THE NATURE AND PURPOSE OF PRACTICAL WORK IN THE SCIENCE CURRICULUM MATERIALS OF ADDIS ABABA ADMINSTRATIVE REGION - THE CASE OF GRADE EIGHT

A THESIS SUBMITTED TO THE
SCHOOLS OF GRADUATE STUDIES OF
ADDIS ABABA UNIVERSITY

IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE MASTER
OF ARTS IN CURRICULUM AND INSTRUCTION

BY
AKALEWOLD ESHETE

JUNE, 2001

ADDIS ABABA UNIVERSITY
SCHOOLS OF GRADUATE STUDIES

THE NATURE AND PURPOSE OF PRACTICAL WORK IN THE SCIENCE CURRICULUM MATERIALS OF ADDIS ABABA ADMINSTRATIVE REGION-A CASE OF GRADE EIGHT.

BY

AKALEWOLD ESHETE

APPROVED BY BOARD OF EXAMINERS

Marew Zewdie	
Chairman, dep. Graduate committee	Sign
Derebssa Dufera	
Advisor	Sign
Johnson Odharo	
External Examiner	Sign
Temechegn Engida	
Internal Examiner	Sign

AKNOWLEDGEMENT

I am indebted to my advisor Dr. Dribssa Duffera (Institute of Educational Research, Addis Ababa University) for his help and guidance throughout the study. I would like also to extend my deepest gratitude to my family members and fiancé-Hiwot berhanu for their support and help. Above all, I thank the Almighty God who helped me in giving health and vigor to start and finish my study.

CONTENT OUTLINE

CHAPTER FIVE

LISTS OF TABLES.

LIST OF ABBREVIATIONS

MOE= Ministry of Education.

UK= United Kingdom.

USA=United States of America.

NETP= New Educational and Training Policy.

AARCD= Addis Ababa region Curriculum Division.

AACAEBCDRD= Addis Ababa City Administration Education Bureau Curriculum Development and research department.

LIST OF APPENDIX

ABASTRACT

Science education is in a state of debate since 1960s; hence, reform becomes characteristic features of the science curriculum and instruction. One areas of debate in science education is the role and aim of practical work though its importance is under consensus. In the Ethiopian context, no clear position statement was given but practical work was taken as an integral parts of the science curriculum and hence designed to give hands-on and minds-on experiences. This paper attempt to examines the nature and purpose of practical work included in the science curriculum materials of the Addis Ababa Administrative Region. Therefore, the science curriculum materials, teacher's opinion and examination booklets were taken as a source of information. Using different content analysis schemes and questionnaire, relevant information was obtained.

Evaluation of these practical activities was made with respects to their potential in providing for problem-solving skills. The specific lesson objectives of the guides were analyzed to reveal the nature of science and aims of practical science included in these guides. The results show that the product of science stirred the curriculum, and exceeds by far, even all the process objectives and the affective dimensions were added together. Such nature of science lacks to give experience in the method and interest to science and hence would distort students image of science as a body of knowledge. Analysis of the guide for practical aims showed consistency. The majority (73.68% in biology, 66.66% in chemistry and 37.70% in physics) had elucidating the theoretical knowledge. Other important aims of practical work like arousing of interest in the science and technology, skills of using models and developing investigative skills are totally not found.

The practical activities in the student textbooks were also analyzed from different perspectives. Unlike what was expected, in the NETP, the result shows consistency with the analysis of aims for practical science. The majority of practical (93.75%in physics and 81.81% in chemistry) served to illustrate the scientific concepts covered. Inquiry level index of these activities showed that 77% of physics activities were found at a level of 0 and 70% of biology and 75% in chemistry at level 1. Maximum opportunity left for pupils, if at all there is, hence, was to collect data and makes generalizations. Through laboratory assessment inventory, again, major problem solving skills -planning was totally absent. Analysis and Application categories were poorly treated and Performance was fairly represented. The curriculum material would, therefore, generally fail to represent the framework guideline stated by the policy.

Evaluation of resource, in line with the materials and apparatus stated in the textbooks revealed that the analyzed schools have no potential, even to perform demonstrations as the only methods of practical teaching, let alone group experimentations. Hence, such result had its own implication- development of practical manipulative skills and problem-solving skills will be deterred. Both the National and school final examination showed consistency in that no practical assessment was found. The majority of questions in both exams booklets ask student's specific information and terminologies. Teacher's response also shows consistency in most cases.

The outcomes of the study have significant implications from the need to have science education policy, improving the school science curriculum materials in line with the resource available and overall appraisal must be effected with the teacher-training program, assessment technique, resource requirements. Teachers must also be challenged to change their 'old' confirmatory position and should be encouraged to use practical work in school science teaching.

CHAPTER ONE

1. INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Practical science has been the subject of controversy. Layton, D in UNESCO (1990) showed how it was perceived from the time when Todhunter made his first attack on the unscientific nature of school experiments and then Armstrong extolled the 'art of making children discover things for themselves' up to present day. Recent authors like Hodson (1996) and Gott and Duggan (1995) traced the changing nature of laboratory work from the 1960s to the present and showed how it was distorted and misrepresented the scientific inquiry.

The last three decades brought a drastic change in both its nature and practices, due to the different curriculum and pedagogical orientations. Just after 1950s, schools in the United Kingdom and America moved from the standard "cook book" exercise that verifies a theoretical part covered to the "guided discovery" through different approaches like Physical Science Study Committee (PSSC), Biological Science Curriculum Study (BSCS), Chem-Study in America and Nuffield courses in UK, to the various "process" course after the initiation made by the American Association for the Advancement of Science called Science- A Process Approach and the Warwick Science (Screen 1988a) Science in Process (Wray et al. 1987) and the Oxford shire Certificate of Educational Achievement (OCEA) in UK (Woolnough 1991; Gott and Duggan 1995). Such new curricula were designed so that students would discover conceptual knowledge through activities designed to mimic scientific inquiry (Hodson 1996).

Such initiations stemmed from the existing unsatisfactory practices, and all had their own critics (Woolnough 1991; Gott and Duggan 1995; Hodson 1996). The standard practical activities were criticized for leading students to the "right result". Such activity gives hardly any freedom on part of students to experience doing science and understands the underlying theory. Guided discovery or "stage-managed heurism" approach to science were criticized for failing to realize their dual aims- to make every individual feel like a scientist and discover a predetermined scientific content. For these aims were logically and practically incompatible (Stevens 1978; Wellington 1981) in Woolnough (1991).

To disentangle such dilemma a new approach was appeared- design courses that focus on a process of science. Such interventions were criticized for their assertions that such processes exist in isolation as distinctively scientific, independent of theory and taught to pupils will be synthesized when students solve a scientific problem (Miller and Driver 1987; Jerkins 1987) in Woolnough (1991). The uncertainty in the basic assumption that pupils learn by a 'step-up' approach whereby they are encouraged to master the basic skills first and thereby enabled to progress to more complex process skills and eventually to practical investigations, led to a holistic approach.

The basic argument, do pupil develop the investigational abilities best by learning the bits and putting them together or do they learn to do investigations by doing investigations? Brought another orientation to practical science - the holistic approach (Woolnough 1991;1994; Gott and Duggan 1995)) in the form of scientific investigations. Investigations allow students to use and apply both concepts and cognitive processes, as well as practical skills. They are considered as a more balanced view of science in response to the extreme of the past (Gott and Duggan 1995).

While practical work in science was and continues to be regarded as essential, its precise purpose is much less certain (Gott & Duggan, 1995). More recently, critical evaluation of the effectiveness of practical work in promoting learning in science has suggested that the returns on investment (of time, resource, and energy) are not good. Klainin (1988) offered reason from its ineffectiveness, namely problems of implementation and of incentive, while Gidding and Fraser (1988) point to lack of conclusive research into the true worth of practical work.

The issue practical work was not new in the Ethiopian school science. Reform in science education in 1950s and after that affected our school science as well. The inquiry approach in the 1970s had a profound influence in the junior and high school science subjects with the provision of inquiry methods and science kits for doing practical. Now we are in a new stage in the Ethiopian school curriculum development. Regions had the privilege to construct their own curricula for primary schools in line with their cultural and physical resources (MOE 1994a). It was assumed that such practice will bring relevance and practical experience to students than the former centralized curriculum. This paper attempts to study, partly, this assertions in line with the major objectives of the study.

1.2 STATEMENT OF THE PROBLEM

Science education, and particularly the way its curriculum was conceived, underwent a major reformation in the period from the late 1950's to the early 1970s. Despite all the recent rhetoric about the importance of primary science, most societies remain unconvinced about the worth of science at this level (Fensham P.J, 1992). This was partly justified due to the confusion created as a result of the various reform which subsumed different aims for science and the mismatch observed between intentions and results of the science reform programs.

As there are different perspectives on the purpose for science education, there is also a rich literature on the different views educators' hold to the inclusions of practical work in the science curriculum (Gott and Duggan 1995; Woolnough 1991; and Joan, E et al. 1986). With the inceptions of different paradigm for science curriculum, the practical work assumed different nature and purposes (Gott and Duggan 1995). Many researches, on the other hand, reported that there was a mismatch between the intended outcomes and the result obtained (Fensham in Jackson 1996). For example, though the purpose of practical experiences at the lower secondary schools in the UK was to encourage enthusiasm and excitement, the Department of Education and Science had criticized the practice as fulfilling the functions of illustrating previously taught theory 'rather than encouraging skills'. The activities were also found to give few opportunities for pupils to design investigations or interpret observations (Bentley and Watts, 1989).

Beside the nature and aims of the activities included in the curriculum materials, other factors could also affect practical science, like the demand for a huge quantity of resources (laboratory rooms, apparatus, chemicals, materials, and time). For this reason some educators, argue against practical science since the return on investment is not good (Layton D, in UNESCO, 1990). Severe resource constraint operate in all Ethiopian schools. The policy do witnessed this condition and suggest it as a task which deserves attention. Besides this the regional curriculum development practice could also contributes both to suggest and supply feasible resources applicable with in the region.

Practical assessment is another important discussion in practical science. Large class sizes and scarce resource together with unrealistic demand on teachers are commonly advanced as arguments against effective assessment of students' practical investigative activities. Berhanu (1999) and Bekalo and Welford (2000) showed that there is no instances of practical assessment in primary and secondary school of Ethiopia. No practical questions are found in the ESLCE in the context of experiment (Bekalo and Welford 2000).

The NETP showed interest in science curriculum development to make it problem solving (MOE, 1994a). Since Ethiopia is characterized as low-income, predominantly rural population, and economy based on primary products, such adopting of new orientation to school science curriculum will inevitably demand commitment often beyond the realistic capacity of the country to deliver. The policy admitted the great shortage in normal facilities of the schools in terms of trained teachers, laboratories and equipment for teaching practical science. The policy also promised to change the severe shortage of these requirements but still no attempt was made by the government, especially in providing laboratory facilities for science courses.

The effectiveness of the science instructions in fulfilling these tasks demands on how the laboratory is used which include the nature of the exercise and investigations, the way the students interact with the teacher and with each other, and the role played by pre and post laboratory discussions. One cannot realize to have these advantages of school practical science unless the science curriculum was planned and implemented properly.

1.3 OBJECTIVE OF THE STUDY

History of education in Ethiopia shows a similar development. The year between 1960s and 1980s there had a swing in the emphasis of the school science. Change in emphasis was made from the concept-led-curriculum to the process-led-curriculum and then back to the concept-led-curriculum (Berhanu, 1996). Ethiopian education was a victim of what Allosp in Woolnough (1991) called cultural imperialism. Even though we had political independence, we were under the influence of the metropolitans at different times. The experiences that the Ethiopian students had and the teaching staffs were all alien to the country.

In the 1994, the MOE issued NETP. The policy advocates problem solving as the central theme that governs curriculum development. With this guideline, a new syllabus was prepared and approved in a workshop held, where all the regions and administrative towns of the country took part, under the auspice of the Institute of Curriculum development and Research. The curriculum materials made for the different subjects were piloted between 1995 and 1998. Formative evaluation was made for each subject and compiled for each region. This research is; therefore, designed to explore the nature and purpose of the practical science in the Addis Ababa grade 8 science curriculum guides. The major purposes of this study are:

1. To identify the expected students practical outcomes of the science curriculum guides.
2. To identify the kinds of practical work in the science curriculum materials.
3. To identify those factors that influence the implementation of students doing practical work.
4. To assess teachers' perception and practices of practical work in their subjects.
5. To suggest how practical work can best be selected and incorporated into the science syllabuses.

1.4 RESEARCH QUESTIONS

The year between the 1940s and 1960s was considered as a high periods in the history of curriculum development in Ethiopia. During these years the schools curriculum was revised for almost eleven times. No evaluation report were available that shows why there was a need to change. Agedew and Zewdeneh (1982) documented only the different subjects that appeared at different times and they never dare to say what really accounted for these changes. The two successive government that came after the feudal regime accused the former regime educational system as elitist, and unresponsive to the needs of the mass. The Military regime employed the Marxists and Leninism as a social philosophy to frame the school curriculum development. The current government declared problem solving in its official document (MOE, 1994a). No attempt was made by the policy and any other document to define what the term problem solving means. Again, no suggestion was made on how to translate this guideline into a coherent framework for developing a curriculum. Each writer was; therefore, left to construct the curriculum materials intuitively. Hence, such context triggered the researcher to check the assertions made by these writers and assess the purposes and nature of practical work in the science curriculum guides. The following questions are taken to frame this research:

1. What aims and purpose has practical work in the grade eight science curriculum guides?
2. What are youngsters expected to do in their school science curriculum materials?
3. What are the factors affecting doing practical work in teaching science in the schools?
4. Do primary school teachers have the education and training background to teach and evaluate practical work in science?
5. How can practical work be properly incorporated into the school science curriculum?

1.5 SIGNIFICANCE OF THE STUDY

Teaching in science should receive special attention in developing countries like Ethiopia where the fruits of modern science and technology have to be utilized for the progress and prosperity of the nation. Teaching and learning process in the Ethiopian context is highly affected by what the curriculum materials (Curriculum guides and student and teachers texts) provides (Berhanu, 1996). It would be logical to study the nature of these curriculum materials in relation to what kind of experiences students have through performing practical activities, instructions to be followed to carryout experiments by the teacher and students to determine their quality with respect to the policy intentions.

Assessing the science curriculum has great advantage in identifying and pointing the place of practical work in the curriculum and in the actual practice. The results of this paper would therefore help curriculum developers at the ICDR and the different regions, textbook writers, educational office of the Addis Ababa Region, science educators at the training institutions and also science teachers. Results of the National document can help curriculum designers to see the place and aims assigned to practical science and its assessment techniques and can effect further revisions in the light of further studies. From the results of the analysis of the students textbooks, textbook writers and teachers benefit in knowing what actually students are supposed to learn by doing the practical suggested. The also learn the pedagogical significance of the different practical work in the development of problem-solving skills and are helped to judge the relevance of these activities in bringing the desired all-round profile of students, so that to effect further revisions.

Educational office of the Addis Ababa Region could also benefit in having the current status of the curriculum materials and the schools laboratory/ resource rooms facilities in line with what was suggested in the curriculum guides. Hence, they can devise sound means to alleviate the conditions and help implementation of the syllabus and ensure students have the required practical skills obtained through manipulating scientific apparatus and use them in solving personal and social problems. Science educators can also benefit in knowing the current practice of teaching science and design training package in their science methodology to help their trainees appreciate the significant role that practical work has and work in the prevailing local contexts.

1.6 DELIMITATIONS OF THE STUDY

This study explored the nature and purpose of activities included in these curriculum material prepared for grade eight by Addis Ababa Administrative Region. Though the assumption was, we can prepare a material that are relevant and potentially feasible, such assumptions in the light of the capacity of schools in realizing, would be under question. Science, in our schools is virtually never being learned by direct experience and most students even never experience a real experiment throughout their school programs. This study analyzes the curriculum guides, students' textbook, examination papers and teacher perceptions on practical work in the government primary schools. Its scope is limited only to the nature and purpose of practical work included in these materials, hence, it focused on the planned curriculum though attempt was made to catch its implementation through questionnaire. Other factors related to practical science -training and assessment procedures are also explored.

1.7 LIMITATIONS OF THE STUDY

This study questioned the wisdom of teaching primary science in the Ethiopian context when the emphasis was placed on practical work, since the local environment provided by the schools does not provide appropriate base. Due to the presence of financial and time constraints the study was limited to government schools only. The unnecessary delay in the process of releasing and the allocation inadequate money as compared to what was suggested in the proposal by the School of Graduate Studies of the Addis

Ababa University restricted the scope. The complete absence of literature on primary science education in the Ethiopian context was another series limitation encountered. An other limitation of the study was the opinion and practice of practical work is based on significantly small number of teachers (40 science teachers) as compared to the large population at primary schools. If there were enough finance, time and literature, all parties- teachers, students, different school types, training institutions would be appraised to come up with a sound recommendation.

1.8 DEFINITION OF TERMS

The following definitions are taken from Gott, R and Duggan, S. (1995: 13)

Practical work — 'tasks' or investigative work which may or may not be practical (in the traditional sense of apparatus experimentation) but which involve the pupil in active data collection or analysis.

Concept — substantive concepts-the facts, laws, theories and principles of science (e.g. gravity, photosynthesis, solubility) also known as declarative concepts.

Conceptual Understanding — The understanding of substantive concepts.

Investigation — A specific type of problem solving defined as 'a task for which a pupil cannot immediately see an answer or recall a routine method for finding it.

Problem solving — the solving of problem, i.e. any activity that requires pupils to apply their understanding in a new situation. Investigations are one type of problem solving.

Procedural understanding

The understanding required in knowing how to do science, the understanding and application of (skills and) concepts of evidence. It is complementary to conceptual understanding.

Processes — The cognitive processes associated with any intellectual activity including the solving of scientific problem. They include hypothesizing, interpreting, predicting, etc.

Skills — Those activities which are necessary but not sufficient in themselves to the carrying out of most practical work, e.g. the mechanisms of the use of measuring instruments, how to construct a graph.

Science curriculum materials

Includes the curriculum material, and the students' textbooks of biology, chemistry and physics of grade 8.

CHAPTER TWO

2. REVIEW OF RELATED LITERATURE

Science education has long been an area of contention. A review of elementary and secondary science curriculum in the United States in the 19th and 20the centuries shows a continuous debate about the primary goal of science education (McNeil, 1999). Another area of debate in science education is the purpose and nature of practical work. Researchers, educators and philosophers of science forward different positions. This section explore the concept of practical work, the aims for school science education and the different perspectives on the aims of practical science.

2.1 WHAT IS PRACTICAL WORK IN SCIENCE EDUCATION?

A number of European educators like Comenius, Lock, Pestalozi, Froebel, Herbert, Huxley etc. influenced the thinking in science education. As a group, they emphasized more child-centered approaches, independent thought, and sense impression as a basis of knowledge, and active rather than a passive role for the learner. The observational and inductive faculties would have to be strengthened through direct contact with the physical world, and students would have given the freedom to investigate on their own. This argument for direct contact with the natural world contributed to the middle to late nineteenth- century fascination with the science laboratory as an essential part of science instruction. Huxley had the believe that the real world has to be experienced directly. Huxley (1899) in (Bybee and DeBoer 1994) argued that:

> In teaching him botany, he must handle the plant and dissect the flower him/herself. In teaching him physics and chemistry, you must not be solicitous to fill him with information, but you must be careful that what he learn he knows of his own knowledge. Do not be satisfied with telling him that a magnet attracts iron. Let him see that it does, let him feel the pull of the one

upon the other for himself. And eventually, tell him that it is his duty to doubt until he is compelled, by the absolute authority of nature, to believe that which is written in books.

Practical work has gradually acquired an increasing prominent place in school science curriculum. The term laboratory work as used in U.S. literature corresponds to the term practical work for the U.K. and literature of its previously affiliated countries (Lazarowitz and Tamir 1994). The term practical work is criticized for too loosely defined and thus can seem both too broad and too specific. Hegarty (1990) defined the students' laboratory work to be a form of practical taking place in a purposefully assigned environment where students engage in planned learning experiences, and interact with the materials to observe and understand phenomena. Such definitions may not be consistent to the Ethiopian context, as a result a more loosely definition were coined.

The fact that there are sever constraints in the resources, especially, the purposeful environment called laboratory for practical doing, and due to suggestion of many such activities in the curriculum guides as demonstrations with in the classrooms, there comes a need to have a more catholic definition of the term. Hodson (1993) in Berhanu (1996) argued that practical work need not always comprise activities at the laboratory bench. He sees that any learning method that requires learners to be active rather than passive, accords with the belief that students learn best by direct experience. legitimate alternatives includes: work with case study materials, writing tasks of various kinds, making models, posters and scrapbook, library based research, etc. This paper will assume practical work as activities especially designed in the students' textbooks, where students are required to interact in some way, from thorough observation (in demonstrations) to employ some problem solving skills in doing the science (in case of doing simple experiments).

2.2 THE AIM OF SCHOOL SCIENCE EDUCATION

The first questions that require resolution before discussion of the aims of practical work must be preceded by the need to clarify the purpose of science teaching as a whole. Important and fundamental questions for which the answer depends on the social conditions and educational priorities as stated by Woolnough in Reiss (1993):

> What is the justification for teaching science in our schools? For educational or vocational reasons? Providing science and technology for all, for future educated citizens, or to provide adequately prepared and motivated students to fulfill the industrial needs of the country?

A variety of opinion exists in the goal of science teaching. Overtimes change in goals influenced subsequent changes in science curricula and instructional techniques. Bybee and deBoer (1994) synthesized two views on the goals of science teaching. The first way includes (1) to acquire scientific knowledge;(2) to learn the processes or methodologies of science; and (3) to understand the application of science. Under such organization, the student should have some knowledge of the products of science, should have experience with and understand the method of science and should understand how science serve as a force in their life.

The second view looks at the ends to which the knowledge, method and application apply. In this case, the goal of science teaching becomes (1) personal development; (2) social efficiency and effectiveness; (3) the development of science itself; and (4) national security. Martin (1997) conclude the goals inherent in the quality elementary science education as:

> The development of scientific literacy which involves developing the information base necessary to arrive at reasoned decision about scientific and technological issue. Though, statement of goals for science education is in a constant state of evolution, almost all people agree that emphasis should be made on less content, teaching more investigative skills, teaching from interdisciplinary perspective, teaching all children, stimulating children's interest in science, and especially, developing scientifically literate citizens.

Science was criticized in the 19th century due to the kind of method it employed and as a result stands against the prevailing religious value. At another time, its value was exalted than other disciplines in its unique contribution to the training of the different faculties of mind. Still now the debate on the aims of school science was continued. Although there is variation in the way science was valued, many reform initiatives in the USA and UK attempts to set in advance the purpose for including science in the school curriculum. For example: the purpose of science in the UK national curriculum (NCC, 1989, pA4, in Ratclifte, 1998), identified as 'the six 'important contribution of science to the school curriculum:(1) understanding key concepts of science will allow them to use them in unfamiliar situations; (2) using scientific methods of investigations will help pupils to make successful, disciplined enquires and use ideas to solve relevant problems; (3) appreciating the contributions science makes to society will encourage pupils to develop a sense of their responsibility as members of society and the contributions they can make to it; (4) learning in science contributes to personal development; (5) appreciating the powerful but provisional nature of scientific knowledge and explanations will bring pupils closer to the process by which scientific models are created, tested and modified; (6) giving students access to careers in science and design and technology is vital.'

With all these reforms, it was observed that practical science assumed different purposes. As shown in the literature, these reforms brought dichotomy in emphasis at the primary and secondary science: process of science was more emphasized in the primary science by taking products of science as a vehicle to teach the basic and integrated scientific skills. At the secondary school, more emphasis was given to scientific investigations which require both the application of science processes and concepts into a complete framework. As Bentley D and Watts M (ed) (1989) described practical investigations are features of most science classrooms as a result of the influence of the Nuffield Curriculum development Projects of the 1960s and 1970s.

2.3 ARGUMENTS FOR/ AND AGAINST THE INCLUSION OF PRACTICAL WORK

Science teaching laboratories are places for learning. Perhaps no other area in science education has attracted so many researchers reviewed as learning, teaching and assessment in the laboratory. This was due to consider its purpose, partly so that investment in laboratory can be defended. With these entire attempts, still we are faced with the problem of defending practical activities as essential component of the science curriculum. Lazarowitz and Tamir (1994) revealed research related to laboratory in science teaching and noted the following points: (a) there is little reference in the review to science in the elementary school, even though hands-on experiences is essential for meaningful learning at this time; (b) certain issues related to the students laboratory, such as separation or integration of content and process, have remained controversial in spite of the research conducted; (c) improving research by formulating more 'telling' questions and using better research design has remained a major challenge even in the 1990s; (d) it is still necessary to provide sound empirical support for the role of the laboratory and the steps that are needed to ensure that the potential of the laboratory will be realized.

A number of writers synthesized the works' of others and suggested a rational for school laboratory experience. Lazarowitze and Tamir (1994) synthesized the work of shulman and Tamir (1973) and Friedler and Tamir (1990) and presented seven rational statements. Tamir, in woolnough (1991) also synthesized the works of Lawson, Schwab, Ausbel, Bruner, Gagne, and others into five major reasons as a rationale for the student laboratory experience in school, into: (1) science involves highly complex and abstract subject matter; (2) students' participation in actual investigations, employing and developing procedural knowledge often referred as skills, is an essential component of learning science as inquiry; (3) practical experiences, whether manipulative or intellectual; are qualitatively different from non-practical experiences and are essentially for the development of skills and strategies with a wide range of generalizable effects; (4) the laboratory has been found to offer unique opportunities conducive to the identification, diagnosis and remediation of students' conceptions; (5) students usually enjoy activities and practical work and when they are offered and given a chance to experience meaningful and non-trivial experiences that become motivated and interested in science.

Most of these dimensions are also relevant to non-laboratory teaching as well. The instructional potential of laboratory is enormous. For some of the intended outcomes, the laboratory is essentially the only available setting in schools (Lazarowitz and Tamir, 1994). According to Ausbel (1968), the laboratory typically carries the burden of conveying the method and spirit of science, whereas the textbook and teachers assume the burden of transmitting subject matter content. Tamir (1990) emphasized that the laboratory is expected to provide for the development of motor and intellectual skills as well as problem solving abilities and affective outcomes since the major learning mode is direct experience. Olson (1973) maintained that schools serve poorly the development of skills, because learning skills require 'direct experience'.

During the last twenty-five years a major re-appraisal made on the uses and methods of practical teaching. However, there is considerable debate about the worth of practical work in school science. Knott and Muttunga in (Matiru, Mwtangi and Schlette 1995) presented three serious areas of debate in this line:

1. The high cost of laboratory work, making it difficult to continue providing facilities and resources to the standard felt necessary;
2. Several time constraints and overloading of time tables leading to serious problems in meeting syllabus requirements in quality and quantity;
3. Dissatisfaction with the effectiveness of conventional laboratory work which does not foster the understanding of scientific concepts and the application of scientific principles to solve problems.

2.4 THE RELATION BETWEEN THEORY AND PRACTICAL WORK

Justifications for doing practical work was argued and almost all authors have the convictions that practical work is vital and indeed central. The main difference lies is that, one group sees practical work being done primarily to enhance the students' understanding of the theories of science and those who see it as being done primarily to develop their ability to do practical problem solving science. An other persistent problem in practical science was the relations between theory and practice as' Is the role of practical work to increase theoretical understanding? Is the role of theory to aid the practical ability? Or should the two aspects of science be kept separate?

There are three distinct positions to this dilemma. Woolnough and Allosp (1985) argued against the practice of making practical work subservient to theory. they suggest a need to reconsider their mutually supportive interactions. They argued for separation between concept learning, which should be the function of non laboratory instruction and process learning, problem solving, getting a 'feel' for science, and developing scientific attitudes, which should be done in the laboratory without the constraints of particular content (Lazarowitz and Tamir 1994).

The second view to this dilemma is the assertion that the various skills and processes of science can be isolated and developed separately, sometimes even out of a scientific context, and then reassembled to produce the complete scientist. This position assumes science process skills (e.g. observation) are not theory-laden and context-independent. They consider the two aspect of science independently as if they have no relations.

The third position takes a holistic approach embracing skills and processes into the whole ability to solve practical problems, an embracing of knowledge and skills into the whole problem solving process, and an embracing of knowledge, skills and attitudes into the whole scientific investigations are central to this approach. Such investigations may be short or extended, related to pure scientific relationships or more technological problems, but each will have the same structure. They will start with a problem, which the student will then take, turn into a manageable task and plan a scheme of work. That plan will then be executed with apparatus selected or constructed, measurement taken, observations made, and results recorded and interpreted and conclusion will be reported in an appropriate manner for communication.

2.5 SCIENCE CURRICULUM ORIENTATIONS AND THE ROLE ASSIGNED TO PRACTICAL WORK.

Science education is in a state of rapid change. There has been argument and debate in recent years on what is important in science courses- process or concept. What is central to such argument was the role of practical work- its aim and not its importance (Gott and Mashiter in Woolnough 1991).

Millar, and Gott and Mashiter in Woolnough (1991) presented and Hudson (1996) criticized the three major movements in science education in the past three decades, had a style of practical work which seriously misrepresented and distorted the nature of scientific inquiry. Discussion on these moves on how they represent the nature and purpose of practical work in their philosophy and curriculum would be presented. History of practical work in the science curriculum was well documented by many authors (See Gott and Duggan, 1995, Woolnough 1991)

2.5.1 THE TRADITIONAL (KNOWLEDGE TRANSMISSION MODEL) SCIENCE CURRICULUM

Such a paradigm represent the curriculum orientation before the era of sputnik in America and the Nuffield Schemes in U.K. The aim of science education was considered as to fill the 'truth' of science. The students are considered as having empty minds and preconceptions. The underlying philosophy of science was inductivist in origin. Students are introduced to the topics through experiments and make neutral observations, generate hypothesis from these data and finally 'discovered' the concept.

The nature of practical work in such view have the purpose to illustrate or refine a concept. They were designed to help students see the concepts in actions. Such practical, do not aim to help students know the discovery process, but on giving understanding of particular concept or theory (Woolnough 1991). Such nature and purpose of practical work was criticized to two points: (1) they limit opportunity to put science in relevant condition since they tightly structured in purpose-built and pupil-proof apparatus; and (2) help students acquire fragmented knowledge in a fragmented contexts hence make recall difficult in a different context.

2.5.2 THE 'PROCESS' MODEL

Such approach to the science curriculum was adopted because of public despair on the event of sputnik in 1960s in U.S. and the 1970s in U.K. The major premise of this paradigm was to copy and translate into a framework what a scientist does as part of his every day activity. Hence, three federally funded K-6 elementary science curricula; SAPA, SCIS and ESS were developed in the 1960s based on the substantial body of research in U.s. and the Science in Process, the Warwick Process Science Projects in the U.K.

The major premise, of such approach was identified to give due emphasis to science methods than its products. Such curriculum initiatives were developed around an elaborate hierarchy of process skills. Acquisitions of these skills were viewed as a linear relationship in which basic skills (observation, inference, classification, predication, collecting and recording data and measurement) are learned before the integrated skills (controlling variables, interpreting data, defining operationally, formulating hypothesis and experimentation). Instructions at primary grades focus on the development of basic skills. According to Screen (Screen 1986) in Gott and Duggan (1995) the process-led scheme had two advantages. First, 'process skills' are not only useful in practicing science but also in questioning the practice of other scientific work. Second, the scheme allows the teacher to observe pupils' conceptions and misconceptions in lesson.

Such practice brought two strands. In the early years of its use, the processes acquired a metacognitive role. Lessons were focused on process skills (like observation) and then proceeds to illustrate what is to be observed. Hence, the processes assumed the status of goal. At a latter year, the processes were taken as a more efficient means to acquire concepts. Hence, they serve as a means and not as ends. In general schemes that adopt the process approach aim to consider, as far as possible, one process at a time as the focus of the lesson. The practical work then serves to illustrate the process in question. Bryce et al (1983) base their scheme on the idea that: "...pupils are encouraged to master basic skills first and there by enable to progress to more complex process skills and eventually practical investigation'.

2.5.3 THE KNOWLEDGE REFINMENT MODEL (CONSTRUCTIVISM).

An alternative model to the knowledge transmission model is called constructivism. Unlike the empty mind assumptions of the former, the latter emphasized that pupils had already an alternative frameworks, or naïve preconceptions. Pupils have their own perceptions about their environment; cultures etc. and always such preconceptions come in conflict with the 'correct' conception of scientific knowledge.

Like the transmission model, the constructivists also emphasized the acquisitions of concepts through revised teaching strategies. Instruction designed to change preconceptions with the 'correct' conceptual understanding. The nature and purpose of practical work is therefore, geared in this direction. Their role is to reveal the mismatch between the pupils' preconceptions and desired concept to be learned and hence, facilitate change in conceptual understanding. Its purpose, therefore, is more than illustration, having more structure and direction than inquiry or discovery. Such role of practical work was criticized as having restricted role in the curriculum.

2.5.4 A TASK BASED APPROACH TO CURRICULUM DESIGN

Gott and Murphy (1987) suggested that science was about the solving of problems in everyday and scientific situations and challenge the existing view of scientific problems.

solving problem in science is not to follow instructions, or 'do as I have done it', fill in a table and display the data in a certain way type. They define problem as a task for which the pupils cannot immediately see an answer or recall a routine method of finding it. They suggest a set of procedures, one must understand and use them appropriately when solving a problem as: (1) identifying the important variables; (2) deciding on their status- dependent, independent or control; (3) controlling variable; (4) deciding on the scale of quantities used; (5) choose the range and number of measurements, their accuracy and reliability; (6) selecting appropriate tabulate and display.

The task based approach reject the narrow conceptions of practical work prevalent in the above models and add open investigations where the procedural understanding comes to play. Such view welds both the processes and conceptual and procedural understanding together into a holistic approach. A curriculum is constructed around a series of tasks, where all have the element of motivational, confidence and ownership of the pupils.

2.6 TYPES OF AIMS FOR PRACTICAL ACTIVITIES.

Researchers and science educators suggest variety types of practical activities and assigned different aims. Here summary was made on the various authors' suggestions, like Woolnough and allosp, beatty and woolnougy, Gott et al, Tamir and Hodson.

Various attempts have been made to classify different kinds of practical work in order to define their respective roles. Woolnough and Allosp (1985) for example, argued that activities suggested in the past by teachers and curriculum designers in the U.K. have four aims: (1) motivation; (2) development of experimental skills and techniques, such as observation, measurements, handling equipments etc; (3) simulating the work of real scientist- 'being a real scientist for the day'; and (4) supporting theory, using practical to discover, elucidate or illuminate theory; and improve retention. They criticized such aim as non -existent in the then educational practices. Finally suggest alternative aims like (1) develop practical skills and techniques; (2) being a problem solving scientist; and (3) getting a feel for phenomena. And suggest three types of practical work to meet such aims: (a) experiences, intended to give pupils a 'feel' for phenomena; (b) exercise designed to develop practical skills and techniques and (c) investigations, where pupils have the opportunity to tackle a more open-ended task as a problem solving scientist.

Beatty and Woolnough in (Bentley and Watts 1989) surveyed teachers and revealed five most important aims for practical work: (1) encourage accurate observation and descriptions; (2) arouse and maintain interests; (3) promote a logical reasoning methods of thought; (4) make phenomena more real through experience; and (5) be able to comprehend and carryout instructions. They also suggest four types of activities that will assist what youngsters actually did to achieve these aims: (a) standard exercises-emphasizes particular procedure and developing skills in using them; (b) teacher-directed discovery experiment; (c) demonstrations; and (d) project work.

Another suggestion came from Gott et al. (1988). They suggest five broad types of practical work designed to serve various purposes as: (1) skills; (2) observations; (3) enquiry; (4) illustrations; and (5) investigative. They declared that such distinction is not watertight. Philip Naylor in Bentley and Watts (1989), assumed practical work as a means for developing skills in pupils, but more importantly a purposeful way of learning about the world. Bentley also described practical work as helping lower school pupils to develop skills through scientific processes. She focused on real-life situations and invite pupils to explore different scientific solutions to the problems faced by pupils in these circumstances.

Berhanu (1996) summarized the aim forwarded by Tamir (1991) and Hodson (1990, 1991, 1993). Tamir suggest a new position for laboratory as the center of instructional process and not as a place where students do confirm or illustrative experiments. From the literature he suggested five aims for practical work: (1) understanding concepts; (2) acquiring habits and capacity; (3) gaining skills like procedural knowledge, including planning and designing, performing, organizing analysis and interpretation of data, application to new situations; (4) appreciating the nature of science; and (5) developing attitudes.

Hudson asserted the way curriculum developers and teacher's use of practical work raises difficulties as resulting of expectation to assist the attainment of all learning goal, which they cannot. He gave five aims for practical work: (1) to motivate, by stimulating interest and enjoyment; (2) to teach laboratory skills; (3) to enhance the learning of scientific knowledge; (4) to give insight into scientific method and to develop expertise in using it; and (5) to develop certain scientific attitudes, such as open mindedness, objectivity and willingness to suspend judgment.

2.7 FACTOR THAT FACILITATES SUCCESS IN PRACTICAL SCIENCE

Some of the factors that were identified to facilitate the success of practical science instruction include: curricula, resources, learning environment, teaching effectiveness and assessment strategies.

2.7.1 CURRICULA

The concept curriculum evokes different meaning to different persons. One approach to avoid this ambiguity is to identify distinct phases of curriculum- intended, perceived and implemented. The goal and objectives represent the intended. Teachers' and students' views reflect the perceived curriculum. Teaching, learning and the learning environment describe the implemented curriculum. Here the focus is made on the implemented curriculum, namely instructional materials, selected activities, and integration of laboratories with other learning experiences.

The nature of classroom transactions is strongly dependent on the curriculum materials, in (1) a laboratory manual consisting of a series of exercises or investigations that may or may not be integrated with non-laboratory exercises or (2) worksheets or (3) a textbook that includes laboratory exercises.

It is not easy to design high quality curriculum materials. It is especially demanding with regard to inquiry-oriented laboratory investigations because of the need to try the experiments to make sure they "work," as well as the importance of having "balanced" exercises in terms of their "cognitive challenge" (Gardner and Gauld, 1990). One of the major characteristics of the "new" curriculum in the USA and UK in the 1960's was extensive use of investigative laboratories. Special groups of scientists and teachers were engaged to develop and test laboratory exercises.

In spite of the heavy investment in preparation of laboratory exercises, content analysis carried out by Herron (1971), Tamir and Lunetta (1978) and Lunetta and Tamir (1981) revealed series deficiencies in these exercises in terms of opportunities to practice and develop major inquiry skills, such as defining a research problem, formulating hypothesis, planning experiments, and identifying limitations of an experiment.

Time allocation and its effective use are major factors to consider in planning curricula for practical work. Doing practical work by nature is time consuming. In addition, the higher the level of inquiry or the lower the level of guidance provided for open-ended problem-solving investigation, the more the time is needed to make the work meaningful (Shulman and Tamir, 1978). In the inquiry- oriented curricula of the 1960s it was often assumed that at least half the class time should be spent on activities and laboratory exercises (Romey, 1969). Interestingly, observations of laboratory classes indicated that (Friedler and Tamir, 1984, Hegarty-Hagel, 1990) the highest inquiry level was associated with more time spent on discussion about management and on arrangements, preparation, and other organizational activities at the expense of discussion of processes and concepts. Kyle, Penick and Shymansky (1979) reported similarly that the time spent on actual laboratory activities was small as compared to the total time of the laboratory lesson.

Blosser (1988) remained us that according to Bruner, teachers should organize curriculum and instruction so that students first experience the material (enactive learning), the react to a concrete presentation of it (iconic learning) and finally symbolize it (symbolic learning) like introducing students to science concepts by having them conduct laboratory activities, discuss their laboratory work, and finally read background material so they can extend and solidify their learning. Such protocol represents a guided-inquiry approach (Igelsrud and Leonard, 1988) rather than the verification approach characterizing many conventional curricula. Equally important is integration of the laboratory with the remaining components of the science course.

2.7.2 RESOURCES

Science teaching in the upper primary through higher level requires special facilities. In the world of Larry small, "science material Support," (1992:)

> If you want to encourage elementary school teachers to teach science through inquiry, you have to provide them with the right stuff at the right time. You have to give teachers a deal they can't refuse.

Showalter (1984) showed the importance of facilities, by saying "research can show that without adequate laboratory facilities and materials, most students cannot learn biology in any meaningful way" (p.1). Davis (1972) also found that provision of equipment and materials had improved patterns of teaching science. Science teachers are also reported that adequate supply of materials made teaching more convenient and more effective, increased the amount of students' experimental work, enabled teachers to broaden the science curriculum. Ainley (1978) found that better facilities were associated with what students perceive as enriched learning environment, namely grater involvement in purposeful activities and more stimulation to study.

Similarly, comments by teacher suggest that adequate facilities led to greater use of laboratory work and exploration as a vehicle for learning. Several studies showed that lack of materials, equipment and facilities was a major impediment to laboratory activities (Beisenherz and Olstad, 1980).

The new curricula of the 1960s emphasized students' investigations in the laboratory. With the introduction of new curricula, there were always corresponding attempts to improve laboratory facilities. A very substantial improvement in laboratory facilities was made in Israeli school between 1966 and 1973 (Abraham, Novak and Schacfer, 1965; Tamir, 1978). Grobman (1963) found that in the United State adequacy of laboratory facilities contributed significantly to students achievement. Ainley (1990) concluded his review of laboratory facilities by stating that "it does appear that lack of resources can limit the way in which curricula based on extensive laboratory work are implemented in practice" (p.237).

A comprehensive study of science facilities was carried out under the auspice of the NSTA (national Science Teachers Association) in 140 selected schools throughout the United States (Novak, 1972) conclusions and recommendations reflect trends towards flexibility, movable furniture, arrangements for individualized work, a large preparation-storage-distribution area, and carrels designed so that they can be used by two students.

Other resources for science laboratory are the presence of laboratory technicians or assistants and the instructional materials that teachers have. Positive correlations were found in several countries between the extent of available assistance and the frequency of laboratory experiences, the level of inquiry in the laboratory, and students' achievements (Tamir and Doran, 1992).

The planned format and procedures of the science laboratory must accommodate the activity and cognitive stage of students. Emphasis should be placed on laboratory work that allow the individual student to work in a cooperative atmosphere and yet affirms the need for individual advancement in understanding science and the use of process skills. This may provide to develop positive attitudes towards the study of science and technology in high school. Examination of the present laboratory text and exercise in science curricula indicates that their major objective is presenting information and technical directions (Lazarowitz and Tamir, 1994).

2.7.3 LEARNING ENVIRONMENT

Learning success is limited to the environment in which learning occurs. The laboratory lesson is often much less formal than non-laboratory lessons. Students are allowed to talk and move about the room. They are free to do what they see fit and they often have opportunities to interact individually or in small group with the teacher and their peers.

The characteristics of learning environment have been studied with instruments through which students or teachers indicate their level of agreement with statements about what happens in class. The Learning Environment Inventory designed by Fraser (1989) is widely used. White (1988) stated that practical work usually takes place in a distinct environment, namely a different room with "color," mystery and address of materials and equipments (p.186). Tamir added that in the laboratory, students usually cooperate and are expected to help each other.

Studies reporting results based on The Learning Environment Inventory pertaining to the laboratory are rare (Lazarowitz and Tamir 1994). A science Laboratory Environment Inventory (LEI) designed specifically for studying laboratory classes has been developed (Fraser et al., 1990). This instrument, revised by Tamir (1991) recommendation will help capture the unique feature of the learning environment of the laboratory.

It was found that students in inquiry-oriented laboratories are more active and initiate more idea than in conventional laboratories. Teachers are less direct; process of science receive more emphasis; there is more post laboratory discussion; and teachers give less instruction in front of the class and move around more, checking, probing and supporting (Eggleston1983; Friedler, 1984). Many investigators reported that such cooperative learning methods enhanced students' academic achievement and self-esteem and improve their classroom learning environment. Studies performed in science classroom at the junior and senior high school levels showed that when the cooperative learning approach was implemented, students academic achievement, inquiry skills, and self-esteem increased; their "on task" behavior was higher; and the classroom learning environment becomes more positive (Johnson, 1976; Humphreys, Johnson and Johnson, 1982; Lazarowitz and Karsenty, 1990). With cooperative learning the boundaries between classroom and laboratory work fade.

Hegartz-Lazarwitz et al. (1984) reported that laboratory settings produce the highest frequency of natural interaction and cooperation on task compared with other modes of instruction in science. This goal can be accomplished when curriculum material is planned to encourage such cooperative interaction. The learning environment in the cooperative classroom was more flexible than in the frontal classrooms. The approach facilitated more interaction among students and teachers and there by created a positive learning climate. Students were more motivated to participate in reaching group goals because of positive attitude towards the learning process.

Learning in a cooperative method required students to make measurements, communicate and read about graphs, interpret data, and design experiments. This skills were enhanced by exchange of ideas and discussion in the cooperative groups.

2.7.4 TEACHER EFFECTIVENESS

Teachers' attitude, knowledge and skills and behaviors can also affect whether the learning in the student laboratory attain its objectives. Teaching in the laboratory requires a high level of skill proficiency and subject matter knowledge, a special kind of subject matter-specific pedagogical knowledge, certain specific attitudes, and a readiness for risk taking.

Research indicates that many teachers are ill-prepared. They perceive inquiry as too difficult and time consuming and as including goals that do not match their personal philosophy and are hard to assess (Welch et al. 1981). Research and evaluation studies indicate various weakness and inadequacies of laboratory work as currently practiced in schools. Tobin's (1987) descriptions summarizes the general finding:

> Although teachers appeared to value laboratory activities they did not implement it in the manner that facilitates the type of learning that was planned....For a variety of reasons most teachers appear to avoid laboratory investigations, particularly in classes containing low ability students. When laboratory investigations are implemented they rarely comprise an integral part of the science program. In most cases the laboratory investigation is intended to confirm something that has already been dealt with in an expository type lesson. Students are usually require to follow a receipt in order to arrive at a predetermined conclusion. As a consequence, the cognitive demand of the laboratory tens to low. (p.210)

Although many factors influence the nature of learning in the students laboratory, the single factor that makes the greatest impact is the teacher. Teaching in the laboratory is in many ways different from teaching in an ordinary classroom. There is no doubt that improved effectiveness of learning in the laboratory can be achieved only through substantial improvement in teacher preparation. The developers of the curricula in the 1960s recognized the need for in-service courses to prepare teachers to teach by the approach they advocated.

In the United States, teacher education materials in the 1960s and 1970s were developed within the framework of particular curricula. In the United Kingdom, science education tutors cooperated in devising a variety of student activities for preservice and in-service course without reference to any particular curriculum. Shadmi (1983) described a physical science course for preservice elementary teachers in which:

> The backbone of the whole learning process is the individual activity of the student. All happens in the physics laboratory... The students work on various assignments planning and carrying out experiments, drawing conclusions and solving problems. ...During the activities individual teacher/ student interaction constantly takes place. ..Homework complements class activities, class

> discussions clarify certain points. ...Some problems are left open and serve as a starting point for the following assignment. ...One cannot over-emphasize the importance of the student's individual activities and his interaction with the teacher. (p.121)

Another skill for teacher is effective management in the laboratory. According to Gallaghers and Tobin (1987) 'the teacher's most important role is to facilitate learning by maintaining an environment in which students... receive challenges and assistance as required... most teachers seem to be preoccupies with management in laboratory activities'.

Berliner (1983) presented a review of the research that is pertinent to training teachers for their executive functions. He argued that mastery of the requisite subject matter areas, together with the managerial skills to meet the demands of complex and dynamic classroom environments may constitute both the necessary and sufficient conditions for effective teaching to take place.

2.7.5 STUDENT ASSESSMENT STRATEGIES

Learning in the laboratory is indeed a unique experience and "practical work involves abilities both manual and intellectual which are in some measure distinct from those used in non-practical work" (Kelly and Lister 1969). Achievements on a laboratory examination differ from achievement on paper-and pencil tests (Assessment of Performance Unit 1984, Tamir 1990). Yeany, Laurussa and Hale (1989) concluded that when physical objects are present, tests seem to provide a more valid measure of both logical reasoning and process skills than corresponding paper-and -pencil tests.

Research shows that paper-and pencil tests are inadequate for assessing students' performance in the laboratory. Yet, the bulk of science assessment is traditionally non practical (Bryce and Robertson 1985). Because the kind of tests used in classes have a strong influence on what and how students learn and where they invest their efforts and paper-and -pencil tests can never do justice to the performance in the laboratory investigation, teachers who are interested in providing learning in laboratory should become familiar with innovative practical laboratory tests.

2.8 SCIENCE EDUCATION IN ETHIOPIA

This section treats the history of science education in the education of Ethiopia in general starting from the inceptions of modern education in the country. Attempt was made to capture major events that took place in the education of science. the first part treats how modern education was introduced followed by the historical account of major event in the science education of the country in general.

2.8.1 MODERN EDUCATION IN ETHIOPIA.

Even though, modern education in Ethiopia had only nine decades, Church education provided sophisticated and peculiar type of education since the 4th century. Girma Amare (1967:4) had made clear some of the limitations of this system of education which has implication to an important objective of modern science curriculum:

> Its curriculum too did not remain strictly religious but also highly conservative, discouraging inventiveness, curiosity and critical-mindedness. Its function was to facilitate man's understanding of the world but rather, accepting the existing order of things as it is, to preserve whatever has been handed dawn through the years, and in turn to pass it on unchanged to the next generation.

Such system had perpetuated unquestioned submissiveness, both to the social and natural order and emphasized life after death to the extent of renunciation of all worldly activities. Leaders of Church, who had great influence both on the people and the monarchs, obstruct the attempt made by missionaries to introduce modern education. It is no doubt, among other things, contributed to the deterioration of ancient civilizations and economic development.

Another important point that needs to be mentioned in this line is the behaviors of the Emperors towards modern education. They were most of the time preoccupied with warfare, and were "content with the traditional schools of the church." Even Emperor Theodros, known by his progressive ideas, was interested in military and technological aspect (mainly acquisitions of firearms) rather than modern education. Pankhurst (1963:294) quoted what emperors said to his English advisor Bell that "he would have been more pleased with a box of English gunpowder than books he already possess".

Towards the end of the 19th century, among other things, the emergence of the country as a victor over the Italians in the Battle of Adwa in 1896 accented the need for modern education. The war itself alerted the exceptionally far-sighted Emperor Menelik to realize the inadequacies of Church education if Ethiopia was to remain independent. As Pankhurst (1962:256) coated Menelik return to the capital victoriously from the Battle of Adwa:

> We need educated people in order to ensure our peace, to reconstruct our country and to enable it to exist as great nation in the face of European powers.

2.8.2 SCIENCE EDUCATION A HISTORICAL PERSEPECTIVE

Education in Ethiopia was criticized by many authors(Temechegn, 2000, Hailu, 1974). Hailu (1974:23) criticized both the traditional and modern education system in Ethiopia as' they failed to inculcate in the learner that knowledge is an active process that demands much mental and physical exertions'. The traditional education was further criticized and which has also relevance to science education by Hailu as:

> ...[T]he narrowness of the area in which initiatives and creativity were encouraged. ...The narrow scope of the curriculum and the virtual absence of argumentation and criticism severely restricted the field in which methodological and substantive innovation could be introduced. ...because of (the traditional fundamental) assumptions, research, investigation, experimentation, theorization and speculation have been, at best, actively discouraged;...The belief in the possibility of new knowledge is heretical and, therefore, has to be eradicated. ...Such system of beliefs hardly favored the existence and development of science....Evidently, then, in traditional societies such as ours, the sciences can hardly exist let alone flourish.'

Such epistemological position, like Lock, believing that knowledge is a gift rather than an acquisition ascribed the passive role for man in general significantly affected the development of science education in Ethiopia and its divergent outcomes in terms of the problem solving abilities of the students in general.

The introduction of science and Technology education in Ethiopia can be traced back to the 1940s. (Berhanu 1996, 1999, MEFA 1948). For example, the elementary school curriculum in 1948 divide the elementary school program into the first and the second elementary program. The first elementary program contain the first two grades and instruction was in Amharic. The second elementary program starts from grade 3 to 6, and instruction of science, among others subjects was in English (MEFA 1948:2).

Agedew and Zewdneh (1982) described the courses that were offered starting from 1907 up to 1975, and science as a subject appeared first in the 1946 version of the curriculum and becomes continued as part of the school curriculum in the subsequent revisions.

History of science and technology education in Ethiopia shows that science teaching has undergone continuous change in its objective, contents, teaching-learning methods and curricular materials (Berhanu 1999). The years between 1940s up to late 1950s, the Ethiopian educational system was under the influence of the British educational system. Both the curriculum materials and teachers are expatriates and were imported from the UK and other countries until early 1970s. These materials were adopted to the country as they were. The teaching of science was strongly teacher-centered emphasizing memorizations (Berhanu 1999).

American educational system begun to prevail over the Ethiopian educational system between the late 1950s and 1974. During this time, the educational system of 6 years of primary education 2 years of junior secondary and four years of senior secondary was adopted. The process and skill movements occurred in 1960s in USA, Science-A Process Approach and the Nuffield Science Projects in the UK together with the political independence movement in Africa had effected curricular changes in Africa in general and in Ethiopia in particular (UNESCO 1987). Hence, for Example, science for young Ethiopia, for grade 7 and 8 was adopted from the textbooks of USA which emphasize learning by doing (Berhanu 1999). During this time, the science curriculum gradually changed from the British curriculum to the American type curriculum.

During the early 1970s the Nuffield science teaching materials replaced the American type science curriculum materials. The Addis Ababa British Council has sponsored these changes for the junior and secondary school sciences. Hence, 'Science Comes to Life' for grade 7 and 8 was written and printed locally in early 1970s. the introduction of these materials was assumed by Berhanu (1999:9) as a 'radical curriculum change made on the national curriculum for science'. Though the inquiry and child-centered approaches of the Nuffield Sciences was appreciated, they were abandoned basically due to the complaints from teachers and supervisors. These materials demand provision of resources like worksheet, raw materials for practical activities, a special teacher-training programs, and a small number of students in a classroom.

Between 1974 and 1989, the socialist government of Ethiopia revised the educational policy, and brought change to the national curriculum. Curriculum materials for elementary and secondary school including syllabi, textbooks, and teachers guides for all subjects and grades, supplementary materials, science kits, some prototype demonstration materials, the curriculum for teacher training institute and the sixth and eight grade national examinations are developed centrally by the ICDR (Anbesu 1994). The curriculum was developed along the socialist educational system, based on the NDR program and the new educational directive. Accordingly, the science education incorporated some guiding principle of the socialist government, such as polytechnic instructions and ideas of Marxism -Leninism into their curricula.

2.8.4 SCIENCE EDUCATION IN THE CONTEXT OF THE 1994 ETP.

The Military government was defeated and replaced by the Transitional Government of Ethiopia in may 1991. among other changes, the change in ideology brought the inception of a new Educational and Training Policy which was declared in April 1994. One of the major area the policy brought was the curriculum. The previous curriculum was criticized for lacking relevance, clearly defined objectives and having too much concentration on theoretical knowledge with little concern to everyday life (MOE 1994). To alleviate this alleged shortcoming the policy addressed a major objective '...make education relevant by providing problem solving skills and all rounded education catering to the need of individual at all levels' (MOE 1994:13).

Based on the stated objectives; a new curriculum has been developed and implemented in most regions. Concerning the assessment and evaluation procedures to be used, the policy has stipulated establishment of national organization for educational measurement and evaluation and assessment would be continuous in academic and practical subjects including aptitude tests to ascertain the formation of all-round profile of students. National examination will be given at grade 8 and 10.

The policy changed the educational structure from 6:2:4 to 8:4. Hence eight years of primary education is followed by four years of secondary education. The primary education is divided into basic education (grades 1-4) and the general primary education (grades 5-8). Though the aim of science education for the country are not explicitly stated in the policy document, Berhanu (1999) identified some objectives from the NETP that throw light up on science and technological education as:

1. To produce citizens capable of identifying and solving problems by strengthening individual's physical and mental potential beginning from basic education for all and at all levels.

2. To produce citizens that show positive attitude and contribute towards popularization, dissemination and development of science and technology in society, creativity and experimenting skills.

3. To produce citizen who are capable of knowing, observing, understanding, changes and appreciate the environment by making education appropriate and relevant to environmental and social needs.

Science education, according to the 1994 ETP, starts from the primary school. Environmental science is offered in grades 1-4. Science, handcraft, agriculture, environmental issues etc. are integrated in environmental science. Science in grades 5-6 is split into basic and social sciences. Linier approach to science start at grade 7 and continues into the secondary education.

The policy did not state the objective of school science. No definite purpose was assigned to the different levels of education. However, some selected physics and biology teachers and curriculum developers from some regions of Ethiopia (Berhanu 1998) identified the purpose of biology and physics education in grade 7 and 8 and suggest them as the objective of science education of the second cycle in general as:

Physics education is:

1. to offer general facts, principles and laws in physics;
2. to understand the physical world around us;
3. to solve major problems of the society;
4. to prepare for higher education;
5. to build students' background in physics;
6. to develop critical thinking;
7. to promote the idea of work and self sustain.

Biology education is:

1. to develop basic knowledge, skills and attitudes which are relevant to the students life;
2. to kelp student know their environment;
3. to solve some basic problem in their environment;
4. to make the student aware of the sciences development and enable them to use the knowledge in regard to health, agriculture and home science.

Science subjects are compulsory up to grade 10 for all students. Technology education is offered integral with the teaching of sciences. Practical activities, project work, social issues etc. help the development of technological skills and attitudes (Berhanu 1999). Science is one of the top prioritized subject in the policy. Time given to science shows this emphasis. All the sciences, biology, chemistry and physics, given at grade 7 and 8 constitutes 360 minutes per week or 25.71% of the share in the school time table.

2.8.5 FORMATIVE EVALUATION OF THE NEW PRIMARY SCHOOL CURRICULUM MATERIAL

To realize the NETP, a new curriculum material has been developed. These materials have been tried out in successive years from 1995 in grades 1 and 5, 2 and 6, 3 and 7 and 4 and 8. This section present the result of the formative report for the grade 8 science curriculum material prepared by Addis Ababa region.

Most of the objectives in the biology syllabus were judged as good and appropriate to cover the important knowledge, skills and attitudes by content analyst in the Formative Evaluative report (ICDR, 1998). Some objectives are judged as ambitious since they are beyond their level and no specialized teacher are found in the field in all the schools at present. Others are also criticized as not being realized with in the existing local contexts. General subject objectives stated in the chemistry syllabus are judged in the evaluation report as 'reflect sufficiently what is stated in the NETP. They are all proper and cover the fundamental aspects of the subject matter' (p.180). The comment goes further as ' the grade level objectives are properly related to solve daily or future problems...developing skills in observation, comparing, and interpretation of experimental data, acquiring skills in handling laboratory equipments, learn prevention of rusting and so on and all of which aim to foster their ability of problem solving in life (p.180). Realization of such objectives depend on, according to the analyst, the presence of qualified teachers, laboratory supply, and other materials which may not be found in the schools.

Physics syllabus was also judged by the analyst as sufficiently covered the basic knowledge, skills and attitudes. All objectives were rated as having relation to solving daily/ future life problems and can be realized with in the existing local conditions provided that teachers are well trained, appropriate instructional materials are provided, laboratory facilities and supplies are made available and more that not, the size of the class are pulled down to the parameter set in the NETP.

In the Ethiopian context, what was provided in the students' textbook determine to a great extent what was going on in the classrooms. The textbooks, once developed in the light of the NETP directives, pilot survey was made and the results were compiled in the Formative Evaluative Report (ICDR, 1998). The content analysts do also commented the science textbooks. Some of these comment, in relations to this study, and will be validated in this study includes:

> ...all the content of chemistry in the textbooks are relevant for handling everyday problems...except the need for minor inclusion of experimental activities relevant to the set up of apparatus...the content of the textbook include testing acids and basic oxides, preparing oxides, salts, alkaline supported by practical activities implies that the content of the text book could promote problem solving. ... the exercises and activities in the textbooks are valid, adequate and appropriate to the grade level. (Comment given to chemistry textbook for grade 8).

> ...Since the nature of the subject physics is the bases for technological development, directly or indirectly, the textual contents are relevant for tackling everyday/ future problems...the topics of the textbook encourage critical thinking and incorporate problem solving approach. (Comment on physics textbooks for grade 8) .

CHAPTER THREE

3. METHODS AND PROCEDURES OF THE STUDY.

As mentioned in the introduction, the aim of this study is to evaluate the nature and purpose of practical work in grade eight science curriculum materials. Descriptive research design methodology was employed. According to Best (1970) in Cohen and Manion (1994), descriptive research is concerned with:

> conditions or relationships that exist; practices that prevail; beliefs, points of views, or attitudes that are held; processes that are going on; effects that are being felt; or trends that are developing. At times, descriptive research is concerned with how *what is* or *what exist* is related to some preceding event that has influenced or affected a present condition or event (p. 67).

3.1 SOURCES OF INFORMATION

For this research the following sources of information were taken:

- Curriculum guides of the three science subjects
- The student's textbook of the three science subjects of Addis Ababa Administration Region.
- The schools laboratory/resource rooms
- The national examination for grade 8 and schools final examination papers.
- Science teachers

3.2 THE SUBJECT AND SAMPLING PROCEDURE

A) school

The universe of this study includes all government primary schools having the second cycle (5-8) in Addis Ababa. There are 63 government primary schools with in this region (AARED, 1999).

Due to constraints like budget, time, manpower out of the six zones of Addis Ababa, only three zones were randomly selected. Again, out of these three zones, only 50 percent of the woredas were included in the study through random procedures. Zone one and three contains four woredas each and zone six contain two wereda. Hence, two weredas from zone one and three and one wereda from zone six were randomly selected. All government primary schools (1-8 or 5-8) found in these sampled weredas were taken as a source of information. Thus a total of eight schools were found in the randomly selected woredas and all are taken as a source of information. Table 3.1 illustrate the sampling procedure.

Table 3.1 Summary of the sampling procedure employed in the study.

ZONES	ONE		THREE		SIX
WOREDAS	FOUR	SIX	EIGHTEEN	TWENTY-EIGHT	TWENTY SIX
NUMBER OF GOVERNMENT PRIMARY SCHOOL IN THE WOREDA	TWO	ONE	ONE	TWO	TWO
NAME OF THE SCHOOLS	A) DEJ. BALCH ABANEFSO B) TESFA KOKEB	A) YEKATIT TWENRY THREE	TEMENJA YAZI	A) CARALO B) WONDIRAD PRIMARY SCHOOL	A) AKAKI PRI. SCHOOL B) FITAWRARI ABAYNEH.

B) science Teachers

About 4233 teachers are found in the second cycle of primary schools in Addis Ababa (AARED, 1999). Out of this, a total of 2109 teachers (1397 male and 712 female) are teaching in government schools. No figure was available to show how much of this number corresponds to science teachers (biology, chemistry and physics) of grade eight at government schools. Table 3.2 gives information on teachers in Addis Ababa by their qualifications and sex. A total of 52 grade eight science teachers were identified in the sampled schools. All these teachers were taken as a source of information. Table 3.3 summarized the number of teachers in these schools by sex and subject they teach.

Table 3.2 Summary on teachers teaching in second cycle of Addis Ababa by qualification and sex.

LEVEL OF EDUCATION	MALE	FEMALE
BELOW GRADE 12	7	4
TEACHER TRAINING INSTITUTE	345	166
SHORT TERM COURSES	9	5
SPORT/TECHNICALVOCATIONAL/HAND CRAFT/AGRICALTURE/MUSIC/ART	10	12
12+1	196	48
12+2	51	48
12+3	19	7
DIPLOMA	746	418
BA/BSc	12	1
OTHERS	2	3
TOTAL	1397	712
	2109	

Table 3.3 Number of science teachers of grade 8 in the sampled schools.

SCHOOL	BOILOGY		CHEMISTRY		PHYSICS	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
BALCHA	3	1	3	0	3	0
TESFA	1	1	1	1	1	1
YEKATIT	2	1	2	1	2	0
WONDIRAD	3	1	3	1	3	1
KARALO	2	1	1	0	2	0
TEMENJA Y.	1	0	1	0	1	0
AKAKI	2	0	1	0	1	0
FIT. ABAY.	1	0	1	0	1	0
	15	5	13	3	14	2
TOTAL	52					

C) Science curriculum Guides and Students textbooks

This study analyses the Biology Curriculum Guide for Grade Eight (ICDR, 1996), Chemistry Curriculum Guide for Grades Seven-Eight (ICDR, 1997a) and Physics

Curriculum Guide for Grade eight (ICDR, 1997b). Such national documents together with the practical activities suggested in the three science grade 8 student textbooks were subjected to analysis by using various schemes (See sections 4.2).

D) National Examination and School First Semester Exam

All the questions included in the grade 8 national examination of the 1992 (E.C) and one-third of the questions from the three schools (Tesfa Kokeb, Karalo, and Akaki Primary Schools) science first semester final examination were analyzed.

E) Resource for Practical Science

Three school were selected randomly one from each zone (Tesfa Kokeb, Karalo, and Akaki Primary Schools) to evaluate the presence and/or absence of resource for science.

3.3 DATA COLLECTION INSTRUMENTS

To obtain adequate and valid information in relation to the purpose of this study, the following types of data collection instruments were employed.

1. content analysis
2. questionnaire
3. checklist

3.3.1 CONTENT ANALYSIS OF THE THREE SCIENCE CURRIULUM MATERIALS

The actual learning depends on the nature of tasks assigned and the opportunities offered to students to learn (Lazarowitz & Tamir 1994). Textbooks often determine the nature of the assigned task. Different content analysis schemes were designed by science educators to assess the nature and purpose of practical activities in the science curriculum materials (See Tamir, P. 1988; Dreyfus, A. 1992; & Orpwood, G. & Souque, J. 1984).

To see the nature and purpose of practical work included in the grade eight-science curriculum materials, the researcher analyzed the Curriculum Guides (written by ICDR) and the biology, chemistry and physics student's textbooks (written by the AAAR Educational Bureau). The nature of science depicted in the three science courses was analyzed through the scheme devised by Klopfer (1971) and latter enriched by Fraser (1971) and Hazel (1989). Such scheme was employed, with minor revisions, to evaluate the objectives in the curriculum guides with respects to the nature of science and the place of practical work reflected in them. The authors claimed that such a scheme were appropriate for various science courses.

To analyze what aims are reflected in doing practical activities, all the psychomotor (skill) and other related objectives were separately identified and were tallied against the lists of aims synthesized from the literature. To analyze their consistency in being translated into the student's textbooks, a list of aims for each practical activity in the student textbooks was identified and tallied against these lists.

Different schemes were available to see the kind and nature of practical activities in science textbooks (Gott & Duggan 1995; Woolnough & Allosp 1985). Gott and Duggan (1995), for example, classified practical activities into five: observation, skill, enquiry, illustrative and investigative. Each activity in the student's textbooks was subjected to this analysis (See Appendix 5-7 for the detailed discussion on the criteria's). The degree of openness and the demand for activities were estimated through the Inquiry Level Index established by Herron (1971) and revised by Tamir (1991).

The Laboratory Assessment Inventory (LAI) Tamir & Lunetta (1978) was employed to see what students are actually doing in their practical science. It helps to validate the lofty claims made by curriculum writers and reviewers.

The researcher gave detailed direction on how to carryout the analysis to a fellow graduate students of biology, chemistry and physics. The same exercise was analyzed by the researcher and the analyst and any item for which there had been disagreement was thoroughly discussed. Since the decisions regarding each item in the LAI is straight forward as *yes* or *no*, an inter-rater agreement better that 90% was easily reached. ILI with its 4 levels, required more time for training. However, at the end of the session, the same degree of agreement was reached.

3.3.2 QUESTIONNAIRE

Questionnaire was prepared by the researcher to secure information on teachers understanding of the issues in practical science, their perception on the current curriculum materials in use and on factors that could affect doing of practical science in their local context. To secure adequate information, the draft questionnaire was piloted in two schools with 12 science teachers of zone four and necessary adjustment was made. The questionnaire contains seven parts. The first part was concerned with providing general information on the teachers, followed by sections on resources, teachers opinion, and practice; training; perceptions on the current curriculum materials; learning environment and assessment procedures. A total of 52 questionnaires were distributed, out of which only 40 was received. The complete questionnaire is found in appendix 1.

3.3.3 CHECKLIST

Experience has show that science will be taught more effectively if science materials are available to teachers when they need them. In the 1970s, science resource materials were available to Ethiopian schools in the form of science kits. Now a days such practice are none existent and no such materials were found in the schools surveyed. On the other hand, the task of making teachers responsible for gathering materials outlined in the teacher's guide did not prove to be realistic or efficient (National Science Resource Center, 1997).

The implicit assumption of the policy was that developers will design experience and resources that would be feasible in the cultural and material context of the regions. The presence of these materials in the schools, would affect teachers implementation behaviors. To evaluate the demands of the curriculum materials with respects to resources and predict their potential effect on students' learning, all the materials and equipments suggested by the textbook writers in all practical activities for each subject were identified. (See Appendix 8). The status of these resources was responded by the school science department heads of the three schools, one from each zones. They indicate the presence &/or absence and some times their number in the school laboratory/ resource rooms.

3.2.4. ASSESSING THE EVALUATION PROCEDURE IMPOSED IN THE NATIONAL AND TEACHERS MADE FINAL EXAMINATIONS IN RELATION TO PRACTICAL SCIENCE.

The NETP (MOE, 1994a) issued a new assessment directions as 'continuous assessment in academic and practical subjects including aptitude test will be conducted to ascertain the formation of all round profile of students at all level. No suggestion was forwarded by the policy or subsequent document what comprises the 'all round profile' and how to assess students' performance in practical subjects.

No extensive research was available in this matter. Berhanu (1999) and Bekalo and Welford (2000) showed that practical assessment in the Ethiopian primary and secondary schools respectively is none existent. Mekasa (1999) also witnessed that practical subjects are ignored. Bekalo and Welford (2000) analyzed the ESLCE and found no practice-oriented questions in the context of experiments, problems to test procedural knowledge and application (P.106).

A number of practical assessment schemes were developed by science educators (Layton D, in UNESCO 1990). Such a schemes cannot be employed in our context because no assessment objectives were available that demands students practical performance. Very few evaluation procedures were suggested in the three curriculum guides in relation to practical science. Practical examinations are none existent in the

Ethiopian Examination system. Both the national and school final examinations reveal this fact.

Both the national grade eight examination and teachers made school examinations are evaluated with respects to the range of assessment objectives they measure. A scheme used by Bekalo and Welford (2000) was employed in the analysis of these exam questions. Bekalo gave four categories: questions that focus on (1) facts, laws, principles and theories; (2) mathematical manipulations of laws and principles; (3) relationships between theories and phenomena; and (4) very specific recall of information about events, conventions, terminology, names, formulas and units.

CHAPTER FOUR

4. ANALYSIS AND DISCUSSION OF FINDINGS

This chapter present the data obtained through content analysis and questionnaire. The first part deals with analysis of the curriculum materials, and assessment procedures through content analysis and is followed by analysis of resource for practical activities and the responses made by teachers' through checklist and questionnaire respectively. Methods of data analysis are shown at each stage of using the different instrument. presentation of data is followed by discussion and interpretation in line with the major research problems outlined.

4.1. CONTENT ANLYSIS OF SCIENCE CURRICULUM MATERIALS

4.1.1. THE CURRICULUM GUIDES OF THE THREE SCIENCE SUBJECTS

INTRODUCTION TO THE GUIDES

In the Ethiopian context, Curriculum Guide is a national document (Anbesu 1994; Berhanu, 1996) where the subject objectives, content, hint for teaching, practical activities, time allotment and materials required are set for the particular grade and subject. The science panel of the Institute of Curriculum Development and Research originally prepared these guides. Once they are prepared, finalization of these document was made through a national workshop, where all the Regions and Administrative Towns of the country took part. Textbook writers are expected to consult this document and present the concept and activities mentioned in these guides as simple as possible and to the level of mental development of that grade students (ICDR, 1996).

The Curriculum Guides contain the general objectives of the subject at a given grade and subject level. Though many developed countries have intermediate document, like policy of science education which state the objectives of teaching science at different levels, they represent the second official document next to the grand policy. Based on these general objectives of the course, a number of units were organized and are suggested in the guide. Each unit presents the overall unit objectives, the specific lesson objectives, the content used to attain these objectives, numbers of periods allotted, methodology, teaching aids and evaluation procedures. In this line, the physics curriculum guide (ICDR, 1997) for grade 8 does not contain both the general subject and unit objective and only specific objectives are found. Hence, it is difficult to judge the consistency of translation from the general into specific objectives. Both the biology and chemistry curriculum guides contains the general course, units and lesson objectives.

This study analyses the Biology Curriculum Guide for Grade Eight (ICDR, 1996), Chemistry Curriculum Guide for Grades Seven-Eight (ICDR, 1997a) and Physics Curriculum Guide for Grade eight (ICDR, 1997b). Such national documents were subjected to analysis by using various schemes (See sections 4.2).

4.1.2 THE STUDENT SCIENCE TEXTBOOKS

4.1.2.1. GRADE EIGHT CHEMEISTRY STUDENTS TEXTBOOK.

INTRODUCTION

The writers of this curriculum material claims that this text was written based on the Current Educational and Training Policy (AARED, 1998). The students' text contains five units and it was assumed to be a continuation of what students experience at grade seven. The units and number of practical activities suggested in the text includes:

UNIT 1- *SONE IMPORTANT COMPOUNDS* (**14**).

UNIT 2- *PERIODIC CLASSIFICATIONS OF ELEMENTS* (**0**).

UNIT 3- *SOME IMPORTANT METALS* (**6**)

UNIT 4- *SOME IMPORTANT NON-METAL AND THEIR COMPOUNDS(***12***)*

UNIT 5- *CALCULATIONS BASED ON FORMULAS* (**0**)

Most units of the text focus on descriptive chemistry (AARED, 1998) where some leading questions are inserted to make the discussion persuasive. Practical activities are taken as an integral parts of the student textbook except in units two and five. Experiments are suggested to ensure chemistry as a practical subject. The inclusion of these practical activities was believed to help students become *creative* and *open mind* (AARED, 1998). Questions and exercises at the end of each unit are suggested to give opportunities to check understanding of the chemistry concepts covered. Unit summaries are included at the end of each unit.

4.1.2.2 GRADE EIGHT BIOLOGY STUDENT TEXTBOOK

INTRODUCTION

The biology textbook was organized so that each unit starts with an introductory section. Some times pictures and activities are included to illustrate the topic under discussion. No suggestion was given to the nature and purpose of practical activities included in the text. Each unit or sub-unit often ends with a set of exercises, multiple questions, true and false, matching and fill in the blank. Unit summary and review question terminate the unit. The following topics and number of activities are included in the student' textbook:

UNIT 1- *GENERAL HUMAN BIOLOGY AND HEALTH(8)*

UNIT 2- *HUMAN AND DISEASE* (0)

UNIT 3- *FLOWERING PLANTS* (4)

UNIT 4- *PHOTOSYNTHESIS* (4)

UNIT 5- *OUR ENVIRONMENT* (4)

UNIT 6- *CLASSIFICATION* (0)

4.1.2.3 GRADE EIGHT PHYSICS STUDENT TEXTBOOK.

INTRODUCTION

The student text was organized by presenting first an introductory note on the topic followed by treating each of the sub-topics. Too often, activities were included. No purpose was assigned to the inclusions of these activities as the chemistry textbook writers gave it. Exercise was suggested requiring only recall of what was treated. Some illustrative diagrams were included here and there in the text. Mathematical formulae were supported with worked out examples. Mostly each units end up with a unit summary and review questions. The whole text contains six units and a number of activities.

UNIT 1- *FORCE* (0)

UNIT 2- *SEEING THINGS* (4)

UNIT 3- *HEAT ENERGY* (4)

UNIT 4- *ELECTRIC CURRENT AND RESISTANCE* (8)

UNIT 5- *ELECTROMAGNETISM* (6)

UNIT 6- *INTODUCTION TO ELECTRONICS* (0)

The three analyzed textbooks share some common features. The texts do not contain an introductory statement (forward) about the book. As a result, it was difficult to know the orientation of the book and the model employed by the writers to set practical activities. No general, unit and lesson objectives of the course are found in all the text books. As a result, students miss what was really expected of them to meet the requirement at the subject, unit and lesson level.

4.2 ANALYSIS OF THE CURRICULUM GUIDES

4.2.1 THE NATURE OF SCIENCE AND THE PROBLEM SOLVING PARADIGM REFLECTED IN THEM.

Education in science, according to Hodson (1996) comprising three major elements: *learning science*- acquiring and developing conceptual and theoretical knowledge; *learning about science*- developing an understanding of the nature and methods of science, and an awareness of the complex interactions among science, technology, society and environment; and *doing science*- engaging in and developing expertise in scientific enquiry and problem solving. Practical work do play a prominent role in the pursuits of these goals. Martin (1997) similarly explored the nature of science form different points- the scientific enterprise, products of science, processes of science and attitudes towards science. These nature of science, for example, are reflected in the definition of science by Rutherford and Ahlgren (1990:) as 'a process for producing knowledge'.

Any discussion of the nature of science imparted by a particular curriculum material stem from the intention of the grand policy. Woolnough in Solomon (1994) highlighted this fact by saying that:

> What is the justification for teaching science and technology in our schools? Is it for educational or vocational reasons? Is it for future educated citizen or to provide adequately prepared and motivated students to fulfill the market demands of the country? What should be the nature of science and technology in schools? Was it designed to develop both the methods and content of the subject? (7).

The three curriculum guides (ICDR, 1996, 1997a, 1997b) were analyzed to determine which elements of science was more emphasized and how practical work was used to help learning science, learning about science and doing science. The NETP advocate the problem solving approach in science education. Both formative evaluation report and the curriculum material writers admitted that the materials adequately reflect the policy intentions. The validity of such claim in terms of the provision of a problem that helps students engage in and develop expertise in scientific inquiry and problem solving with out a model for curriculum development is under question.

According to Glasgow N.A (1996), learning from problem situation has been and continue to be a condition of human existence and survival. He represents the paradigm as:

> Problem- based learning is a basic human learning process founded in patterns of reasoning that allows early humans to survive in their environment. Reducing this concept and approach to specific classroom practice is a natural extension of a basic human process. In this approach, the student take on a problem or projects related to science subjects as a stimulus for learning in the content areas, subjects or disciplines. In doing so, the students' exercise or further develop their problem solving skills. This approach or method of learning has two educational objectives: the acquisition of an integrated body of science knowledge, concepts and principles related to the

problem, and the development or application of problem solving and reasoning skills (12).

In this line, the curriculum guides of biology, chemistry and physics were analyzed to see whether (1) they reflect the problem-solving paradigm imposed by the policy; (2) they do reflect current understanding of the nature of science education; (3) what aims of practical science are more emphasized? The specific educational objectives stated by the guide were analyzed to determine whether they emphasize the problem solving paradigm, the whole nature of contemporary science and pertinent aims of practical science.

4.2.1.1 ANALYSIS OF THE SCIENCE OBJECTIVES IN THE CURRICULUM GUIDES

There is much discussion today about the need to specify goals, aims and objectives for course of all kind including practical science. One matter that complicates this task is the literature on practical science which rarely distinguishes clearly between general goals, aims and objectives (Boud D, Dunn J and Hazel E.H 1989). Most authors would agree that course aims should be consistent with the more specific objectives of the course.

Hofstein and Lunetta (1982), for example, provided many goals and identify the need to define goals where practical science could make a special and significant contribution. One of the most important general goal in practical science course concerns scientific enquiry. Laboratories were considered as important places where knowledge is generated and validated. Students gain an appreciation of these processes and develop abilities required to solve real problems. However, unless at some stage students learn about the processes of scientific inquiry through being engaged in it, it is unrealistic that they will be in a position to reach a full appreciation of the practice of science. We can analyze for such provision in the curriculum guides by simply classifying objectives into categories that determine how the concepts, methods and applications of science are emphasized. Based on these results we can judge the status of the nature of science and problem solving approach in the guides.

Examinations of goal, aims and objectives are difficult if they are not explicitly stated, preferably in written form. Written statements greatly aid communication and help attempt to monitor their provisions to the problem-solving paradigm, nature of science reflected in them, aims of practical science included in them. Klopfer's scheme was used to analyze the objective of the guide. This scheme was used by many educators since it provides all important objective categories of science at all levels. Look Appendix-4 for definition of each category. Table 4.1 present analysis of specific objectives of the guides with respects to the standard schemes for categorizing science objectives developed by Klopfer (1971).

Table 4.1 summaries of aims with respects to Klopfer categories.

CATEGORIE	TITLE OF CATEGORY	PROPORTION OF STATED OBJECTIVES		
		BIOLOGY	CHEMISTRY	PHYSICS
A.0	KNOWLEDGE & COMPREHENSION	90 (81.8 %) DEFINE DRUG & DRUG ABUSE (P.7).	100 (81.9 %) GIVE EXAMPLE OF OXIDES (P.2).	94 (63.5%) STATE THE LAW OF REFLECTION (P.8).
B.0	PROCESS OF SCIENTIFIC INQUIRY I: OBSERVATION, MEASURING, CLASSIFYING.	2 (1.8%) CLASSIFY PLANTS AS MONOCOTS & DICOTS (P. 23).	0	8 (5.4 %) MEASURE THE VOLTAGE & THE CURRENT USING THE INSTRUMENTS (P. 24)
C.0	PROCESS OF SCIENTIFIC INQUIRY II: SEEING A PROBLEM & SEEKING WAYS TO SOLVE IT.	5 (4.5 %) IDENTIFY SOME FUNGAL DEASESE OF PLANTS & HOW THEY ARE SPREAD. (P.).	1 (0.81 %) TEST WHETHER A GIVEN COMPOUNED IS CARBONATE OR NOT. (P. 34).	8 (5.4 %) DISTNGUISH BETWEEN STATIC AND KINATIC FRICTION. (P. 3).
D.0	PROCESS OF SCIENTIFIC INQUIRY III: INTERPRETATION OF DATA & FORMATION OF GENERALIZATIONS.	0	3 (2.45 %) USE PERIODIC TABLE TO GENERALIZE THE PROPERTIES OF CERTAIN GROUPS. (P.21).	6 (4.05 %) STATE THE RELATIONSHIP BETWEEN CURRENT AND VOLTAGE. (P.35).
E.0	PROCESS OF SCIENTIFIC INQUIRY IV; BUILDING, TESTING & REVIEWING A THEORETICAL MODEL.	2 (1.8 %) EXAMINE THE LOCATION OF BLIND SPOT OF THEIR EYES. (P.2).	2 (1.63 %) DETERMINE THE MOLECULAR FORMULA OF A COMPOUND FROM ITS EMPRICAL FORMULA. (P. 44).	11 (7.43 %) DRAW THE REFRACTED RAY WHEN THE INCIDENT RAY IS GIVEN, STATE WHETHER A GIVEN IMAGE IS REAL OR VIRTUAL. (P. 15).
F.0	APPLICATION OF SCIENTIFIC KNOWLEDGE & METHOD	5 (4.5 %) SHOW THAT PLANTS USE WATER TO MAKE FOOD (P.28).	13 (10.63 %) USE INDICATORS TO DIFFERNTIATE ACIDIC OXIDES FROM OTHER TYPES OF OXIDES (P.4).	19 (12.83 %) USE THE RIGHT HAND RULE TO DETERMINE THE DIRECTION OF MAGNETIC FIELD AROUND A CURRENT CARRYING STRAIGHT CONDUCTOR (P.29).
G.0	MANUAL SKILLS	5 (4.5 %) COLLECT PRESERVE & IDENTIFY FLOWERS (P.24).	1 (0.81 %) CAREFULLY HANDLE & USE SIMPLE LABORATORY APPARATUS & CHEMICALS (P.16).	2 (1.35 %) CONNECT RESISTORS IN SERIES AND PARALLEL (P.26).
H.0	ATTITUDES & INTEREST	1 (0.9 %) CLARIFY THEIR VALUES ABOUT CAUSE & PREVENTION OF DESEASE (P.12).	2 (1.63 %) RECOGNIZE THE SPECIAL DANGER ASSOCIATED WITH CONCENTRATED SULFURIC & NITRIC ACIDS & TAKE NECESSARY PRECAUTIONS WHILE USING THEM P.11).	0
TOTAL NUMBER OF STATED OBJECTIVES		110	122	148

From the above table, one can say that the curriculum guides focus mainly on Category A.0- the products of science, especially the low mental processes: knowledge and comprehensions and the learning science according to Hodson. The chemistry (81.9%) and biology (81.8%) Curriculum Guides contain the highest percentages of low order objectives followed by physics (63.5%). Inquiry objectives totally comprised (from Category B.0 through E.0) 22.3 % for physics, 8.1 % for biology and 4.88% for chemistry.

Application was relatively emphasized by the physics (12.83%) and least represented in the biology (4.5%). This relatively higher number of objectives of the category F.0 in the physical sciences was due to the presence of scientific topics that require calculations, hence required mainly applications of scientific knowledge (formula) learnt. Hence, relatively higher number of objectives in the category F.0 involves a straight forward application of scientific knowledge than application of scientific methods. In such cases, students can easily fail to appreciate the challenging aspects of problem solving in real life situation.

Manual skills were least represented in the chemistry (0.81%) and biology contains relatively higher percentage of objectives for this category (4.5%). Science curriculum guides were also judged not only in the setting of products and processes of science that would help students acquire understanding of science, they were also about developing attitudes, commitment and enthusiasm for science. No objectives were stated to the affective domains in the physics curriculum guides. This category generally receive least emphasis in the three guides.

Problem solving require application of both procedural and conceptual understandings, the knowledge and concept of science and the process of science comes into play. very few objective were found in the three curriculum guides that state investigative ability in the contexts of practical science. Some objectives are found in the guides where students are asked to solve theoretical problems using mathematical formula like, 'use the magnification equation to solve problems concerning heights of objects and images' (Physics curriculum Guide for Grade 8, 1997). The procedural understanding, which is central to the problem solving ability, was not treated adequately. Such task types, according to Welford in UNESCO (1990) are not primarily intended to develop investigative ability hence, aimed at concept acquisitions.

Fraser (1976) classified the aims of the Australian Science Education Project (ASEP) and compared the list with statements found in the literature. He found consistency in the proportions of aims in most categories. For example category A.0= 9%, B.0=10%, C.0= 11%, D.0= 14% etc. This means out of objectives stated in the document only 9% of the objectives are was devoted Category A.0. When compared to ours results, it is apparent that our curriculum is overridden by the products of science. Science process skills, which some called it, the heart of what is learning is all about, are under represented in our curriculum guides. Carin A and Sund R (1989) use analogy from bible to show the central role that process and inquiry skills play in solving problems: 'give people a fish and they eat for a day. Teach them how to fish and they eat for a life long' (p.67).

All the analyzed documents have almost all the objectives for the different categories in the Klopfer's scheme with different proportions (except one category each). Practically no objective was found that expect students and guides textbook writers to employed the skills of planning, experimenting, making a fair tests, identify variable, hypothesize etc, that a genuine problem solver employs in solving a problem. Very few problem-solving objectives were represented by the document. The content of science was more emphasized than the methods and the affective dimensions. Unlike this result, in all the three textbooks, the content analyst in the evaluative report believe that the guides contain all relevant objectives in their field (ICDR, 1998).

4.2.2 ANALYSIS OF THE CURRICULUM GUIDES WITH RESPECT TO THE AIMS OF PRACTICAL SCIENCE.

Hofstein and Lunetta (1982) pointed out that many goals for the practical science are almost synonymous with those defined for science courses in general. They identified the need to define goals where laboratory work could make special and significant contributions and to capitalize on the uniqueness of this form of teaching.

Laboratories are important places to generate knowledge and students develop appreciations of those processes and abilities through practical science. Although some of these attributes could take place in other settings as well, but in the laboratory, they are put together. Students learn about the processes of scientific inquiry and a full appreciation of practical science through being engaged in it. Many authors have proposed sets of aims for laboratory work which focus on the purposes of laboratory activities (Bond, Dunn and Hegal, 1989; Matiru, Mwangi and Schlette 1996; Berhanu 1996).

The third domain that Bloom described, along side the cognitive and the affective, was the psychomotor domain. It is self-evident that these psychomotor skills can only be developed by using the scientific equipment actively involved in scientific activities, and equally self-evident that these are important in any science education. To know about science, even to like science, it is not sufficient in itself; a student should also be able to do science. In this line, Berhanu (1996) evaluated the aims of practical science included in the grade 9 and 10 physics curriculum materials. He found pertinent aims of practical work included in accord with the contemporary view. Such list was adopted to assess the provision of the three science curriculum guides with respect to the aims for practical science.

Together with the psychomotor domains, other objectives which were stated in the curriculum guide under the 'demonstration' and 'do experiment' suggestion were taken for analysis. Other objectives, even though had the affiliation to the practical science, but if not stated under the context of these suggestions, were not included in the analysis. In this study, 126 objectives (21 from biology, 36 from chemistry and 69 from physics) were drawn from the three guides. Table 4.2 summarize the result of analysis of aims of practical science included in these guides.

Table 4.2 summaries of the results of analysis of aims for practical science

CRITERIA	BIOLOGY	CHEMISTRY	PHYSICS
TO AROUSE INTEREST IN THE SUBJECT AND DEVELOP INSIGHT INTO THE DEVELOPMENT OF SCIENCE AND TECHNOLOGY	0	0	0
TO DEVELOP MANIPULATIVE SKILLS	5(23.8%) ...dissect eyes of cattle or sheep and show the structure ...use keys to classify plants and animals.	6(16.6%) ...write balanced chemical equation for the reaction of acid anhydrides with water, basic oxides and bases. ...use indicators to differentiate acidic oxides and soluble basic oxides from other types of oxides.	17(24.6%) ...carefully handle equipment. ...read electrical instruments.
TO DEVELOP UNDERSTANDING OF SCIENTIFIC PROCEDURE	0	0	2 (2.89%) ..select factors to measured and kept constant. ...identify the factors that affect the resistance of a conductor.
TO ELUCIDATE THEORETICAL KNOWLEDGE AND SCIENTIFIC CONCEPTS	14 (71.4%) ...to Show the requirement for seed germination ....show that plants use water to make food	24 (66.66%) ...explain the action of acids on carbonates and hydrogen carbonate. ...describe the properties of acidic anhydride (acidic oxides).	26 (37.76%) ...explain how the factors affects the resistance of the conductor. ...to show the direction of the magnetic field around a straight current carrying conductor.
TO DEVELOP SKILLS IN READING AND WORKING WITH DIAGRAMS	1 (4.76%) Diagram and label the human ear.	0	7 (10.14%) ...read and record the current and voltage ...draw the refracted ray when the incident ray is given.
TO DEVELOP THE ABILITY TO OBSERVE, RECORD AND DISCOVER REGULARITIES.	0	0	4 (5.79%) ...record the data. ...observe experiment and record results.
TO DEVELOP THE SKILLS IN SOLVING PROBLEMS APPLYING LEARNT RELATIONS.	0	6 (16.7%) ...calculate formula mass or molecular mass ...convert molar masses to moles and vice versa.	13 (18.84%) ...use the formula Rt=R1+R2 and 1/R1=1/R1 +1/R2 to solve related problems.
TO DEVELOP THE SKILLS OF USING MODELS.	0	0	0
TO DEVELOP INVESTIGATIVE SKILLS.	0	0	0

Analysis of the curriculum guide for practical aims shows that the aim to elucidate scientific concept or a theory were the most dominant aims. It accounted for 71.4 percent in biology, 66.66 percent in chemistry and 37.76 percent in the physics guides. Development of the manipulative skills, which are important for the development of skill in every day life and doing science in the respective subjects, comprised the second most emphasized aims for practical science. They comprise 23.8 percent in biology, 16.6 percent in chemistry and 24.6 percent in physics. The third emphasized aim in these guides was the development of problem solving skills using learnt laws comprising 16.6 percent in chemistry and 18.84 percent in physics and are absent in biology. Physics curriculum guide also have objectives to develop skills related to reading diagrams (10.14 percent) and ability to observe, record and discover regularities (5.79 percent). As indicated in the table, the physics curriculum guide has fairly treated more aims for practical science. For further discussion, see the Appendix 3.

No objectives were found to arouse students' interest in the subject matter and development of insight in science and technology, in the development of skills in using models and development of investigative skills in science. This result shows consistency with the discussion on the nature of science. Still the traditional conceptions of the science curriculum prevailed both in the analysis of the nature of science and aims for practical science. High percentage of illustrative aims strengthen the emphasis placed on the development of conceptual and theoretical knowledge. Such findings make the claim of content analyst of the formative report and science curriculum writers under question.

4.3 ANALYSIS OF PRACTICAL WORK IN THE TEXTBOOKS

4.3.1 THE KINDS OF PRACTICAL ACTVITIES INCLUDED IN THE THREE SCIENCE TEXTBOOKS

Most units in the three textbooks are represented by a scientific concept, except one topic in physics (unit 2- seeing things) and another unit in biology (unit 6 classification). No separate period was specifically allocated for the practical part, and so does in the schools timetable. Periods are suggested in the syllabus, for the exposition of scientific content and doing practical activities. Teachers are, therefore, required to take this general guideline and plan their time for doing practical work, although there are no empty slits in the school programs to inject practical science.

The curriculum guide, especially physics, give proper hints as to the kind of practical activities to be done and the methods to be adopted. Teachers may not benefit from such document since they may not have it. All practical activities suggested in the three-science student textbooks are analyzed. They appear in different names: Activities, Experiments, and Practical activities. The textbook writers gave no indication of whether such names are given intentionally having different meaning in their minds or not, was not known. Literature on kinds of practical work clearly shows that these terms can be used interchangeably (Bekalo and Welford, 2000).

Each practical activity was taken from the three textbooks and is subjected to analysis. They are denoted (See in the Appendix 2) by the notation like A-3.4 (148), meaning Activity found in the students textbook in Unit 3 Sub-units 3.4 and on Page 148. Seventy-four activities (32 in chemistry, 20 in biology and 22 in physics) are found in these science textbooks. Every activity was analyzed using the scheme suggested by Gott et al (1988). They classified practical work into five: inquiry, illustrative, skills, observations and investigative. Gott and Duggan (1995) showed that the boundaries between them is not watertight. For example, skills and observational practical are almost implicit to some degree in other types. Enquiry practical are designed and structured to make the student discover a particular concept for himself. Care should be taken, in designing these practical, to make each pupils arrive at the same ends. Illustrative practical aim to demonstrate or illustrate a particular concept which was introduced by the teacher or textbook in advance. Students, hence, 'see' the concept in action. Skills practical aims to help pupils learn or practice a particular skill, like setting up, reading and using instrument (microscope), draw line or bar graph etc. They are designed to equip the basic skills necessary to carryout other practical sciences. Observation was described as 'theory-laden', in that, whenever pupils do observe in science, they use their conceptions to an event or objects in question. In observation practical, pupils do apply their ideas to the observed phenomena. Investigative practical aims to allow pupils use concepts, cognitive processes and skills to solve problem. They are less structured than enquiry or illustrative practical. Table 4.2 will summarize the result of the kinds of practical activities found in the three science textbooks.

Table 4.3 summary of the findings of the kinds of practical work in the three science textbooks of grade eight.

KINDS OF PRACTICAL ACTIVITIES	BIOLOGY N=20	CHEMISTRY N=32	PHYSICS N=22
SKILLS	0	0	0
OBSERVATIONS	1	0	2
ENQUIRY	13	1	2
ILLUSTRATIONS	6	30	18
INVESTIGATIONS	0	0	0
NOT RATED	0	1	0

The most frequent kind of practical activities, from the above table, was found to be illustrative practical. It is highly prevalent in the physics and chemistry textbooks. They account 93.75 and 81.81 percent of the total activities suggested in the chemistry and physics respectively. In biology, unlike the physical sciences, can best be handled through enquiry approach (Mekuanent 1994), and hence, enquiry practical is the most frequent ones. They account 65 percent of the total activities stated in the biology textbook. The major difference between illustrative and enquiry practical, according to Gott and Duggan (1995) is:

> Illustrative practical can take the form of demonstration by the teacher or practical where pupils are given detailed instructions or 'receipt' to follow. The main aim of illustrative practical is concept consolidation. The spring activity, *for example*, is a typical practical where the pupils either 'discover' Hooks Law in an enquiry practical, or if it is followed directly teaching on the topic, the same activity can be used as an illustrative practical enabling pupils to see the concept in action (p.21). (Italics is added)

From this we can say that, though the policy and the syllabus have their own intentions, at this level, huge number of activities in the chemistry and physics textbooks are designed to promote concept acquisition through illustrative practical. The major purpose of illustrative practical, as shown in the literature, is to show how the scientific concept dealt is seen in action with the major intentions that seeing is believing. These illustrative practical were found usually after the treatment of the concept, and are designed to show it to the student and consolidate and hammer the theoretical part dealt in advance. This result is consistent with the analysis of aims for practical science and still diverge out from the new intentions.

In doing these activities (enquiry and illustrative), students are required only to follow a certain number of prescribed procedures to reach at the required result. Students usually know, especially in illustrative practical, the answer before they start the experiment since they have dealt with the topic before they are doing the activities. Even in the enquiry practical, the assumption was that, students will have enough information before doing the activities to set the stage, called by Ausbel (1968) as advance organizers. Advance organizers are important in giving direction to the individual. Most inquiry exercises were found to contain more information, some times leaving only the last concluding statement. In such cases, they significantly reduce the cognitive challenge of the task into only suggesting a simple linear statement on part of the learner.

Example 1: In physics student textbook on page 83 there is a sub-topic on how to measure current. The text present to the students how current remains the same in the series connections and differs in the parallel connections (This statement is the major purpose of the activity). This topic was followed by diagram on how the ammeter is connected with a circuit. Then comes an *Activity 4/2- Measuring Current*, and command students to set up the apparatus as shown in the diagram: connect the dry cells, battery bulb, connecting wires, switch and an ammeter and finally to take three readings each after three minutes interval. In this activity, there is no need for the student to do even the experiment because he already knows the answer. The way the experiences are organized does not make the individual to question beforehand, and does not create mental disequilbrum, as Piaget says, but rather gave the meaning and relationships which the students themselves are supposed to find. It is only through this attempt that the student resolve mental disequilbrum, but in reality what the textbook was doing is that, it stabilize the mind and hence demotivate the student to do the activity.

Example 2: In chemistry grade eight students textbook on page 11, there is a discussion on the Acids and Their Properties. Acids were depicted as having two major properties (1) they have sour taste, and (2) usually their solutions change the color of indicators, for example, turn litmus paper into red, methyl orange into red, and phenolphthalein remains colorless in acidic solutions. This discussion was immediately followed by an activity (A-1.2A) *The Effect of Acids on Indicators*. The textbook gives the list of chemicals and apparatus and procedure to be followed. The student is ordered finally, to fill their observations (the kind of changes they learn when acid is added to the indicators by the text) on the table provided.

Example 3: Inquiry practical in biology, for example, Activity 1.4 (7) aims to enquire what is the effect of changing light intensity on the size of the pupils. A hand torch was suggested as the material required and under procedure, students are instructed in groups of two, in a dark room but good enough to observe the partners eye. Then to shine the light on the partner's eye and observe what is happening to the pupils. Such exercise was followed by two questions that help summarize the whole practical: (1)

what happened to the size of the pupils? And, (2) why do you think the change takes place? No discussion on the role of iris in regulating the amount of light ray passing through the lens was discussed in advance. Students learn the topic after the practical was dealt.

These discussions will clearly show that in these textbooks (especially in chemistry and physics) practical activities are considered as subservient to theory. Their purpose was to illustrate the scientific concept taught, and not considered mainly as a means of learning or means of identifying and testing misconceptions as declared by constructivists. Unlike them, the biology textbook contains 65 percent inquiry practical. Only 25 percent of the activities were found to be illustrative. Skills and investigative practical were not found in all the analyzed textbooks. Only one practical in biology and two practical in physics were found to be observational. No observation practical was found in the chemistry textbook.

Each practical activity in the textbook was structured in such a way that they have their own statements of aims, material and apparatus required, procedure to be followed and some leading questions that instruct students to the required answer. Though such aims usually written as if the students are going to investigate(see Appendix 2), explore and discover some thing, in reality these activities are found to require only make students to verify or confirm what has been learned. Virtually no practical was found to test students ability to employ their procedural understanding given a scientific problem, like giving decisions by their own concerning what to measure, when to measure and how much to measure to arrive at an average ... instead, students are told exactly in the textbook what should they measure, observe and interpret. They do not encourage students to form hypothesis and predictions and in essence, students are persuaded to accept the explanation given by the text with out questions. The development of divergent thinking skills and problem-solving abilities wished by the Educational and Training Policy through such conditions is under question. This fact is well illustrated in the following example.

Example 4: In the Physics student textbooks the Activity 3/1 on page 59, aims to **investigate** *how the quantity of heat to be supplied depends up on (a) the mass of substance to be heated, (b) the temperature rise required, and (c) the type of the* substance heated. Materials, equipments required, and procedures to be followed are given. Data on temperature were presented in the table after 30 minutes interval. The time versus change in temperature graph was presented and finally the book itself states the type of relationship observed in the graph as: The time required is proportional to the temperature rise, and then concludes the heat required is proportional to the temperature rise. Finally shows the relationship with a mathematical form: Q = mc T. Where C is a proportional constant known as specific heat capacity of the material (AACAEBCDRD, 1999).

Thus, the purpose of the activity is not as it was stated but shift from the investigative practical to verification. Such activity is not investigative and hence cannot help students develop problem-solving abilities, as is the case in investigative exercises, because the student does or think nothing, but read. An alternative approach must be sought to make each practical at least demanding to a certain extent. For example, designing an inquiry or illustrative standard experiment may not be feasible in our context since school have deprived of such scientific apparatuses. An alternative approach can be at least to specify the apparatus and the material and procedural demand of the task and then provide second hand data at different time interval and ask students to organize the data into graphs, tables etc and then interpret the result.

4.3.2 ANALYSIS OF THE PRACTICAL ACTIVITIES FOR INQUIRY LEVEL INDEX

The Inquiry Level Index was first designed by Herron (1971). The scheme has three levels depending on the tasks that students have to accomplish-problem, materials and methods and conclusion. At Level Zero, the problem, method, and the answer are all provided and the students have to follow instructions and obtain the results specified by the text. At level one, the questions and method are given and the student has to find the answer. At level two, the question is given; the student has to design a method and find an answer. At level three, the student is presented with a phenomena, she/he has to formulate a relevant question, design a method and find an answer to the question. Tamir (1991) added a fourth dimension to the Herron's' scheme, called collection of data and such scheme was employed for this study. Methods of determining the ILI of the activities are shown in the examples below.

To find the Inquiry Level Index for an activity, the activity was evaluated at four levels. Aims (statement of problems), materials and methods, collection of data and conclusions (answer). Whenever each level was stated by the text, they are considered as 'given' and if not, they are rated as 'open'. Open levels give chance for the pupil to use his knowledge, method or skills of science to recommend an answer. **Example 1**:

Activity 5/3 (p.111) in the Physics textbook, the aim of the activity was stated as: *to observe the direction of magnetic field around a straight current carrying conductors.* Apparatus and detailed procedure to carryout the practical was suggested. The set up for plotting magnetic field was depicted in fig 5.3 (p.111). Finally, the book itself gave a summary: *'Activity 5/3 verifies that field lines around current carrying straight conductors are circular.* You might observe that the direction of field lines depends on the direction of current' (AACAEBCDRD, 1999).

Example 2: Activity 1.8 (P.26) in the students' biology textbook, for example, states the aim of this activity as: *to discover the distribution of touch receptors in the skins.* The material and procedure were discussed and students are expected to collect data from different parts of the hand-forearm, palm and fingertips and finally give conclusion based on their data. There are some leading questions that ask students to draw a general statement based on the evidence they have: what do these results indicate about the density of touch receptors in these regions. Chances are given to students to collect data on different parts of the body and make conclusions. Table 4.3 show the process of analyzing the above two practical using the ILI.

Table 4.4 Analysis of the sampled practical activity.

ACTIVITY	IDENTIFYING PROBLEM	DESIGN PROCEDURE	COLLECT DATA	DRAW CONCLUSIONS	LEVEL OF INQUIRY
A-5/3 (111)	GIVEN	GIVEN	OPEN	GIVEN	0
A-1.8 (26)	GIVEN	GIVEN	OPEN	OPEN	1

To determine the degree of openness of the activity and their demands for enquiry skills, all the practical activities suggested in the students' textbooks were analyzed using the Tamir (1991) index. The results of these analyses can be shown in table 4.4.

Table 4.5 Summary on the Inquiry Level Index for the activities included in the three science textbooks.

LEVELS OF INQUIRY	NUMBERS OF ACTIVITIES IN		
	BIOLOGY	CHEMISTRY	PHYSICS
0	6	8	17
1	14	24	5
2	0	0	0
3	0	0	0

From the above table, one can say that the majority (70%) of the activities in the biology and (75%) in the chemistry textbooks are at level 1 and (77.2%) are 0 in the physics textbooks. No activities were found in the three textbooks with the Inquiry Level Index of two and three. The reasons for this might be due to the nature of content dealt in physics. The content in physics appear more abstract than biology, which are difficult and remained abstract unless they are sampled with illustrative practical. The majority of activities in physics require a scientific apparatus to demonstrate the concept under discussion. Due to lack of these apparatus at the disposal of the schools, textbook writers goes up to the point of giving conclusions to the activities. In biology and chemistry activities, though the textbooks indicates clearly the problem, methods, materials and procedures to be followed, they gave chance to the student to gather data and draw conclusions based on the evidence they have. To do so, the textbook writers gave deliberately one or two questions that demand students to state relationships or generalizations and conclusions. Almost in all activities (except one activity in chemistry which was discarded in this analysis A-4/8 (119) (Test for Ammonia), the science textbooks identify for each activity the aim, design procedures on how to proceed, and state the material and equipments that the students are supposed to use.

Real problems in life does not only solved by collection of data and giving conclusions. For example, Gott and Duggan (1995) gave a more catholic definition of 'problem' as any activity that requires a pupil to apply his or her understanding in a new situation. Bentley and watts(1989) also defined a 'problem' when a person has a goal which cannot be achieved directly. Kahney (1986) in Bentley and watts (1989) make distinction between well defined and ill-defined problems. In well-defined problems have the goal, the possible move and strategies are all given at the start. Ill-defined problems are one in which the goal and the permissible move have to be supplied by the problem solver. An example taken from Bentley and watts (1989:81)

> You are lost in the wild of tropical country. You have not drunk anything for three days. All you have around you is some swamp water, some coconut trees and some bamboo trees. You have a sharp knife, some matches and a spare of shirt. Find a way of producing pure water from the swamp. You must also find a way of producing it is pure.

In life students encounter ill-defined problems and they are expected to define them operationally, plan, collect data and give recommendations based on the evidence they have. Even though the actual routes in solving problems are not always linear, students enter into a complex physical and mental processes. No one is there always with them and define their own personal problem they encounter in life. All the problems found in the text are well defined problems. The practical identified by the text were structured to guide students thinking in one direction and hence limit divergent thinking suggested by the policy. No provision was left for students to plan, hypothesize and test their hypothesis and always the procedural demands of the activities are given by the textbook. Contrary to this, solving problems in reality requires the application of both conceptual and procedural understandings to the problem.

4.3.3. ANALYSIS OF PRACTICAL ACTIVITIES WITH RESPECT TO THE LABORATORY ASSESSMENT INVENTORIES.

The LAI was designed by Tamir and Lunneta (1978) to analyze the laboratory exercises/ investigations in science textbooks. It has four major categories, namely Planning, Performance, Analysis and Application. Each of these categories are represented by specific skills. By using each skill the evaluator marks either 0 or 1, 1 meaning the skill is used, and 0 means that there is no opportunity to use the skill. Tamir and Gracia (1992) using such scheme found that hardly any opportunities exist to develop either planning or application skills in the currently published laboratory exercises. Few analytical skills, namely, 3.2 (Determining relationships, concluding); 3.6 (Explaining relationship) and 3.1 (Transforming results) were found. This instrument was considered as a powerful tool in order to identify what kinds of specific skill are employed by each practical activity. Each activity was evaluated across each level of the LAI. Number 1 was assigned if that particular skill was asked by the text for the student to use in doing the activity. In such way, all the biology (N=20), chemistry (N=22) and the physics (N=32) were analyzed. Table 4.5 will summarize the results of the activities using the LAI scheme. You can refer to the Appendix 7 for detailed discussion on this matter.

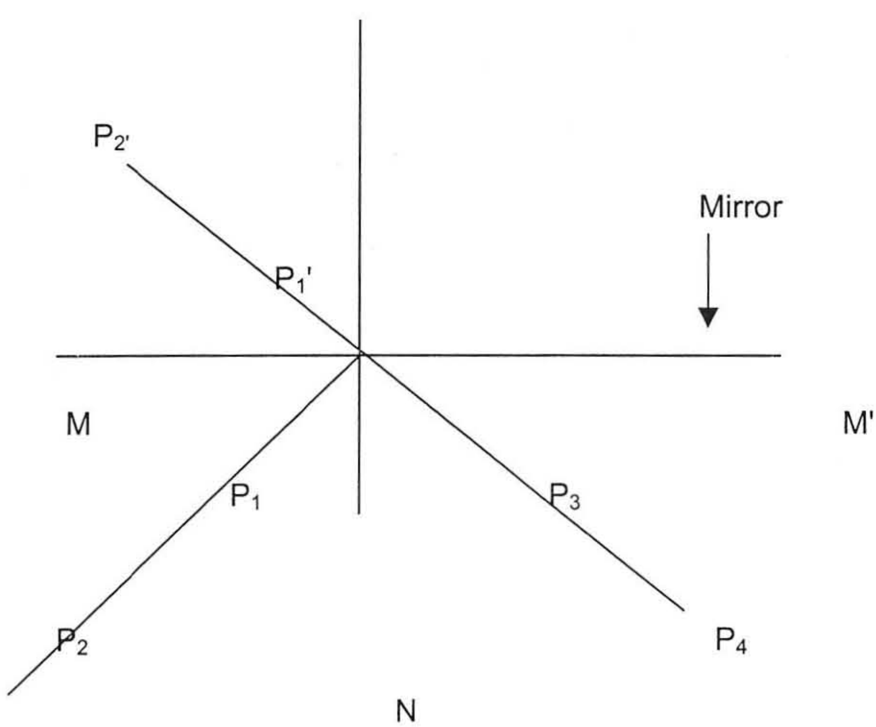
Table 4.6 Results of content analysis of the practical activities included in the three science textbooks of Addis Ababa Region through Laboratory Assessment Inventory.

	BIOLOGY N= 20	CHEMISTRY N=32	PHYSICS N= 22
INQUIRY LEVEL	6 = 0 14 =1	8 = 0 24 = 1	17 = 0 5 = 1
PLANNING			
1.1 FORMULATING A QUESTION.	0	0	0
1.2 PREDICTING EXPERIMENTAL RESULT.	0	0	0
1.3 FORMULATING HYPOTHESIS.	0	0	0
1.4 DESIGN OBSERVATION/ PROCEDURE.	0	0	0
1.5 DESIGN EXPERIMENT.	0	0	0
PERFORMANCE			
2.1A CARRIES OUT OBSERVATION.	15	28	14
2.1B CARRIES OUT MEASUREMENT.	3	2	12
2.2 MANIPULATE APPARATUS.	16	22	6
2.3 RECORD RESULTS.	9	18	8
2.4 PERFORM NUMERICAL CALCULATIONS.	2	0	6
2.5 EXPLAIN PROCEDURE.	3	6	0
2.6 WORKS ACCORDING TO OWN DESIGN.	0	0	0
ANALYSIS			
3.1A TRANSFORM RESULTS TO TABLE.	0	2	3
3.1B TRANSFORM RESULTS TO GRAPH.	0	0	1
3.1C MAKES DRAWINGS BASED ON OBSERVATION.	0	0	3
3.2 DETERMINE RELATIONSHIPS/ CONCLUDES.	12	21	8
3.3 DETERMINE ACCURACY OF EXPERIMENT.	0	0	0
3.4 DEFINE ASSUMPTION/ LIMITATIONS.	0	0	0
3.5 FORMULATES GENERALIZATION/ MODEL.	0	1	1
3.6 EXPLAIN A RELATIONSHIP.	1	5	3
3.7 FORMULATE NEW QUESTIONS.	0	3	0
APPLICATION			
4.1 PREDICT BASED ON OBTAINED RESULTS.	6	14	2
4.2 HYPOTHESIZE BASED ON OBTAINED RESULTS.	0	0	0
4.3 APPLIES FINDING IN NEW CONTEXT.	0	1	0

Method of analysis using LAI can be shown by taking one activity from physics textbook-A-2/2(19-20). This activity was assigned to be illustrative since students have dealt with the Laws of Reflection before they are doing the activity. This activity, therefore, was designed basically to verify the scientific Law. The procedure outlined in the textbook was as follows:

1. Obtain a white sheet of paper and draw a straight horizontal line about its center. Then place it on a piece of soft board on a horizontal bench and use four pins to hold the paper to the board.

2. Place a strip of plane mirror vertically so that its silvered surface in on the line you have drawn. Label this line MM'. Stick two pins P_1 and P_2 on the paper in front of the mirror so that the line P_1 and P_2 is at an angle to MM'. The pins P1and P2 should be 5 or 6 cm apart. With the eye at a convenient point, *observe* the images P'1 and P'2 of the two pins and stick two other pins P3 and P4 in a straight line with these images. The set-up is shown in Fig 2.9. Now remove the mirror and the pins. *Draw* the line P_1P_2 and P_3P_4.



If you did the experiment carefully, you will find that the lines meet at a point on MM'. Call this point O and draw on perpendicular to MM' as shown. *Measure* the angle P_2ON and P_4ON and *record* your results. Repeat the experiment for different angles and *tabulate your result,* as shown on Table 2.1. Angles P_2ON and P_4ON are angles of incidence and reflections respectively. This experiment can be done as easily using a ray box instead of pins.

Table 2.1

Exp.	Angle of incidence	Angle of reflection
1	10^0	-
2	20^0	-
3	-	-
4	-	-

From these results, it can be seen that the angle of incidence equals the angle of reflection in each case. The result obtained in these experiment explain the two laws of reflection which can be summarized as follows.

1. The incident ray, the reflected ray and the normal at the point of incidence all lie in the same plane.
2. The angle of incidence is equal to the angle of reflection (i.e. i= r).

Physics student textbook (AACARCDRD, 1999: 19-20).

Using LAI, each of the Planning, Performance, Analysis and Application stage were used to see what kind of specific skills was demanded by the task for students to do. It appeared that, as in all activities, no skills under Planning were found. Students are not asked to formulate questions, hypothesize or design a procedure for the activity. A number of Performance skills are required by the task. Students are asked to make observations, to measure, manipulate apparatus (for the apparatus suggested was simple), record results. Students are also asked to exhibit two skills under Analysis - Category 3.1a (Transform the data into table and Category 3.1c (Make drawing based on observations). No Application skills were found in this exercise.

The finding shows that the most important skills that were used in the context of problem solving are not emphasized. Like the results of Tamir and Gracia (1992), all the planning skills are not found in the entire practical. No practical was found to demand students to formulate a question from a discrepant observation, predict what will be the experimental results, formulate hypothesis, design observation/ procedures and design experiments. From the four categories of the LAI, performance was fairly represented in the analyzed practical. Each practical has almost some where in its design instruct students to observe particular happenings, hence are the most frequent skills.

Manipulation of apparatus was another most emphasized performance skill. Many practical require simple apparatus that can be found easily and students can have them. Such skills are important in carrying out scientific experiments and do familiarize students with the apparatus. Category 2.6 (Working according to own design) was not found in the analysis, since such provision goes with the Planning category. As a group, analysis was second to the planning, in receiving meager attention by the designers of these activities. Even the simplest task to set for students to do, like Category 3.1a-3.1c is almost non existent. Such skills are important in helping students communicate the result of experimentation, and in so doing, helps generalization simple. Category 3.2 (determining relationship/ generalization) was well treated in each textbook.

4.4. ANALYSIS OF RESOURCE FOR PRACTICAL SCIENCE

In spite of the growing interest in practical work in the school science since the 1960s, research provide little evidence as to what helps students be good at investigation (Toh K, in woolnough 1991). Critical evaluation of the effectiveness of practical work in promoting learning in science has suggested that the return on investment (of time, resource, energy) is not good (Layton D in UNESCO 1990). On the other hand, there are evidence that it is the 'stuffs' and materials that makes science inviting to children and bring them into the world of scientist and how they work (National Science Resource Center, 1997).

Cessac J in (UNESCO, 1960) presented a survey made in 1958 in Nigeria primary and secondary schools by using two indicators to give a rough picture on the status of school equipments. He employed the number of chemical balance and the number of microscope in the chemistry and biology laboratory respectively. Another dimension to evaluate the capacity of the school laboratory/ resource room facilities can be made on the basis of the presence and/or absence of the ancillary rooms, running water, gas supply, electricity, sinks, gas juts, etc. Annual expenditure of the schools on the current supply and maintenance of science equipment can also be used to predict the feasibility in implementing the science syllabus with respect to practical activities.

To ascribe the status of schools with respect to the provision of resource available for effective implementation of the science courses, inventory checklist was employed. The materials and apparatus suggested in the practical activities of the three science textbooks were identified and this list was checked against what was available in each schools (See Appendix 8 for detailed list of the materials suggested by the textbook writers). This list was given to three randomly selected schools, one for each zone. Science teachers respond to this list by circling the material, chemical and apparatus that was found at their schools. Table 4.7 summarized the status of the three schools with respect to the lists of most important laboratory apparatus and materials, identified by science teachers and synthesized by the researcher, as mandatory and minimum requirement for teaching the respective subjects.

Table 4.7. Lists of resources and materials identified by school teachers as mandatory to teach the sciences through practical emphasis and the status of the three schools.

		SCHOOL A	SCHOOL B	SCHOOL C
PRESENCE OF TIME TABLE FOR LABORATORY		NO	NO	NO
PRESENCE OF SEPARATE ROOM CALLED LABORATORY / RESOURCE ROOM		HAVE MINI LAB + RESOURCE ROOM	RESOURCE ROOM	RESOURCE ROOM
MATRIALS FOR BIOLOGY	MICROSCOPE	OLD, SEMI FUNCTIONAL	NO	NO
	DISECTING SET	NO	NO	NO
CHEMISTRY	BALANCE	NO	NO	NO
	BUNSEB BURNER	NO	NO	NO
	TEST TUBES	FEW	FEW	NO
	CHEMICALS	FEW	FEW	FEW
PHYSICS	MIRROR	CONCAVE + PLANE MIRROR	PLANE	PLANE
	THERMOMETER	NO	NO	NO
	VOLTMETER	NO	NO	NO
	COMPASS NEEDLE	NO	NO	NO
	AMMETER	NO	NO	NO
	SENSITIVE ZERO GALVANOMETER	NO	NO	NO

Percentage of materials found in the three schools as compared to what is stated in the three curriculum materials can give the whole picture of the school context with respects to practical science and is presented in table 4.8.

Table 4.8. Percentage of materials and resources found in the school with respects to the materials, apparatus and chemicals suggested and found in the three schools.

MATERIALS AND APPARATUS SUGGESTED	SUBJECT	SCHOOL A	B	C
	BIOLOGY	53.65 %	42.1 %	19.3 %
	CHEMISTRY	23.95 %	25.6 %	18.1 %
	PHYSICS	57.69 %	42.7 %	15%
CHEMIICALS SUGGESTED	BIOLOGY	100 %	33.3%	66.6%
	CHEMISTRY	21.05 %	19.9%	15.5%
	PHYSICS	-	-	-

This may indicate among other compounded reasons, science was virtually never being learned by direct experiences, and nearly all students never experience a real experiment through out their school program. All teachers use the textbooks all the time and hence served as a course outline, the framework, the testing and the view of science. It is therefore unthinkable to expect teachers give emphasis to practical methods, even demonstration. The percentage shown above shows only the presence or absence of the apparatus, materials and chemicals found and not their abundance. For example, the whole biology practical require only three chemicals and their presence in the resource/laboratory room was checked and not their abundance to carryout the practical by students.

Discussion with the school teachers and the school directors revealed that in all the Addis Ababa Administrative region government primary schools (1-8), only three schools have already established a mini-laboratory room, one of which was the sampled school selected for this analysis. There is no annual budget for the laboratory practical activities in general and almost all the schools attribute to the lack of budget even for the major task of the schools. In all the schools, there was a resource room filled with students and teacher made models and charts. There are enough two-dimensional instructional resources. One old model microscope was found in one of the school analyzed (school A - Yekatit 23 Primary School), only the low power objective is functional and teachers use it in order to show when they are dealing with the parts of microscope and not for practical purposes.

The mini-laboratory is located at the end of one row of rooms having a 7X 5 meter in area. One long balcony was found in front of the rows of desks facing the blackboards just the same way in normal classrooms. There are about three dusty cupboards. One old almost non-functional microscope is locked in the wooden cupboard. Some chemicals like permanganate solution, iodine and other cheep chemical that can be found easily from the local drug store. Sever chemicals shortage is operating in all schools. The science department head pointed a small 5-7 centimeter long magnesium ribbon locked in the glass cupboard. He laughed when he said 'this magnesium is not used for experiment (one activity in chemistry requires the burning of magnesium), but to show the students when teachers are dealing with the topics metal'. Teachers response also revealed this same observation.

4.5 ANALYSIS OF THE ASSESSMENT PROCEDURES USED IN THE SCHOOLS AND NATIONAL EXAMINATIONS.

In the 1970s and 1980s a considerable effort was made to isolate and define domains of practical activity. Hofstein et al. in Layton (1990), for example, identified three practical domains: (a) skills in the performance of routine laboratory tasks; (b) ability to make observations; and (c) problem solving ability. Ben-Zui et al in Layton (1990), divided Hofstein's third domain into: (a) planning and designing of investigations; (b) performance of experiments; (c) observation of particular phenomena; and (d) analysis, application and explanations.

Such attempt to isolate and describe process domain was supposed to provide a basis for assessment of practical abilities and not to test only students' knowledge of scientific concepts in science teaching. In the Ethiopian context, although the recent Educational and Training Policy exalted the need for making students solve problem in each discipline, there was virtually no coherent framework and detailed criteria have been developed and advanced for the assessment of practical skills in education in general and in science in particular.

Research into the assessment of students' engagement in solving practical problems indicates that they rarely design and carryout effective investigations involving the manipulation of key variables if the experiment involves a level of conceptual understanding beyond their current achievement (Gott and Murphy, 1986).

The 1994 NETP has given emphasis to a new assessment directive in the Ethiopian school. The policy states: 'continuous assessment in academic and practical subjects including aptitude tests will be conducted to ascertain the formation of all round profile of students at all level (p.18). Following this intention, no document was available that give guidance to curriculum developers and teachers on the technique necessary to assess students' problem solving skills.

The three science syllabuses of grade eight were evaluated in this respect. They contain evaluation procedure for each stated specific subject objectives. Example: One objective in the chemistry curriculum guide for grade eight (p.22): At the end of this lesson, students should be able to explain the uses of the periodic table. Evaluation procedure deigned for this objective: Ask the student to explain the importance of the periodic table. In general check the attainment of the objectives by giving different exercises, quizzed, tests etc. Continuously assess the students' performance.

Almost all evaluation procedure stated to the corresponding lists of specific objectives emphasizes the conceptual understanding of students. No procedure was found to assess students' practical skills in the context of experiment. Under the psychomotor domain, the chemistry and biology guides contain a general subject objectives in relation to the practical science. For example, the chemistry curriculum guide for grade 7-8 (ICDR, 1997), states them as follows: The chemistry course will also contribute to the development of the students' skills. It will enable the students to:

1. Exercise the necessary precautions in handling acids and bases;

2. Develop skills in identifying acidic, basis, and neutral chemicals and handling laboratories (science rooms) equipments and chemicals equivalent to their levels;
3. Plan and carry out experiments similar to those included in their course;
4. Use the periodic table in generalizing the characteristics of the representative elements and in their future study of chemistry;
5. Use experimental methods in their everyday life to acquire more knowledge;
6. Develop skills in observing, comparing and interpreting experimental data equivalent to their level;
7. Use and interpret symbols, formulas, models and equations;
8. Develop skills in solving mathematical problems based on formulas.

As analysis of objectives of the syllabus shows this general skill objectives of the course are not well translated into the specific objectives of the syllabus, and no evaluation procedure was suggested for assessing these skills in practical context, especially objectives 3 and 5. There is no assessment objective in the syllabus that command teachers to evaluate their students' ability to make accurate quantitative measurements to make, interpret accurate observation of qualitative nature and to make records of all observations and conclusions.

This section analyzed two sets of questions- national grade eight examinations of the 1992 E.C. and the Final examination of the three science subjects offered from three randomly selected schools for resource inventory. All the National examination questions and one-third of the questions from the final examination of the three subjects was taken through systematic procedures. The result of this analysis is shown below.

Since, there is no document available that show guidance for assessment (Bekalo 2000, Mekasha 1999, Berhanu, 1999) and since there is no assessment technique available in the two analyzed examination that test practical abilities, this study employs the scheme designed by Bekalo and Welford (2000) to see the kinds of questions employed in the examinations. Table 4.9 summarize the results of analysis of the national and school first semester examinations respectively.

Table 4.9 summaries of the analysis of the national and schools final examinations.

	Facts, Laws, Principles and Theories	Mathematical laws & principles	Relationship between theory & Phenomena	Specific information, events, conventions, terminology, dates, names, units etc.
Physics national Examination N= 45 and ***Schools Final Examination N=45***	7 (15%), ***8 (17.7%)*** Q.27. Which of the following is correct about the energy conversion by a heat engine? 1. Mechanical energy to electrical energy 2. Chemical energy to mechanical energy 3. Electrical energy to mechanical energy 4. Mechanical energy to chemical energy.	18 (40%), ***7 (15.5%)*** Q. 21. A car has a 12V battery & its headlamp which are in parallels have a power rating of 60W. What is the current flowing through the filament of the headlamp? 1. 0.2A 2. 2A 3. 5A 4. 0.5A	6 (13.3%), ***0*** Q. 30. A body is traveling with a certain speed V. The frictional force on the body is greatest when it is 1. Sliding on a solid surface 2. Rolling on a solid surface 3. Moving on a water surface 4. Flying in air.	14 (31.1 %), ***30(66.7%)*** Q. 29. Which of the following instrument is used to measure wind speed? 1. Wind vane 2. Rain gauge 3. Thermometer 4. Anemometer
Chemistry National Examination N= 60 and ***First semester schools Final Examination N=60.***	15 (25 %), ***6(10%)*** Q.11. Why is an atom electrically neutral? 1. It contains equal number of protons and neutrons. 2. It contains equal number of protons& electron 3. The number of neutrons is greater than the electron 4. The number of neutrons is greater	4 (6.6 %), ***0*** Q.27. Calculate the number of moles of 12 g of calcium carbonate. (Atomic weights: Ca= 40, C= 12, O=16) 1. 0. 30 2. 0.12 3. 0.18 4. 1.2	6 (10 %), ***4 (6.67%)*** Q.3. A test tube with a colorless liquid was placed in a beaker of boiling water. The colorless liquid started to boil immediately. The boiling point of the colorless liquid is 1. Between 0^0 C and room	35 (58.3 %), ***50 (83.3%)*** Q.8. Some ice cubes are put in a pot & heated. The change of state that will occur first is 1. Melting 2. Boiling 3. Condensation 4. Freezing.

	than the valence electron.		temperature 2. Between room temperature & 100^0 C 3. Above 100^0 C 4. Less than 0^0 C	
Biology National Examination N=60. ***First semester schools final examination N=60***	17 (28.4%), ***21 (35%)*** Q.60. Which of the following is correct about artificial classification of plants and animals? It 1. Is based on their habitat. 2. Was introduced by carlous Linnaeous. 3. Is based on evolutionary relationship of organism 4. Uses binomial nomenclature.	0%, ***0%***	3 (5%), ***0%*** Q.26. If you do not eat enough fresh fruit and vegetables, which disease will you suffer probably? 1. Pellagra 2. Night blindness 3. Beriberi 4. Scurvy.	40 (66.6%), ***39 (65%)*** Q. 50. The only epidermal photosynthetic cells in leaf are called 1. Palisade cells 2. Sponge cells 3. Guard cells 4. Stomata.

All the questions analyzed have the same format with the national Examination. Chemistry and Biology exams contain 60 questions and the Physics booklet contains 45 questions, all of them used multiple-choice questions.

Literature on assessment (Murphy and Gott, 1984) associated with problem solving divided science activities into six categories: (1) use graphical and symbolic representations, (2) use of apparatus and measuring instruments, (3) observation, (4) interpretation and application, (5) planning of investigation, and (6) performance of investigation.

Giddings and Fraser, and Black (1988) identified four broad categories to assess the above practical activities: written laboratory reports, written test items, laboratory practical work and observational assessment. In the analyzed schools and National Examination booklets, three of the above (written laboratory report, laboratory practical work and observation) assessment techniques are not found. Only one evaluation procedure was found in the chemistry guide that requires students to write laboratory report. As the result of analysis shows, in the above table, only written test items are dominating the assessment practice both at national and school levels. According to literature, such scheme can be used even to assess reading measuring instruments, planning, designing, applying learnt knowledge and interpretation of data etc. Its usage in the analyzed assessment documents was quite limited. The majority of questions in the three subjects exams are devoted to ask students about specific information, events, names, terminology etc. Few question in the national examination, for example, three questions in biology, two in physics and one in chemistry state questions in the form of diagram, and students are asked to identify the part. All the remaining questions had the same type.

4.6 TEACHER'S OPENNION ON THE PRACTICAL WORK IN THE SCHOOL SCIENCE CURRICULUM.

Proper implementation of the new science courses in the light of the New Educational and Training Policy and the nature and purpose of practical work included in the three science courses was also explored through survey of teacher's opinion on the range of issues associated with current understanding in science education.

A questionnaire containing 30 items were dispatched to 8 schools randomly selected from the three zones. All science teachers at grade 8, in each school, were asked to complete the questionnaire. Out of the 52 questionnaires, only 40 were returned. The next section analyses teacher's response to these items of the questionnaire. Table 4.10 summarized number of science teachers for each subject, their qualifications and average years of experience.

Table 4.10 summary of the sampled teachers by subject, sex, qualification and years of experience

SUBJECT	TOTAL	SEX OF TECAHERS		QUALIFICATION	YEARS OF SERVICE				
		MALE	FEMALE		1-5	6-10	11=15	16-20	21-25
BIOLOGY	13	10	3	Dip.	6	2	2	-	3
CHEMISTRY	15	13	2	Dip.	10	3	2	-	-
PHYSICS	12	10	2	Dip.	6	3	-	2	1

The table shows that all the teachers involved in the study, according to the standard of the Ministry of Education, qualified to teach at this level. The majority (55%) of respondents have below 5 years of teaching experience in their respective subjects. Only 25% of them had more than 11 years of experience. Teaching loads, number of sections and students per teacher is summarized in table 4.11.

Table 4.11 summary of teachers average number of teaching loads, number of sections and average number of students per section per grade.

SUBJECT	GRADE	NO. OF TEACHERS	AVERAGE No. OF PERIODS/ WEEK	AVERAGE No. OF SECTIONS/ TEACHER	AVERAGE CLASS SIZE
BIOLOGY	7	*7	-	4.25	80. 75
	8	13	21.3	5.2	80.75
CHEMISTRY	7	*4	6	4.25	70.6
	8	15	22.2	5.6	78.7
PHYSICS	7	*10	6	4.25	75.4
	8	12	24	5.5	75.2

* Numbers of grade 8 teachers who have teaching load at grade 7.

On average, teachers have above average teaching loads. Almost 83.3% of the physics, 53.8% of biology and 26.6% of chemistry grade 8 teachers have also teaching loads at grade 7. They encounter on average a large number of students (78.2 students at grade 8 and 75.58 at grade 7), unlike what was stated in the education sector strategic which is 50 students per class (MOE, 1994b). By any standards, this result shows the state of overcrowded classroom in our primary schools. Student/ teacher's ratio is so large, and together with teaching load at both grades makes that there is almost no time and place for teachers to prepare and conduct practical science.

The rest of the items in the questionnaire were designed to review teachers perceptions on resource (Item 8-10), their current teaching (Item 11-19), training (Items 20-21), curriculum materials (Item 22-27), learning environment (Item 28), assessment (Item 29) and finally their opinion on how to improve the role of practical work in the science curriculum (30).

4.6.1 TEACHERS RESPONSE TO THE PURPOSE OF PRACTICAL ACTIVITIES INCLUDED IN THE STUDENTS TEXTBOOK

Teachers were asked to respond what they think was the purpose of doing practical work included in their science courses. Hence, they were asked to rank a number of purposes for doing practical work. The result show consistency across subjects teachers. All the respondents put concept discovery as the most frequent purpose and skill acquisition as the least for biology and chemistry, and raising questions and devising solutions was least rated by physics teachers. The result of content analysis showed that illustration was the most frequent purpose both in the analysis of aims for practical science and kinds of practical work, and hence this result shows gap between the purpose teachers assume to underline their science subjects and what actually revealed through content analysis. They are consistent with the results of content analysis in saying that skill acquisitions and raising questions and designing ways to solve them (Planning in LAI scheme) was the least treated purpose in the three science subjects. No other objectives were specified by the respondents (like the developing interest in the subject matter, familiarize students with important standard apparatus and measurement techniques, to train students in making deduction from measurements and interpretation of experimental data etc). On the other hand, teachers' response to the basic purpose of practical work as concept discovery has its own implication. At least one might expect teachers implementation behavior is the result of the value and understanding they assign to the vital objectives of their course. This assertion may not be always true even if all other equally important conditions for doing practical work are held constant.

Table 4.12 teachers response to the purpose of practical activities.

PHYSICS TEACHERS RESPONCE	BIOLOGY TEACHERS RESPONCE	CHEMISTRY TEACHERS RESPONCE
1. CONCEPT DISCOVERY	1. CONCEPT DISCOVERY	1. CONCEPT DICOVERY
2. CONCEPT ILLUSTRATION	2. OBSERVATION	2. OBSERVATION
3. OBSERAVTION & SKILL ACQUISITION	3. CONCEPT ILLUSTRATION	3. REAISING QUESTIONS & DEVISING SOLUTION
4. RAISING QUESTIONS & DEVISING SOLUTIONS	4. REAISING QUESTIONS & DEVISING SOLUTION	4. CONCEPT ILLUSTRATION
	5. SKILLS ACQUISTION	5. SKILLS ACQUISTION

4.6.2 TEACHERS JUSTIFICATIONS FOR DOING PRACTICAL WORK IN SCIENCE

Slight variation was observed in the teachers' response to the reasons why practical activities were included in the science curriculum and in the subject they teach. For example, 25% of biology and 50 % of chemistry teachers justify the inclusion of practical activities in the following way: (1) students learn science by doing science; (2) scientific concept and principles are abstract unless supported with practical work; (3) to motivate students in the science lessons; (4) to help students think like scientists; (5) to help students acquire scientific skills. 50 % of the physics and 12% of the biology teachers gave helping students learn science by doing was the sole justification for doing practical work. 33% of physics and 62.5% of biology teachers attributes to the illustrative functions. Motivational and thinking like scientists received 10% each by chemistry teachers.

The majority of teachers (83% of physics, 77% in biology and chemistry) perceive practical work as any thing that can be done in the school laboratory, classroom and even outside of the classroom. It is equated to any hands-on and minds-on activity. Hence, their perceptions differ from the definition given by the Westerners: as some thing done in the sophisticated and high tech laboratory. Other perceptions was summarized as:

- It is the one which contain the actual teaching aid rather than those which are taught in theory with in classrooms.
- It is the way to teach students by showing all the theory that they have told by performing themselves and reporting what they have observed.

Such comment shows that some teachers assign the role of practical wok as confirmatory to the classroom content and even the uses of teaching aids. Unlike this, hundred percent of chemistry and physics, and 88.8 % of the biology respondents strongly relate the significance of practical work in helping students gain more scientific knowledge. This justifies the more balanced and central role of practical work in science curriculum, as not only having an illustrative function, but as opportunities for students to learn more about science and doing science.

4.6.3 TEACHERS RESPONSE TO THE FACTORS THAT AFFECT PRACTICAL WORK IN THE SCIENCE CURRICULUM

There are different factors that play in the school context and potentially affect the implementation of practical science. Though there are many factors at work in school, this study explored factors like resource, curriculum materials, training, learning environment and assessment procedure. Allosp in Woolnough (1991) attribute three important factors that affect practical science in elementary school of low-income countries: (1) very large classes, (2) limited background in practical science and slight confidence of teaching method other than expository, and (3) the nature of examination which never test practical skills in science.

4.6.3.1 TEACHERS RESPONSE TO AVAILABILITY OF RESOURCES.

Teachers were asked to respond to the availability of adequate resources for practical work in their respective schools. Such resource includes budget for practical activities, facilities in the school laboratory/ resource rooms, chemicals etc. As it was expected and highlighted by the policy, sever shortage of resources for practical work was identified. This fact was also substantiated by the result obtained through inventory list for resources. The majority (50% of physics, 44.4% of biology and 50% of chemistry teachers) responds that there is virtually no resource for doing practical activities in the schools. This result was partially justified by their response to the annual budget their school have for practical science. 83% physics, 88.8% biology and 90% chemistry teachers agree that their school has no budget allocation to purchase materials, equipment and other resources demanded by the syllabus. In the same way, no regular schedule was available in the school timetable assigned for the practical part of science called laboratory.

4.6.3.2 TEACHERS EFFECTIVENESS

The competence that teachers have in their respective fields of study and in teaching the subject was partly attributed to their interest towards their current profession. As Desta (1984) stated teachers join a particular field of study primarily due to their interest in the subject. This interest drives them to read and know more in their areas of specialization. The surveyed science teachers' attribute to different factors concerning how they become science teachers. The majority (50% of physics and chemistry, and 55% of biology teachers) attribute to their personal interest. A relatively small percentage (25% in chemistry, 33% in physics and 11.1% in biology) attributes to fate or chance. A good job opportunity received lesser preferences (16.6% in physics and 12.5% in chemistry).

Teachers were also asked whether they are satisfied with their current practice in science teaching. Despite all the deficiencies observed in the analysis, their response lies along a continuum. Eighty percent of chemistry through 50% of physics and 33.4% of biology teachers responded positively. Those who respond negatively to this item attributed their dissatisfaction to the reason that science teaching requires doing practical work which they cannot do for various reasons (66.6% of physics, 83.3 of biology and 50% of chemistry teachers). Other reasons identified were teaching science is difficult (25% of chemistry teachers), no laboratory room and equipments (33.3% of physics and 25% of chemistry), and overcrowded classrooms (16.7 % biology) in the schools.

One might expect some teachers, some how, may execute some of the practical activities. To secure information, from those who respond positively to their science teaching, they were asked to identify what kinds of procedures do they employ in conducting laboratory activities. Biology and chemistry teachers had responded consistently. The majority (62% in biology and 44.4% in chemistry respond that they never employ any procedure since they hardly do any practical activities included in their textbooks. Twenty-five percent of biology and 44.4% of chemistry responded, if they does, they use teacher demonstrations. The least favored option was - to use 4-5 students per group. Equal number of respondents (33.3%) was obtained among physics teachers in using the three procedures. Such result is doubtful on part of the researcher since no capacity was identified in the schools with respect to resource and materials to undergo even teacher demonstration let alone experiments per groups.

4.6.3.3 TRAINING

Teachers were asked to respond whether they feel competent or not in teaching their subjects of specialization. Almost all 100% of biology and chemistry and 83.3% of physics teachers respond positively. Those 16.6% of physics teachers attribute their feeling of incompetence to lack of 'enough' science methods course in their teacher-training program. The majority (66.7% of physics, 33.4% of biology and 70% of chemistry) teachers respond that they never had a chance to participate in any kinds of workshop and seminar designed to improve their science teaching. Those who did (33% of physics and 33.3% of biology) teachers had such chance only once and (66.7%) of biology, teachers had the chance twice.

4.6.3.4 CURRICULUM MATERIALS

Another important parameter that helps to realize objectives of education at any one level is the provision of curriculum materials according to the major premise emphasized by the grand policy. Different regions of Ethiopia did manage to prepare their own curriculum materials for primary education. In these lines, Addis Ababa Administrative region Educational Bureau has published curriculum materials for the various subjects.

Teachers were asked to judge the nature of these materials and this section analyzed teacher's response in the light of current understanding.

Recent trend in science education at primary level was to emphasize on less content and more on the processes of science (Martin 1997). Teachers were asked to rate the amount of content expected by their students to cover given the time available in the school calendar. A result of teacher's response shows variation and is shown in table 4.13.

Table 4.13 Teacher's response to amount of content covered by the text.

SUBJECT TEACHERS	MUCH	AVERAGE	LITTLE
BIOLOGY	12.5%	25%	62.5%
CHEMISTRY	40%	20%	40%
PHYSICS	16.7%	16.7%	66.6%

Such result shows inconsistent with what the researcher believes and what he witnessed through conversation. Significantly higher percentage of teachers respond that the content in the textbooks as little. This result is partly justified due to the fact that large number of teachers never did any kind of practical science in their classrooms. One female teachers of biology in one of the primary school (Tesfa Kokeb) highlight the condition as :' To carryout all the activities which are stated in the grade eight biology student textbook effectively, the biology period must be raised to five period/week for every section. Unless, the stated activities will be good for noting'.

Teachers also judged the adequacy of the included practical activities in the textbook, given the level of students, differently. Table 4.14 shows this result.

Table 4.14 Teachers response to the adequacy of the included practical activities in the students textbook.

SUBJECT	ADEQUATE	AVERAGE	POOR
BIOLOGY	33.3%	44.4%	22.3%
CHEMISTRY	60%	20%	20%
PHYSICS	66.6%	-	33.45

The majority of respondents judged that such activities were found interspersed with in the different topics, analysis of these textbooks shows that there are some units with out even one activity and even most activities are concentrated mostly at one point in the text (See Appendix 2 for their special distributions with in the text). 83.3% of physics, 55.5% of biology and 44% of chemistry teachers judge the present textbook was inviting to make practical activities.

4.6.3.5 LEARNING ENVIRONMENT

Learning environment, the physical and emotional setting of the school was judged by teachers to be rated as good or bad. Hundred percent of chemistry, 60% of physics and 44.5% of biology teachers responded that there is no conducive environment that foster desirable attitude of students to practical science.

4.6.3.6 ASSESSMENT PROCEDURES

Science teachers were asked to respond what kind of assessment technique they frequently use to determine students' mastery of practical skills. Even though, paper and pencil tests are inadequate to evaluate students' practical skills, the majority of teachers (80% of physics, 66.6% of biology and 80% of chemistry) witnessed that they employ paper and pencil test as the only assessment procedure. An interesting result, for which the researcher is skeptical, was that 10 percent of chemistry, 11.2% of biology teachers responded that they use actual experiment done by the student to assess their mastery of practical skills. Twenty percent of physics, 10% of chemistry and 22% of biology teachers use observation to assess students' practical skills.

The last item of the questionnaire asked teachers to give their opinion on how to improve the role of practical work in school science courses. The response was summarized as follows:

1. To prepare good working environment for doing practical activities like making available the necessary equipments, materials, chemicals, resources and laboratory rooms at the disposal of teachers.
2. To reduce the number of students that teachers encounter in each classrooms.
3. Acquainting science teachers with issues of practical science through workshops and seminars and strengthening the pre-service and in-service science methodology course in this line.
4. Schools must find a period in their overcrowded schedule for practical science.
5. School personnel needs to have the awareness concerning the significance of practical science to the problem solving ability of students.

CHAPTER FIVE

5. RESULTS, CONCLUSION AND RECOMMENDATIONS

The objective of this study was to identify the nature and purpose of practical work included in the grade 8 science curriculum materials of Addis Ababa Region. Hence the curriculum guides and the student textbooks of the three science subjects were analyzed in the light of the contemporary issues in practical science. For this purpose the objectives of the guides, the practical activities in the student textbooks and examination documents were analyzed through content analysis, questionnaire and resource inventory checklists.

This section will, therefore, presents the major result identified and finally recommend some possible alternatives to alleviate the problem encountered. The curriculum guides were analyzed with respects to two major issues: to see what nature of science was represented and whether pertinent aims for practical science were included. It was expected that the nature of science included in the guides were always depend on the major theme and objective of the science curriculum at primary second cycle. The curriculum in tern was governed by the problem-solving paradigm identified by the Educational and Training policy.

4.1 SUMMARY OF THE RESULTS OF THE NATURE OF SCIENCE AND PROBLEM SOLVING PARADIGM

Analysis of aims included in the curriculum guides through Klopfer's scheme reveals that:

5.1.1 The nature of science was not fully represented. Among the 380 specific objectives (110 in biology, 122 in chemistry and 148 in physics) analyzed 81.8% of objectives in biology, 81.9% of objectives in chemistry and 63.5% of objectives in physics emphasized the product of science. Hence, the knowledge and comprehension objectives by far out numbered even when all the other objectives were put together. From all the domains, the affective domain was found to be represented least (0.9% in biology, 1.63% in chemistry, and 0% in physics).

5.1.2 Some categories in the Klopfer's scheme are not represented even by a single objectives, for example, observation, measuring and classifying in chemistry, the development of attitudes and interest in the individuals in the physics and interpretation of data and formulation of generalization in the biology curriculum guides.

5.1.3 Application of scientific knowledge (4.5% in biology, 10% in chemistry and 12.83% in physics) was more emphasized than applications of scientific methods. According to some authors, when a curriculum emphasize simple applications of scientific knowledge over methods, it would fail to help students appreciate the challenging aspects of problem solving in real life situations. Objective which emphasize problem solving in practical science was represented least in the guides. All stated problem-solving objectives require students only to solve a problem through learned law and mathematical formula. They are mostly stated in chapters where there is no practical activity, for example, unit 5 in chemistry and unit 6 in physics.

5.1.4 No consistency was observed in translating the general course objectives of the guide in to the specific lesson objectives with in the guide. This was manifested in all guides. General objectives in the biology and chemistry guides contain a number of objectives in the cognitive, affective and psychomotor domains. Nevertheless, such proportions were not found in the unit and specific lesson objectives.

4.2 SUMMARY OF AIMS OF PRACTICAL SCIENCE

Analysis of objective was also made in order to identify some pertinent aims for practical sciences included in the curriculum guides. Hence, the psychomotor domains and other related objectives found in the guide were compared with the list of contemporary aims for practical work in school science. The result of this analysis shows consistency across the science subjects and is summarized as follows:

5.2.1 In all the analyzed guides, important objectives like arousal of interest and insight into the development of science and technology, to develop the skills of using models and to develop investigative skills were not found.

5.2.2 The most emphasized aim, as opposed to the intentions, was found to be the verification of theoretical knowledge and scientific concepts covered by students (71.4% in biology, 66.66% in chemistry and 37.76% in physics), followed by the development of manipulative skills in the subject matter (23.8% in biology, 16.6% in chemistry and 24.6% in physics) and development of problem solving skills using learnt relations (16.7% in chemistry and 18.84% in physics) consistently across the three science subjects guides. Similarly 33% of physics and 62% of biology teachers justify the illustrative role for inclusion of practical activities in their subject.

5.2.3 Teachers response to the major aim of practical activities included in the students textbook shows consistency. Concept discovery was judged to be the most frequent aim and the development of skills and ability to see problems and device ways to solve them as the least.

4.3 SUMMARY ON THE KINDS OF PRACTICAL ACTIVITIES

Another document evaluated, along with the guides was the student textbook of the three science subjects: biology, chemistry and physics. Textbooks in the Ethiopian context affect what is going on in the classroom. They are almost the only instructional materials available in most cases. Analysis of such materials was, therefore, mandatory to know what students are actually doing. The science textbooks were analyzed from different directions and important information was obtained. The first attempt was to identify the kinds of practical activities included in the materials, and the following important results are discovered:

5.3.1 The majority (93.75% and 81.81%) of the activities in the chemistry and physics respectively were found to be illustrative. The biology was found to have 65% practical devoted to inquiry. Very few observational activities (5% and 9%) were found in biology and physics respectively. No investigative and skill practical activities were identified in all the subjects.

5.3.2 The most emphasized aim working underneath for doing such activities was to confirm the theoretical materials covered. In nearly all cases they are closely related with the content covered or will be covered. No practical activity was found to be added for its own sake. Such finding was found to be consistent with the result of analysis of aims for practical science. According to literature on practical science, such aim alone was deficient in helping students appreciate the methods of science and was deficient in bringing the required all-round profile of individuals who can solve personal and social problems.

5.3.3 Inconsistency was observed between the statement of aims stated for each activities with what was actually provided to students by the same activity. Many activities have aims to enable students discover, investigate, but in essence, they were found to be confirmatory.

5.3.4 All the activities (both inquiry and illustrative) were too much structured and show inconsistency in their presentation. They were sometimes too structured in such a way that students have noting to do in doing these activities. Too much help and guidance was given by the text. Few open-ended questions were identified with in the activities that gives chance to students to make decisions.

4.4 SUMMARY OF THE INQUIRY LEVEL INDEX OF THE ACTIVITIES.

The demand imposed by the task on the students was also another aspect analyzed. The Level of Inquiry Index revised by Tamir (1991) was employed to bring relevant information in this regard. Using such scheme, each activity was analyzed at four levels to see what kind of chance was left for the student by each practical. The following results were identified:

5.4.1 The majority (77.2%) of physics practical was identified to have an inquiry level index of zero, and about (70%) and (75%) of the biology and chemistry was found to have inquiry level index of 1 respectively. No practical activities were found with ILI of two or three.

5.4.2 The absence of practical at inquiry level index of two and three had its own implications. Real problems in life demand skills like ability to plan, to design a procedure which are absent in the analyzed materials.

4.5 SUMMARY OF THE SKILLS AND ABILITIES EMPHASIZED BY EACH ACTIVITIES.

Practical activities included in the text were also analyzed through the LAI scheme designed by Tamir and Lunetta (1978). Such schemes were identified to have power in disproving the lofty claims made by curriculum designers. Using such schemes, each practical was analyzed at four levels, to see what specific skills are demanded by the activity to be exerted by students in order to solve the challenge imposed by the task. Important results were obtained through such analysis and is summarized as follows:

5.5.1 All the 74 activities included in the three textbooks were failed to include the planning skills. No activities require students to plan their investigation given scientific problems. All these tasks are done by the text, hence students never learn such skills and apply them in their daily life.

5.5.2 Performance skills were fairly represented in the activities. Category 2.1a(Carries out observation), Category 2.2 (Manipulate apparatus) and Category 2.3 (Record data) were more emphasized than other performance skills. Category 2.6 (Working according to own design) was not found in all practical activities.

5.5.3 Analysis was treated least next to Planning. In doing all activities suggested by the text, students record their result into tables for analysis in only few activities. They never construct graphs out of their result and never makes drawings based on their observations. The most emphasized skill here was Category 3.2 (Determine relationship/ conclusions). Most activities ask students to conclude; though the text did it in advance in the theoretical part.

5.5.4 The third least emphasized, next to Analysis was Application. Category 4.1 (Predict based on obtained result) fairly received attention than other skills in this category.

4.6 SUMMARY OF TEACHERS RESPONSE TO THE FACTORS THAT AFFECT PRACTICAL SCIENCE

Another dimension analyzed, beside curriculum material was the factors that affect practical science in school. Hence questionnaire, checklist and content analysis of exam papers employed to surface these factors working in schools. This section summarize teachers response to the different factors together with results of resource inventory and result of examination booklets.

5.6.1 50 % of physics, 44% of biology and 50 % of chemistry teachers respond that virtually no resource is available for doing practical activities in the schools. 83% of the physics, 88.8 % of biology and 90 % of chemistry teacher witnessed that their school has no budget allocated for the purchase of materials required for practical activities. No regular schedule was found in all schools time table for doing practical science. This was substantiated by the result of resource inventory. Almost all schools lack important apparatus and chemicals suggested in the guides

5.6.2 The majority of teachers (50% of physics and chemistry and 55% of biology) attributes to their personal interest in becoming the science teacher. 25% of chemistry, 33% of physics and 11.1% of biology attributed to fate or chance. Good job opportunity received the least preference(16.6% of physics and 12.5% of chemistry).

5.6.3 80% of chemistry, 50% of physics and 33.4 % of biology teachers respond that they are satisfied in their current teaching. Those who respond negatively attribute to several reasons like teaching science require doing practical work which they cannot do for various response (66.6% of physics, 83.3% of biology and 50% of chemistry teachers), teaching science is difficult (25% of chemistry teachers), no laboratory room and equipments (33.3% of physics and 25% of chemistry) and overcrowded classrooms (16.7% of biology teachers).

5.6.4 Biology and chemistry teachers respond consistently to the kind of procedure they use in conducting practical activities. 62% of biology and 44% of chemistry teachers respond that they never employ any practical activities stated by the text. 25% of biology and 44.4% of chemistry employ teacher demonstrations as the only means and small group experimentation was the least favored procedure (33% of physics teacher).

5.6.5 100% of biology and chemistry and 83.3% of physics teachers respond that they feel competent in teaching the subject and 16.6% of physics teachers attribute their feeling of incompetence to lack of 'enough' science method courses in their teacher education program.

5.6.6 The majority (66.7% of physics, 33.4% of biology and 70% of chemistry teachers) never had a chance to participate in any kinds of workshop and seminars designed to improve their science teaching. Among the one who had, 33% of physics and 33.3% of biology had such chance only once and 66.7% of biology teachers had it twice.

5.6.7 Significantly higher percentage of teachers (62.5% of biology, 45% of chemistry and 66.6% of physics) judge the content of the textbooks as little, and the activities are adequate and found interspersed evenly with in the text. 83.3% of physics, 55% of biology and 44% of chemistry teachers respond that the present textbooks do invite teachers to make practical activities.

5.6.8 100% of chemistry 60% of physics and 44.5% of biology teachers respond that there is no conducive environment to foster practical science in schools. On average, teachers have more than 21.3 periods per week at grade 8 and 6 periods per week at grade 7. About 83.3% of physics, 53.8% of biology and 26.6% of chemistry teachers had also teaching load at grade 7. They encounter on average 78.2 students at grade 8 and 75.68 students at grade 7.

5.6.9 The majority of teachers (80% of physics, 66.6% of biology and 80% of chemistry) witnessed that they employ paper and pencil tests as the only assessment technique. 20% of physics, 10% of chemistry and 22% biology teachers use observation to assess students practical skills. Actual experiment done by students was selected by 10% of chemistry and 11.2% of the biology teachers. This result shows consistency with what was identified in the analysis of the national and schools final examination papers. No practical assessment technique was observed. In both assessment documents, the written test type was used and such technique was not even employed to the maximum, rather students knowledge of specific information was appraised.

5.6.10 Teachers suggest a number of opinion to improve the role of practical work in the school science. They suggest the need for creating good working environment through providing resource for practical science, reduce students population per class, acquaint teachers with the issues of practical science through various means, allocation of a separate time table in the schools program for practical science and the need to change the awareness of schools personnel about the role of practical science in realizing important problem solving skills.

4.7 CONCLUSIONS.

Summary of the above results shows that in the analyzed documents fairly represent the practical outcomes. Genuine problem solving skills were not sufficiently treated, as a result, the transfer of such skills into real life personal and social problems was under question. Adequate proportions of the different kinds of practical activities were not included. Illustrative practical dominate the physical science curriculum where as the life science has relatively more inquiry activities. Virtually no skill and investigative practical was found. Students are engaged largely in re-stating the relationship, they had been taught, in doing these activities. Generally speaking, few problem solving skills were treated in the analyzed materials. Absence of laboratory rooms, scientific apparatus, materials and chemicals suggested in the texts, together with teaching load and large number of students per class were identified as the major factors affecting practical science. Practical assessment was also not found in both National and schools examination documents.

Based on the major finding of the study presented in the preceding pages, it can be possible to conclude that the present curriculum materials of the region do not reflect adequately the modern trends in practical science and the problem solving paradigm of the policy. The planned curriculum was drifted further away from the intentions of the Policy. This immense gap between the intention and the planned curriculum could be partly attributed, according to the researcher, to three general factors:

1. The presence of literally no literature on science education, especially at the primary level in the Ethiopian context and basing a reform on such context would inevitably brought such mismatch.

2. Though the problem solving approach was known in the educational literature, virtually no comprehensive research paper was found in the Ethiopian context. The knowledge of this approach as a guideline for setting the stage for educational practice was a new occurrence, and even among educators and practitioners in the field, was under question let alone the commission writers.

3. The shortage of the time span from the onset of the reform to writing curriculum materials, tryout project, evaluations, and up to the country/region wide implementation. In additions to the above challenges, this makes the situation worsen.

4.8 RECOMMENDATIONS

Summary of results shows that there lies inconsistency in almost all aspects analyzed. The major reason the researcher gave attribute to this effect was the inadequate provision given to textbook writers in translating the concept of problem solving paradigm into the different science courses. The behaviors, skills and abilities demanded by a problem solving individual were not identified beforehand and, hence, the writers own perception guide the process. Such attempt, therefore, accounted largely to the difference between what the literature said on this issue and what was identified. Meeting these requirements would be mandatory and that of urgent demand to secure what was envisaged by the policy.

The results of the study has many implications for improving the science education of Ethiopia in general and the grade eight science subjects in particular. Important recommendations were forwarded by the researcher that would alleviate the problem encountered starting from suggesting a separate science education policy , science curriculum development, training of science teachers assessment system and resource for teaching science

5.8.1 IMPLICATIONS FOR SCIENCE EDUCATION POLICY

There is a felt need for a separate policy statement for science education, showing its unique attributes at different ladder of education and its contribution to the all-round profile of students at a given level. A scheme of work should be prepared to assign the target capabilities and skills across age and levels of education to guide designing of curriculum experiences.

5.8.2 IMPLICATION FOR SCIENCE CURRICULUM DEVELOPMENT

The study revealed both the strength and weakness in the curriculum materials. There are several defects in our present science curriculum of grade eight which needs revisions. Such revisions can be generally recommended in order to keep in pace with the fast growing knowledge and discoveries. The curriculum guide of the three science courses needs to be revised continuously from time to time to reflect adequately the contemporary nature of science and aims of practical science and its assessment procedure . The process of science should be considered as another independent entity of science education and needs to get emphasis along with the affective domains.

Revision of these science textbooks was recommended in the light of the new problem solving paradigm. A simplified model of problem solving must be looked for in order to guide the writing of curriculum materials. Care must be taken in providing the different kinds of practical activities to give the whole nature of science in all courses. Especially appropriate place should be given to investigative and skill practical activities which can be feasible under the resource and time constraints. From the experience of other countries like, Israel, such activities can be prepared by a team of science educators and teachers. Due respect should be given to the nature and kinds of the activities, the appropriate challenge (level of inquiry) given their experience and maturity levels of students and provision of important problem solving skills. separate time table is recommended for the execution of practical activities in the school time table and clear statement should be assigned to secure teachers implementation behaviors.

5.8.3 IMPLICATIONS FOR SCIENCE TEACHERS AND TEACHER EDUCATION

This study revealed important implication for teachers both at work and the teacher education and training programs. To the best of the researchers' knowledge, the elementary school science teachers in general are not sufficiently trained in the way the curriculum was developed. Beside this, the school resource context, teaching loads and large student population per section would make their teaching practical science more difficult. Such fact can be addressed through sound strategies in the pre-service and in-service programs. The researcher, therefore, makes two important recommendations.

The need to make improvement and revision in the teacher training program as a whole and science education in particular in line with the new paradigm. Enough provisions should be given in the pre-service science courses to give trainees experience in the practical science and on modern science teaching methods.

Due to their critical role in the process of implementing the curriculum, teachers should be encouraged and challenged to change their perceptions and practice of practical science through training in workshops and seminars.

The number of practical activities included in the text together with the number of students in the given classroom should be taken into consideration in assigning teaching load for teachers. Strategies must be devised to start first with demonstration exercises and going to small group experimentation as the resource for science improved and teachers had experience in practical science.

5.8.4 IMPLICATIONS FOR SCIENCE ASSESSMENT SYSTEM

Paper and pencil examination was the dominant assessment system in Ethiopia. In the analyzed examination documents, the only objective type question identified was multiple question. The practical skills of the science processes are not found in these summative assessments. The curriculum guide never gave a means to assess the psychomotor domains.

I recommend the need to have a clear assessment document at the national levels that show the essence of practical assessment. The evaluation procedures suggested in the guides should be revised and care must be given to include practical assessment techniques, otherwise, teachers can easily neglect assessing this aspects of science teaching.

Science educators and practitioners in the field should be involved to design assessment techniques that can work in the Ethiopian context. From experience of other countries, paper and pencil examinations can also be used to assess important elements of practical science. Such practice should be explored and strengthened to raise the assessment techniques of the primary school science teachers and national examinations.

5.8.5 IMPLICATIONS FOR RESOURCE IN SCIENCE TEACHING

Laboratory work was taken as an integral parts of the science curriculum at grade 8. Hence, such activities demand provisions of equipments, chemicals, row materials and facilities sometimes beyond the scope of the schools budget. That was why only few demonstration activities were used in our schools. The strength of the analyzed materials, in this line, was that simple apparatus suggested for most activities especially in biology. The physics and chemistry texts largely require apparatuses beyond the capacity of the schools and this was observed in the survey. The following recommendation is therefore suggested:

1. When reviewing the activities, care must be taken whether the suggested apparatus was with in the reach of most schools. In case, where the inclusion of such apparatus is a must, and if are not available in schools, the purpose of the

activity can be adjusted, for example, from skills practical to other process skills like interpretations of data, drawing conclusions etc. The best recommendation here is to develop practical experience which is realistic and can be applied in the local context.

2. To devise investigative activities based on the local science and technology and utilization of local resources for practical science.

3. Commitment of the government and other agencies to provide at least some major apparatus identified for each course in order to give at least some real experiences for students. Cheep and less costly materials can be looked for and be available at the disposal of schools, so that they can even bought it with their scarce budget.

4. Extend the use of pedagogical centers and the primary science kits to the teaching of practical science.

REFERENCE

Abraham, N., Novak, A., and Schacfer, J.R.(1965). 1995 revised BSCS biology laboratory findings and their implications. BSCS Newsletter, 19, 25-29.

Addis Ababa Educational Bureau (1999). Abstract of Region 14 Educational statistics. Addis Ababa. Berhane Selam Press.

Agedew, R and Zewdneh, Y.(1982). Effective Change in the Primary Teacher Training Program of Ethiopia: Historical Development Analysis and Synthesis of the System of Education: Recommendation for Improving Teacher-Training Program. (Unpublished).

Ainley, J.(1978). An evaluation of the Australian Science facilities Program and its effect on Science Education in Australian School. University of Melbourne.

Ainley, J.(1990).School Laboratory work: some issues of Policy: In E. Hegarty-Hazel (Ed), The student Laboratory and The Science Curriculum (pp. 223-241). London, Routledge.

Allosp, T.(1991).'Practical Science in Low Income Countries': In woolnough, B (Ed) Practical science, Milton keyness, Open University Press.

Amare, G.(1967). Aims and purpose of Ethiopian Church Education. Ethiopian Journal of Educational research Vol. 1. No.1.

Anbesu, B.(1994) The Primary Education reform Programmed5 in Ethiopia: In Dalin. P.(Ed) How Schools Improve- An International report: Cassel. Villier House.

Assessment of Performance Unit. (1984). The Assessment Frame work of science at Ages 13 and 15 APU Science Report for teachers, 2. London: Department of Education and Science.

Ausbel, D.P. (1968). Educational Psychology: A Cognitive View, Newyork: Holt; Reinhart and Winston.

Beisenharz, P.C., and Olstad, R.G. (1986). The use of laboratory instruction in high school biology. American Biology Teacher, 42, 166-168.

Bekalo, S.A., and Welford, A.G.(2000) Practical Activities in Ethiopia Secondary Physical Science: Implication for Policy and Practice of the Match between the Intended and Implemented Curriculum. The Ethiopian Journal of Education Vol. XX No. 2.

Bentley, D., and watts, M.(Ed) (1989) Learning and Teaching in School Science- Practical Alternative. Open University Press. Great Britain.

Berhanu H.(1999) Students assessment in Primary School Science- Time for reappraisal. In Educational Journal. Ministry of Education Public Relation. Dec. 1999, Addis Ababa.

Berhanu, H. (1996). Practical Physics in Ethiopian secondary schools: Conceptualization and Organization of Practical activities in grade 9 and 10. Paper submitted in partial fulfillment of the requirement for the degree of Med, University of Leeds, UK.

Berhanu, H. (1999). The state of Science and technology Education in Ethiopia at the Pre-University level. (Unpublished) ICDR, MOE.

Berliner, D.(1983). Training Teachers for their executive functions. In P. Tamir, A. Hofstein and M. Ben Peretz (Eds) Preservice and in-service education of science teachers(pp. 545-564). Philadelphia; Rehovot Balaben International Science Series.

Blosser, P.(1988). Labs-are they really as valuable as teachers think they are? Science Teachers, 55, 57-59.

Bryce, T.G.K., and Robertson, J.J.(1985). What can they do? A review of Practical Assessment in Science. Studies in Science Education, 12, 1-24.

Bryce, T.G.K., McCall, Macgregor, J., Robertson, I.J. and Weston, R.A.J.91983). Techniques for the Assessment of practical skills in Foundation Science. London, Heinemann.

Bybee, R.W and DeBoer, G.E.(1994). research on Goals for the Science Curriculum: In Gabel D.L (Ed) Handbook of Research in Science Teaching and learning, National Science Association.

Carin, A. A and Sund, R.B. (1989) Teaching Modern Science (5th Ed). Merrill Publishing Company. Columbus.

Davis, J.(1972). An assessment of change matriculation and Science facilities initiated by NDEA Title III 1956-1970. University of Tennessee.

Fensham, P.J., (1996) Science and technology: In Jackson (Ed) *Research on Curriculum Studies*

Fraser, B. 91989). learning Environment research in Science Classrooms; past progress and future prospects (NARST Monograph No. 2). Washington, D.C: National association research in Science teaching.

Friedler, Y., and tamir, P.(1984). teaching and learning in High school Laboratory in Israel, research in science Education, 15, 89-96.

Gallagher, J.J., and Tobin, K.91987). Teacher management and student engagement in high school Science. Science Education, 71, 535-555.

Gardner, P., and Gauls, C. (1990) Lab work and Students' attitudes: In E. Hegarty-Hazel (Ed), The student Laboratory and The Science Curriculum (pp. 132-158). London, Routledge.

Gott, R. and Murphy, P.(1987) Assessing Investigation at ages 13 and 15, Science Report for Teachers: 9, London. DES.

Gott, R., and Mashiter, J.(1991) Practical work in Science - A Task- Based approach: In woolnough (Ed) Practical science , Milton Keyness, Open University Press.

Hailu, F.(1974) Knowledge and Its Attainment in the Ethiopian Context: In Journal of Educational Research, Vol 7 No.1.

Hegarty-E.H.(1990). The Student Laboratory and The Science Curriculum. Routledge. Grate Britain.

Herron, M.D. (1971) The nature of Scientific Inquiry. School review, 79, 171-212.

Hodson, D.(1990)'A Critical Look at Practical Work in Science,' International Journal of Science Education, 7(256 33-40)

Humphreys, B., Johnson. R.T., and Johnson, A.W.(1982). Effects of cooperative, competitive and individualistic learning on students' achievement in science class. Journal of Research in Science Teaching, 19, 351-356.

Igelsrud, D., and Leonard, W.H., 91988). Labs: What research says about biology laboratory instruction. American Biology Teachers, 50, 303-306.

Johnson, R.T.(1976). The relationship between cooperative and inquiry in science classrooms, Journal of research in science Teaching, 13, 55-63.

Kelly, P.J., and Lister, R.(1969). assessing Practical Ability in Nuffield a level biology. In J.F. Eggleston and J.F Kerr (Eds), Studies of assessment(pp. 129-142). London: English University Press.

Knott, M., and Mottunga, P.(1995) Methods of Teaching and Learning :In Matiru, B., Mwangi, A., and Schlette, R (Ed) Teach Your best- A hand book for university lecturers, German Foundation for International development.

Kyle, W.C., Penick, J.E., and Shymensky, J.A.91979). Assessing and Analyzing the performance of students in college science laboratories. Jornal of Research in Science Teaching, 16, 545-551.

Lazarowitz, R., and Tamir, P.(1994). Research on Using laboratory Instructions in Science : In Gabel D.L (Ed) Handbook of Research in Science Teaching and learning, National Science Association.

Lazarowitz. R., and Karsenty, G.(1990). cooperative learning and Students academic achievement, Process skills, learning environment and self-esteem in tenth grade biology classrooms. In S. Sharan (Ed), Cooperative Learning, theory and research (pp.123-149). New York: praeger.

Martin, D.J.(1997). Elementary Science Methods: A constructivist Approach. Albany. Delmar Publishers.

McNeil, J.D. (1999) Curriculum: The teachers Initiative, (2nd Ed) Prentice Hall. New Jersey.

Mekasha, B.(1999) Classroom Assessment in Primary School Vis-à-vis The new Curriculum: In Educational Journal. Ministry of Education Public Relations. Dec, 1999. Addis Ababa.

Mekuanent Kelemu (1992). An evaluation of the teaching of Biology in some selected senior secondary schools of Addis Ababa Vis-à-vis an Enquiry Model. A thesis submitted in partial fulfillment for the degree of master of Arts in Biology Education in the Addis Ababa university. Unpublished. Graduate Studies AAU.

Millar, R. (1991) A means to an end: the role of processes in Science Education: In Woolnough (Ed) Practical science , Milton Keyness, Open University Press.

Ministry of Education (1948) Elementary Schools Curriculum. (Unpublished).

Ministry of Education (1994a) Education and Training Policy. EMPDA. Addis Ababa.

Ministry of Education (1994b) Education Sector Strategy. Addis Ababa.

Murphy. P., and Gott, R.(1984) Science Assessment Framework, Ages 13 and 15, Assessment of Performance Unit, Science report for Teachers; 2, DES.

National Science resource center (1997) Science for All Children- A Guide to Improving Elementary Science Education in Your School District. National Academic Press. Washington DC.

Novak, J.D.(1972). facilities for secondary School Science Teaching: Evolving Patterns in Facilities and programs., Washington, D.C: National science Teachers association.

Olson, D.R.(1973) What is Worth Knowing and What can be taught. School review, 82, 27-43.

Ratcliefte, M. (Ed) (1998) The purpose of science Education. *ASE Guide to secondary Science Education.*

Reiss, M.J.(1993). Science Education For Pluralistic Society: developing Science and Technology Education Series. Open University Press.

Romey, W.U.(1969). Inquiry Techniques for Teaching science. Englewood Cliffs, N.J: printice-Hall.

Screen, P.A. (1986). The Warwick Process Science Project. School Science review, 72(260): 17-24.

Selmes, C., Ashton, B.G., Meredith, H.M. and Newal, A. (1969). 'attitudes to science and scientists', School science review, 51, 7-22.

Shadimi, Y.(1983). Training primary school teachers. In P. Tamir, A. Hofstein, and M. Ben Peretz (Eds), Preservice and in-service education of science teachers(pp. 117-124). Philadelphia; Rehovot Balaben International Science Series.

Showalter, B. (1984). What is Unified science education? prism, 11, 1(2). Columbus: center for Unified Science Education, Ohio State University.

Shulman, L.s., and Tamir, P.(1973). Research on Teaching in the Natural science. In R.M.W. travers (Ed) second Handbook of Research on Teaching (pp. 1098-1140). Chicago: Rand McNally.

Tamir P. and Lunetta, V.I (1978). an analysis of laboratory activities in the BSCS version . The American Biology Teachers, 40, 353-357.

Tamir, P.(1985) 'Content analysis focusing on inquiry' Journal of Curriculum Studies, Vol 17, No. 1, 87-94.

Tamir, P.(1990) Evaluation of students work and its role in developing policy. In Hegarty-Hazel (Ed) The student Laboratory and The Science Curriculum (PP. 242-266). London: Routledge.

Tamir, P.(1991)' Practical Work in School Science: An Analysis of Current Practice": In Woolnough (Ed) Practical Science, Milton Keynes, Open University Press.

Tamir, P., and Doran, R.(1992). Conclusions and discussions of Findings related to practical skills testing in science. Studies in Educational Evaluation, 18, 393-408.

Tamir, P., and Lunetta, V.N.(1981). Inquiry Related Tasks. In High school Science Laboratory handbooks. Science Education, 65, 477-484.

Tamir, P., and Pillar Garcia, M.(1992) 'Characteristics of Laboratory exercises included in Science text Books in Catalonia(Spain), International Journal of Science Education, 14, 381-392.

Temenchegn, E. (2000). What research says about African Science Education: IER Flamboue Vol No. Addis Ababa University.

Tobin, K.(1987). Secondary Science Laboratory Activities. European Journal of Science Education, 8,199-211.

UNESCO (1960) Science Teaching in the Secondary School of Tropical Africa. Abidjan Meeting of Experts on the Teaching of Science in Tropical Africa. France.

UNESCO (1987) Science and technology Education in Primary Schools of Tomorrow, Series and Survey in Comparative Education, Paris.

UNESCO (1990) Innovations in Science and Technology , Layton D (Ed) Vol. III.

Welch, W.W., Klopfer, L.E., Aukenhead, G.S., and Robinson, J.T.(1981). The role of Inquiry in Science Education: analysis and recommendations. Science Education, 65, 33-50.

Welford, G.(1990) Assessment of Practical Work in School Science: In Layton D.(Ed). Innovations in Science and technology Education. Vol. III UNESCO.

White, R.T.(1988). Learning Science. Oxford: Basil Blackwell.

Woolnough, B.(1991) (Ed) Practical Science, Milton keyness, Open University Press.

Woolnough, B., and Allosp, T.(1985) Practical Work in Science, Cambridge, Cambridge University Press.

Woolnough, B.E (1994). Effective Science Teaching developing Science and Technology Education. Great Britain. St. Edmundsbury Press.

Wray, J., freeman, J., Campbell, L., hoyal, P., Nimenko, G., Smyth, S. and Whiston, L. (19870. Science in Process. Teachers' resource pack. London, Heinemann Educational Books.

BOOKS/ DOCUMENTS ANALYZED

Addis Ababa City Administration Educational Bureau Curriculum Development and Research Department (1999) PHYSICS Student text Grade 8. Mega Publishing Enterprise. Addis Ababa.

First Semester Biology, Chemistry and Physics Examination of the Kokeb Tesfa, Caralo and Akaki Primary Schools

ICDR (1997) CKEMISTRY CURRICULUM GUIDE FOR GRADE 7-8.

ICDR (1997) PHYSICS CURRICULUM GUIDE FOR GRADE 8.

ICDR SCIENCE PANEL (1996) BIOLOGY CURRICULUM GUIDE FOR GRADE 8.

Ministry of Education National Organization for Examination 1992 E.C Grade 8 National Examination.(Booklet 1- Math's and Biology and Booklet 2- Chemistry and Physics)

Region 14 Educational Bureau (1999) CHEMISTRY GRADE 8 Student text. Mega Publishing Enterprise. Addis Ababa.

Region 14 Educational Bureau (1999) Biology Grade 8 Student Text book. Mega Printing Enterprise. Addis Ababa.

APPENDIX 1

ADDIS ABABA UNIVERSITY
FACULTY OF EDUCATION DEPARTMENT OF TEACHER EDUCATION AND CURRICULAR STUDIES

Title: ***The Nature and Purpose of Practical Work in the Science Curriculum Materials of Addis Ababa Region- A case of Grade 8.***

Questionnaire to be filled by grade 8-school science (biology, chemistry, physics) teacher.

INSTRUCTION: The purpose of this questionnaire is to gather information on science teachers' opinion regarding the *Nature* and *Purpose* of *Practical Work* included in the present Region 14 elementary school science curriculum. Since the reliability of this survey depends on the objectivity of your response, you are requested frankly to fill this questionnaire.

DIRECTION: 1) Do not write your name

2) Check ( ) on the space provided.

3) In place where your response in written is required, please make a brief comment.

4) Respond to all question with respect to the subject you teach.

5) Use Amaharic (if you like) to show your reaction In the extended response type.

General Information

1. Personal Data

- Name of the school____________________________________
- Sex   Female [ ]   Male [ ]
- Current academic qualification

A) B.SC   B) Diploma   C) Certificate

D) Any others (specify)_______________

2. Which subject/s are you teaching now?

Biology [ ] Chemistry [ ] Physics [ ]

(If you teach more than one subject)

Biology& Chemistry [ ] Physics & Maths [ ]

Others (Specify)____________________________

3. Years of experience in teaching the subject/s? (Indicate separately for each subject)

Biology______ chemistry________ Physics_________

Biology & Chemistry _____ Physics & math's _______ Other (specify)_____

4. How many periods per week do you teach? (Indicate for each subject).

Biology______ chemistry________ Physics_________

Biology & Chemistry _____ Physics & math's _______ Other (specify)______

5. In how many grade/s do you teach the subject/s? (Circle the grade/s)

A) 5   B) 6   C)7   D)8

6. How many section/s per grade do you have at present?(Indicate your response for each grade separately)

A) G. 5___Section B) G.6 ___section C)G.7 ___section D) G.8 ___section

7. On average, how many students do you teach per class per grade? (Indicate the average number of students at a grade/s you teach)

A) G.5 _____   B) G.6 _____   C) G.7______   D) G.8 _____

B. Resource

8. Are there adequate resources- finance, facilities, chemicals etc, available for the stated exercises in the textbooks?

   A) Yes there is

   B) Only for some experiments

   C) There is severe shortage

   D) Not at all

9. Does your school have annual budget allocated for purchase of materials, equipment and resources necessary for conducting practical activities?

   A) Yes ______ B) No______

10. Is there a regularly scheduled period for science (Biology, Chemistry, Physics) laboratory period?

    A) Yes ____ B) No

    If yes, how MANY period/s are allocated for the laboratory?

    A) Double period ________ B) Single period __________

TEACHERS

11. What factor initiated you to become a science teacher?

    A) Fate (by chance)

    B) Encouragement from science teachers

    C) Good job opportunity

    D) Personal interest in being science teacher

    E) Any other (specify)____

    ____

12. Are you satisfied in your present practice in science teaching?

    Yes ☐ No ☐

13. If, your response for question NO. 12 is NO, why do you think is the reason? It is because

    A) Teaching science is difficult

B) I am not interested in teaching at all

C) Science teaching requires doing practical which I cannot do for various reasons

D) Preparing for teaching is tiresome.

E) Any other (specify)____

____

____

14. If again your response for question No.13 is (C), what do you think is the reason for not doing practical work in your schools (classrooms)?

____

____

____

____

15. Which of the following procedure(s) do you most often use when conducting laboratory activities?

A) Individual student experiments

B) Student paired for activities

C) 4-5 students per group

D) Teacher demonstration

E) No procedure is used since there is no practical work in my

16. Have you ever-participated in workshop and seminar designed to improve your science teaching

A) Yes B) No

If yes, how many times

A) Once B) Twice C) three and more

17. Practical work in science means

A) What students do in the science laboratory with sophisticated apparatus

B) Any thing which is practical and happens in school laboratory, classrooms and even out side of the classroom

C) If other specify

____

____

____

18. What reason (or justification) you give for doing practical work in science? this is because
    A) Students remember more by doing science
    B) Students learn Science by doing science (more than remembering)
    C) Scientific concepts and principles are abstract unless supported with practical work
    D) To motivate students in the science lesson
    E) To help students think like scientists in the laboratory
    F) To help students acquire scientific skills.
    G) Any other specify)__________________________________

    ____

19. Students gain more scientific knowledge by participating in practical work.

    Strongly agree ☐ Agree ☐ Strongly disagr☐

TRAINING

20. Do you believe that you are competent in teaching science for that grade?

    A) Yes ☐ B) NO ☐

21. If your answer to the above question is no, what do you think is the reason?
    A) I am not trained to teach that subject
    B) I never had enough science method courses in the teacher-training program.
    C) I have a number of other duties, which takes my time for preparation.
    D) If other specify________________________________.

CURRICULUM MATERIAL

22. The amount of content expected by the student to cover in the subject you teach (Or, the concept, ideas and issues included in the text as compared to the number of periods available for the teaching of that subject) is?

A) Much C) Little

B) Average D) Other

23. Rank the following statements according to the subject you teach. (Use 1-4 and No. 1 shows first and No. 4 is the least ranked).

The textbook is full of _______

A) ( ) Scientific facts and procedures

B) ( ) Scientific processes-designed to teach specific processes one at a time.

C) ( ) Theories followed by practical activities

D) ( ) Short notes followed by exercises

24. Do the practical activities included in the textbook

A) Adequate

B) Average

C) Poor

25. In the textbooks, where do the practical exercises mostly found?

A) Concentrated at the end of each chapter

B) Before the formal topic begins

C) Dispersed with in the topics

D) If other specify____

26. What do you think is the purpose of doing practical work included in the textbooks? (Rank them from the most ranked-1- to the least ranked-5.)

A) ( ) Concept illustration/ consolidation

B) ( ) Raising questions and devising solutions

C) ( ) Observation

D) ( ) Concept discovery (inquiry)

E) ( ) Skills acquisition

F) ( ) If other specify____

27. Are the textbooks generally inviting to make practical exercise in classrooms (like specifying what should be done, stipulating the materials and procedure to be followed…)

A) Yes ☐ B) NO ☐

LEARNING ENVIRONMENT

28. Is there conducive learning environment that foster desirable student attitude to practical activities?

A) Yes there is

B) No there is not

ASSESSMENT

29. What kind of test you commonly prepare to assess students' mastery of practical work?

A) Paper-and pencil test

B) To do actual experiment

C) I concentrate on factual information

D) Through observation

E) If other specify

____

____

30. What is your opinion, on how to improve the role of practical work in school science course?

____

____

____

____

____

APPENDIX 2

SUMMERY OF AIMS FOR PRACTICAL ACTIVITIES.

All the aims for practical activities included in the three curriculum materials will be summarized as follows.

SUMMARY OF AIMS FOR PHYSICS PRACTICAL ACTIVITIES.

Activity Number	Aims for the activities.
A-2/1 (12)	To show that light travels in a straight lines.
A-2/2 (19)	-
A-2/3 (28)	Determining the focal length of a concave mirror.
A-2/4 (29)	To determine the mirror formula.
A-3/1 (59)	To investigate how the quantity of heat to be supplied depend up on mass, temperature and the type of substance heated.
A-3/2 (64)	-
A-3/3 (67)	To show the low of heat exchange
A-3/4 (72)	-
A-4/1 (82)	-
A-4/2 (84)	Measuring current.
A-4/3 (85)	Measuring voltage
A-4/4 (85)	Relationship between current and potential difference.
A-4/5 (93)	The relationship resistance and the temperature of conducting wire.
A-4/6 (94)	To show that current for series connections of resistors is the same.
A-4/7 (97)	To measure current in every branch of the resistors
A-4/8 (97)	To measure the voltage across each resistor.
A-5/1 (107)	Magnetic lines of force of bar magnet.
A-5/2 (110)	Oersted's experiment.
A-5/3 (111)	To observe the direction of magnetic field around straight current carrying conductors.
A-5/4 (113)	To observe the effect of magnetic materials on the magnetic field.
A-5/5 (116)	Plotting the shape of magnetic field produced about a current carrying solenoid.
A-5/6 (123)	Varying magnetic lines of force cutting a conductor create current through the conductor.

SUMMERY OF AIMS FOR THE BIOLOGY ACTIVITIES

Activity Number	Aims for the activity.
A-1.1 (3)	Do both eyes work together?
A-1.2 (4)	Dissecting a sheep's eye
A-1.3 (6)	Investigation of the blind spot.
A-1.4 (7)	What is the effect of changing light intensity on the size of the pupils?
	What is the advantage of having two eyes?
A-1.5(7)	Temperature detection.
A-1.6 (25)	
A-1.7 (26)	Investigating heat and cold receptors
A-1.8 (26)	To discover the distribution of touch receptors in the skin
A-3.1 (146)	Is water necessary for germination of seeds?
A-3.2 (147)	Is light necessary for germination?

A-3.3 (148)	Is warmth necessary for germination?
A-3.4 (148)	Is air necessary for germination?
A-4.2.1 (164)	Is water necessary for food making?
A-4.2.2 (164)	Activities to see stomata through the microscope material?
A-4.2.3 (165)	Is light necessary for photosynthesis?
A-4.2.4 (166)	Testing for starch in a green leaf?
P.A (176)	-
P.A (182)	making a rough analysis of the particles in the soil by sedimentation method.
P.A (183)a	To estimate the percentage of water in a soil sample?
P.A (183)b	To estimate the percentage of humus in a soil sample.

SUMMARY OF AIMS FOR CHEMISTRY PRACTICAL ACTIVITIES.

Activity number	Aims for the activity.
A-1.1A (8)	Preparation of acidic oxides by direct combustion
A-1.1B (9)	Preparation of basic oxides
A-1.1C (10)	Preparation of nitrogen dioxide (NO2)
A-1.1D (10)	Preparation of carbon dioxide by the action of acid on carbonates.
A-1.2A (12)	The effect of acid on indicators?
A-1.2B (14)	Action of acids on metal
A-1.2C (15)	Action of acids on carbonate or hydrogen carbonate.
A-1.2D (17)	Preparation of sulphurous acid.
A-1.2E (19)	dehydrating properties of concentrated sulphuric acid.
A-1.3A (23)	The effect of bases on indicators.
A-1.3B (26)	Preparation of sodium hydroxide from sodium and water
A-1.3C (26)	Neutralization reaction
A-1.4A (30)	Preparation of sodium chloride by neutralization.
A-1.4B (31)	preparation of salts by the action of acids on metal
A-3.1 (71)	Reaction of sodium with cold water.
A-3.2A (76)	reaction of calcium with water.
A-3.2B (77)	Burning of magnesium.
A-3.3 (81)	heating aluminum.
A-3.4 (84)	heating iron and sulphur
A-3.5 (87)	The effect of heating and cooling iron.
A-4.1 (102)	preparation of wood charcoal.
A-4.2 (103)	Laboratory preparation of carbon monodioxide.
A-4.3 (105)	laboratory preparation of carbon dioxide.
A-4.4 (106)	test for carbon dioxide
A-4.5 (110)	Test for carbonate
A-4.6 (114)	laboratory preparation of nitrogen
A-4.7 (117)	laboratory preparation of ammonia.
A-4.8 (118)	To determine the solubility of ammonia.
A-4.9 (119)	test for ammonia
A-4.10 (120)	To demonstrate the properties of nitric acid.
A-4.11 (129)	The action of heat on sulphur.
A-4.12 (136)	laboratory preparation of chlorine.

APPENDIX 3

LISTS OF PSYCHOMOTOR AND OTHER OBJECTIVES STATED UNDER THE PRACTICAL CONTEXT IN THE GRADE 8 PHYSICS CURRICULUM GUIDE

1. identify the types of force
2. differentiate between contact and non-contact force
3. describe the dependence of non-contact force with the variation between the bodies.

4. explain how and why friction appears
5. distinguish between static and kinetic frictions
6. Use ray diagram to construct the image formed by pinhole camera.
7. explain the functions of a pinhole camera in terms of object and image distance from the pinhole
8. distinguish between umbra and penumbra
9. Use ray diagram to show formation of shadow and eclipses describe using ray diagrams the solar and lunar eclipses
10. distinguish between diffuse and regular reflection
11. explain how mirrors are made
12. Draw the reflected ray when the incident ray on a smooth surface is given.
13. describe the image in a plane mirror
14. Use ray diagram to octate image for single mirror like the plane mirror, the concave mirror, and the convex mirror.
15. Use the mirror equation to obtain the distance of image, the distance of objects on the focal length if two of the three are given or described to them
16. Use the magnification equation to solve problems concerning heights of objects and images
17. explain why headlight of cars and search lights have concave reflections
18. explain why rear view mirrors car are concave mirrors
19. state the law of reflection
20. Draw the refracted ray when the incident ray is given, state whether a given image is real or virtual.
21. Use ray diagram to locate images for both concave and convex lenses.
22. Use the lens equation for image formed by single lenses to solve related problems.
23. explain how the focal point and focal length of a converging lens can be determined by experiment
24. Dispense white light using a prism

25. Use the formula to calculate the specific heat capacities of substances.
26. Use the formula to calculate the heat absorbed by a body.
27. Perform an experiment to determine the specific heat capacity of a solid.
28. Perform an experiment to determine the specific heat capacity of a solid.
29. identify the parts of a steam engine and describe their functions
30. Use $I=Q/t$ in solving related problems.
31. Read electrical instruments.
32. Measure the voltage and the current using the instrument.
33. Record the data.
34. Find the ratio (V/I) and interpret it.
35. state the relationship between current and voltage
36. Use the equation $V=IR$ in solving related problems.
37. Measure the resistance (V/I) of conductors with different cross sectional area and length.

38. select factors to be measured and kept constant
39. Collect data and interpret it.
40.identify the factor that affect the resistance of the conductor.
41. explain how the factors affect the resistance of the conductor.
42. Carefully handle equipment
43. Observe experiments and record results.
44. Connect resistors in series and parallel.
45. Measure the voltage drop across each resistors and the current passing through each resistor in both series and parallel connections.
46. Read and record the current and voltage measured
47. Interpret the recorded data
48. explain what happens to current and voltage in series and parallel currents
49. Use the formula Rt= R1+R2 and 1/Rt=1/R1+1/R2 to solve related problems.
50. identify the color that stands for each number
51. Read the color code of the resistor.
52. Find the value of the resistance of the resistor from its color code.
53. Map the magnetic field due to a bar magnet.
54. To show the direction of the magnetic field around a straight current carrying conductor.
55. state the factors that are required to increase the magnitude of a straight current carrying conductors and a solenoid
56. distinguish between a magnet and an electromagnet
57. explain the action of a compass when current passes through a conductor that is placed immediately above or below it
58. Map the magnetic field to straight current carrying conductor; and a solenoid.
59. Use the right hand rule to determine the direction of the magnetic field around a current carrying straight conductor
60. Apply the right -hand rule to determine the polarity of the ends of an electromagnet.
61. explain the principle used in an electric motor
62. Construct a simple electric motor.
63. Construct a simple generator.
64. distinguish between a step-up and step-down transformer
65. Solve problem concerning Vs, Vp, Is, Np, Ns and Np.
66. Find the effective capacitance of capacitors connected in series and parallel.
67. Read the color code of the capacitor.
68. interpret the color code of the capacitor
69. Find the value of the capacitor from its color code.

LISTS OF PSYCHOMOTOR AND OTHER OBJECTIVES STATED UNDER THE PRACTICAL CONTEXT **IN THE GRADE 8 BIOLOGY CURRICULUM GUIDE.**

1. explain how the eye is physiologically protected
2. explain the role of the external eye muscle
3. relate the structure of human eye with their functions
4. show how images are formed in human eye
5. Dissecting eye of cattle or sheep and show the structure.
6. examine the location of the blind spots of their eyes
7. Diagram and label the human ear
8. explain methods of controlling plant diseases
9. explain the structure and functions of roots
10. explain the structure and functions of stem.
11. explain the structure and functions of leaves

12. Collect, preserve, and identify leaves.
13. Collect, preserve and identify flowers.
14.Collect preserve and identify seeds.
15. show the requirement for seed germination
16. show the requirement for seed germination
17. Show that plants use water to make food.
18. describe the nature of stomata
19. Show that plants use sunlight to make food.
20. describe that plants prepare food in their leaves
21. Use keys for classifying plants and animals.

LISTS OF PSYCHOMOTOR AND OTHER OBJECTIVES STATED UNDER THE PRACTICAL CONTEXT IN THE GRADE 8 CEMISTRY CURRICULUM GUIDE.

1. describe the properties of acidic anhydrides (acidic oxides)
2. write balanced chemical equation for the reaction of acid anhydrides with water, basic oxides and bases
3. describe the properties of basic anhydrides
4. use indicators to differentiate acidic oxides and soluble basic oxides from other types of oxides
5. explain how oxides can be prepared
6. prepare some oxides
7. use universal indicator paper to determine the approximate PH of a solution and tell whether the solution is basic or neutral
8. explain the action of acidic on carbonates and hydrogen carbonates
9. distinguish between strong acids and weak acids
10. explain the difference between a concentrated acid solution and dilute acid solution
11. explain two methods of preparing acids
12. describe the properties of bases
13. distinguish between strong and week bases
14. explain the difference between dilute solution and concentrated basic solution
15. explain two methods of preparing bases
16. prepare salts
17. carefully handle and use simple laboratory apparatus and chemicals
18. explain the general chemical properties of metals
19. describe the occurrence and general properties of the alkaline earth metals
20. explain the main uses of calcium, magnesium, barium and their important compounds.
21. explain the occurrence and properties of aluminum
22. state the properties of aluminum that make it useful in the production of cooking utensils, airplane parts and chewing gum wrappers
23. explain the main uses of iron
24. explain the main methods of protecting iron from rust
25. explain the uses of carbon
26. describe the preparation and properties of carbon dioxides
27. explain the properties of the carbonates and hydrogen carbonate of sodium and potassium
28. explain the preparation, properties and uses of ammonia
29. tell the properties and uses of nitric acid
30. explain the properties and uses of sulphur
31. describe the properties, preparation and uses of sulphuric acid
32. describe the occurrence, preparation and properties and uses of chlorine
33. calculate formula mass or molecular mass

34. calculate moles of atoms and moles of molecule
35. convert molar mass to moles and vice versa
36. calculate the mass percent of a given element in a compound

CRITERIA	BIOLOGY	CHEMISTRY	PHYSICS
To arouse interest in the subject and develop insight into the development of science and technology			
To develop manipulative skills	5,12,13, 14,21	2,4,7,9, 13,17	25,31,32,37,42 44,45,50,51,52 53,58,59,60 67,68,69
To develop understanding of scientific procedure			38,40
To elucidate theoretical knowledge and scientific concepts	1,2,3,4,6,8,9,10, 11,15,16,17, 18,19,20	1,3,5,8,10, 11,12,14,15, 18,19,20,21, 22,23,24,25, 26,27,28,29, 30,31,32	1,2,3,4,5 7,8,11,12,13,14, 18,19,20,24,28,29, 35,41,48,54,55, 56,57,61,64
To develop skills in reading and working with diagrams	7		6,9,10,15,21,22,46
To develop the ability to observe, record and discover regularities.			33,39,43,47
To develop the skills in solving problems applying learnt relations.		5,16,33, 34,35,36	16,17,23,26 27,30,34,36,49,62, 63,65,66
To develop the skills of using models.			
To develop investigative skills.			

APPENDIX 4

CATEGORIES OF THE AIMS OF SCIENCE COURSE

Klopfer (1971) proposed a scheme which categorizes the aims of science courses under nine general headings, each of which encompasses a range of appropriate for various courses of science subjects. Fraser (1974) added literature skill and Boud, Dunn and Hazel (1989) added communication skill to the list. I will use this scheme to evaluate the objectives of the three science syllabus to see to what extent these objectives are taken into consideration and also to see the place of practical work in the three science syllabuses.

Category	Title of Category	Proportion of Stated Aims		
		Biology	Chemistry	Physics
A.0	Knowledge and Comprehension			
B.0	Process of scientific inquiry I: observing and measuring			
C.0	Process of scientific inquiry II: Seeing a problem and seeking ways to solve it.			
D.0	Process of scientific inquiry III: Interpretation of data & formulation of generalization.			
E.0	Process of scientific inquiry IV: Building, testing & reviewing a theoretical model.			
F.0	Application of scientific knowledge and methods			
G.0	Manual skills			
H.0	Attitudes and interest			
Total Number of Stated Aims				

APPENDIX 5

1. TYPES OF PRACTICAL WORK

To define their respective roles, different classification schemes were designed for practical work by different authors. Gott et al., (1988), for example, classified practical work into five categories. Their boundary was assumed to be not watertight. Particularly, skills and observations are to some degree implicit in other types.

SUMMARY OF TYPES OF PRACTICAL WORK

Type of practical	Aims
Skills	To acquire a particular skill
Observation	To provide opportunities for pupil to use their conceptual framework in relating real objects and events to scientific ideas.
Enquiry	To discover or acquire a concept, law or principle.
Illustration	To 'prove' or verify a particular concept, law or principle.
Investigation	To provide opportunities for pupils to use concepts, cognitive processes and skills to solve problems.

	biology	chemistry	physics
skills	0	0	0
observations	P.A (176)	0	4/1 (82), 5/3 (111)
enquiry	A 1.1 (3), A 1.2 (4), A 1.3 (6), A 1.4 (7), A 1.5 (7), A 1.7 (26), A 1.8 (26), A 3.1 (146), A 3.2 (147), A 3.3 (148), A 3.4 (148), P.A (183), P.A (183).	3.5 (87)	2/3 (28), 4/8 (97)
illustrations	A 1.6 (25), A 4.2.2 (164), A 4.2.3 (165), A 4.2.4 (166), P.A (182), 4.2.1 (164)	1.1A(8), 1.1B(9), 1.1C(10), 1.1D(10), 1.2A(12), 1.2B(14), 1.2C(15), 1.2D(17), 1.2E(19), 1.3A(23), 1.3B(26), 1.3C(26), 1.4A(30), 1.4B(31), 3.1(71), 3.2A(76), 3.2B(77), 3.3(81), 3.4(84), 4.1(102), 4.2(103), 4.3(105), 4.4(106), 4.5(110), 4.6 (114), 4.7(117), 4.8(118), 4.10(120), 4.11(129), 4.12(136)	2/1 (12), 2/2 (19), 2/4 929), 3/1 (59), 3/2 (64), 3/3 (67), 3/4 (72), 4/2 (84), 4/3 (85), 4/4 (86), 4/5(93), 4/6(94), 4/7 (97), 5/1 (107), 5/2 (110), 5/4(113), 5/5(116), 5/6(123)
investigation	0	0	0
Not rated		4.9 9119)	

APPENDIX 7

THE LABORATORY ASSESSMENT INVENTORY (LAI)

The LAI was designed by Tamir and Lunetta (1978) to analyze the laboratory exercises/investigations in science textbooks. It has four major categories, namely Planning, performance, Analysis and Application, each represented by specific skills. For each skill the evaluator marks either *yes* or *no*, *yes* meaning the skill is used, *no* meaning that there is no opportunity to use the skill.

1. Recognize and	Your task will be to learn as much as you can about the organ in the frog.
2. Define problem	On the basis of your observation, make a hypothesis about the possible functions of cork in the living tree. formulate hypothesis
3. Predict	What is likely to happen if glycerinated muscle fiber is exposed to salt as before and then ATP is added drop by drop.
4. Design observation and measure procedure	What control would you suggest for this inquiry
5. Design experiment	Device an experiment to test tolerance of vinegar acts to PH changes
6. Carryout observation, measurement, experimental procedures	Place it in a drop of 5% solution and observe with the microscope, measure the size of organs for sets of experimental conditions.
7. Record results, describe	Record results for the effect of temperature on rate of heartbeat.
8. Transform results into standard format	Make a graph of the data
9. Analyze, interpret, make inference	Analyze your data and determine the mean generation time of organism.
10. Explain, conclude, make knowledge claim	What explanation can you give for the different cork cell shape in your presentation?
11. Define limitations or assumptions	Is an identification of a spot on a chromatography such as this proof that it is the same as one of the known amino acid?

APPENDIX-8
RESOURCE INVENTORY CHECKLIST

The following lists of materials and apparatus are listed from the three instructional materials (the students textbooks) of the science courses for grade 8.

Chapter/ Activity		materials and Equipments suggested in PHYSICS textbook.
2	A-2/1	Three card boards, candle
	A-2/2	Plane mirror
	A-2/3	Concave mirror, Optical bench, Optical pins, Cork
	A-2/4	Concave mirror, Candle, Screen, Optical bench.
3	A-3/1	Thermometer, Cork, 12V electric supply, Insulated lid, Immersion heater, Plastic container.
	A-3/2	Large beaker, Thermometer, Heater, 12V power supply, Joule meter.
	A-3/3	None
	A-3/4	Tin can with press-on lid, Bunsen burner, Stand.
	A-4/1	Used up dry cell
4	A-4/2	Dry cell, battery bulb, connecting wire, switch, an ammeter.
	A-4/3	A voltmeter
	A-4/4	4 Dry cells, Voltmeter, Ammeter, Bulb, Switch, Connecting wires
	A-4/5	Voltmeter, Ammeter, Copper wires, Bulb, Connecting wire, 4 dry cells.
	A-4/6	2 Voltmeters....
	A-4/7	2 Ammeter..
	A-4/8	2 Dry cells, connecting wires, 2 flash light bulbs, a voltmeter.
	A-5/1	bar magnet, iron filings, compass needle, card board.
	A-5/2	Dry cells, switch, a resistor, compass needle, long connecting wires.
5	A-5/3	Dry cells, straight wire, a resistor, iron filings, switch, magnetic compass (compass needle), card board.
	A-5/4	A bar magnet, an iron slab, magnetic compass.
	A5/5	A solenoid (insulated wire coiled in the form of a spring), a magnetic compass, a jar of iron filings, dry cells, card board, connecting wires.
	A-5/6	A sensitive center-zero galvanometer, a conductor, a horse shoe magnet.

DECLARATION

This thesis is my original work and has not been presented for a degree in any other university and that all source of materials used for the thesis have been fully acknowledged.

AKALWOLD ESHETE

This thesis has been submitted for examination with my approval as university advisor.

Dr. DEREBSSA DUFERA