teachers to begin to appreciate the concept maps in their science lesson. This exercise will help the teachers to identify the ideas children hold about magnetism concepts.	Pupils' concept maps.
10.30-11.00am.	Tea break				

11.00-1.00	Planning of practical activities on any topic of their choice.	Same	Teachers are expected to choose a topic of their choice and develop practical activities to teach the topic. The teachers are advised to start their discussions on this exercise by raising productive questions on the topic. Out of these questions raised, the teachers can plan practical activities to find answers to the questions raised. The teachers are expected to show the materials needed to carry out the practical activities which they planned.	This exercise is to help the teachers to develop more on the skills of planning activities on other topics in their science curriculum. This is a way that the learnt skills from the magnetism could be transferred to other topics in science curriculum.	Primary science textbooks and any other resource book(s) relevant to their plan. Paper and pencils.
2.00-3.30pm.	Planning the story that will help in ascertaining the understanding of the planned activities.	Same as above.	In this activity, the teachers are expected to develop a tool to help them in ascertaining the understanding of the individuals who will carry out the activities which they planned above. The teachers are to plan the activity similar to that of the 'magnetism' story which would be used on them during the 2-day workshop.	This activity is to help the teachers to develop the skills of planning activities and also assessing the understanding of their pupils in the planned activities.	Resource books. Paper and pencils.
3.30-4.15 pm.	Discussion of the benefit of the workshop	Same as above	Teachers are expected to discuss in their groups what they think they gained in the workshop.	This will help the teachers to identify what they think they gained from the workshop. It is also meant to provide to the teachers opportunity to reflect in their practice.	

APPENDIX Fi.
Examples of 1-day workshop (Reflection workshop) outcomes.

RESPONSES FROM TEACHERS IN DIFFERENT GROUPS.

HEAD TEACHERS VIEW.
GROUP 1

In our schools all the head-teachers have accepted the teaching strategies. They all insisted that the strategies should be taught to other teachers for classroom teaching. We organised other colleagues and taught them the strategies which only the senior classes agreed to try them. They all liked the strategies.

OUR PERSONAL & OUR COLLEAGUES VIEWS
ii & iii:-The teachers' views about the use of the strategies their colleagues views , and pupils views are as follows:-

GROUP 1
The teachers in primary six were all interested in the lesson with new skill (concept mapping) to enable the teachers to make their lesson easily understood by the pupils.
<u>BY THE TEACHER:</u>
The teacher finds it difficult to link some of the words concepts they lack appropriate linking words. With time and many examples being used, the problem was gradually being overcame.

<u>By The Children</u>:
They are very much interested in the strategy but it was generally noticed that the pupils lacked the words to use in linking up the concepts.

Our Colleagues view about the workshop:
Other teachers are very interested in knowing what we learnt at the workshop. They are eager to gain the knowledge. They were briefed in a similar workshop which was organised for them.

CRITICISM ON CHILDREN CONCEPT MAPPING
Group 1
A) It appears that most of them are not provided with adequate activities as to help them draw and link the map very well.
B) The arrows are not well used and this makes most of the maps meaningless.
Observations on the pupils Concept mapping on magnetism.
GROUP 5
1. The arrows were not properly used.
2. The linking words were not properly used as to convey the meanings fully.
3. Some of the mappings were so scanty. This shows that the pupils have not understood the lesson.

GROUP 4
It is impressing to see that the pupils are generally able to make concept maps linking concepts or Ideas. Pupils are eager to put down their ideas on map though some pupils are poor in spelling words. On the other hand, few pupils drew very nice intelligent maps within short space of time.

Children's Idea on Magnetism

Observations from the children's Idea.
GROUP I

1. The way most of the children are answering the questions show that they are not provided with adequate learning experiences or activities.
2. Most of the questions are not answered e.g. suggesting investigations.
3. They lacked appropriate terms to make their points clear.
4. Very few of them exhibited mastery of the subject or lesson.
5. Some of the questions appear to be very difficult for the pupils to answer. e.g. suggesting investigations, and questions on compasses.

Group 9

Q2: Children's Ideas on Magnetism before teaching it.
Like in Ojiako Memorial P/S, Adazi-Nnukwu.
Before: They did fairly good because he could not define magnet or know what a magnet is, but after being exposed to the activities, they were able to cope with some of the tasks in the puzzle.
In Central school Awka, some of the children did not answer the questions before the activities, but answered them comfortably after the activities.
In Central School Ekwulobia, Nwosu Obnike Ernest, The children didn't answer the questions correctly while they did well after the activities.
Generally, the children performed better after activities.

<u>THE IMPORTANCE OF THE WORKSHOP.</u>
GROUP 1

WHAT WE GAINED FROM THE WORKSHOP.
In fact, we thank you very much for the opportunity given to us to attend this workshop. We, as a matter of fact gained a lot from the workshop. From the series of activities done in magnetism, we now conclude that science is discovery and this discovery should be done through a play way method. We also thank you for the strategies adopted, viz: concept mapping, question the object, etc. These strategies will help us practicalize science and also in the assessment of our pupils.
We now have confidence in carrying out activities on magnetism which we couldn't do before the workshop.

<u>PLANNED INVESTIGATIONS IN THE CLASSROOM.</u>

GROUP I (TOPIC: SIMPLE MACHINES)

Objectives:
At the end of the lesson, the pupils should be able to:
a) define a simple machine
b) give examples of simple machine used in their environment
c) explain the meaning of simple lever machine
d) state the components of simple lever machine
e) group a collection of simple lever machines into their appropriate types.
f) outline the components of simple pulley machines
g) improvise and use a pulley machine
h) outline the various uses of simple lever and simple pulley machines in our everyday life.
i) define friction and give some instances of natural applications of friction in everyday life.
j) list useful and harmful effects of friction in everyday life.
k) enumerate how to reduce friction.

Strategy: - Ask the Object.

a) What is simple machine?
b) What makes machine simple?
c) What are the examples of simple machine?
d) What are the uses of simple machine?
e) How can simple machines be grouped?
f) What are the examples of each group of the simple machine?
g) What is friction?
h) What are the effects of friction?
i) How can friction be reduced?

MATERIALS:
Scissors, broom, hoe, cutlass, plank, stool, table, tin-cutter, bottle opener, hammer, spoon, wheelbarrow, spanner.

PLANNING INVESTIGATION

Activity I
What is a simple machine?
i) Call out two children from the class, ask one of them to use hammer and the other to use stick to drive a nail into their desk. Ask them to state how they find the work.
ii) Let two other children to sweep the class with broom and 'melina' leaf respectively. How easy do they find the work? Which other things make our work easier?

Activity II
Identifying parts of simple machines.
i) The teacher provides many examples of simple machines commonly used in the homes on the table. Let the pupils study them closely and find out the turning points, where the force is being applied, and where the work is actually being done. Do you notice any similarities with the tools?
ii) A piece of plank is got and placed on a stool used by the teacher. Two pupils play on this for sometime and the positions of the turning points, force (effort) and where the work is actually being done are marked.

Activity III TYPES OF LEVERS
There are different types of levers.
a) Type 1
b) Type 2
c) Type 3

Classify the following simple machines into the above 3 types. Pliers, Forceps, bottle opener, crow-bar, scissors, spanners, sugar-tong, tin cutter, pincers, wheel barrow, coat tong, hook and broom.

Activity IV PULLEY AS A SIMPLE MACHINE.
i) A wooden reel of thread is used as a pulley and a strong wire passed through it to act as a support. One end of the twine is tied to a stone which act as a load. Let the children used the other end of the twine to raise the load. How do you feel the job of raising the load? What so you feel is the advantage of the pulley?
ii) The teacher now joins 2 or more reels together and ask the pupils to use it in carrying or lifting a heavier load. What do you notice? Is it easier to lift a load with more reels than with one reel?

Activity V FRICTION
i) Ask the pupils to rub their palms together for 10 seconds. What do you notice?
ii) Push a book on the surface of the desk or table. What do you notice?
iii) Rub two pieces of toasted bread together - Describe your observation.
iv) Strike the sharp edge of a cutlass against a stone or on a cemented floor. Describe what you observe.

v) Put a few drops of water on the surfaces of two pieces of glass and rub them on each other. Describe what you observed.

Activity VI REDUCTION OF FRICTION
MATERIAL: Oil or grease or any other lubricant, bead.
Put a heavy book flat on the table. Let the pupils push it across the table. Now put some marble or round lead pencils under the book and push it across the table again. What difference do you notice?

SHORT STORIES

GROUP 1 (A short story on simple machine)

This story was developed after a workshop at Awka, Anambra State Capital in Nigeria. It was organised by Mrs Anosike, from the department of Science Education, Institute of Education, University of London. This research work was based on strategies and planned investigation.

THE STORY
Two children, Joe and Obi played with some simple machine devices which make work easy such as broom, spoon, hammer, scissors, tin-cutter, wheel barrow. These devices are found in their environment.
Joe picked up a plank and a nail and asked Obi to use the plank and drive the nail ;inside the damaged wooden desk. While he is doing this, Joe laughs and checks his wrist watch. How long it will take Obi to do it. He again give him a hammer to do the same job. He also check his watch to find out the time. The result is that it took a lesser time to do the job with hammer.
Joe: Obi, which of the two devices did you found easier for the work?
Obi: The hammer.
Joe: Why?
Obi: It took me less time and less energy. Also it was easier for me.
Joe then told him that simple machine makes work easy.

This time Obi got a plank and place it on a stool used by the teacher. He asks Joe to sit on one end of the plank while he sits on the other end. The first on count to get 50 wins. As they were playing, the see saw game, they were laughing at each other, as the plank swings each of them at each side. Joe was the first to get 50 counts and won. This see saw is a form of simple machine called lever. It is used for lifting heavy loads.
Obi: Do you know what made the plank to up and down?
Joe: It moved up and down because the weight of the heavier load pull down one end of the machine while the lesser weight goes up.
Obi: As the see saw game continued, he point to the position of the load, fulcrum and effort. The first type of lever is when the fulcrum is between the load and the effort. The second types is when the load is found between the fulcrum and the effort. Joe, I have given you two types of lever, try and give me the third type.
Joe: The third type of lever is when effort is found between the fulcrum and the load.

Obi is using a pulley to draw a bucket of water from school well. A pulley is another type of a simple machine used commonly in the homes and school to draw water from wells. It is also often used to lift heavy loads or objects, therefore it saves energy. Now Obi used a rope to draw water from the same well, mindful of the time it took him.
Joe: Which of them is faster to draw water?
Obi: The pulley.

UZOMA ASK ADA
Ada tried to walk fast on a rough surface such as cemented surface and smooth surface.
Uzoma: Which of the surfaces do you find easier to walk?
Ada: On the rough surface.
The teacher asks Ada and Uzoma to rub their palms together and feel them on your faces.

Teacher: What do you notice?
Ada and Uzoma:They are warm.
Teacher: Friction is the force which opposes the movement of one body on another.

Group 9
Story on Minerals.
One day, when the teacher mentioned the word, 'mineral' in the classroom, the children thought that it was the ordinary soft drinks we take. They started giving her examples of minerals as fanta coke, sprite etc.
The teacher: Oh , yes they are usually called minerals. But they are other things found around us which are called minerals.
Tom: Do you mean that there are other things called minerals around us?
Are they like fanta and coke?
Teacher: No, they are not.
Tom: What do they look like?
Uju: I was travelling to Enugu with my uncle and I saw a carriage with black substance like the charcoal we use for cooking.
My uncle said that they are minerals used for producing other minerals which are useful to us.
I do not understand what uses they are to us.

A: Suggest what the teacher could have said at this point.

Uju: Can these minerals be found in our school compound?

B:Suggest places where minerals can be obtained in Nigeria.

Tom: But I am still worried about the difference between the charcoal from the fire wood and coal which Uju saw with her uncle. I really don't know if they are the same.

C: Suggest a method to prepare charcoal in the laboratory.

Luke: But the teacher said that minerals can be seen in different states.

D: Give types of minerals.

Tom: How can crude oil be refined?

E: Write here the instructions the teacher gives the group on how to refine crudeoil.

Teacher: She called the class together and asked them the following questions based on minerals.

1. What are minerals?
2. What are the sources of minerals?
3. Name types of mineral you know
4. What are the states of minerals?
5. How is crude oil obtained from the ground?
6. How can the crude oil be refined?
7. Can minerals be tested in the classroom?
8. How can minerals be used in the home?
9. Compare the characteristics of coal, carbon, and limestone.

F: Write three more questions that might have come from the children.

G: List which of these questions in 1-9 that could be answered by practical investigation using materials easily available in the classroom.

H: Explain how you would investigate question 9 experimentally.

i. How would you answer questions 5,6,& 8.

Group 9

1. We gained a lot of experience such as; Being able to raise questions that could lead to investigations.
We discovered that most of the questions we raise in the class were straight forward questions which require only one word answer, but with the introduction of 'Ask the Object' we have been able to categorize our questions.
2. How to work in groups
3. Concept Mapping in Teaching: This enables the teacher to assess children's ideas on the topic before and after teaching as well as enables the teacher to check if the stated objectives are achieved at a glance.
4. The investigation method enables the child to learn and discover things by him/herself.
5. The reflection on practice is so important as this gave the teachers opportunity to discuss the problems they faced during their field work.
6. We learnt how to plan activities in science to bring about proper investigation in the classroom which gives the children opportunity to think, learn and retain what is being learnt.

APPENDIX G.
INITIAL INTERVIEW PROFORMA.
Background Information.

Name of school..

Name of Teacher...

Number of years of experience..

Academic Qualification...

Sex..

Any Science Professional training Obtained...

Science Teaching.

Do you teach as science as a separate subject. Yes No.
If Yes, How may periods of science do you have for pupils
...
Did you complete the questionnaire in December 1992/January, 1993 or May-July, 1993? Yes No.
If Yes or No, Tell the outcome of the survey. Talk about the purpose of the visit. Say about the intended workshop.
Do you agree that magnetism is difficult to teach? Yes No.
If No, What other topic(s) is difficult to teach?...
Will you like to attend the workshop? Yes No.
If Yes, What do you think that the workshop will provide for you?
...
...
...
Any question about the project?..
What strategy(ies) do you use often in teaching primary science?
...
...
Is there any strategy you would have liked to use but have constraints in using it? Yes No. What strategy(ies)...

Primary science Assessment

Do you assess in primary science? Yes No
Why do you assess in science?...
Do you assess practical activities in science Yes No.
If yes, Any difficulty to do that?..
...
How do you make up for continuos assessment in primary science?
...

APPENDIX H.
FIRST, SECOND, THIRD OBSERVATION OF TEACHERS SCIENCE LESSONS PROFORMA:

Topic of the lesson.. Date....................................... Record/Notes
Look out for any changes in the classroom in terms of materials provided, pictures on walls, classroom organization or reorganization.
<u>Lesson in progress-</u>
Time of the lesson..
Strategies used by Teacher ....
Record-Grid.

	0-5	5-10	10-15	15-20	20-25	25-30	30-35
Teacher talk information							
questions							
closed							
open							
who asked, boy							
girl							
pupil talk to teacher							
Answer to questions							
Who answers, boy							
girl							
time used for activities							
time for conclusion							
materials provided for lesson							
writes on board							
Teacher use of everyday knowledge.							
Teacher use of scientific knowledge							
pupils perform activities							
In groups							
Individually							
Pupils use of everyday knowledge of science							

Pupils use of scientific knowledge							
Pupils require assistance from teacher							
Boys							
girls							

APPENDIX I
MAGNETISM STORY

A SHORT STORY ON MAGNETISM.

This story was developed in the Department of Science Education Institute of Education, University of London after the researcher observed through survey carried out in Nigeria in May/July 1993 that primary teachers and pupils in Nigeria percieved the teaching and learning of magnetism difficult. The story was originated by Jenny Frost, a lecturer in the department who came up with the idea of using a story about a teacher in a classroom with children studying magnetism.
The story was made up of what happened between the researcher and Jenny when playing with magnets. It is designed to provide a context in which teachers can demonstrate their competence as well as where they might need help. At various point in the text there are capital letters in bold **(A,B,C,....H)**, where a response is required. More detailed instructions about each response are given at the end of the story.

The Story
Sam, a ten year old old boy in primary five had often played with magnets with his friends. They had tried to find out what magnets could pick up and what they couldn't and had tried sticking magnets to different things in and around the house. The magnets he had played with had been ones in toys such as his two toy trucks which had magnets to couple them together and the 'souvenir' magnets from one or two places which people often stick on the doors of their refrigerators. Until today, however , he had never had never had a school lesson on magnets.

The teacher divided the class into groups of four and each group was provided with different type of materials of various sizes, weights and shapes , and also four bar magnets. The magnets were relatively strong ones, made of the magnetic alloys which have been developed since the 1950's. The forces between the magnets could therefore be easily felt by the children. The teacher asked the pupils to find out as out as much as they could about the magnets in the first fifteen minutes. During this time she went round and spoke to each group in turn . Below are some of her conversations with different groups. The first conversation came from Sam's group.

Sam: (Picking up one of the magnets). *This will pick up metals.*
Teachers: *How do you know?*
Sam: *Because I've tried it at home. They stick to cars and fridge doors.*
Teacher: Try the metal things in your tray. I've given you some paper clips and some brass paper fasteners and a saucepan, which I think is made of aluminium.

Sam: (Sam tries the metals in his pile of materials and then comments on what happens.)
Oh **A. Write what Sam might have said.**

Teacher: Later, you can try and find what metal things in the room will stick to magnet. Make a list of the ones which do.

B. The metal objects included the following: pair of Geometry compasses, hair clip, gold ring, gold earclips, silver ring, Aluminium metal catches on the louvre windows, brass paper clips, wooden legs on tables, Golden latch and handle on the door, Steel drawing pins. Underline those that will stick to the magnet and those that will not.

At this point another child , Patience , picked up two magnets and played with them.
Patience: *Look, I can't push these together!*
Teacher: *Show us what you mean.*
Patience holds two magnets, one in either hand and tries to make them stick together. Instead the two ends push apart. She then drops one on the table and this time when she picks it up she finds that the two magnets stick together.
Patience: That's funny, they wouldn't stick together just now, and they are sticking very well.
Teacher: Play with them a little longer and see what you have to do to make them stick together and what you have to do to make them push apart.
All the four children try this out and explore this behaviour of magnets, while the teacher goes and talks with another group. When she returns, the group are sure they have sorted how it happens. Patience explains.

Patience: *It is like this.* **C. Assuming Patience had found out correctly how to make the magnets stick together and push apart, write here what she might have said. Remember she will not know words like 'attract' and 'repel' so use only words she has already used.**

Ofori: I read somewhere that magnets have N and S poles. There was a picture of two ends of the magnets painted different colours. These are all one colours; do they have poles?

Teacher: Yes all magnets have poles. Do you know they are only called 'North pole' and 'South pole' because people found that one end of a magnet points to the North pole of the earth and one to the South pole of the earth. Originally they were called 'North-seeking pole' and 'South-seeking pole' but people shortened their names to 'North pole and South pole'. It's easy to find out which end of your magnet is which all you have to do is this.

D. Write here the instruction the teacher gives the group, for finding the N and S poles of their magnets.

The teacher left Sam's group trying out their two investigations and went to other groups. After 15 minutes, she called the class together and asked them what questions they had about magnets. She wrote these on the board; they are listed below:

1. What metals stick to magnets?
2. Do all magnets have N and S poles?
3. Are all magnets rectangular in shape?
4. How do magnets manage to pull things when they are not touching them?
5. How far away will they work?
6. Will they work through wood and paper? If they do, Does it make a difference if you have a lot of paper or a little?
7. Compasses are often called 'magnetic compasses' why is it so?
8. What is a magnetic field? I read about it in a book.
9. A book talks about magnets which attract and repel; what does that mean?
10. Who first discovered magnets?
11. Do magnets occur naturally?
12. What was the first magnet ever discovered?
13. What are other uses of magnets other than in toys?
14. How are magnets made?
15. How do magnets work?

E. Write three more questions that might have come from the children.

F. List which of the questions, 1-15, that could be answered by practical investigation, using materials easily available in the classroom.

G. Explain how you would investigate question 6 experimentally.

H. How would you answer questions 4, 7 and 9?

Footnotes

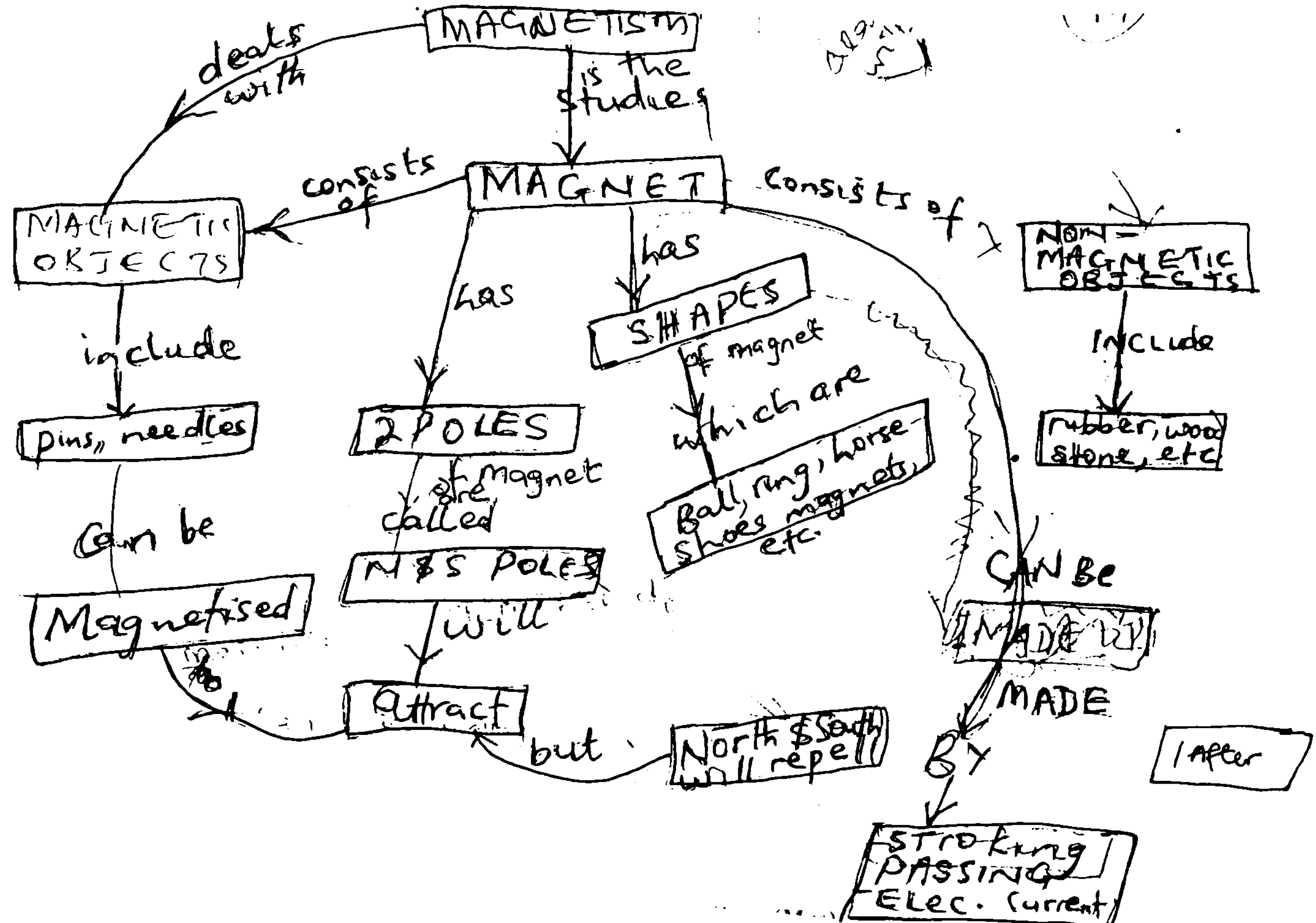
The toy trucks have magnets on both ends of them. It is possible to make one truck pull the other or one truck to push the other , by turning it round so that the magnets repel instead of attracking. The magnets used in these toys are often 'ceramic' magnets, (they have been moulded and fired like pottery) and they contain ferrites as the magnetic material.

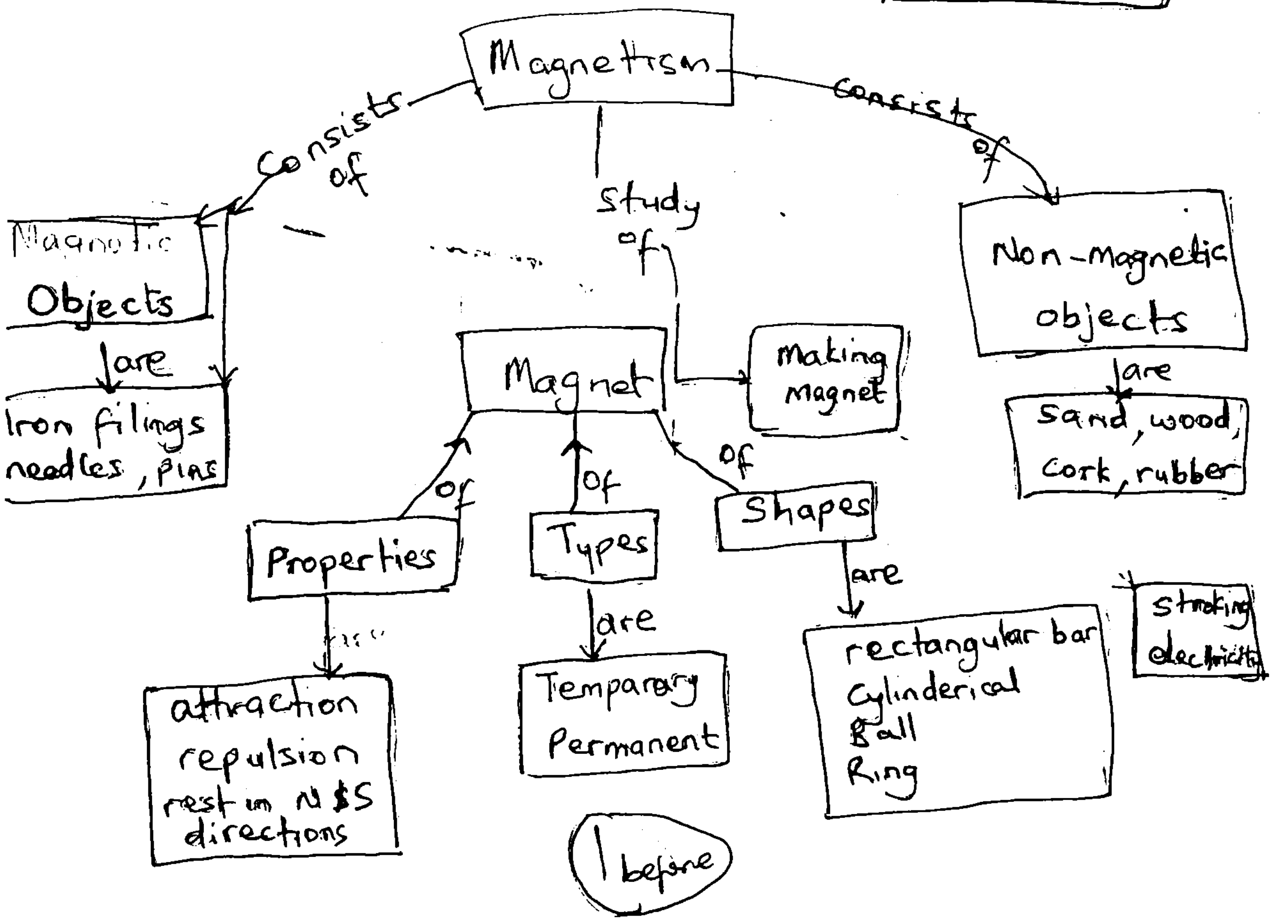
2. These magnets are made of magnetic material (often the ferrites) embedded in a thin layer of plastic.

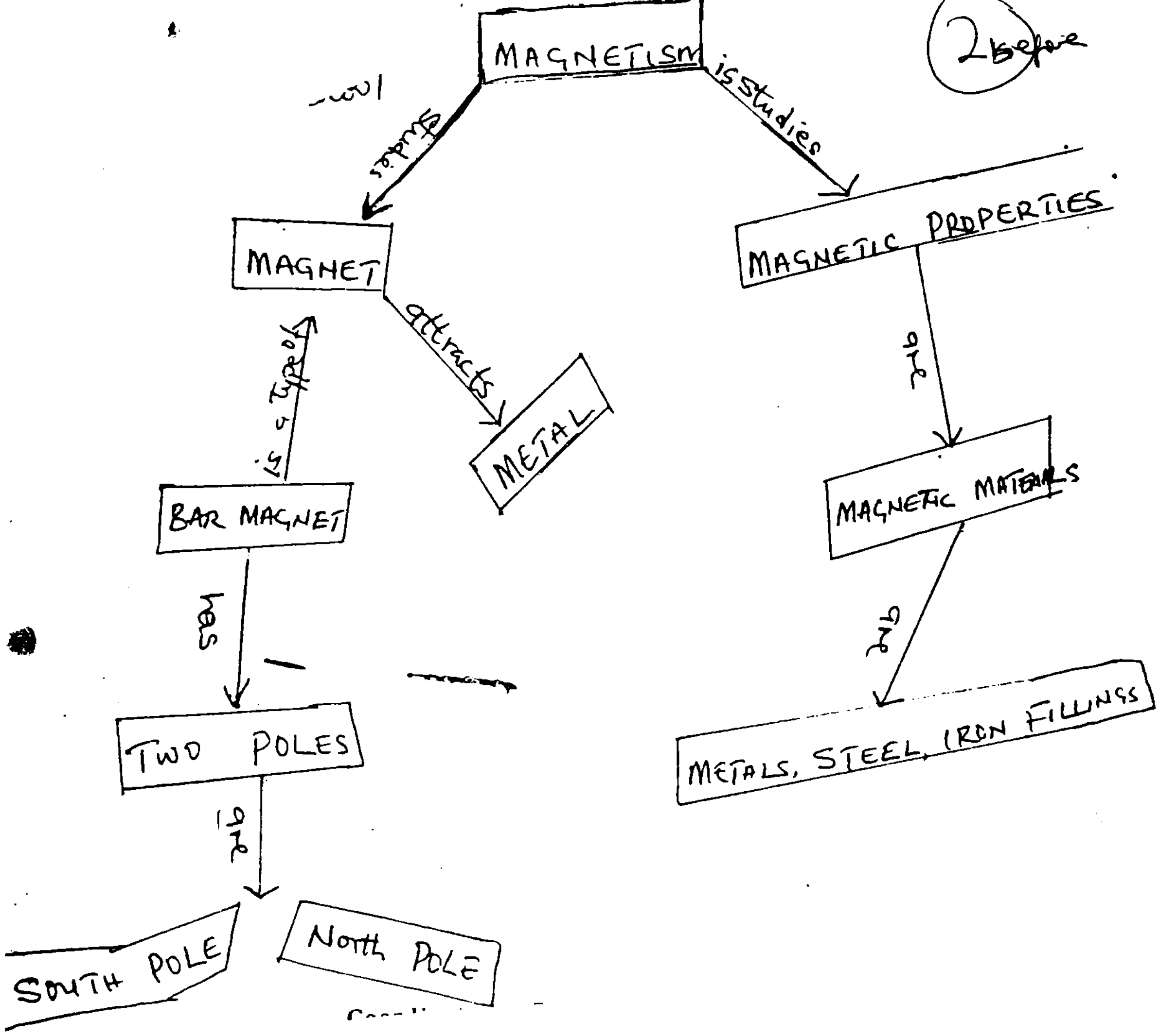
3. Alloys such as those which go under the trade name of 'Alinico' can be magnetised much more strongly, and hold their magnetism for much longer, than the old fashioned steel magnets. Such alloys are made of various combinations of aluminium, nickel and cobalt.

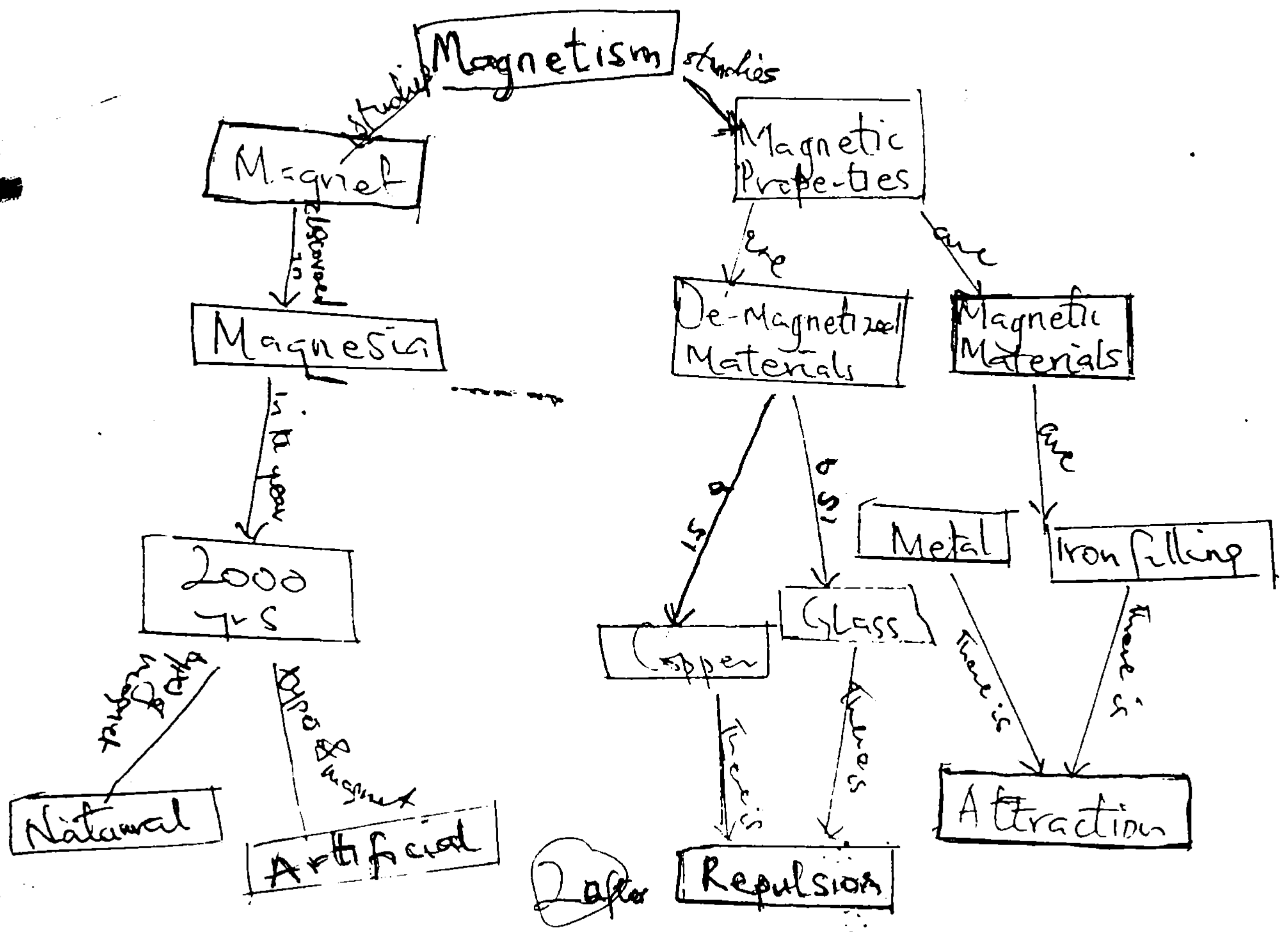
APPENDIX J

CONCEPT MAPS FROM 15 GROUPS OF WORKSHOP PARTICIPANTS



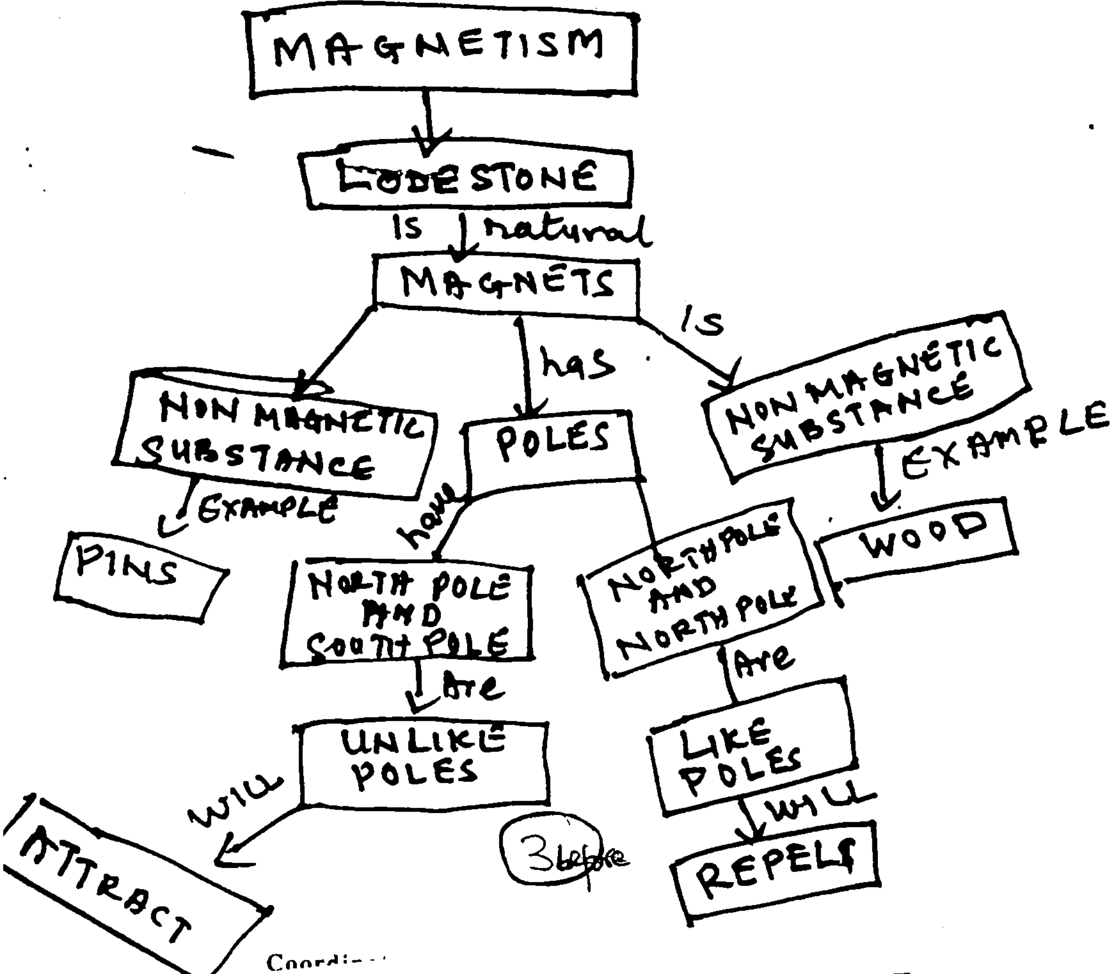


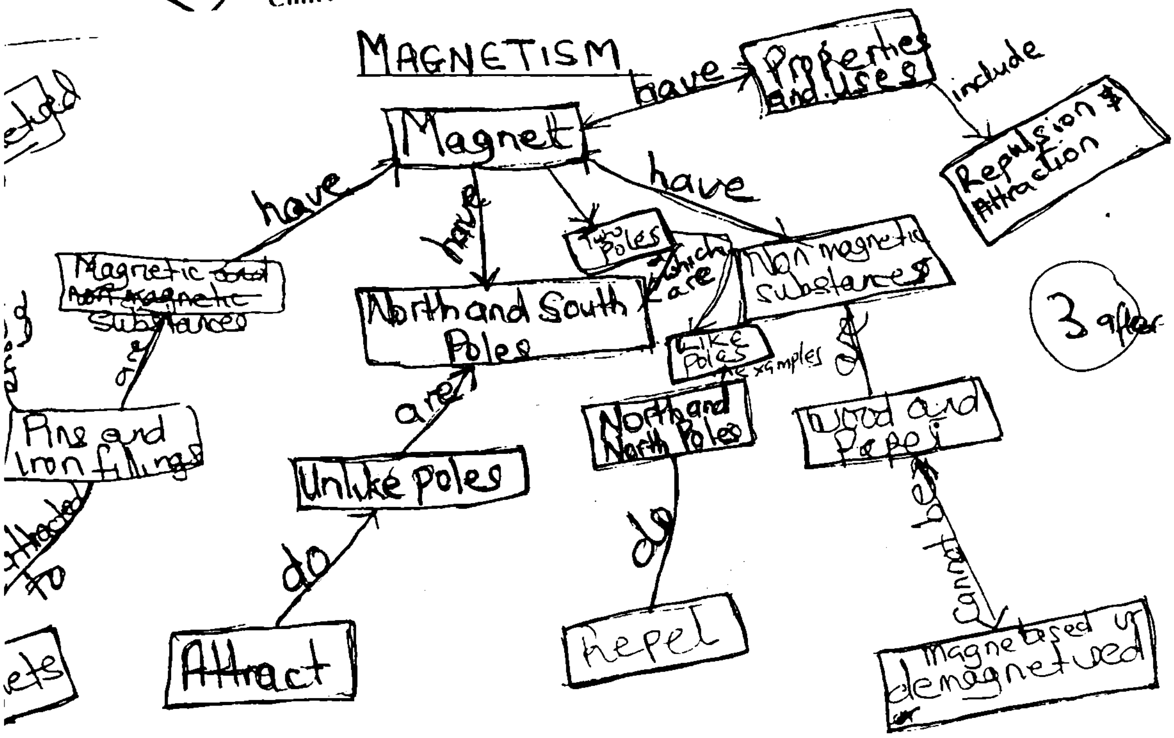

2 before
MAGNETISM
studies
is studies
MAGNET
MAGNETIC PROPERTIES
attracts
METAL
is a type of
BAR MAGNET
are
MAGNETIC MATERIALS
has
are
TWO POLES
METALS, STEEL, IRON FILLINGS
are
SOUTH POLE
North POLE

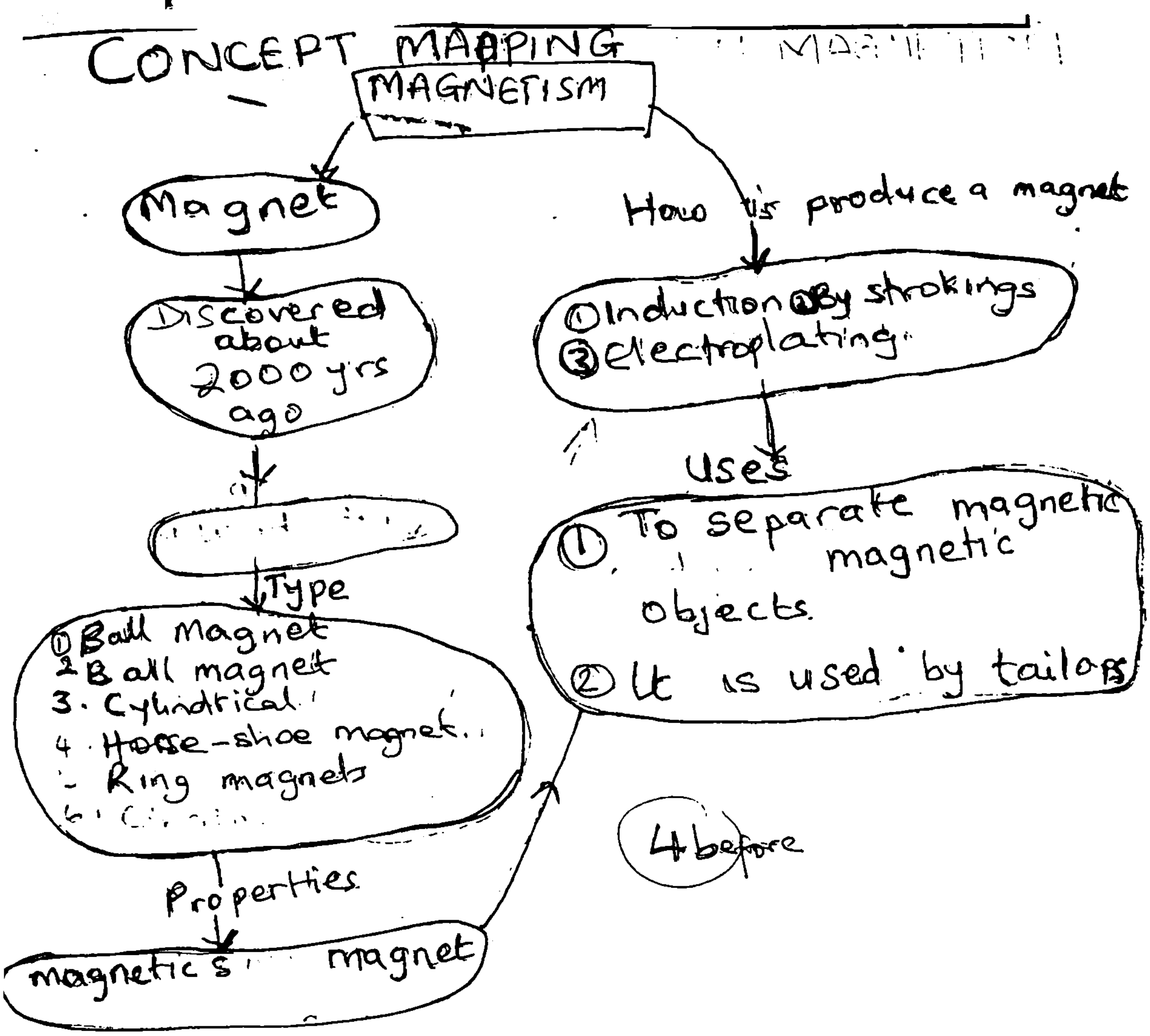

Magnetism
studies
studies
Magnet
Magnetic Properties
discovered in
are
are
Magnesia
De-Magnetized Materials
Magnetic Materials
is a
is a
are
2000 yrs
Metal
Iron filling
Copper
Glass
there is
there is
Natural
Artificial
Repulsion
Attraction
2 after

441

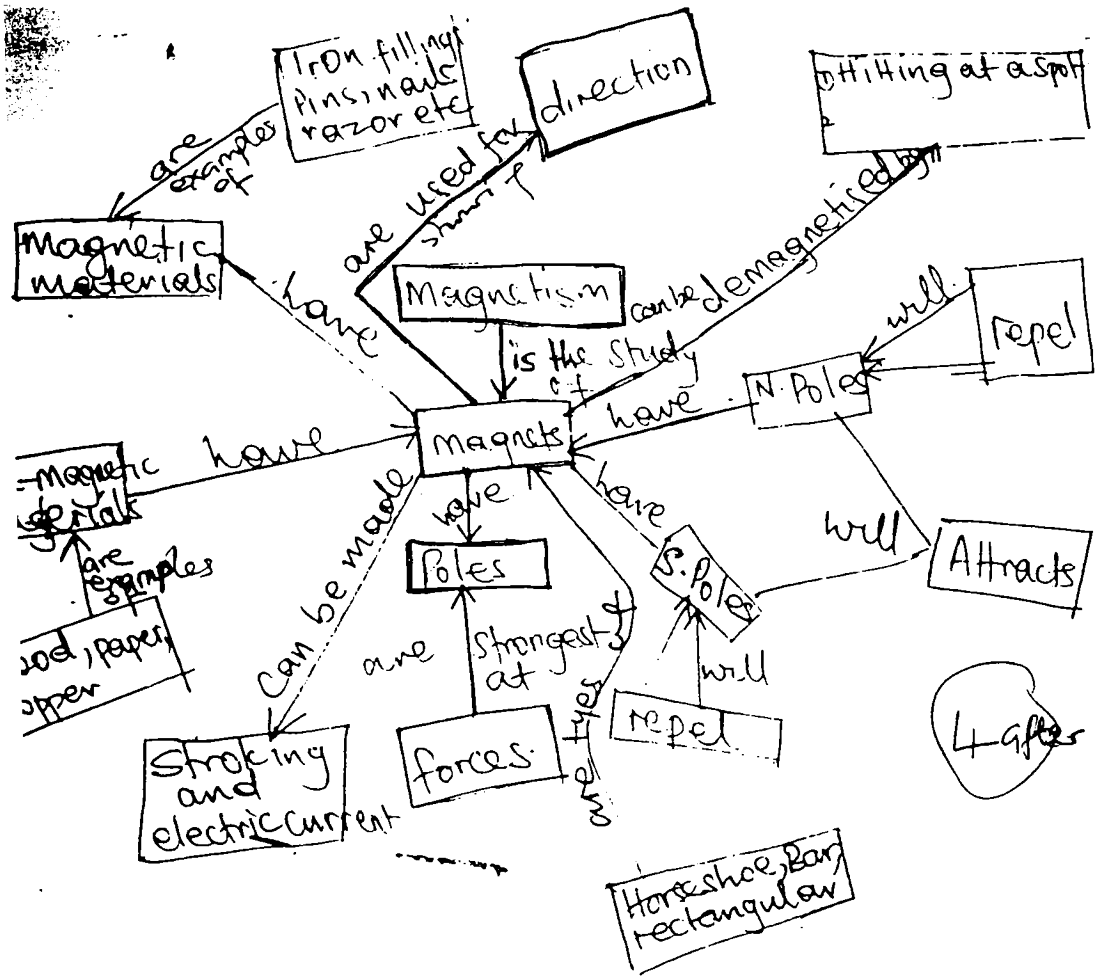
NCEPT, MAPPING ON MAGNETISM



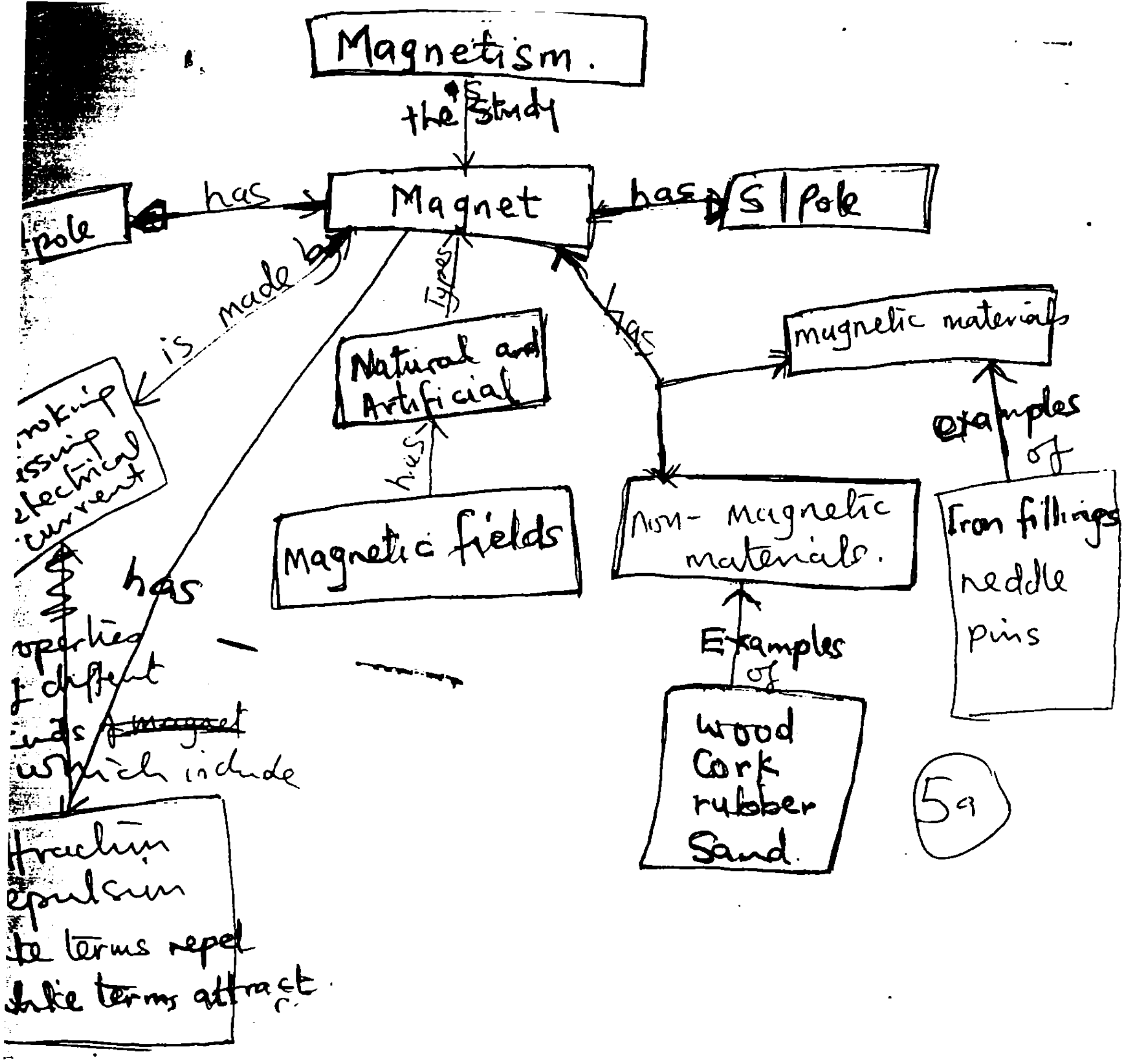




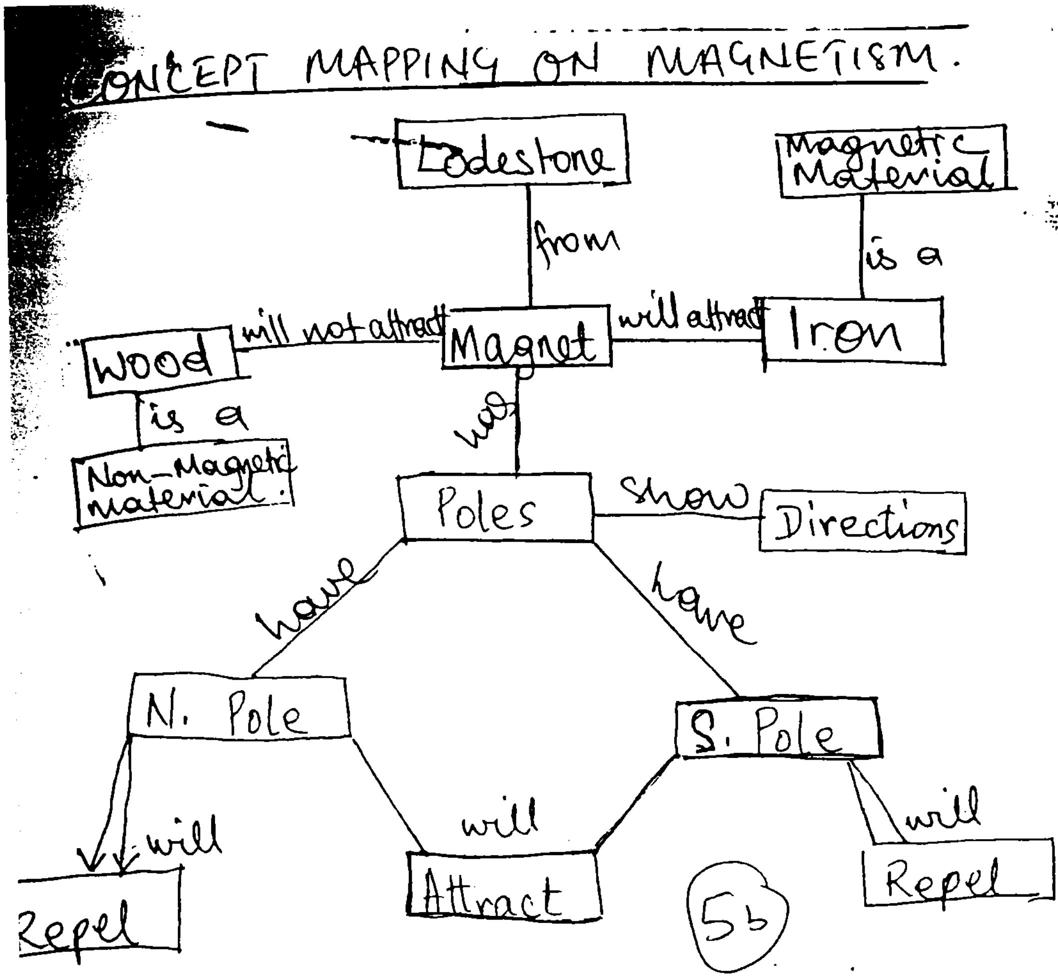
Concept map drawn by group 4 before the workshop.



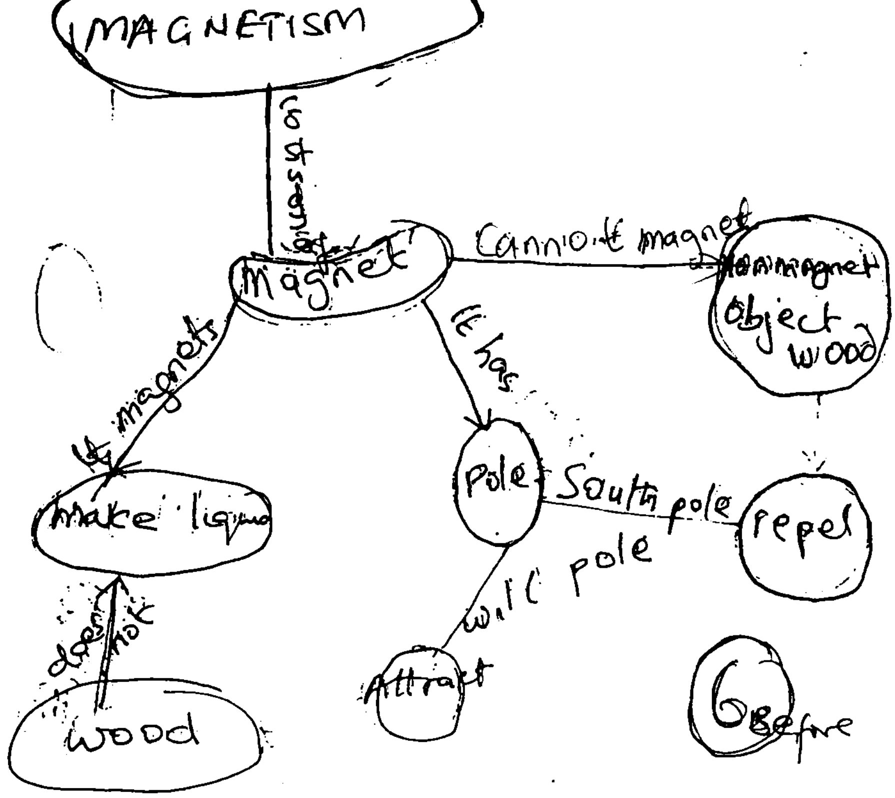
Concept map drawn by group 4 after the workshop.

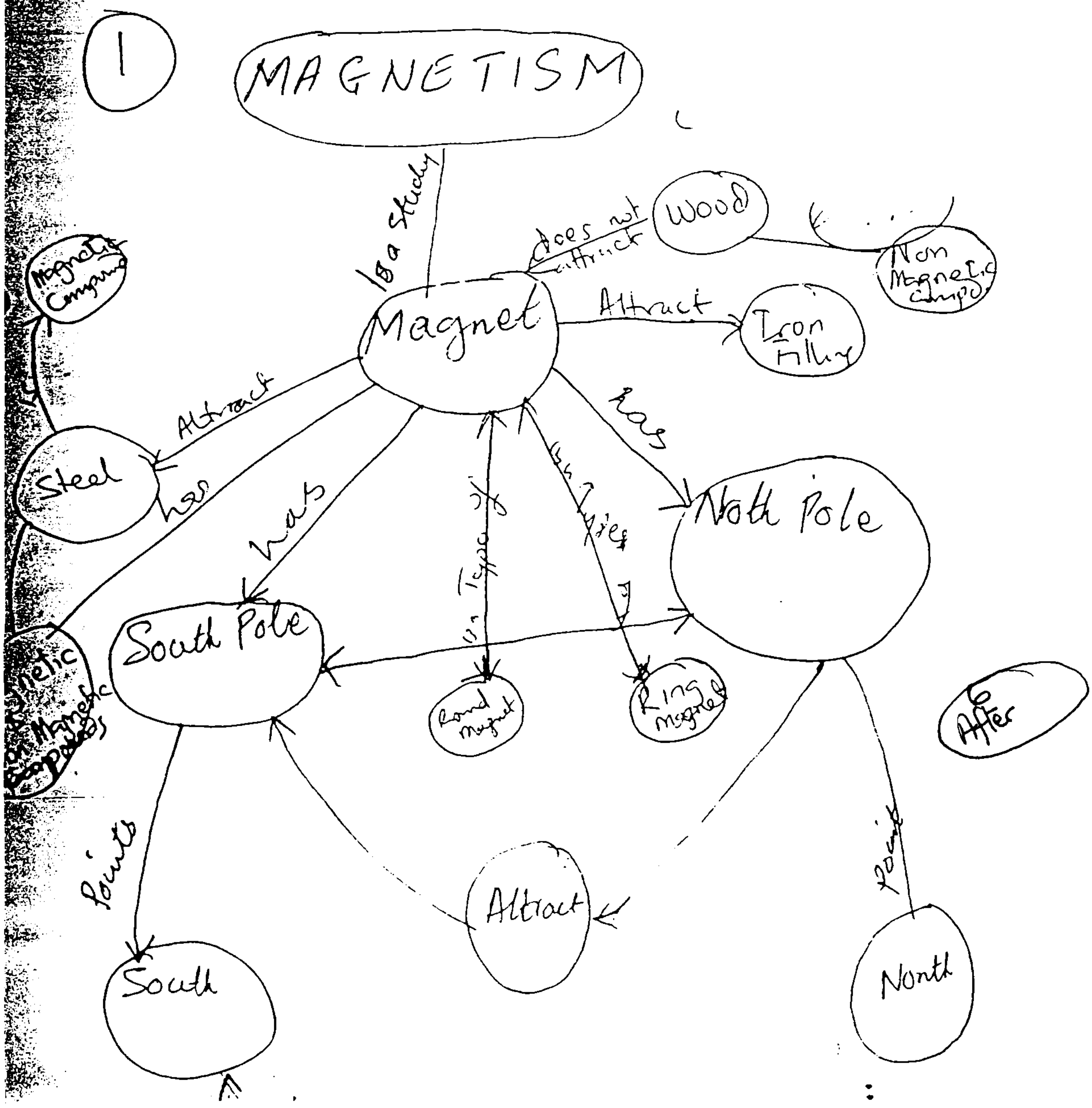


Concept map drawn by group 5 after the workshop.



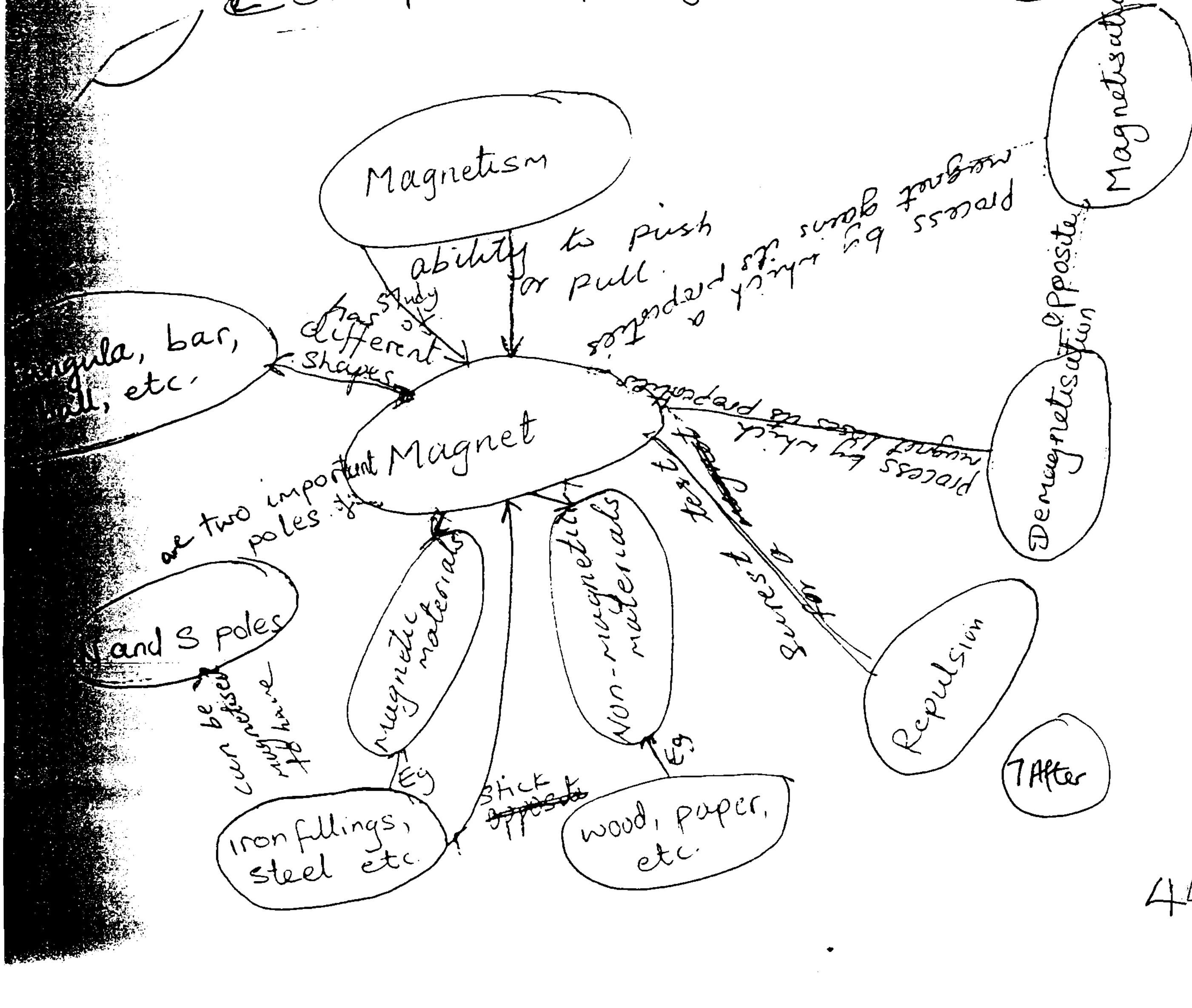
Concept map drawn by group 5 before the workshop.

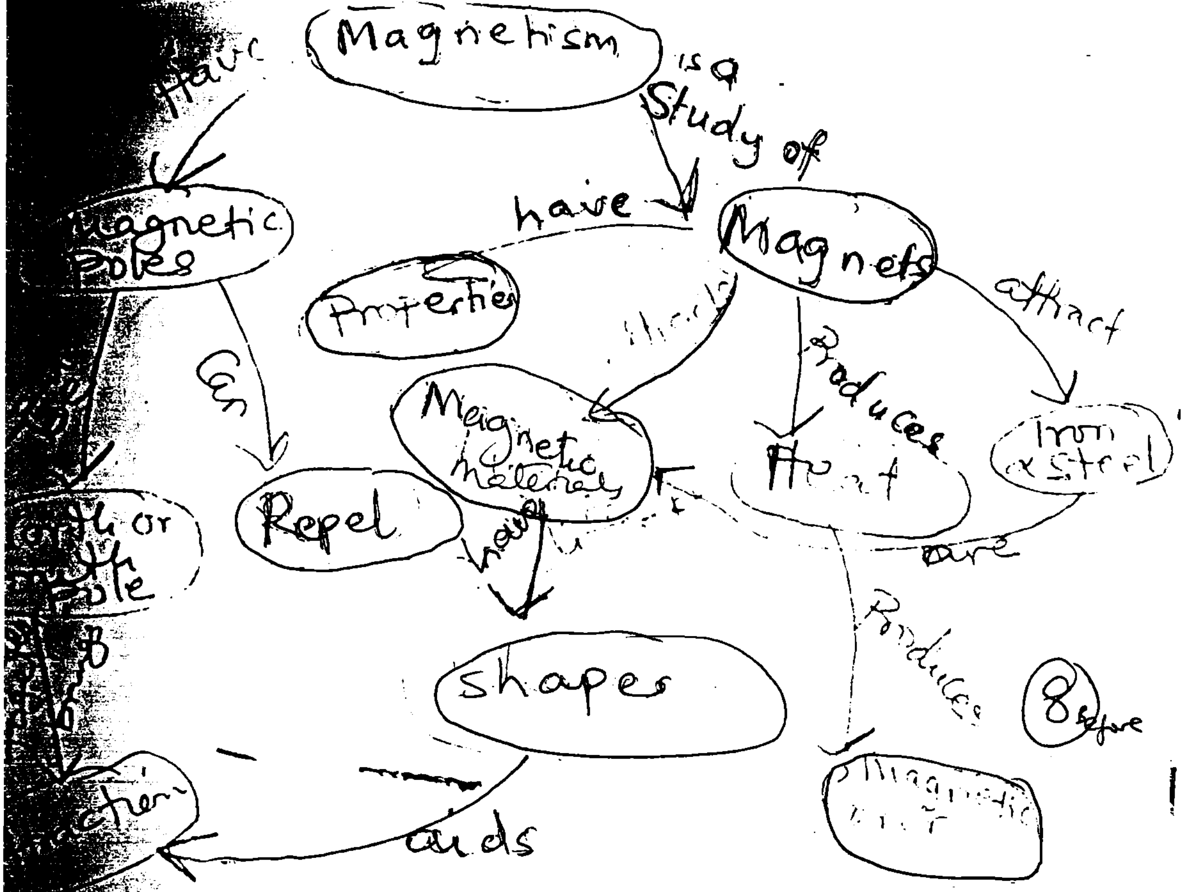

MAGNETISM
Magnet
Cannot magnet
object
wood
It has
Pole
South pole
repel
will pole
Attract
make liquid
does not
wood
6 Before

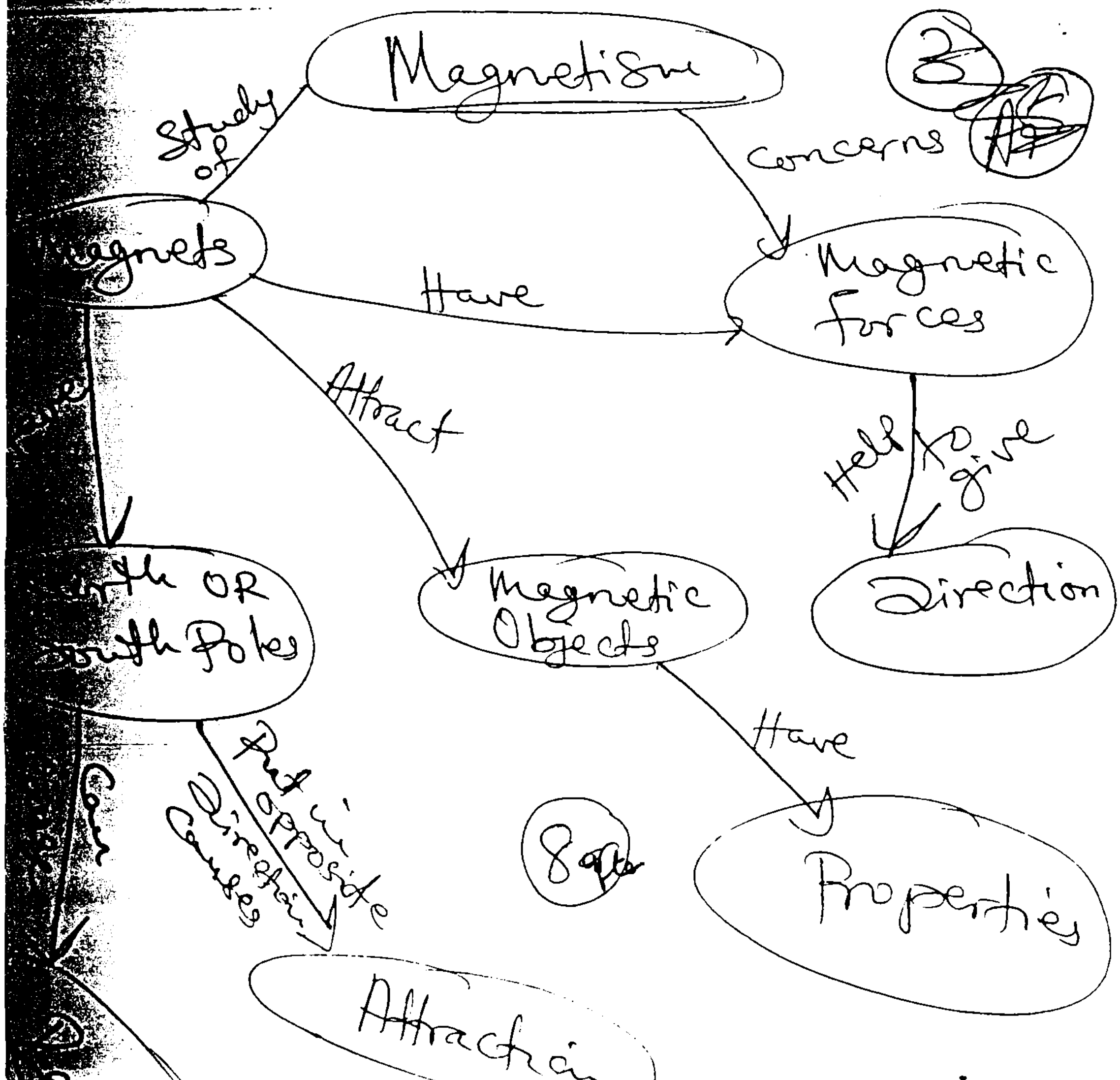

1
MAGNETISM
Magnet
Wood
does not attract
Non Magnetic
Attract
Iron
Attract
Steel
has
North Pole
South Pole
Round magnet
Ring magnet
Attract
points
South
North
6 After

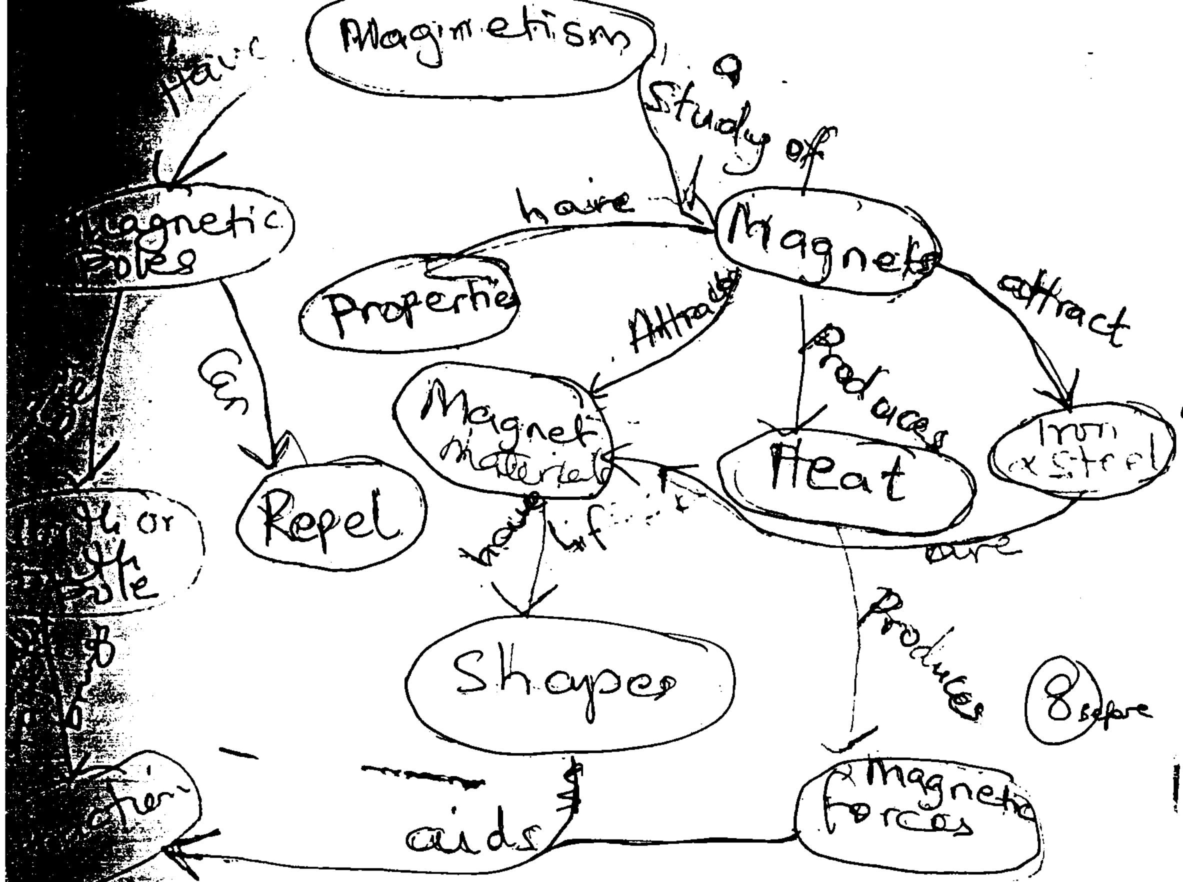
Concept Maping

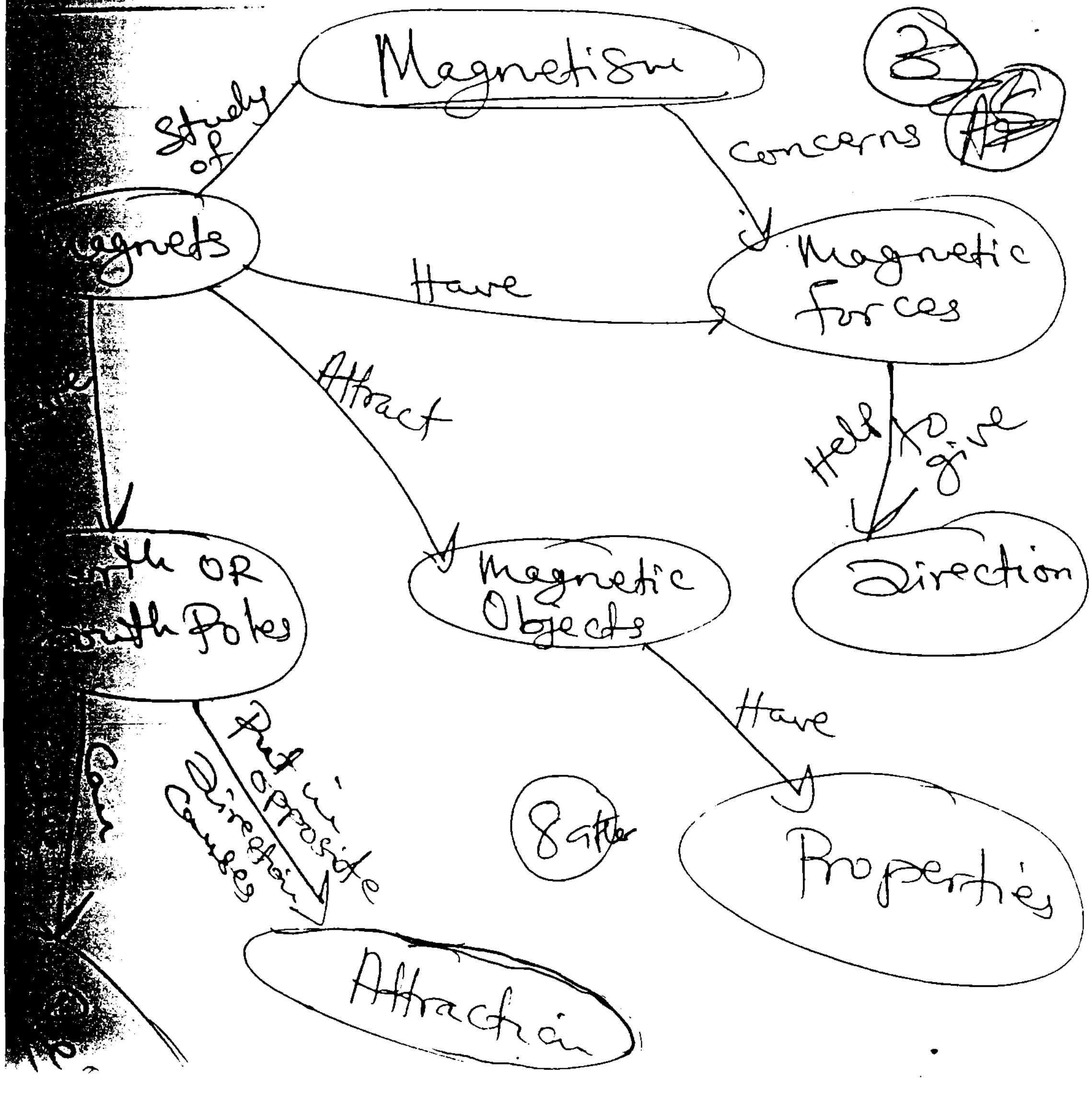
Concept Mapping



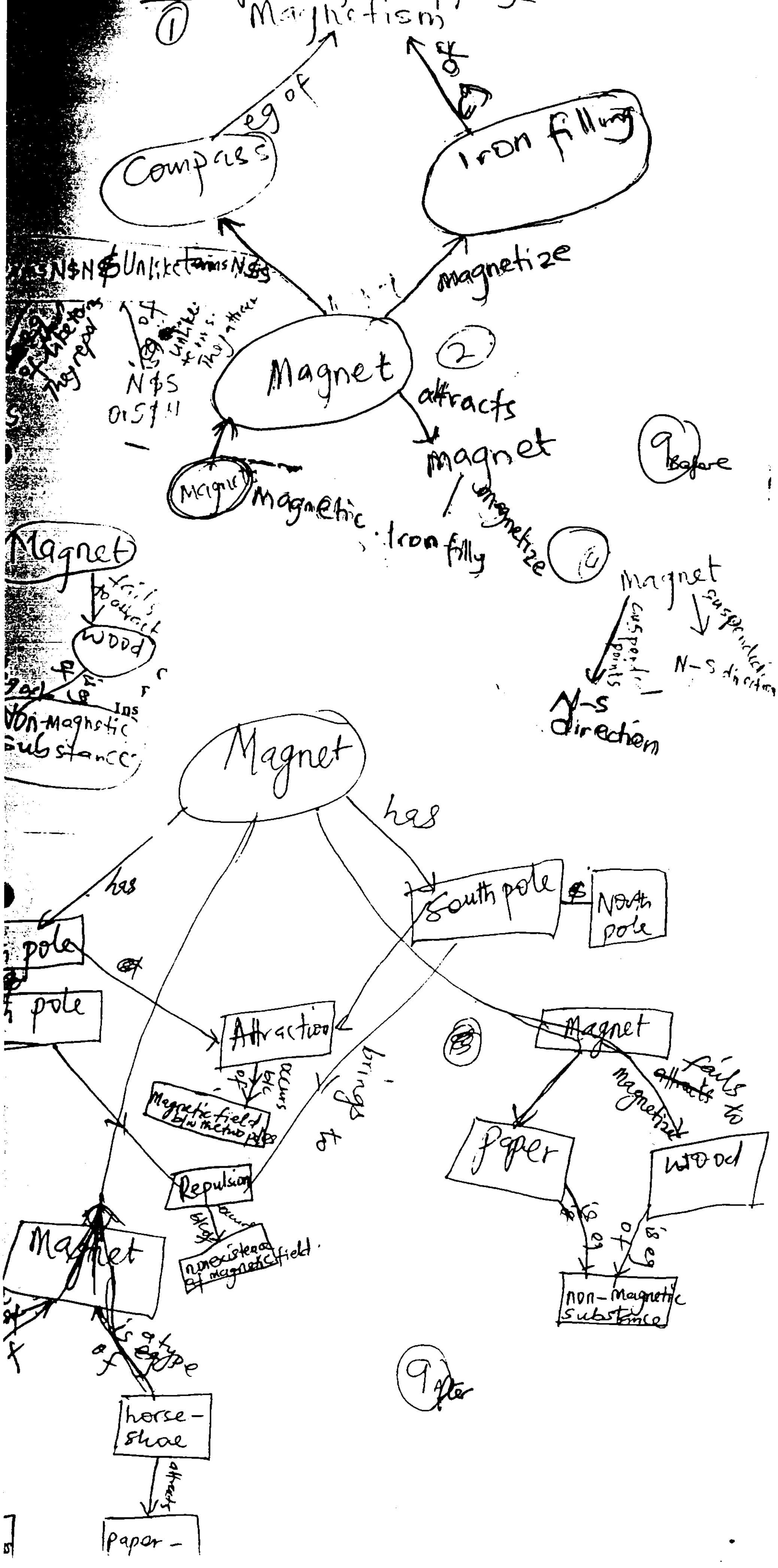

Magnetism
is a Study of
Magnets
have
Properties
Magnetic Poles
Can
Repel
Magnetic material
have
attract
Iron & Steel
Produces
Heat
are
Produces
shapes
aids
8 before


Magnetism
Study of
concerns
Magnets
Have
Magnetic Forces
Attract
Help to give
Magnetic Objects
Direction
Have
Properties
8 after
Attraction

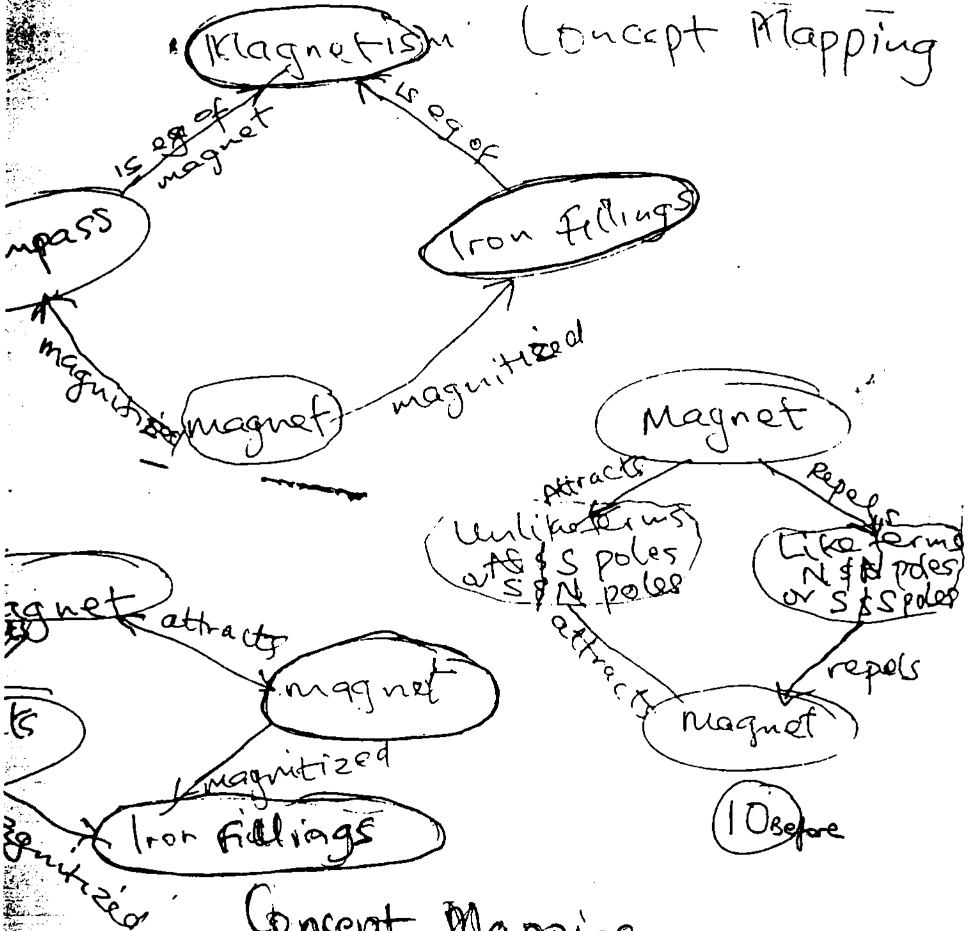

Magnetism
Study of
Magnets
have
Properties
Attracts
Magnet materials
attract
Iron & Steel
Produces
Heat
Repel
Shapes
Produces
Magnetic forces
aids
8 before


Magnetism
Study of
Magnets
concerns
Magnetic forces
Have
Attract
Magnetic Objects
Help to give
Direction
Have
Properties
Attraction
8 after

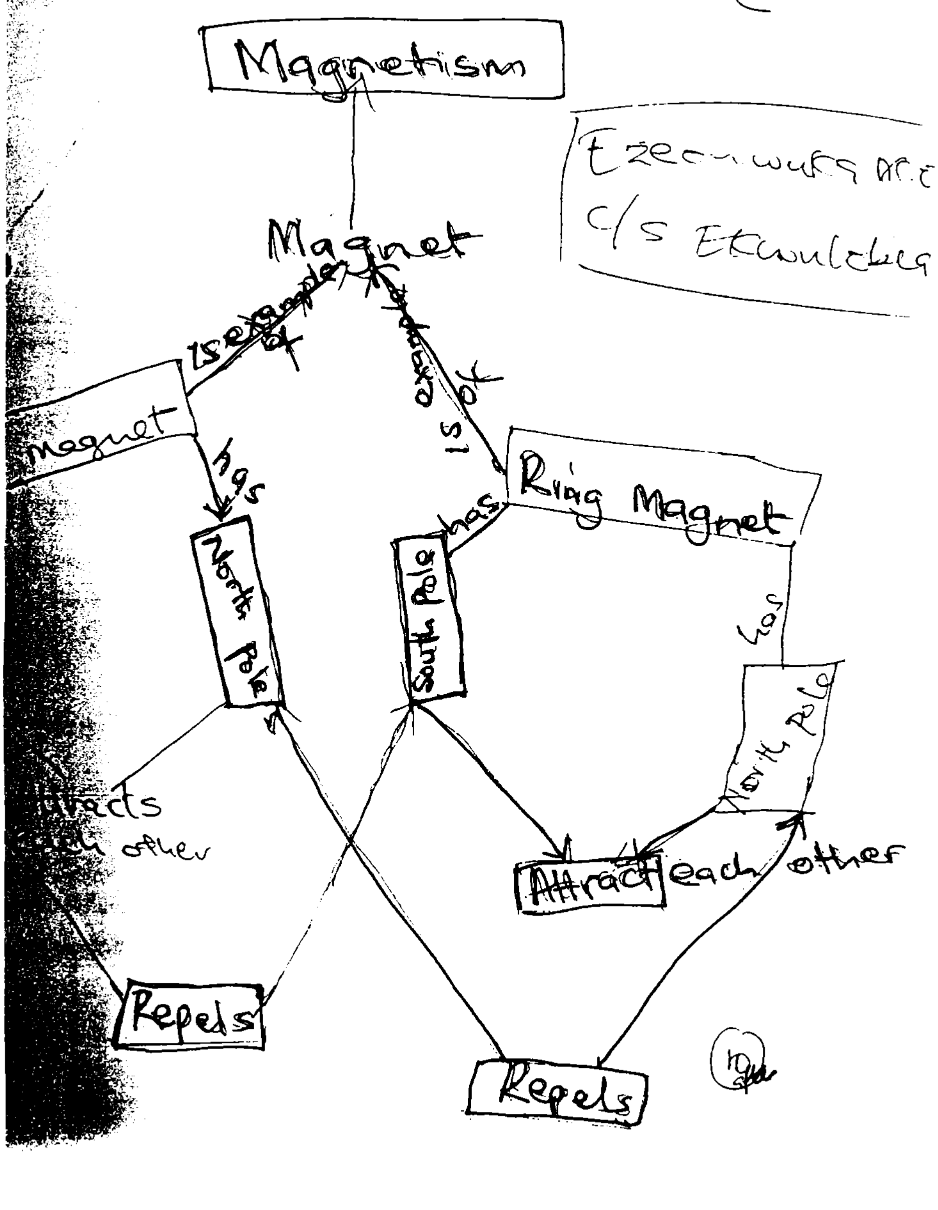
Concept of Mapping:

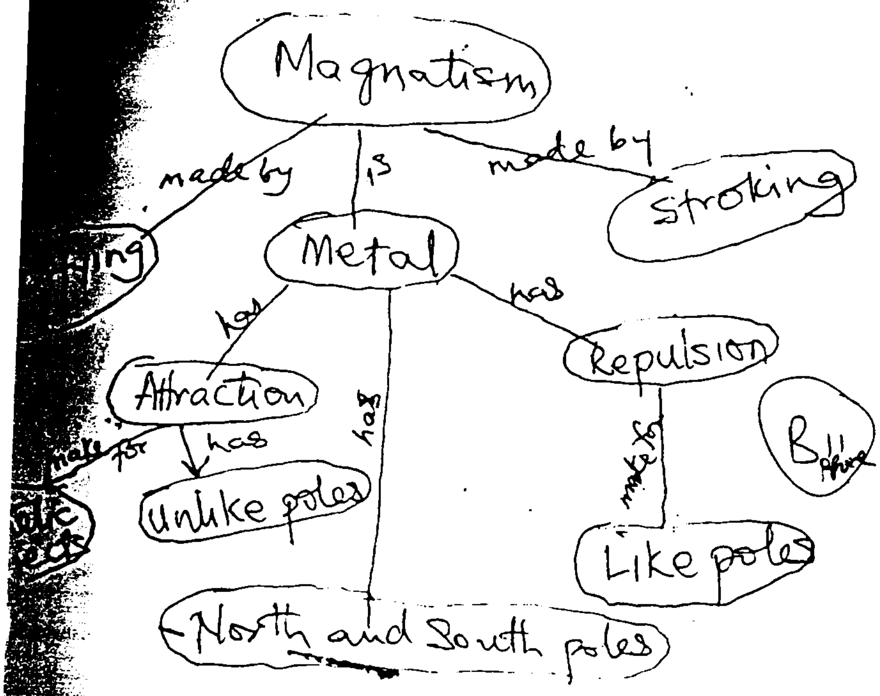


Concept Mapping

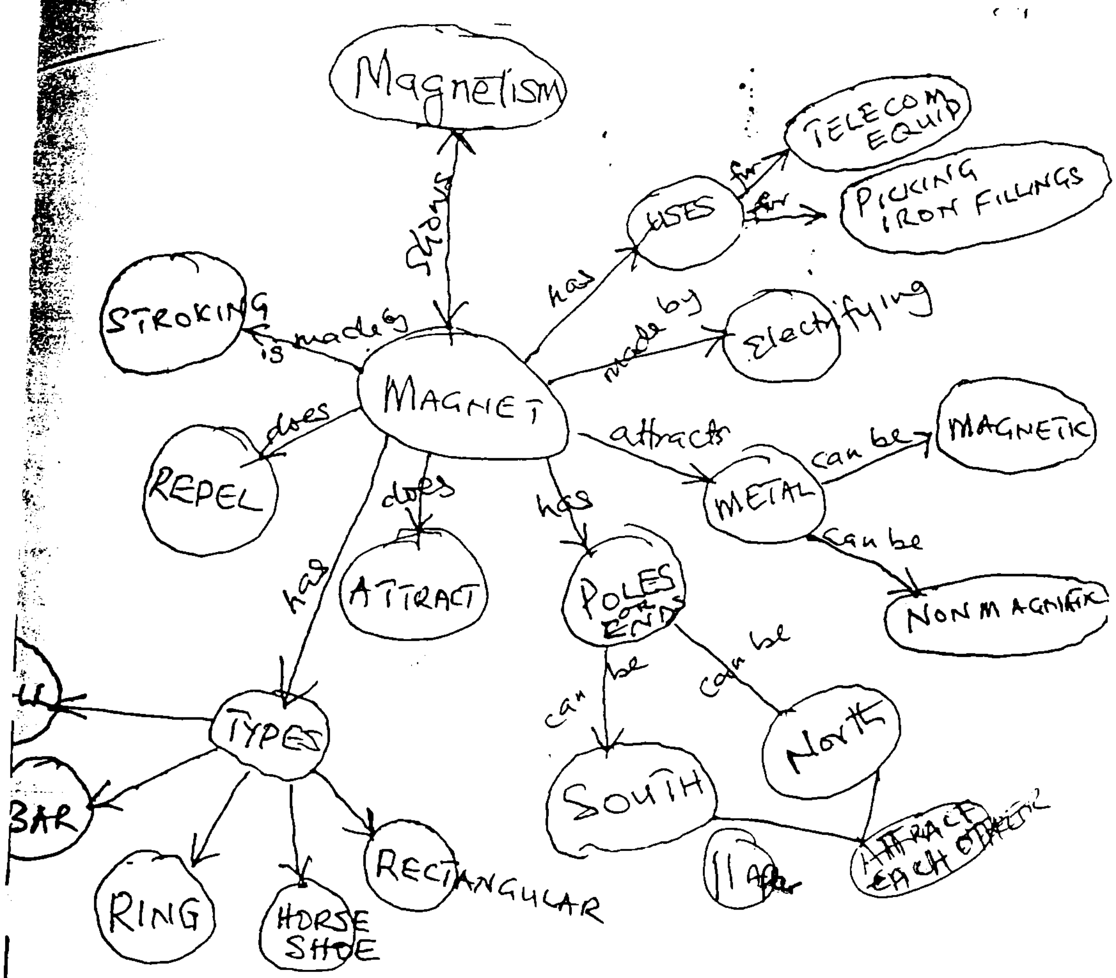


Concept Mapping

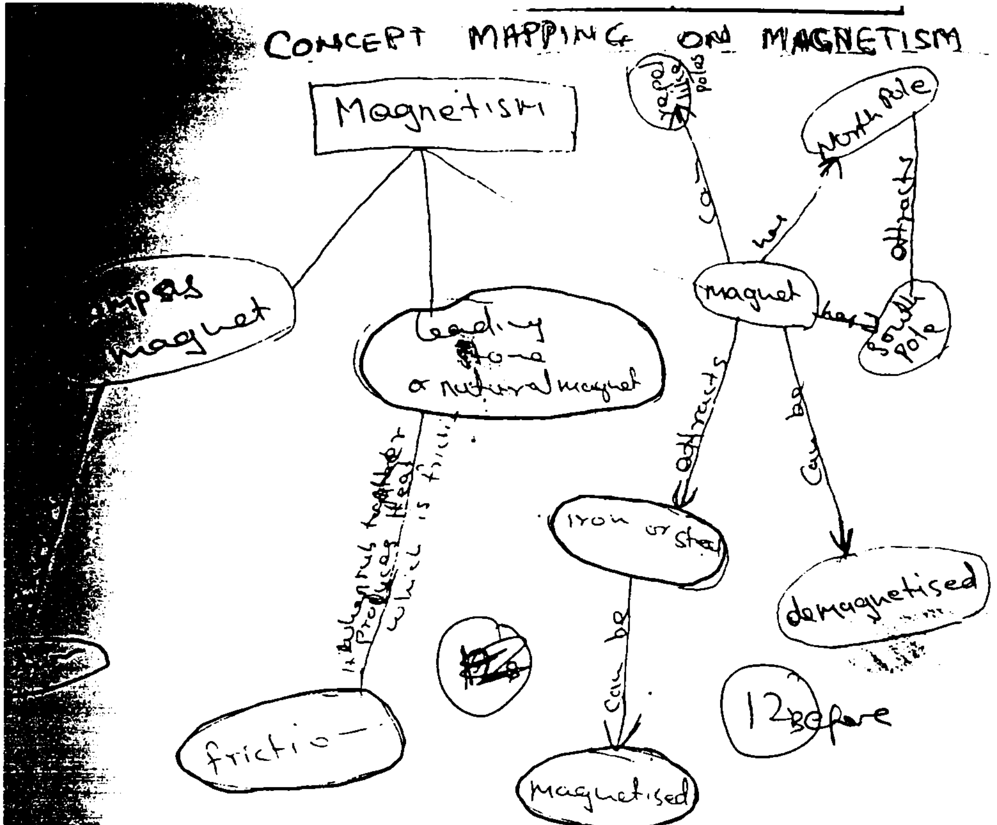




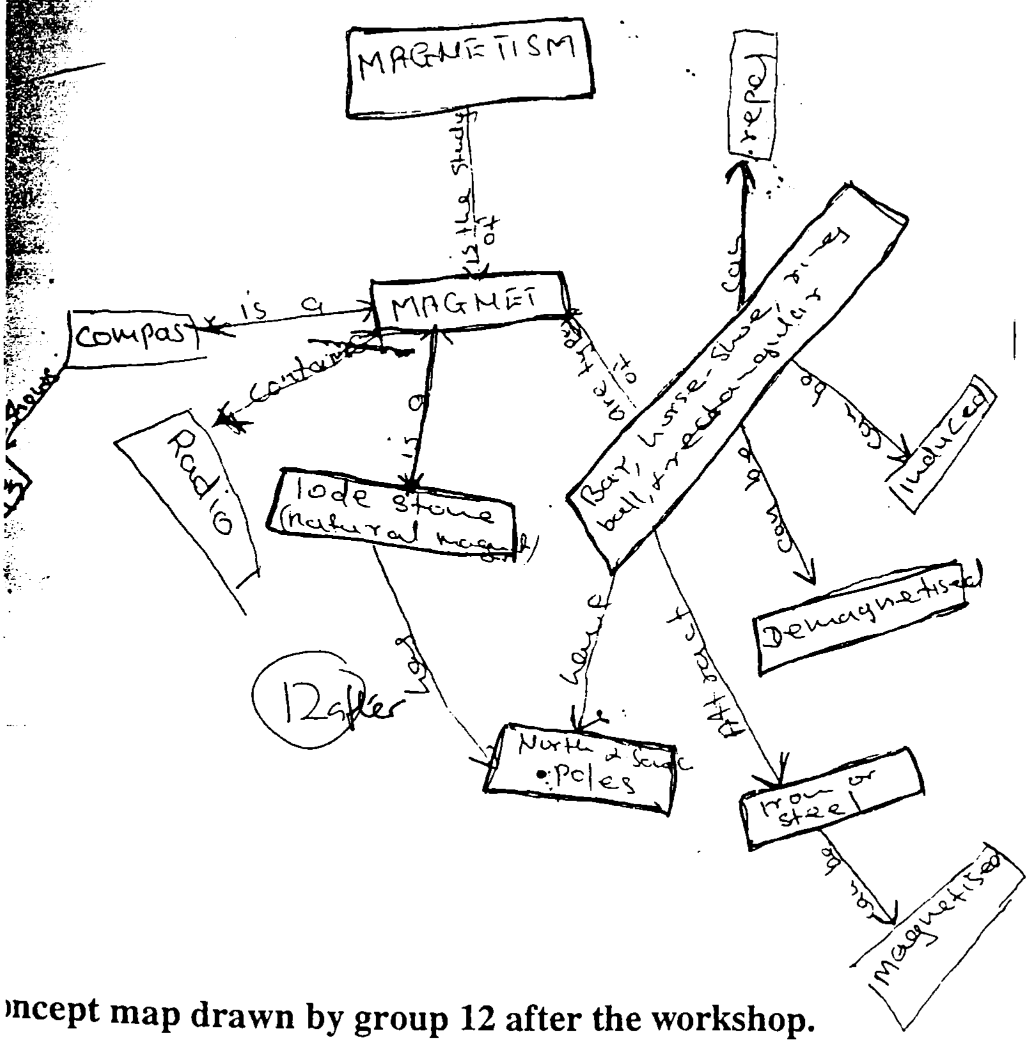
Concept map drawn by group 11 before the workshop.



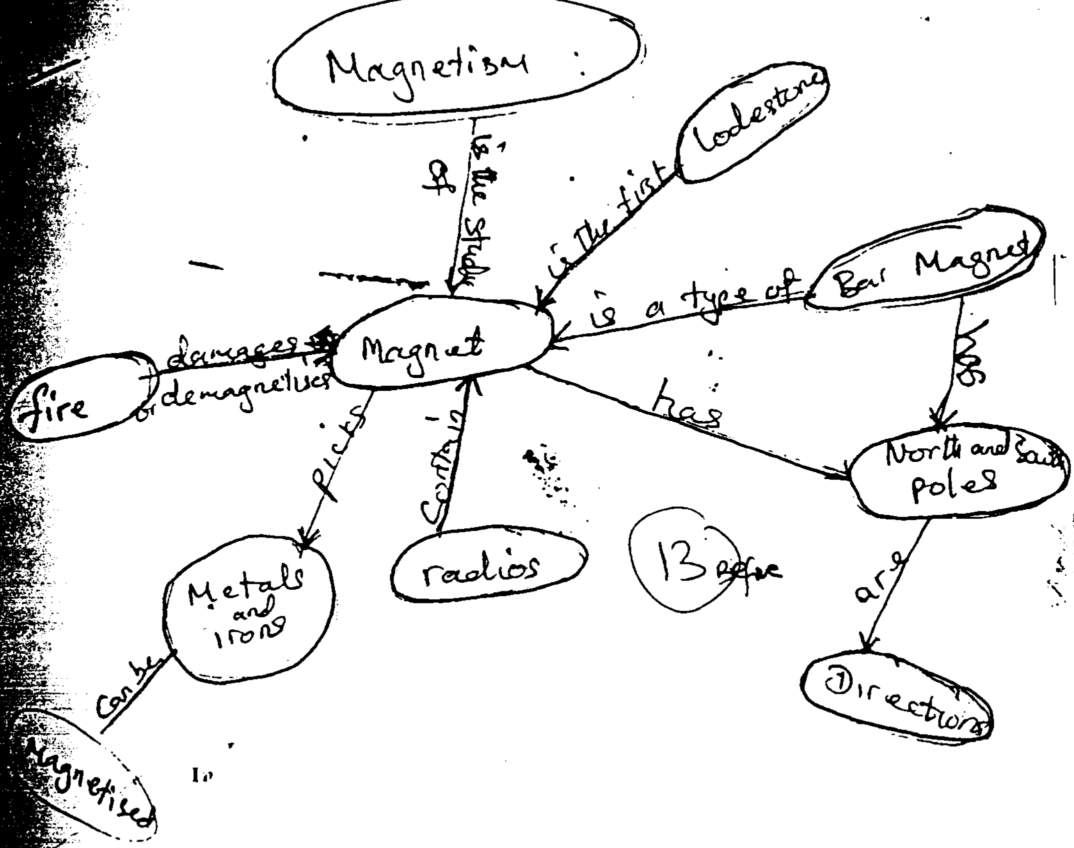
Concept map drawn by group 11 after the workshop.



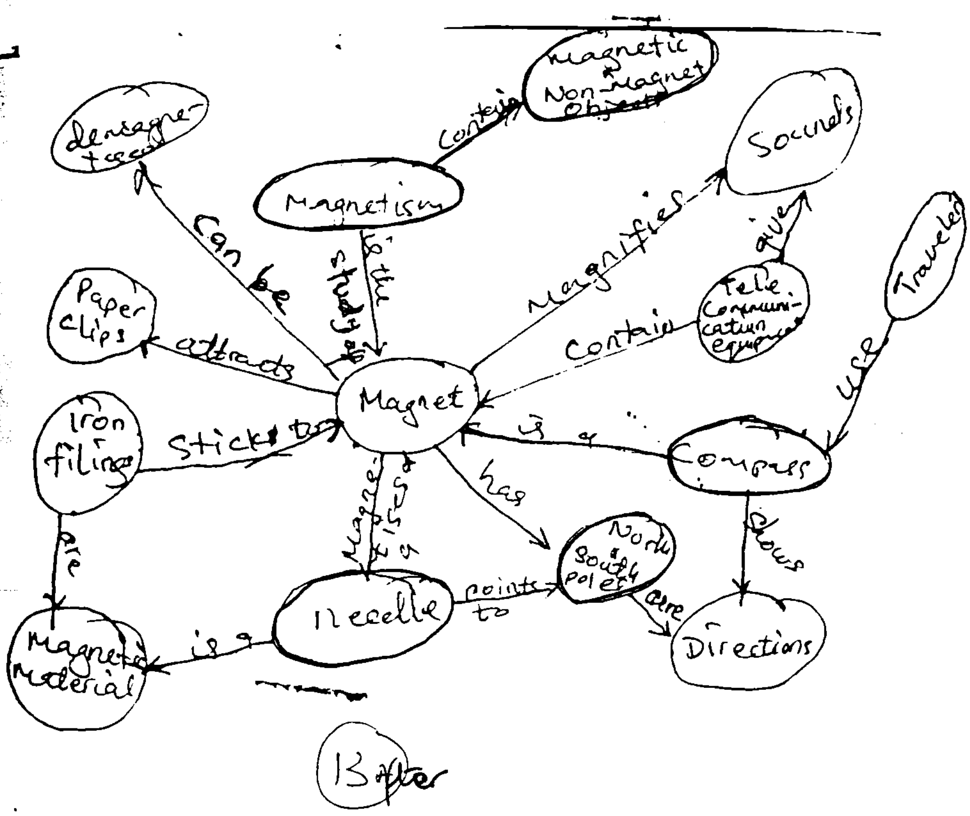
Concept map drawn by group 12 before the workshop.



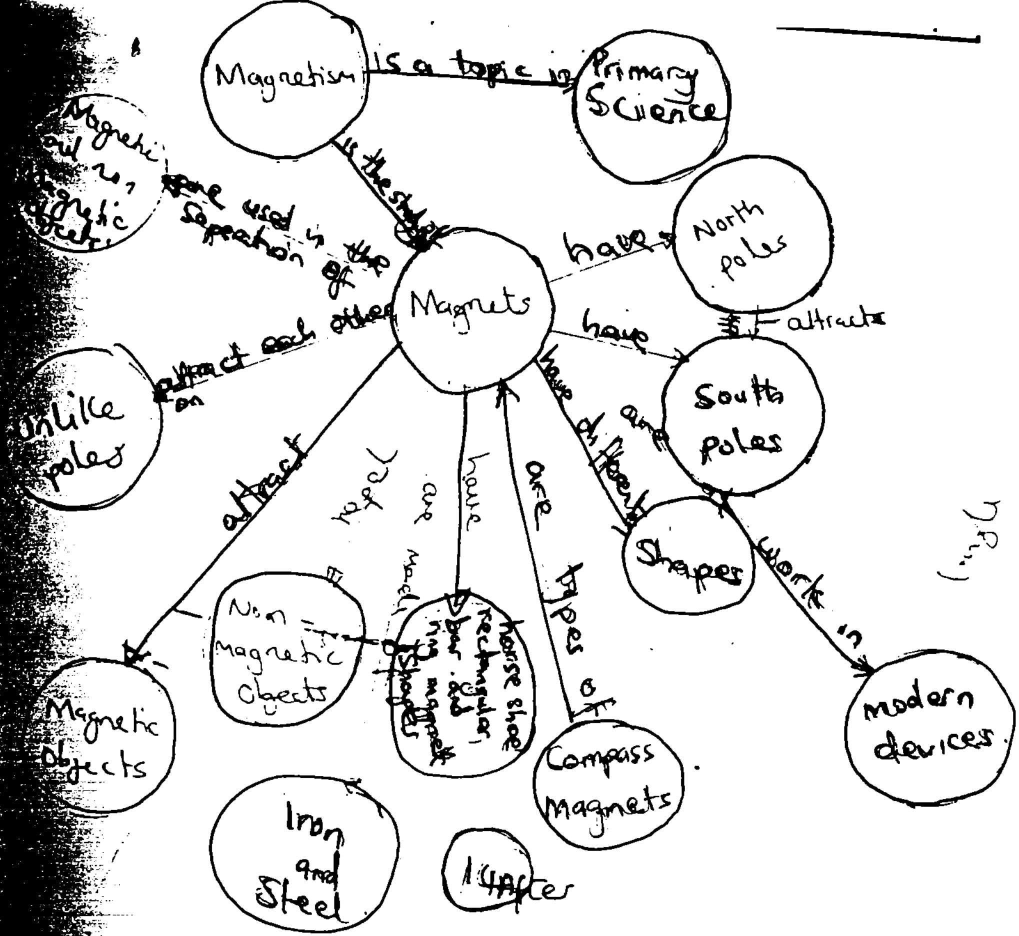
ncept map drawn by group 12 after the workshop.

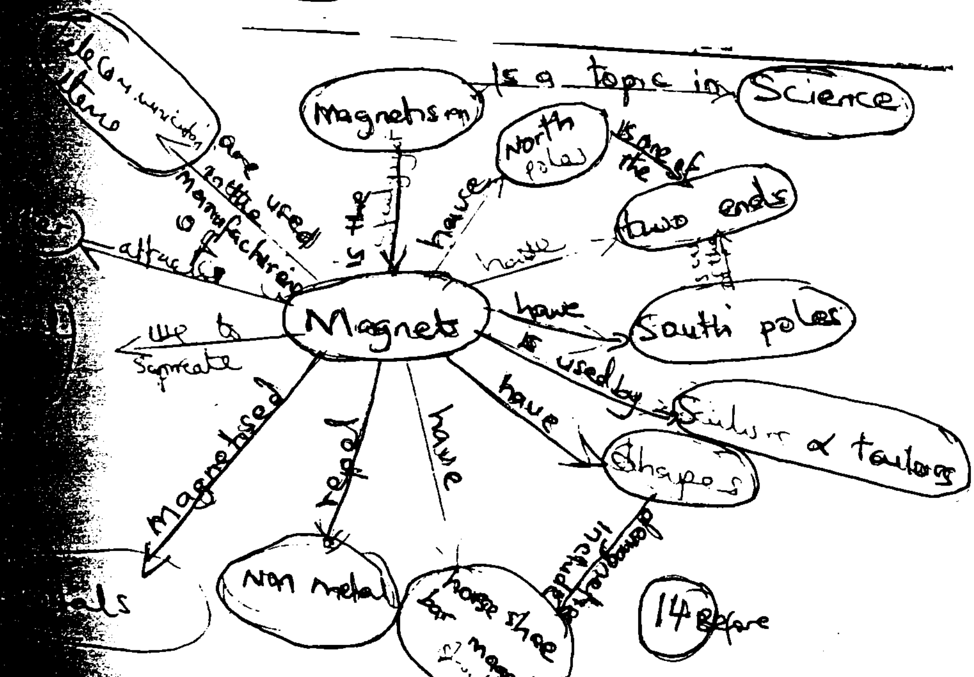


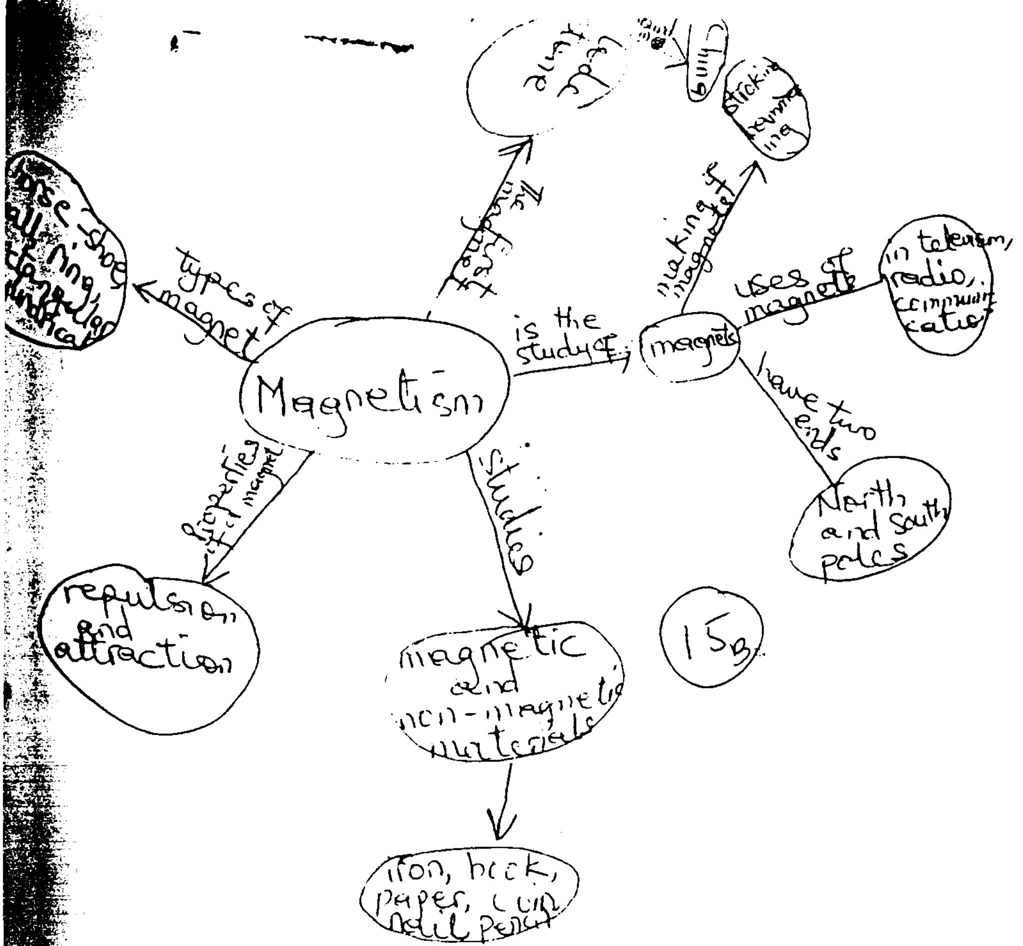
Concept map drawn by group 13 before the workshop.

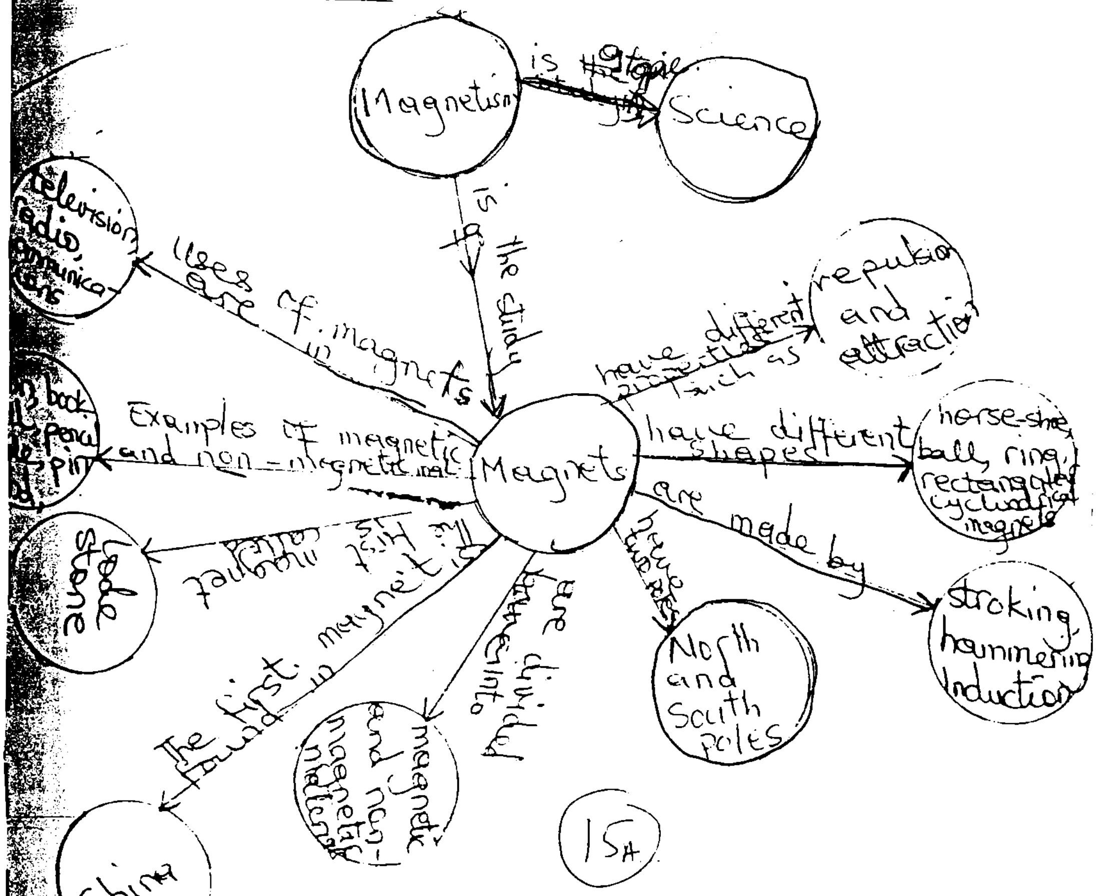


Concept map drawn by group 13 after the workshop.


Magnetism
is a topic in
Primary Science
Magnets
have
North poles
have
South poles
attracts
have different
Shapes
work in
modern devices
are types of
Compass Magnets
Non magnetic Objects
attract
Magnetic Objects
Unlike poles
attract each other
Iron and Steel
14 After


Magnetism
is a topic in
Science
North poles
is one of the
two ends
have
South poles
Magnets
used by
Shapes
repel
Non metal
have
horse shoe bar magnets
magnetised
14 Before


Magnetism
is the study of
magnets
types of magnet
horse-shoe, ball, ring, rectangular, cylindrical
properties of magnet
repulsion and attraction
studies
magnetic and non-magnetic materials
iron, book, paper, coin, nail, pencil
uses of magnets
in television, radio, communication
have two ends
North and South poles
making of magnets
stroking, hammering
lode stone
15B


Magnetism
is topic
Science
is the study
Magnets
uses of magnets are in
television, radio, communications
Examples of magnetic and non-magnetic
have different properties such as
repulsion and attraction
have different shapes
horse-shoe, ball, ring, rectangular, cyclindrical magnets
are made by
stroking, hammering, Induction
have two poles
North and South poles
are divided into
magnetic and non-magnetic materials
The first magnet is found in
China
The first magnet called
lode stone
15A

APPENDIX K.
2-day WORKSHOP ACTIVITIES MANUAL.

Materials required:
Bar magnets, Horse-Shoe magnets, Round magnets, Small pieces of magnets.
Iron fillings, Plain papers, paper clips, needles, corks, gold ear-ring, silver spoon, aluminium spoon, Magnetism Game Board.

Activity 1.
You are provided with two magnets of different shapes and sizes. Try each magnet on another and make observation when doing the following :-
a. What happens when you use a particular end of the magnet on one end of another magnet. Try the same process with the other end. Record your observation.
b. Try the process with as many types of magnet as you are provided with. Do you have the same feelings with all of it?
c. Try your magnet on your pile of materials and classify those that attract to and those which do not attract to magnet.

Activity 2.
a. Place two magnets in the position as shown in the diagram below. Place a plane sheet of paper on the magnets as they are placed in the position described below. Gently sprinkle the iron fillings on the plain paper close to the position where your magnets lie. What happens? Draw to show the alignment of the iron fillings.

Change the position of the magnets and repeat the process.
Draw to show your observations.
b. Use a strong magnet to move the steel pins on top of the plain paper. Add more of the paper and try to move the pins again. Continue this process until the pins stop moving. Why do you think the pins stop moving?

Activity 3.
Let's Go Fishing.
Tie a rope on your Horse-shoe magnet. Use it to catch as many fishes as you can from the pond.
Are there fishes that you couldn't catch?
Can you explain why you couldn't catch them?

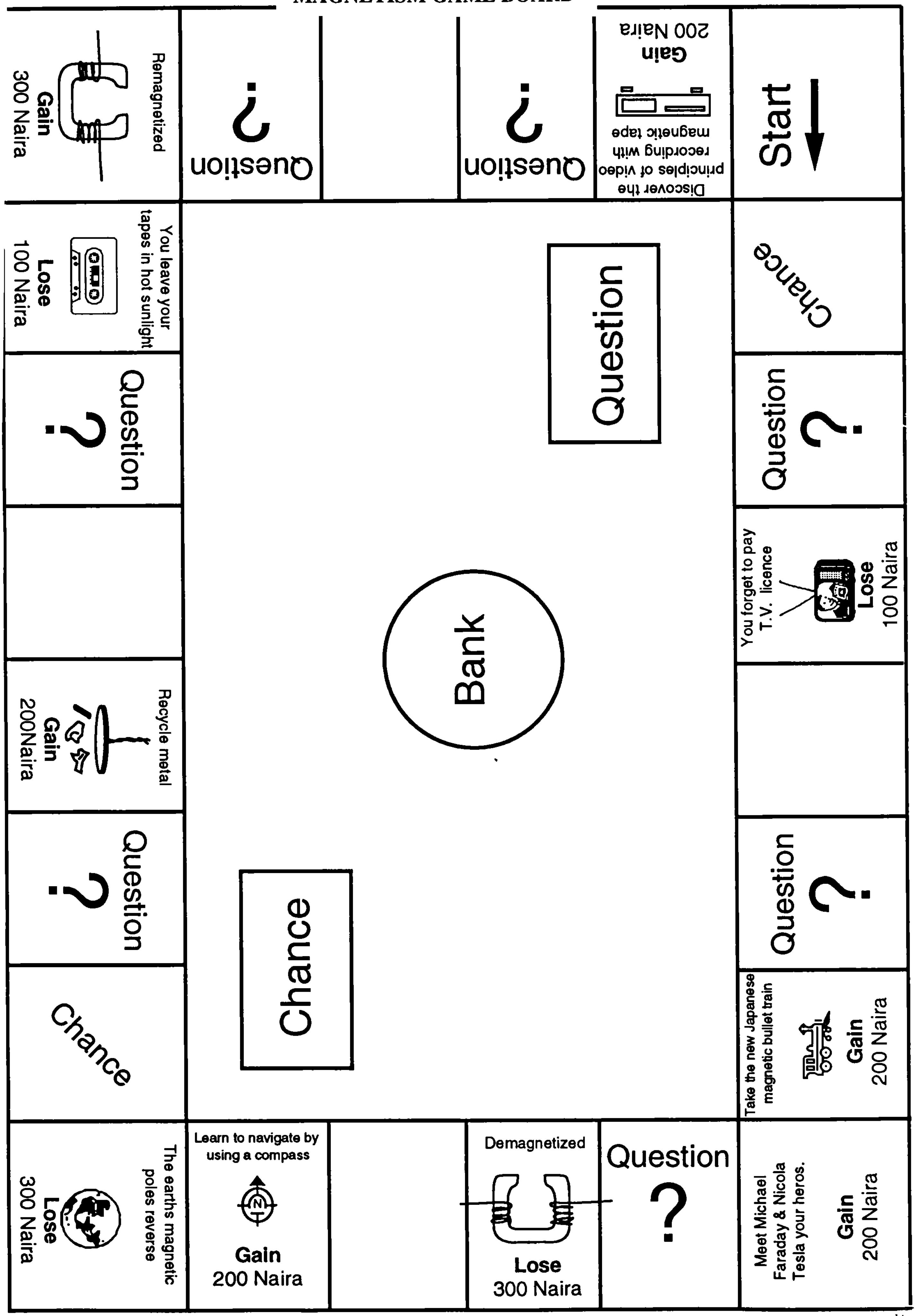
Activity 4.
Stroke a needle with a magnet. Insert the needle into a cork and put it into a large container filled with water. Allow it to float.
Where is the North and South poles positioned?
Tie the Bar magnet on a rope of about 50cm long to enable it dangle. Allow to dangle until it stops.
Which position is the north pole?
Can you draw the position of your workshop centre from this experiment.?

Activity 5.
"Indian Rope Trick "
Look at the trick on this workstation carefully and say why you think the paper clip is standing on its own.
Give an explanation to this effect.

Activity 6.

Provided are the game board and the accessories. Read the instruction for the game and play in pairs. You can exchange where you are more than two in a group.
What are the advantages and disadvantages of the game?
In a class of 40 pupils, in what ways can this game be used to teach magnetism?
When in your own view is the best time to use this game?
Give your view of the merits and demerits of the game?

APPENDIX L
MAGNETISM GAME BOARD



Guidelines for playing the Magnetism Game:

To start the game, each player picks 500 Naira from the bank before the game starts. Every player chooses a 'seed' which is either blue or red. Each represents a magnet carrying two poles. The two 'seeds' are placed in the 'START' position at the same time before the game starts. An arrow on the game baord shows the direction in which a player can move.

Naira: This is paper money in the local currency which the player uses in playing.

The Bank: This is point on the game board where the paper money are kept when playing the game.

Chance Cards: These are set of cards which have writings on them and commands the player on what to do when one of it is used. Each of the card has different command to give. When a player lands on a chance point marked on the game board, the player picks one of the cards and then reads it aloud to the hearing of the oponent. The player who picks it would do as commanded on the card.

Questions: There are squares on the game baord which are marked 'Question'. A set of questions are made which are to be kept on the space marked 'Question' provided at the centre of the game board just as in the 'Bank' and 'Chance Card'. If the individual lands on a position marked 'question', the oponent picks a question from the question bank and reads it out to the other player. The one who lands on the question answers it. If the answer provided is correct, the person gains 100 Naira, otherwise, the person loses 100 Naira.

APPENDIX M
CHILDREN'S IDEAS ON MAGNETISM SCHEDULE

What do you think is a magnet?

Draw on the space provided below to show your perception of what a magnet is

What do you think magnets are made of?

How can you differenciate a magnet in the midst of several other objects?

Draw on the space provided different type of magnets you have seen before.

How does a magnet work?

Make a list of all kinds of objects that can stick to the magnet.

Do you think that all the objects listed above are made of the same materials?

Does your mother have a magnet in her sewing kit? What does she use it for?

How can you separate objects like iron and steel when mixed together? Can you invent a game using the above idea? What is a compass? What is the use of a compass? Can a magnet be used as a compass?

APPENDIX N.

FOLLOW-UP INTERVIEW PROFORMA.

Name of school...

Teacher Code...

Date of Visit..Time...

Talk with the Headteacher.

Explain the purpose of the visit and thank him/her for cooperation.

Did the participated teacher inform you of the outcomes workshop. Yes No

If Yes, How did you think that the workshop is affecting or has affected your school?

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....

Have you organised any similar workshop in your school? Yes No.

If No, Do you intend to do so?

How do you think that the other colleagues can benefit from this workshop?

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To the participated Teacher.

Thanking you for attending the workshop.

Find out from the teacher the following:

What do you think are the benefit of the workshop?

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Have you used the strategies? Yes No.

If Yes, Did you have any difficulty(ies) using them?

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If Yes, Are the problems solved? How?

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What are the pupils attitude to the use of the strategies? Any change of attitude observed?

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Do you think that the strategies have helped in changing pupils' attitude to science? If yes, How?

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....

What were your colleagues' attitude to the use of the strategies?

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....

Can you run a similar workshop for your school? Yes No.

If yes, Any assistance required?...

If No, Why?.. ....

Have you used the strategies in other topics in science? If Yes, What topics?

....

Have you used the strategies to teach other subjects that are not science? If Yes, What subjects?

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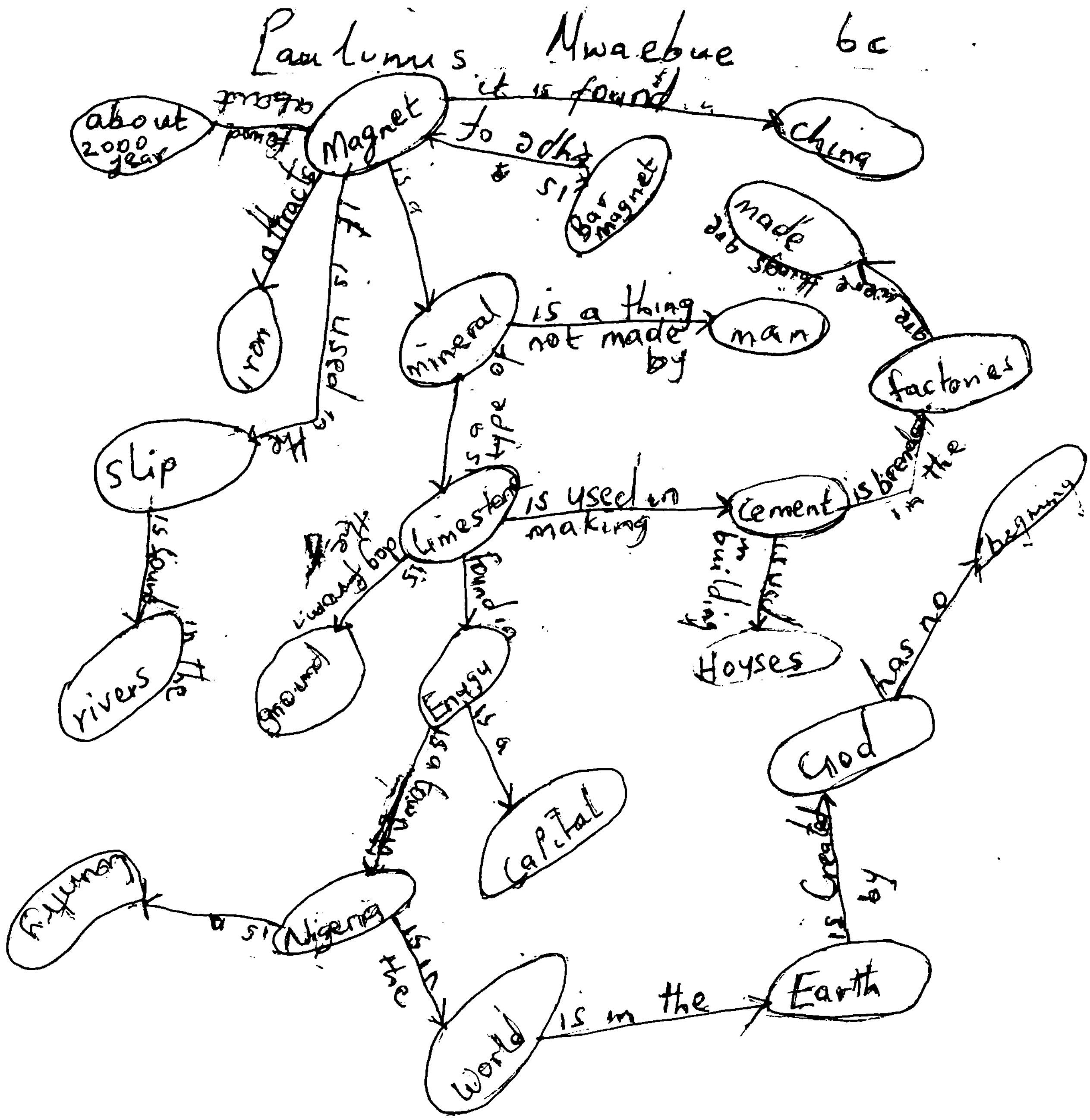
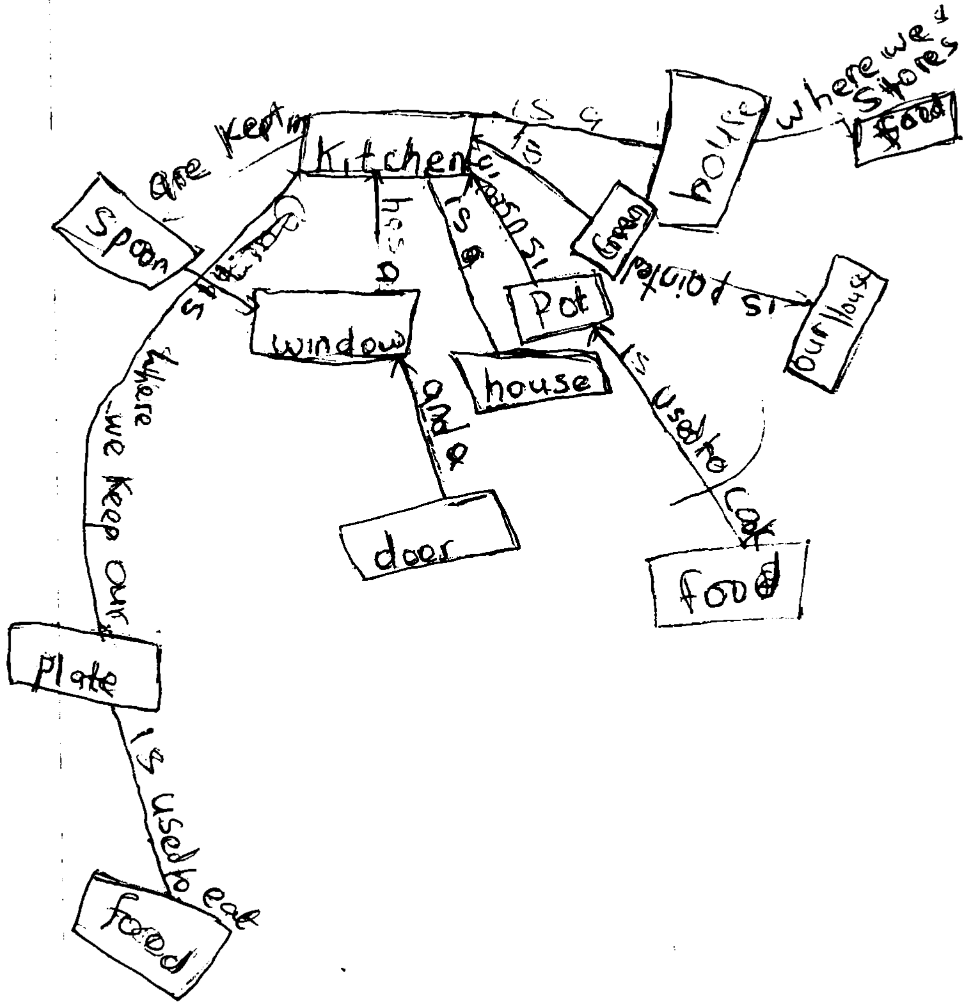
....

APPENDIX O
CHILDREN'S CONCEPT MAPS ON DIFFERENT SCIENCE TOPICS AND OTHER SUBJECTS .

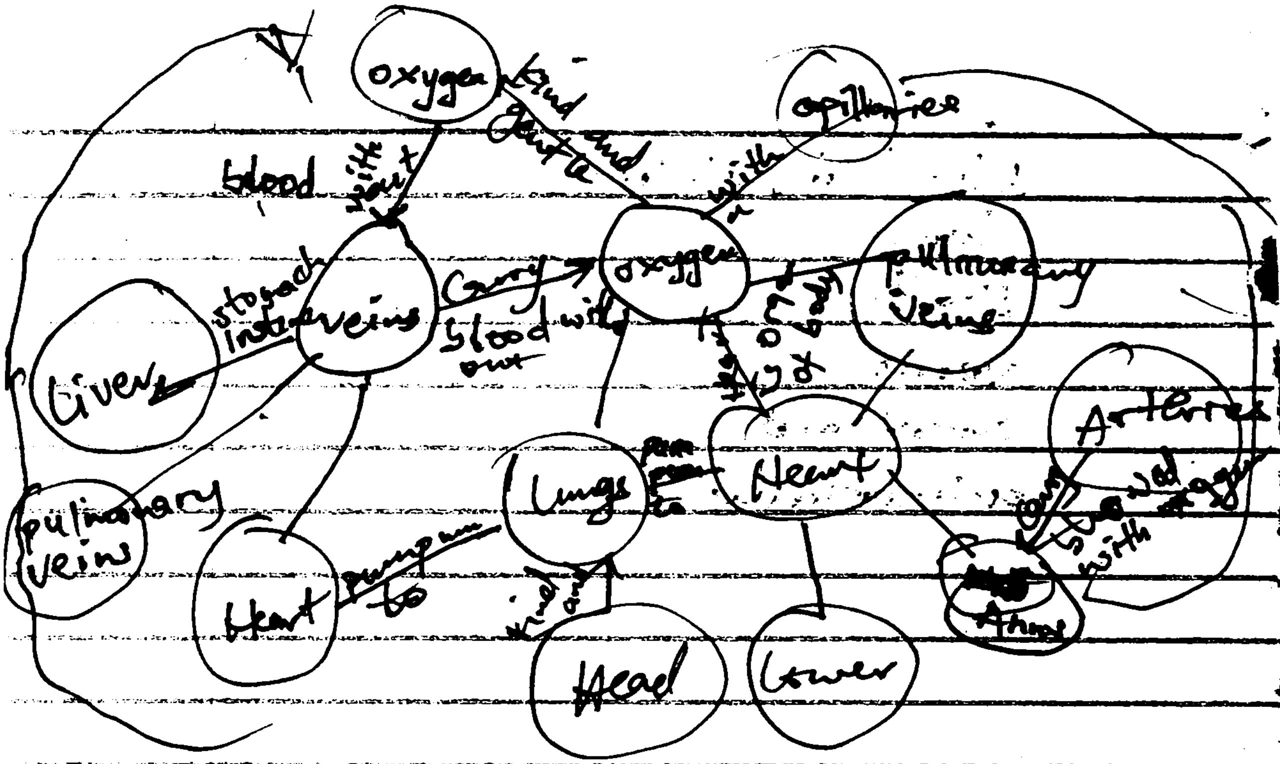


Ifeoma Arachie 13/7/17

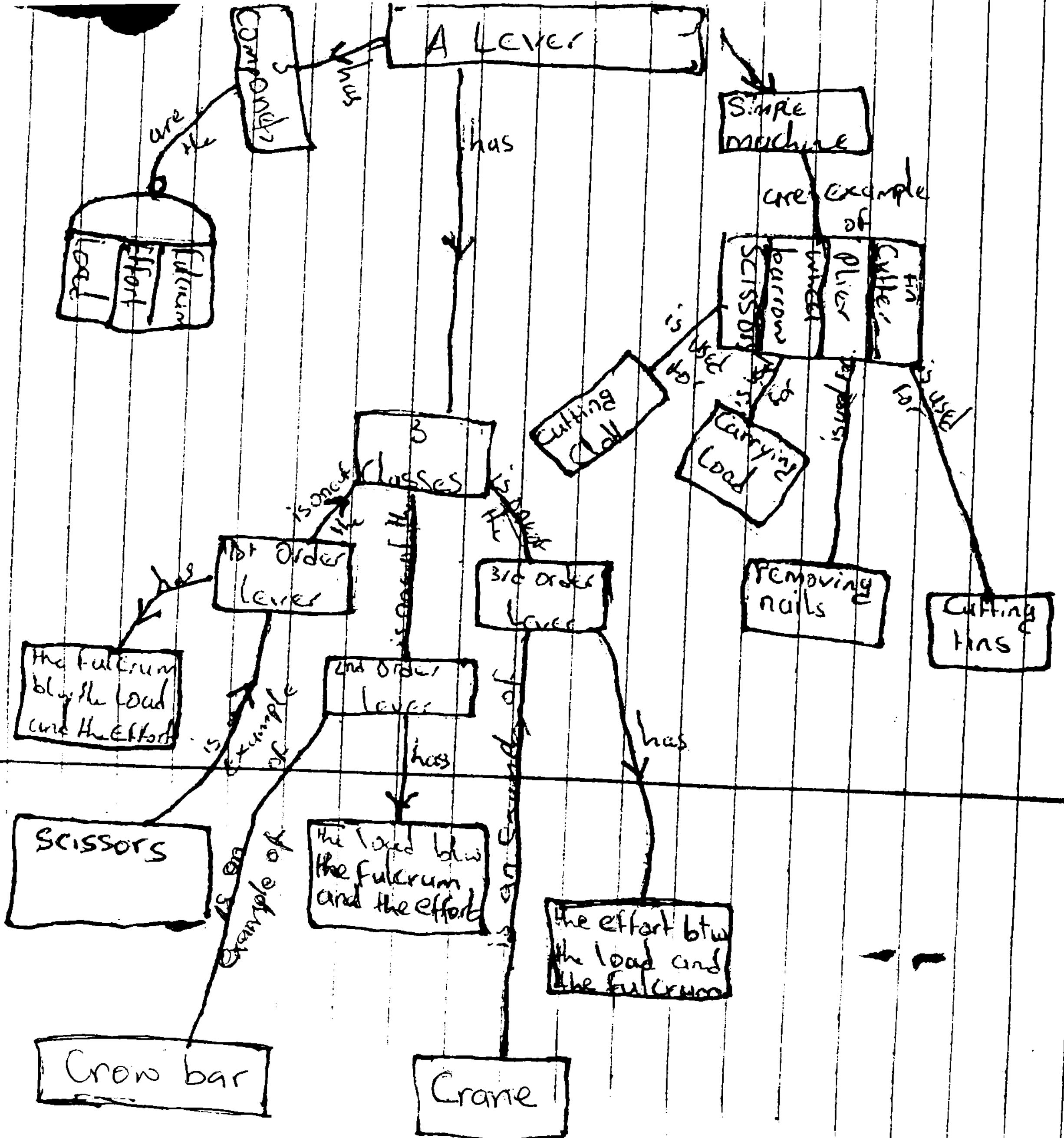
Concept maping



Union primary School Nibo



Obiageli Anagbogu
6B


A Lever
has
Components
are the
Load
Effort
Fulcrum
has
Simple machine
are example of
Scissors
wheelbarrow
Plier
Tin cutter
is used for
Cutting cloth
Carrying Load
Removing nails
Cutting tins
3 Classes
1st Order Lever
2nd Order Lever
3rd Order Lever
has
the fulcrum b/w the load and the effort
has
the load b/w the fulcrum and the effort
has
the effort btw the load and the fulcrum
is an example of
Scissors
Crow bar
Crane