AUDIO-VISUAL AIDS FOR IMPROVING SCIENCE TEACHING IN SUDANESE SECONDARY SCHOOLS

by

Malik Badri

Submitted in Partial Fulfillment of the
Requirement for the Degree of Master of Arts
in the Education Department of the
American University of Beirut

Beirut, Lebanon

1958

AUDIO-VISUAL AIDS IN

SCIENCE TEACHING

FOR HIS DEVOTION TO THE CAUSE

OF EDUCATION IN THE SUDAN

I DEDICATE THIS STUDY

TO MY BROTHER

YOUSIF

M.B.

ACKNOWLEDGEMENT

The author wishes to express his deep gratitude and indebtedness to Professor Allen Vincent-Barwood under whose supervision this study was made.

For his valuable suggestions and criticisms Dr. Frederick R. Korf deserves sincere thanks.

To Mr. Ahmed Saad, the Chief Science Inspector of Sudanese Secondary Education, Mr. Nasr El Haj Ali, the previous Director of Education, Mr. Mutwakil Amin, the Head of the Examination Council, and the principals and science teachers of the secondary schools and teacher training colleges surveyed, the author wishes to record his thanks for the useful information supplied

Malik Badri

American University of Beirut
Beirut, Lebanon
June, 1958

ABSTRACT

Although the term "audio-visual aids" is very recent, the method of audio-visual instruction, due to its simple and natural qualities, is as old as education itself. Modern develepments in the field of the audio-visual field are largely due to the work of educational pioneers like Comenius, Rousseau and Pestalozzi, and to the contributions of modern psychologists.

Of all the school subjects, the teaching of general science is probably the most affected by recent developments in audio-visual instruction, because it depends mostly on observation and sense perception. More direct and concrete audio-visual aids like fieldtrips, demonstrations, exhibits, objects and specimens are usually better than more abstract aids like still pictures, filmstrips, charts and chalkboards; but, at times, semi-concrete aids can make the teaching of general science more effective than life itself. Motion pictures can control the time factor and use animation to explain processes that cannot be seen by the human eye. Mock-ups can reduce distracting details to give the learner an understanding of a motorcar engine that will not be acquired even by studying the real engine itself.

Because the secondary school level is the most verbal stage of Sudanese education, general science is taught by the most passive and stereotyped methods. Science teachers and school administrators do not

appreciate, nor properly utilize and store, audio-visual aids. Questionnaires and interviews have shown that, (other than chalkboards, diagrams, and charts), secondary schools are generally very poorly equipped with audio-visual aids for science teaching. It was found that the major obstacles to the use of audio-visual aids in science teaching in Sudanese secondary schools are lack of funds, lack of understanding of the value of audio-visual instruction, overcrowded curricula and the preparations for centralized general examinations. These obstacles are very much interrelated.

A better understanding of what audio-visual aids are and what they can do, will solve many obstacles to their utilization. If the Ministry and school administrators appreciate the value of audio-visual aids, the negligible budget given for them will automatically increase. If the science teachers understand what audio-visual aids can do, they will not give crowded curricula and centralized general exams as reasons for not using visual forms. Properly utilized, these materials can help them to teach more in less time and in a more effective and interesting manner.

With a better understanding of audio-visual instruction, the problem of lack of funds itself will not hinder a practical science teacher from utilizing audio-visual materials. Taking nearby fieldtrips, collecting objects and specimens; sending for free audio-visual materials; borrowing motion picture projectors, films and projectionists from the University of Khartoum, the Ministry of Social Affairs and many other foreign agencies; and utilizing other community resources are all free of charge.

A good deal of expensive laboratory equipment may be substituted by materials the students bring from their homes or the science teacher purchases at a low cost from garages, grocery houses, food-markets etc. By seeking the help of the art, photography, and science school clubs, the science teacher can inexpensively improvise many materials like charts, maps, diagrams, models, mock-ups, bulletin boards, flannel and electric boards, dioramas, lantern slides, filmstrips, and 2" x 2" slides. Inexpensive opaque, lantern slide, and filmstrip projectors can be constructed from inexpensive lenses, sheet iron and projection bulbs. An intense beam of light and a convex lens can adapt a microscope to act as an inexpensive microprojector.

To help science teachers to gain more familiarity and appreciation of audio-visual instruction, audio-visual programs should be started in the Headquarters of the Science Inspectorate System. To be successful these programs should grow out of the needs and capabilities of the Sudanese secondary science education, and should make use of what other more advanced Arab countries have done in the line of audio-visual instruction. Emphasis should be given to simple inexpensive materials which are expected to be found or produced in the majority of schools. Through demonstrations, talks, workshops, equipment labs, and summer institutes, the science teachers can get proper training in audio-visual education. An audio-visual center should also be started for the distribution, production, and maintenance of audio-visual materials and equipment.

TABLE OF CONTENTS

Chapter | Page

1. WHY USE AUDIO-VISUAL AIDS? 1

Introduction

Historical Basis of Audio-Visual Aids

Early Historical Background.
The Birth of Audio-Visual Education.

The Psychological Basis of Audio-Visual Aids.

The Law of Interest.
The Fact that Generalizing and Concept-Building Proceed from the Concrete to the Abstract.
The Principle of Transfer of Learning

The Contributions of Audio-Visual Aids.

The Use and Misuse of Audio-Visual Aids.

The Proper Utilization of Audio-Visual Aids.
Misconceptions and Misuses of Audio-Visual Aids.

Summary

II. MODERN AUDIO-VISUAL MATERIALS AND METHODS FOR IMPROVING SCIENCE TEACHING 20

The Demonstration; The Fieldtrip; Exhibits and Displays; Objects, Specimens and Models; The Motion Picture; Projected Still Pictures; Flat Unprojected Pictures; Graphics; The Chalkboard; Summary.

Chapter Page

III. AN INVENTORY OF THE UNDERSTANDING AND UTILIZATION OF AUDIO-VISUAL AIDS TO SCIENCE TEACHING IN SUDANESE SECONDARY SCHOOLS 69

Introduction

A Survey of Audio-Visual Aids to Science Teaching In The Intermediate and Elementary Schools.

Bakht-er-Ruda Combats Verbalism in Elementary and Intermediate Education.
Bakht-er-Ruda and Science Education.

A Survey of Audio-Visual Aids to Science Teaching in the Secondary Schools.

A Survey of the Science Teacher's Understanding of Audio-Visual Aids.
An Evaluation of Secondary Schools in Terms of Their Use to Audio-Visual Aids to Science Teaching.
What Audio-Visual Aids to Science Teaching Are Used?
How Are These Materials and Equipment Utilized?
How are Audio-Visual Materials and Equipment Stored and Maintained?
Audio-Visual Aids and Scientific Extra-Curricular Activities.

Summary

IV. OBSTACLES TO THE USE OF AUDIO-VISUAL AIDS TO SCIENCE TEACHING IN SUDANESE SECONDARY SCHOOLS AND SUGGESTIONS FOR OVERCOMING THEM 104

Introduction

The Results of the Questionnaires

Lack of Funds

Suggestions for Overcoming the Problem of Lack of Funds.

Chapter Page

The Problem of Overcrowded Curricula and the Preparations for General Exams.

Some Suggestions for Overcoming the Problem of Overcrowded Curricula and the Preparations For Centralized Exams.

Lack of Understanding of the Value of Audio-Visual Aids.

Some Suggestions for Overcoming the Obstacle of Lack of Understanding of the Value of Audio-Visual Aids.

Summary

V. SUGGESTIONS FOR IMPROVING THE TEACHING OF GENERAL SCIENCE IN SUDANESE SECONDARY SCHOOLS BY THE USE OF INEXPENSIVE AUDIO-VISUAL AIDS.................................... 127

Introduction

How to Improve Challboard Utilization

How to Improve the Demonstration Method by Inexpensive Aids.

The Fieldtrip an Effective Inexpensive Aid

A Fieldtrip to the Slaughterhouse of the City of Omdurman.

Other Possible Fieldtrips in the Sudan.

How to Make Inexpensive Graphics

Compiling a Still Picture File

Making Bulletin Boards, Flannel Boards and Electric Boards.

Making Models

Improving Science Exhibits

How to make Lantern Slides

Chapter Page

How to Make an Inexpensive Lantern Slide Projector

How to Make an Inexpensive Opaque Projector.

Making Filmstrips and 2" x 2" Slides

Making an Inexpensive Microprojector.

Utilizing the Motion Picture by Borrowing Films
and Projectors.

Summary

LIST OF TABLES

Page

Table I

Audio-Visual Aids to Science Teaching Used in Sudanese Secondary Schools. 87

Table II

Obstacles to Use of Audio-Visual Aids to Science Teaching as Reported by Science Teachers. 106

Table III

Obstacles to Use of Audio-Visual Aids to Science Teaching as Reported by Administrators. 107

LIST OF FIGURES

Figure | Page

1. The Demonstration Can Be Used Most Appropriately to Show the Performance of an Operation 24

2. The Demonstration Should Be Tried Out Previously 25

3. The Apparatus Should Be Kept Simple 27

4. It is Impossible to Bring a Tiger Into the Classroom to Study Its Hair 35

5. How an Archerfish Gets Its Prey 40

6. White Blood Cells Fight "Invading" Bacteria 41

7. White Blood Cells "Eat" Bacteria 42

8. The Filmstrip Accommodates Individual Differences 46

9. The Filmstrip Projector is Easy to Handle 47

10. Even a Small Budget Can Provide a Wide Selection of Filmstrips 47

11. Example of Photographic Frames Scientific Filmstrip 49

12. Example of an Animated Drawing Frames of a Scientific Filmstrip 50

Figure Page

13. The Microprojector - an Inexpensive Aid 57

14. An Example of a Scientific Cartoon 63

15. The Magnetic Chalkboard 67

16. Bakht-er-Ruda Combats Verbalism 75

17. Work in Large Pattern 130

18. Use Simple Drawing Templates 132

19. The Grid Method 133

20. The Projection Method 134

21. The Comic Drawing Technique 135

22. A Simple Wheel and Axle 137

23. Producing Electricity from a Lemon 143

24. An Example of a Free Diagram 156

25. A Student-Made Cutaway Model 160

26. A Teacher-Made Mock-up 161

27. How to Make an Inexpensive Lantern Slide Projector 164

28. An Inexpensive Lantern Slide Projector Cooled with a Water Jacket 165

Figure Page

29. An Inexpensive Opaque Projector 166

30. An Inexpensive Copying Stand 167

31. Some Frames from the Teacher-Made Filmstrip, Cotton in The Sudan 169

32. Some Frames from the Teacher-Made Filmstrip, Energy and Food 170

33. Some Frames from an Animated Drawing Student-Made Filmstrip 171

34. Making an Inexpensive "horizontal" Microprojector 174

35. Making an Inexpensive "vertical" Microprojector 174

CHAPTER I

WHY USE AUDIO-VISUAL AIDS?

Introduction

This chapter is intended to show the importance of audio-visual aids to learning and why they should be used. The background of the audio-visual movement, its historical and psychological basis, shows the obstacles that stood in the way of its development and the great efforts exerted by the educational pioneers for its cause. It also shows its relation to other branches of modern education.

After this historical approach, its contributions to learning in the modern world are discussed; but, to clarify the fact that mere exposure of the learner to audio-visual materials will not guarantee these contributions claimed, a summary of the steps to the proper utilization of audio-visual aids, together with a list of possible misconceptions that the teacher should guard himself against are presented.

Hence, other than calling attention to the advantages of audio-visual instruction, this chapter has another important contribution to the whole problem of the thesis; it clarifies in a functional manner what audio-visual aids really are and what they are not; what they intend to do and what they do not intend to do.

Historical Basis of Audio-
Visual Aids

(a) Early Historical Background[1]

Although the terms "audio-visual aids", "visual instruction" and "visual-sensory aids" are very recent, the method of audio-visual instruction in its broadest sense is as old as education itself. The audio-visual method of education due to its simple and natural qualities, must have been the most common method of primitive man. Before the invention of language, man must have conveyed his ideas through facial and other "visual" expressions.

When the cave man took his son for a practical exercise in swimming or horse riding, he undoubtedly used the audio-visual demonstration and field-trip methods. For a lesson in self protection or hunting, the father might find it most practical to make a small bow and arrow for his son. The child would have used the bow and arrow happily without knowing that the modern audio-visual expert of today would consider it a good illustration for the use of the 'working model' in child education.

It is quite a long time since the discovery of the value of the still picture and the influence of colour in education. The ancient Chinese proved 'one picture is worth ten thousand words' is as modern as the use of the motion picture in the classroom. The clay backed picture insc-

---

1. This section is condensed from the following sources:
   a. Carrol, Teacher Education and Visual Education for the Modern School, pp. 9-11.
   b. McKown and Roberts, Audio-Visual Aids to Instruction, pp. 4 & 5.

riptions and the three dimensional images of the ancient Egyptians could be ranked among man's first attempts to use the model and the still picture in education.

The ancient Greeks and the Romans also used different types of audio-visual aids in their schools. The Greeks used the dramatization method to mould moral and political attitudes, and their schools were active in the utilization of the field-trip. The Romans used art and sculpture to commemorate their war victories. Visual aids used in Roman schools to concretize verbal symbols were approved by the intellectual leaders of the age e.g. Cicero (B.C. 106-43) who believed that visual forms help the students in remembering abstract concepts.

Though the motion picture is one of the modern developments in audio-visual education, Blackton[1] claims that its basic concept of illusion of motion, was discovered by the Romans who used images drawn on temple pillars. Successive pillars had on it the picture of a goddess that exactly resembled the figure on the previous pillar except for a slight change in position; a man galloping with a horse past the pillars, would receive the impression that the goddess was moving.

Education during the Middle Ages (400-1400) became very abstract, but it was not free from some visual aids like statues, marionettes and engravings that were used to help in religious instruction.

---

1. Blackton, J. Stuart, History of Movies, Blackton Production Co. 1934. A 16 mm. motion picture. As quoted by Carrol, op.cit., p. 9.

(b) The Birth of Audio-Visual Education:[1]

With the development of inscribed and written records, man entered a stage of abstract life in which human experiences could be put down in the form of symbolic representations of word symbols. The pioneers in various subjects made their first-hand studies, and they wrote down the results to be transmitted to others. As the sphere of human knowledge increased, more and more information began to be studied vicariously, and the gap between theory and practice increased.

During later centuries, when man felt the great need for education, the press of larger quantities of students, and the higher cost of learning through first hand experiences resulted in the lecture and the book being the major tools of instruction. The simplicity of such a teaching procedure, together with the simplicity of testing for memory of words has brought the use of audio-visual aids to a minimum, and has accordingly strengthened the tradition of over-verbalization.

In the seventeenth century, pioneers of educational reform were declaring a war against verbalism and were advocating the return to learning through seeing and doing. This marked a Renaissance in education. The genial Moravian Bishop Comenius (1592-1670) has been credited as the founder of modern education, and the father of the audio-visual movement. Comenius advocated decorating the classroom walls with pictures and filling the books with them. He also recommended the use of other

---

1. This division is summarized from:
   (a) Miller and Blaydes, Methods and Materials for Teaching Biological Sciences, pp. 98-99.
   (b) The Dept. of Audio-Visual Instruction of NEA. The School Administrator and his Audio-Visual Program, 1954 yearbook pp. 3-7.
   (c) Dale, Audio-Visual Methods in Teaching, pp. 58-61.

visual aids like models, engravings, charts and maps.

Comenius is remembered for having produced the first "visualized" textbook in existence, which he called Orbis Sensualum Pictus; the book is popularly referred to as Orbis Pictus meaning "the world in pictures". It contains one hundred and fifty pictures, each providing a topic for a lesson in learning Latin.

Jean Jacques Rousseau (1712-1778) exerted a great influence on the minds of men through his writings. At his time education was based on the interests and age level of adults. The child was looked at as a miniature adult, and was expected to behave like an adult. In his famous book Emile, Rousseau strongly criticized this situation, and suggested a new system of education based on nature, the interests of the child, and concrete illustrations.

Though Rousseau was very successful as a writer, he could not apply his educational principles efficiently, because he was a failure as a teacher. This task was left to Pestalozzi (1746-1827), who brought the educational theories of Comenius and Rousseau into practical existence, thus rendering the cause of audio-visual education one of its greatest services. Pestalozzi's wonderful utilization of the field trip and clay modeling in visualizing the study of geography and nature study strongly influenced the teaching methods in Europe and eventually in the United States.

Other educational reformers like Herbart (1776-1841), and Froebel (1782-1852) continued to strengthen the movement toward realistic learning.

Herbart's most significant contribution to modern Education is the principle of apperception. This principle of relating the new learning to what the learner already knows, had its effect in showing the importance of sense perception in education and accordingly the need for audio-visual aids. Froebel is well known as the originator of the kindergarten, in which he applied the concept of "learning by doing", which forms the cornerstone of audio-visual education. As a student of Pestalozzi, Froebel strongly emphasized the field trip and first-hand observations in nature study.

This quick glance at the history of the audio-visual movement in education makes it apparent that the tradition of verbalism, of teaching empty words without meaning, has been the enemy of educational reformers for the past centuries. From Comenius to Dewey, the cause of audio-visual instruction was handed over from pioneer to pioneer, and even today, the struggle is still going on. We are far from having achieved what we should accomplish for realistic learning.

The Psychological Basis of Audio-Visual Aids

The psychological theory that supported the parrot-like teaching and the difficult corriculum of the nineteenth century was called "the theory of mental faculties and formal discipline". This principle advocates that the human mind is made of faculties or powers for different abilities. For example memory, imagination, reason, etc. These faculties could be sharpened by studying certain specified difficult subjects. The study of mathematics was supposed to give command of the faculty of attention, the study of Latin to develop the powers of reasoning and observation, and the discipline of athletics to train the faculty of will power. Once these faculties were sharpened, all problems of reasoning or attention could be solved, however different they might be from mathematics, Latin, or athletics. It is unlikely that audio-visual aids could flourish under such a psychological belief, since the whole field of audio-visual education aims at making learning more direct and more interesting.

Gates[1] believes that William James (1890) was the first to attack the theory of mental faculties experimentally. He carried out an experiment to prove that training the memory by a certain discipline does not result in positive transfer as the theory presupposes. Though this experiment was very crude, it had a great significance in stimulating more refined experiments carried out by such great psychologists as E.L. Thorndike. These new studies in psychology of learning attacked the theory of mental faculties and hence paved the way to modern educational principles. Out of the many contributions of psychology to education, the following laws and principles had the greatest share in furthering the cause of audio-visual aids:

a) The Law of Interest

b) The fact that generalizing and concept - building proceeds from the concrete to the abstract.

---

1. Gates _et al_, _Educational Psychology_, pp. 486-87.

c) The principle of transfer of learning.

(a) The Law of Interest[1]

The role of interest in learning was greatly overlooked by the advocators of the old mental disciplinary theory. Motivation was largely extrinsic, in which the child is urged to study his school work either negatively through fear of punishment or positively through such rewards as grades, prizes, privileges, honours, etc. With the development of modern psychology, the disadvantages of motivating school work through fear of punishment or expectation of reward were brought out. The "doctrine of interest", stresses the fact that the child has some inherent interest: it is the role of the educators to discover, develop, and capitalize upon these interests. The doctrine made a shift from extrinsic to intrinsic motivation.

One does not need to say much about the impetus that this law of interest has given to audio-visual instruction, since one of the reasons given against the utilization of audio-visual aids by the conservative school is that it makes education too interesting for the child. Children find great interest in concrete things that they can see and handle; this interest cannot be satisfied except by showing the child objects that he can see and manipulate, which is the essence of audio-visual instruction.

---

1. This section is distilled from:
   a. McKoun and Roberts, op.cit., pp. 20-21.
   b. Miller, op.cit., p. 99.

(b) The Fact that Generalizing and Conceipt-Building Proceeds from the Concrete to the Abstract[1]

The heavy hand of verbalism has been the greatest enemy of audio-visual aids for many centuries. The war started by Comenius against the tradition of oververbalization is still going on. Psychology of learning has loosened the grip of verbalism by calling attention to the fact that learning proceeds from the concrete to the abstract, and that there are basic differences between the child and the adult.

By classifying imaginary into concrete and abstract, psychologists have indicated how clear concepts and generalizations are built by the two antithetical processes of differentiation and integration, thus showing that no clear generalizations can be formed without a variety of first hand experiences. Research studies in mental development have shown that the basic differences between the child and the adult is maturity, and that maturity comes through concrete experiences rather than empty verbalism.

All these studies stimulated many educational psychologists such as L.C. Pressey,[2] to re-examine the various textbooks assigned to elementary and secondary school children, and to test the student understanding of the abstract concepts used in them. The results proved that the children were

---

1. This sub-division is condensed from the following sources:
   a. Gates et al, op.cit., p. 184.
   b. Henry C. Ruark, "The Wealth of Materials Available for Instruction through Audio-Visual Aids", Instructional Materials as Educational Potential in the Library and in the Classroom, pp. 20-21.
   c. J. Kinder, Audio-Visual Materials and Techniques, p. 52.
2. L.C. Pressey, "A Study in the Learning of the Fundamental Special Vocabulary of History from the Fourth through the Twelfth Grades", A Study abridged by Gates, op.cit., p. 186.

ignorant of many words and concepts used freely in their textbooks, in spite of the fact that they succeeded in using these concepts correctly in their oral conversations. These results indicated that the child does not get meaning from the concepts he reads or hears in a lecture, but that he gives meaning to them from his past experiences.

Accordingly the printed page, which was the most important item in formal child education, has lost much of its significance as the central focus of effective learning. Teaching without audio-visual aids has become a sign of inefficient instruction since clear sharp images cannot be built except on a firm base of rich concrete and semi-concrete experiences. In trying to clarify this fact by giving a concrete illustration of a classroom situation, Henry Ruark says:

> Teaching... is primarily the communication of ideas, of mental images. What are the major steps in this process? Let us consider teaching with no audio-visual materials to aid us. The steps are four: (1) You analyze the subject for major points to present. These teaching points exist in your mind as mental images. (2) You then translate these images into words. (3) You repeat the words to the students; they develop their own mental images, translating again from your words. (4) You check and test to see if in truth the students have received the mental pictures you intended.
>
> If both you and your students have performed perfectly, then the images in the minds of your students are identical with yours. This happy situation is seldom realized, however, for two reasons: First, it is practically impossible for the instructor to describe accurately in words alone the images which exist in his mind; and second, it is just as difficult for the student to derive from those words the same meaning the instructor intends.
>
> So we see that words alone will fail the modern educator.[1]

---

1. Ruark, Instructional Materials as Educational Potential, p. 21.

The fact that almost any modern book about audio-visual aids starts with a chapter about the relation of the concrete to the abstract and the process of concept-building is a strong indication that this psychological principle has probably given audio-visual instruction its greatest justification.

(c) The Principle of Transfer of Learning[1]

The theory of mental faculties advocated the idea that full transfer of learning is expected through the training of different faculties or powers of the mind. Modern psychology has disproved this naive concept of transfer.

Experiments carried on by C.H. Judd and E.L. Thorndike have proved that transfer of learning depends upon the following two principles:

(1) Thorndike's principle of identical components.

(2) Judd's principle of generalization being the basis for transfer.

The first principle indicates that the quantity of carry over in learning varies directly with the similarity between the situations. This principle has provided the psychological support for the new movement for making education as similar as possible to real-life situations. Audio-visual materials that bring the world into the classroom or take the child to the outside world are of obvious pertinence in this connection.

The second principle advocates that the more systematically or-

---

1. Some of the ideas in this section are paraphrased from: Gates, et al, op.cit., pp. 491-501.

ganized and generalized the learning, the more likely it is to transfer. Or that carrying over learning depends on one's ability to form accurate concepts, generalizations, and broad principles rather than to repeat unrelated details and empty verbalism. Since no clear and sharp generalizations and principles can be developed without concrete and semi-concrete audio-visual experiences, this principle had a far reaching influence in furthering the use of audio-visual materials.

Thus we come to the conclusion that audio-visual instruction is very much indebted to educational psychology mainly because it called attention to the value of intrinsic motivation, the importance of concrete experiences in learning, and the need for making education as similar as possible to real-life situations.

Contributions of Audio-Visual Aids

The contributions of audio-visual instruction summarized by Edgar Dale, James D. Finn and Charles Hoban in the Encyclopedia of Educational Research, is probably the most reliable statement on this subject; the summary is distilled from a large number of significant research studies carried out by the National Education Association and prominent audio-visual experts and educators. Dale, Finn and Hoban have found that audio-visual aids, properly utilized in a teaching situation, have the following characteristics:

1. They supply a concrete basis for conceptual thinking and hence reduce meaningless word-responses of students.

2. They have a high degree of interest for students.

3. They supply the necessary basis for developmental learning and hence make learning more permanent.

4. They offer a reality of experience which stimulates self-activity on the part of pupils.

5. They develop a continuity of thought; this is specially true of motion pictures.

6. They contribute to growth of meaning and hence to vocabulary development.

7. They provide experiences not easily secured by other materials and contribute to the efficiency, depth and variety of learning.[1]

These seven characteristics of audio-visual materials will be examined in more detail as the advantages of individual audio-visual materials are discussed in Chapter Three of this study.

<u>The Use and Misuse of Audio-Visual Aids.</u>

1. <u>The Proper Utilization of Audio-Visual Aids</u>:

The proper selection and utilization of an audio-visual material is a very important factor in determining its value as a teaching aid. According to Kinder[2] and Miller[3], the more realistic an audio-visual material is, the more effective it will be. For example: a living specimen of planaria is more realistic and more effective than a model of planari; a model is more concrete than a film; a film is more valuable

---

1. <u>Encyclopedia of Educational Research</u>, 1952, p. 84.
2. Kinder, <u>op.cit.</u>, p. 51.
3. Miller, <u>op.cit.</u>, pp. 99-100.

than a still photograph; a photograph is more realistic than a chalkboard diagram of planaria; and, finally, a diagram is more effective than merely telling the students about planaria.

However, if the teacher wants his students to learn about the nervous system of planaria, then an enlarged model or a microscopic slide, though they are less realistic than the specimen, would be better for the purpose. If the lesson is about the life history and habits of the animal, then the motion picture will excel both aids because it has a great ability to provide continuity of experience by arranging seemingly unrelated facts into a meaningful sequence. It can also condense the life processes of months in a few minutes.

In many instances, a successful teacher will need the use of more than one audio-visual material. To continue the example of the planaria, if the aim of the lesson is to study its internal structures, then the enlarged model will be excellent, but it should be coupled with examination of the living specimen to give the students a correct picture of the small size of the animal. Accordingly, the value of any audio-visual material depends upon the type of learning the teacher is expecting his students to acquire.

Steps to Proper Utilization of Audio-Visual Aids

Although each audio-visual material has its own special points of effective use, the following general steps in their utilization are applicable to all audio-visual aids:

a. Teacher Preparation:

The most important item in teacher preparation is the determination of the immediate and long-range purposes for showing the material. With these purposes in mind, the teacher can then select suitable audio-visual aids in terms of the interests, needs and abilities of his students. Once the material is selected, the teacher should prepare himself for any difficulties that might arise. He should preview the material and arrange the classroom if it is a film, a filmstrip or a demonstration. He should improvise a chart, a map or a diagram, and make the necessary arrangements if it is a field trip.

b. Class Preparation:

To prepare the students for the audio-visual exposure, the teacher should arouse their interest, clarify the purposes to them, explain difficult concepts or words, and show them what to look for.

c. Show the Material:

If the material is to be shown in the classroom, for example a filmstrip, a set of slides, or a film, the teacher should make sure that the room conditions are most appropriate for the show. He must darken the room, ventilate it properly, and make sure that everybody can see and hear well. In field trips, the materials are seen outside the classroom. To get the best results, the teacher may find it necessary to divide a large class into groups and to guard against possible distractions.

d. Follow-Up:

To make sure that his students have really benefitted from the audio-visual material exposed, the teacher should follow-up by testing his students orally or by writing, by making further activities like individual or group reports, by carrying on more audio-visual experiences, and by evaluating the material itself by asking himself the following questions:

a. Did the material give a true picture of the ideas it is supposed to convey?

b. Was the material worth the expense, time and efforts put into it?

c. Was its physical condition satisfactory?

d. Was the material suitable to the age level and experience of the students?

Of course these same questions would have been asked about the material before deciding to use it in class; but after the experience the answers may vary, and the teacher may thus learn to improve subsequent presentations.

2. Misconceptions and Misuses of Audio-Visual Aids:[1]

a. Audio-Visual instruction does not intend to over-simplify education.

One of the most dangerous misconceptions that may develop

---

1. This part is adapted and compressed from:
   a. McKown, op.cit., p. 3.
   b. Dale, op.cit., pp. 63-64.

from an overzealous enthusiasm for the use of audio-visual materials, is oversimplification. The audio-visual movement has founded itself on the ruins of the old mental faculty theory which advocates the extreme notion that making all education very difficult is the best way to train the mind. In their zest to adopt audio-visual aids, some teachers have gone to the other extreme of trying to make all education easy and concrete. They have tried to bring education down to a few big ideas that can readily be visualized by means of a poster or a motion picture, overlooking the fact that some essential classroom ideas are by their very nature complex and abstract.

b. Audio-visual aids are a means and not an end in themselves:

The tendency to oversimplification has probably resulted from the fact that some 'audio-visually minded' teachers have considered audio-visual experiences as an end in themselves and not as a means to further the learning task, which is the real end. A change of focus from the materials that help learning to learning itself will probably bring this misconception to a minimum.

This misunderstanding is also well exemplified in the fact that sometimes the effort, time, and money spent, in constructing a visual device are out of all proportion to the vividness and clarity gained.

c. Audio-visual aids are not developed to be a substitute for the teacher:

That the development of audio-visual education is a threat to the position of the teacher is another misjudgement; audio-visual aids, when properly used, will only increase the importance of the teacher. A film or a slide set shown in class should neither be a chance for the teacher merely to sit back and watch, nor should it be a substitute for reading or for the spoken word. By following the steps for the effective utilization of these materials, the teacher, with an equal investment of time and energy, may be expected to increase both the quality and efficiency of his instruction.

d. Audio-visual aids are not concerned with motion pictures only:

It is true that the invention of the motion picture has had far reaching effects in the communication of ideas, in commerce, entertainment, etc. It is true that its introduction to education has revolutionized the audio-visual field, making it one of the most popular and spectacular audio-visual aids; but, unfortunately, these facts have developed a serious misunderstanding (even among teachers) that the words audio-visual education and motion pictures are synonymous. Such a one-sided view of audio-visual instruction can only result in a failure to see the values inherent in the use of the numerous other types of aids.

Summary

This chapter has emphasized that audio-visual instruction is as old as education itself, that its cause has been gathering dust for three centuries, mainly because of the tradition of oververbalization, and that its development is largely due to the work of pioneers like Comenius, Rousseau and Pestalozzi, and to the contributions of modern psychologists. The proven contributions of audio-visual materials to learning, provided that they are properly utilized, have been stressed.

CHAPTER II

MODERN AUDIO-VISUAL MATERIALS AND METHODS FOR IMPROVING SCIENCE TEACHING

Introduction

Science is a subject that lends itself quite easily to the audio-visual field because it depends mostly on observation and sense perception. It can be very abstract when taught through verbal methods only, and it becomes very exciting and interesting once concretized by audio-visual aids. Of all the school subjects, the teaching of general science is probably the most affected by recent developments in audio-visual methods. Edgar Martin carried out a study to evaluate the teaching of general biology in the public high schools of the United States of America. 55.3 per cent of the schools offering general biology responded to the question "What changes or innovations have been made in the last five years, which you feel have contributed significantly to the education of the youth in your school?" The increased use of audio-visual aids and biological equipment ranked first. It was reported by 261 schools, (61.4 per cent of the schools offering general biology), which is more than twice the number of schools that reported the second most significant innovation.[1]

---

1. W. Edgar Martin, ed. The Teaching of General Biology in the Public High Schools of the United States, p. 42.

This fact may be the reason for the difficulty that one faces when one tries to differentiate between the methods of teaching general science and the audio-visual materials for improving these methods. While Richardson and Cahoon[1] give the demonstration and the field trip as methods of teaching science, Edgar Dale[2] and Hass and Packer[3] present the laboratory method itself as an audio-visual material; the former gives the demonstration a separate chapter among the other audio-visual aids. Many general science textbooks consider the motion picture projector, the filmstrip and slide projectors and the microprojector as logical parts of the laboratory equipment, while some visual aids books classify the microscope and microscopic slides as visual materials.

Evidently any attempt to draw a line between the methods of teaching general science proper, and the audio-visual materials and methods, is just another misunderstanding of the role of audio-visual instruction as an aid to learning. Yet the inclusion of general science teaching methods like the laboratory and demonstration methods in audio-visual instruction textbooks has definitely vitalized the teaching of general science. Principles for the proper utilization of these methods, their relationship with other audio-visual aids, and how they can be coupled with them have been effectively developed.

This chapter is intended to show the contributions of audio-

---

1. John S. Richardson and G.P. Cahoon, Methods and Materials for Teaching General and Physical Science, pp. 9-12.
2. Dale, op.cit., pp. 42-49.
3. Hass and Packer, Preparation and Use of Visual Aids, p. 135.

visual materials to the teaching of general science in the modern world. Each material is defined, its advantages as an aid to science education discussed, and, if necessary, its limitations and special points about its utilization brought out. Thus the main contribution of this chapter to the whole problem of the thesis is to give the Sudanese administrators of rich schools, and government administrators dealing with science education, a quick survey of the audio-visual materials used in science teaching and to show their necessity for an effective science teaching program. At the end of the discussion of every material, a list of the sources from which it may be purchased is added to help those convinced to use some of their school budgets in buying audio-visual materials. To avoid overlapping with Chapter Five, intensive discussions about the use of free and inexpensive materials and how to improvise them are not included.

An effort is made to arrange the materials in the order of their reality and concreteness. Audio-visual aids like the demonstration and the field trip in which the student is either doing the work himself or is watching an actual realistic teaching situation are tackled first; more abstract materials like the graph, the diagram and the chalkboard are considered later.

A. The Demonstration

Because of its realistic nature, the demonstration method is considered to be one of the most effective audio-visual methods of teaching physical and biological sciences. Seeing actual experiments of sinking precipitates and rising pungent gases, of dissected animals or dispersed light can never be substituted by a chart, a model or motion picture. The demonstration can be carried out by the teacher or the student.

The demonstration method as the most effective audio-visual aid[1]

Even though the laboratory method is usually more concrete and effective than the demonstration method because every student has the chance to handle the apparatus and make his own conclusions, the demonstration is at times most desirable if one of the following situations should occur:

1. When the apparatus to be used in an experiment is expensive and unsuitable for the students to handle, or when it is very sensitive and may be destroyed by clumsy manipulation. For example an experiment in electricity that requires the use of very sensitive or costly galvanometers that may be spoilt by any mistake in running a current higher than their capacity in the circuit.

2. When several experiments must be performed in one class-session so that the s tudents may get the relation between them. Spreading these experiments over long-separated lessons will fail to bring out this connection. Introducing the subject of converging and diverging lenses and showing the real and virtual images formed by them is an illustration

---

1. Some of the ideas in this division are summarized from:
   a. Saunders, The Teaching of General Science in Tropical Secondary Schools, p. 85.
   b. Richardson and Cahoon, op.cit., p. 19.
   c. The illustrations in figures 1, 2 and 3 are reproduced from: Wayne University College of Education, The Demonstration as a Teaching Technique (A filmstrip).

of this situation.

3. When a hasty review of some scientific principles or laws is desirable. This item is a corrolary of the previous one, since the main aim of a review is to rearrange the isolated facts and details into larger wholes and to see the connection between them.

4. When the experiment involves some danger. For instance the experiment of igniting hydrogen and oxygen to produce water or melting a domestic fuse in a 220 volts circuit.

5. When skills such as weighing, operating special equipment or pouring reagents are to be learned by students. To acquire such operations, it is more effective to see a skillful person doing them for the whole group, showing the points to watch, rather than to learn them through individual tutoring.

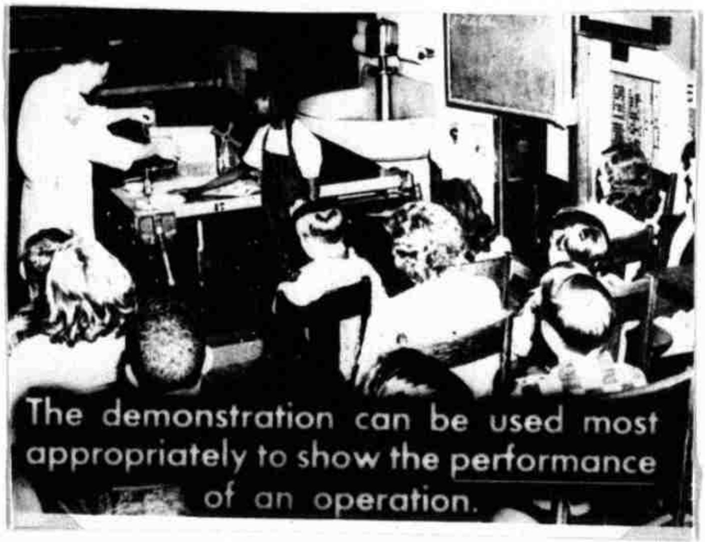


Fig. 1

6. When the apparatus or equipment is not enough to facilitate the use of the lab. method. That the demonstration is an inexpensive teaching technique is one of its most important advantages an an audio-visual aid.

Criteria for a good demonstration[1]

The utilization of the demonstration as an audio-visual material follows the general steps given in Chapter Two; however, it has some special points of proper utilization that should be emphasized at this stage:

1. The demonstration should be rehearsed and tried out previously:

No demonstration, however simple it is, should be presented to a class before it is tried out previously. By following this rule the teacher will make sure that every piece of apparatus and equipment is exactly where he wants it to be. Nothing is more ruining to a demonstration than a sudden interruption by the teacher followed by statements like, "Excuse me. I must get the graduated cylinder from the lab." A simple illustration of this fact is witnessed nearly every day in classrooms. After some interesting discussions, the science teacher runs to the chalkboard to visualize some concept to the class. Finding no chalk in the chalk tray, the cupboard or the desk, he will finally

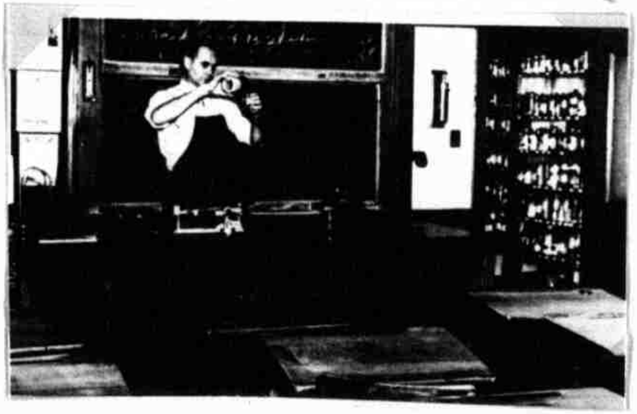


Fig. 2 The demonstration should be tried out previously

---

1. Compressed from:
   a. James Kinder, Audio-Visual Materials and Techniques, p. 360.
   b. Dale, op.cit., pp. 142-48.
   c. Richardson and Cahoon, op.cit., pp. 20-21.
   d. Saunders, op.cit., pp. 85-86.

send a student to fetch some chalk from the supply room. This interruption will definitely spoil the psychological moment for the presentation of the visual illustration.

2. <u>The teacher should keep up the attention and interest of the class</u>:

A demonstration is like a dramatic performance in which the teacher should do his best to keep his audience interested, and to be clever at detecting signs of bewilderment and boredom. The teacher should be a bit of a "showman" in assuring an atmosphere of suspense just before the essential point of an experiment and in inspiring the class with the sense of the dramatic. Connecting the experiments demonstrated with things seen and handled by the students, planning for students participation in manipulating the apparatus, or reading scales, and shooting questions whenever necessary are also useful in keeping the class active and attentive.

3. <u>The demonstration should be visible to all students</u>:

It is absolutely essential that every student should be able to see what is taking place at the demonstration table when the teacher is performing an experiment. The ideal situation in such a case, is a classroom in which the students sit at chairs arranged in tiers. Other arrangements to solve this problem when such a lecture room is not available will be discussed in Chapter Five.

The demonstration table should be adequately lighted and the apparatus used must be large enough to be seen from the sides and rear of the room. The science teacher should take full advantage of the largesized equipment made by apparatus companies to overcome this problem.

4. The demonstration should be kept as simple as possible:

The teacher cannot give all the details and chemical formulae he knows about carbon and carbonates in one demonstration lesson on the preparation and uses of carbon dioxide. One of the most confusing things to a student is to give him the basic ideas and the refined points all at the same time. A demonstration lesson should only stress the general principles and key points, and the teacher should continuously summarize as he goes along. The problem of overloading the demonstration with details could be avoided if the teacher places himself in the role of his poorer students while he is preparing his lesson.

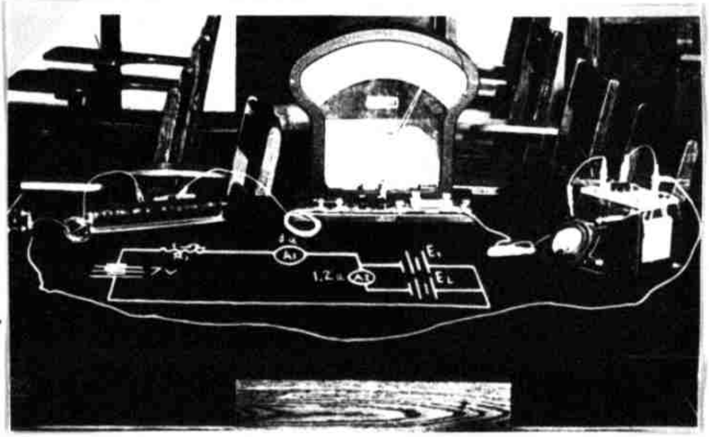


Fig. 3 The apparatus should be kept simple

The apparatus used should likewise be kept as simple as possible. Elaborate complicated equipment will only obscure the purpose of the experiment.

B. The Field Trip[1]

The field trip as an audio-visual aid is unique in that it gives

---

1. Condensed from:
   a. Richardson and Cahoon, op.cit., pp. 55-65.
   b. Haas and Packer, op.cit., pp. 168-169.
   c. Heiss et al, Modern Science Teaching, pp. 292-293.

the students of science first hand experiences with processes and phenomena which cannot be transferred to the laboratory or the classroom. Even when the material could be brought into the classroom for example a specimen or an animal, the field excursion has the advantage of showing these materials in their natural context. The impressions the students get from the breath-taking heat of a glass furnace, or the sharp, pungent odour of a tanning room can never be substituted by any other audio-visual aid.

<u>Some of the advantages of the field trip are</u>:

1. It tends to bring school life into contact with the outside world, thus facilitating the transfer of learning.

2. It develops interest in natural as well as man-made things, giving students a better understanding of their environment.

3. It can be easily adapted for all levels of teaching.

4. It builds the accuracy of observation, the joy of discovery, initiative and self-activity.

5. It develops respect for and appreciation of the work done by different members of the community.

6. It tends to increase the spirit of co-operation in the students.

<u>Some limitations and special points of effective utilization of the field trip are</u>:

1. The field trip, probably more than any other audio-visual aid, requires careful planning and preparation by the science teacher. Surveying the place to be visited, planning for student activities, discovering the

problems to be visualized by the trip and deciding what to look for; arranging for problems of safety, lodging, transportation, meals and apparatus to be taken; informing the school administration, the managers of the place to be visited, and the parents are some of the problems of planning a science teacher may have to carry out.

Any carelessness on the part of the teacher in planning the trip may have undesirable results; for instance, overlooking the problem of safety in field excursions which brings the students near to moving machinery, hot pipes, open pits, exposed electric wires, and flying particles may result in a catastrophe. Forgeting to tell the school administration or the managers of the factory to be visited may end in postponing the trip if not in its complete failure. A lack in student preparation will change an excursion from an educational aid to mere recreation.

2. Very well informed guides interested in their field or poor ones who know very little science may spoil the trip by giving the students extremely high technical knowledge or distorted scientific information. The science teacher can avoid such a possible danger by explaining the purposes of the trip to a well informed guide or by previewing the place before hand to become the guide himself.

3. Especially in a large class, the students at the back may easily get distracted. Dividing a big class into groups, asking a second teacher to help in handling the students, and making the purposes of the trip clear to the class will bring possible distractions to a minimum.

C. Exhibits and displays:[1]

An exhibit is a collection of materials (usually three dimensional) arranged according to a deliberate plan to convey educational ideas. An exhibit is more artificial than a field trip as its materials are either taken away from their natural setting or they are mere pictorial or three-dimensional representations of the real thing. However, this artificiality has a great educational value when the exhibit is effectively utilized.

The exhibit and the field trip may be coupled when the students are taken in a field trip to see an exhibit or a public museum. Some professional exhibits like the annual International Damascus Fair, the "Atoms for Peace" exhibit that was held in Beirut in 1956, and similar national exhibits present very valuable scientific knowledge visualized in a spectacular manner. Sometimes very costly apparatus and equipment that cannot be otherwise seen by the students of science are displayed in such exhibits. Accordingly, well planned field trips to such displays should not be missed by the science teacher.

Commercial advertizers have accumulated a great deal of knowledge about the ways in which people react to what they see in an exhibit or a display. The audio-visual instruction field, has capitalized upon the results of these studies to 'advertize' and 'sell' educational ideas. Hence, display as a powerful new means of communication is of very great

---

1. Some of the information in this section are adapted and summarized from:
   a. Dale, op.cit., pp. 184-85.
   b. Marjorie East, Display for Learning, pp. 3-4.
   c. Saunders, op.cit., pp. 212-20.
   d. Haas and Packer, op.cit., p. 135.
   e. W. Wittich and C. Schuller, Audio-Visual Materials Their Nature and Use, pp. 167-69.

importance to the teaching of general science.

The science teacher needs to know the techniques of exhibiting and displaying to improve upon his methods of instruction in the classroom and in extra-curricular activities. In its simplest form, a display of a push-button electric motor or an induction coil placed in the show-window of the laboratory, will form a very motivating exhibit to introduce the subject of electromagnetism. A bulletin board exhibition of colourful photographs, newspaper clippings and hand drawn diagrams will make a good review for any physical or biological unit.

Without the knowledge in the skills of display, a school science museum may be a complete failure. The way in which the collected materials are displayed, are sometimes more important to an observer than the value of the materials themselves. Putting a radio-valve side by side with a bottled snake will make a very poor display. If these materials are further crowded with other objects in a dark corner of the room, the exhibit will become still less effective; if the museum itself is placed in a room where nobody is expected to see it or come near to it, then this will completely devitalize it. All these problems of lighting, labeling, housing of materials, and similar difficulties can be avoided by following the rules of exhibiting developed by the field of audio-visual education.

The 'science fairs' in which the school displays the scientific activities of its students to parents and visitors is an item of general science extra-curricular activities that completely depends upon the techniques of display. Nothing makes an exhibit more attractive and interesting than moving objects, flickering lights, unusual figures, brightly coloured materials, and experiments that involve the participation of the audience. These rules can also vitalize the 'science fair'; attend any parent's day and you will see the people crowded near displays of moving coils, of unusual human embryos, and experiments that ask the visitor to push a button or blow in a tube to find the capacity of his lungs.

Some Mediums for Improving School Displays:

The bulletin board:

The bulletin board is an audio-visual device for displaying to the learner a wealth of visual materials. The science teacher and his students can use the bulletin board for classroom or school exhibits. The bulletin board may display scientific announcements, bulletins, cartoons, charts, diagrams, maps, posters, newspaper clippings from scientific magazines, student drawings, graphs, pictures and photographs, lab. manuals and weekly quizes. Even three dimensional materials like booklets, models and specimens can be displayed. Because of its versatile nature, the bulletin board is of utmost importance in the science laboratory, as well as the science museum and yearly exhibits.

The electric board:

The electric board is a very effective teaching technique in vitalizing school exhibits because it requires the participation of the audience. A chart, a map, or a diagram showing its information by the help of electric lamps lighted by a dry cell is constructed. The visitor or learner is asked to push a button, and several small electric bulbs will light to show the distribution of coal or radium in a world map, the parts of a flower in a floral diagram, or the functions of the blood in a human chart. At times the electric board is used to test the audience by giving them multiple choice questions, the right answer to which will light a bulb.

<u>The felt board</u>:

The feltboard is an audio-visual aid that makes use of the fact that materials like wool, hair, and cotton felt or flannel will adhere to like surfaces. A felt or flannel board is thus a flat surface covered with a stretched piece of felt. Letters, words and other symbols cut out of felt or wool will stick on the surface of the board because of the adhering force of felt for felt.

The feltboard is an effective classroom aid as well as a valuable medium for exhibits. The science teacher can make his own felt cutouts of atoms, beakers and busen burners. This will make a very quick display of atomic structures and other scientific processes which can be collected and used again for as many times as required.

By sticking pieces of felt on the back of pictures, photographs and other flat materials, the feltboard can act as a very attractive bulletin board, and hence help in improving scientific exhibits. At times when felt is stretched over a sheet of iron, a feltboard can support materials made out of felt as well as three dimensional objects with small magnets stuck on them.

D. Objects, Specimens and Models:[1]

Objects, specimens and models are among the audio-visual aids that have become an important part of the science laboratory. These materials lend themselves so much to the teaching of general science - especially the biological side - that it has become very doubtful whether any effective science teaching can be achieved without them.

1. Objects

An object is the real thing itself; a frog, a thermometer, a fish, a motor-car are all examples of an object.

The field trip takes the class to the outside world to see the real thing but the object transfers the real thing into the classroom. If the field trip has the advantage of showing the thing in its natural setting, the object has the advantage of directly presenting the thing without unnecessary details and distractions.

Especially in the field of biology, the science teacher should not substitute the real organism itself by any vicarious audio-visual materials except for a very good reason. Excuses like "I don't like

---

1. Some of the ideas in this section are from:
   a. Heiss et al, op.cit., pp. 338-360.
   b. Hass and Packer, op.cit., pp. 141-150.
   c. Miller and Blaydes, op.cit., p. 99.
   d. Dale, op.cit., pp. 108-114.

creepy things like worms and insects", or "slimes, molds and frogs are filthy" are unacceptable. Such an undesirable attitude will be passed to the students. Usually children have great interest in keeping animals and this should encourage the science teacher to make cages and aquaria for housing larger animals even in the laboratory itself. Hundreds of interesting experiments will develop by themselves in such a rich teaching situation.

2. Specimens

A specimen is a sample, a fragment or a part of an object - for example the skin of a cow, a piece of rock or a branch of a tree.

Though the object is much more concrete and realistic than the specimen, it is not always possible or even desirable to use it. It will not be possible to bring a tiger or a llama into the classroom to study its hair; only a small piece of the skin will do. Similarly, it will be impractical to transfer a car to the laboratory if the desired results could be obtained by using the engine. It may be possible to buy a sheep for a classroom demonstration of the circulatory system, but

Fig. 4 It is impossible to bring a tiger into the classroom to study its hair (Adapted from Dale, op.cit., p. 318).

to purchase its heart and lungs only will be much cheaper and will not seriously handicap the lesson.

In all such cases, it is evident that a part of the object is more advantagous than the whole thing. If the limitation of the specimen is that it is less realistic, it has the advantages of being less expensive and of concentrating the attention of the class at the required part of the object.

3. Models

A model is a three-dimensional representation of an object. Usually it is either smaller or larger, include every detail or much more simplified than the real thing.

If the object is the real thing, the specimen a part of the real thing, and the model merely a wooden or metalic representation of the real thing, why then should a science teacher prefer the use of such an artificial aid as the model? The answer is that he should not use it if the object or the specimen is presentable, but in many instances, a model will be very much better than either the object or the specimen. The following examples will clarify these situations:

a. The object may be too large:

The classroom cannot accomodate an aeroplane, nor can a specimen of it be of value to a science teacher who wants to explain to his class how a place flies, but an exact model of the object will do the job successfully. At other times, the object may be so big that all the people of this world are living on it. In such a case, the working model of the earth - called the globe - will be an ideal visual aid. Even the sun and the moon can be brought down into the classroom with the earth to concretize the changes of seasons by the scaled-down model called a planetarium.

b. The object may be too small:

Flowers, cockroaches, flies and human internal organs could be easily seen and handled; but a detailed study of their internal structure will be very difficult without scaled-up models that increase their clarity by the use of techniques like texture and colour. Other objects like the amoeba, the cross-section of a leaf, and the uglena cannot be seen except by the help of a microscope. Enlarged solid and cut away models of similar animals and plants are definitely better than reality itself. Still further down, atoms and molecules are undetectable by even the most powerful microscopes, but coloured wooden balls that can be purchased at a low cost can make Dalton's atomic theory more meaningful and can visualize any organic or inorganic chemical formula. Even the structure of the atom itself with its electrons and protons can be made clear by enlarged models.

c. The object may be "unusable" or too complex:

Sometimes an object is neither too small nor too large to be presented to a class, but it teaches very little when it is examined as it appears. To show the structure of the human eye or brain, a model that can be taken apart will be more effective. If we are to get a thorough understanding of how a storage battery stores electric energy, a labelled cut away model of the battery will give more information than the object itself. A working model of a heart will reveal the concepts of the ventricles, auricles and heart beat, more than a real heart. Similarly, to understand how the steam engine or the internal combustion engine of a motor-car works, the real objects will be of very little value to a secondary school student, but a very much simplified working cutaway model or a mock-up will do the job easily.

d. The object may be too ancient:

A unit in biology dealing with pre-historic animals can be very much improved by models and dioaramas of cave men and ancient animals like the Dinosaur. Though the object and the specimen are more realistic, the model is in many instances a more effective aid. However, due to its artificiality, a model may give the student wrong concepts of size, texture, and colour, and may oversimplify the working of complex machinery. To make up for these limitations, the real thing should be presented with the model wherever possible.

Sources of Models are:

1. American Institute of steel construction, Inc., Dept. of Education Services, 101 Park Ave., New York 17, N.Y.

2. General Scientific Co. 1700 Irving Park Rd., Chicago 13.

3. New York Scientific Supply Co., Inc., 28W 30th St., New York 1, N.Y.

4. World's Natural Science Establishment, Inc., Rochester 9, P.O. Box 24, Beachwood Station, New York.

E. <u>The Motion Picture</u>:[1]

The motion picture is one of the most effective and spectacular audio-visual materials. Other than the direct audio-visual aids that bring the learner into contact with actual life situations, television and motion pictures are the only aids that show objects in motion. Bringing the cinema to the classroom has revolutionized the audio-visual field. The motion picture continued to gain popularity to the extent of overlooking the value of other materials.

The most extensive educational research work in the field of audio-visual instruction has been concerned with the value of the instructional sound motion picture. Some of the results of these studies are given below with the contributions of the motion picture in improving the teaching of general science:

1. <u>The motion picture compels attention</u>:

The motion picture compels attention because, by being in a darkened room, and brilliant white light coming only from one spot-the screen-most outside distractions are cut off. The motion picture also

---

1. Summary from:
   a. Dale, <u>op.cit.</u>, pp. 214-18.
   b. Mckown, <u>op.cit.</u>, pp. 148-53.
   c. DAVI Yearbook, <u>op.cit.</u>, p. 11.

provides an intense experience, sometimes of high emotional quality, at other times with the help of music, colour and narration.

2. The motion picture heightens reality:

The motion picture like most other audio-visual aids is an edited version of reality. Unnecessary details and distractions are ommitted to show the connection between different phenomena. This advantage is of great value to the teaching of general science. Complete processes which at normal times extend over periods of months, and which take place at different localities separated by hundreds of miles, can be presented in a ten minute film. Films like, "From Iron Ore to Pig Iron" (Eastman), "From Trees to Newspaper" (Eastman), "Cotton, from Seed to Cloth" (Eastman) and biological films about the life cycles of animals and plants are all good examples of this advantage of the motion picture. The film that traces cotton from the time it is planted till it gives its finished product of cloth will require months of study in real life situations.

3. The motion picture can control the time factor:

Many processes in industry or nature take place so slowly or so quickly that the human eye cannot detect them; but the motion picture camera can overcome this barrier of time to slow down the flight

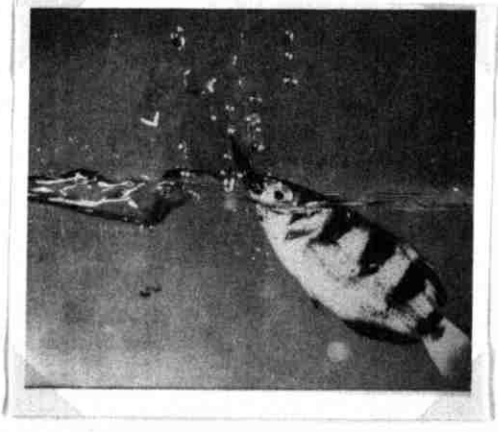


Fig. 5 (Reproduced from Dale, op.cit., p. 224)

of a humming bird so that the wings barely move on the screen, or to speed up the unfolding of a leaf.

The illusion of slow motion is achieved by high-speed photography. This phenomenon can show the student of general science how insects carry pollen grains from the anthers to the stigma of a flower, how projectiles come out of guns, or how the vibrations of the human vocal chords produce sound. Figure five shows how this technique is utilized to clarify how an archerfish gets its food by "spitting its insect prey down".

In time-lapse photography, the motion picture camera which usually operates at a speed of 24 frames per second, is made to move only one frame every twenty or thirty minutes, and then the finished film is run in the projector at the normal speed of 24 frames per second. By so doing the experiments of botany that need days and weeks to perform will be shown in a few seconds. The class can see opening buds, plants growing quickly towards the sun light, and roots moving away from it.

4. <u>The motion picture can be used to present processes that cannot be seen by the human eye</u>:

Through animated drawing, the motion picture has given one of the greatest contributions of audio-visual aids to the teaching of general science. Taking a class on a field trip to a refinery will show them nothing

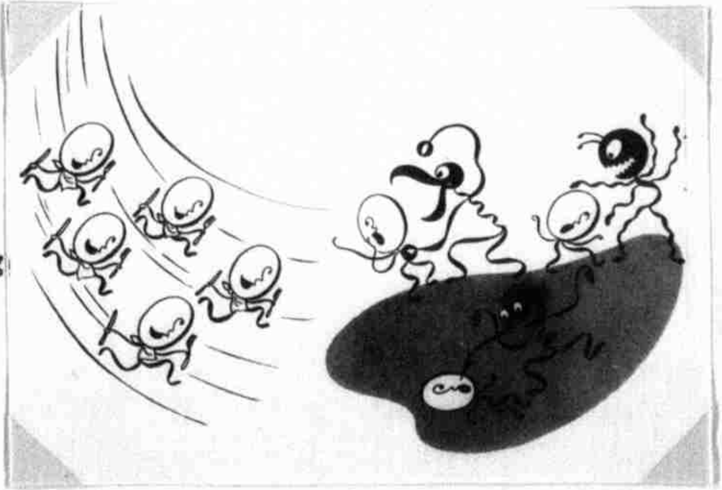


Fig. 6

more than pipes and huge tanks, but by the help of animation, the student can see exactly what processes and reactions take place in each tank or boiler. Through animated drawings even very highly abstract concepts such as sound waves, the exchange of the molecules of carbon dioxide and oxygen in blood circulation, and the flow of electrons through a wire can easily be demonstrated. The use of comic figures and actions of cartoon figures in scientific instructional films adds to the value of this teaching aid. Figures six and seven are taken from, "The Story of Blood," an animated drawing film produced by the American National Red Cross. The figures show how white blood corpuscles fight the "invading" bacteria by "eating" them.

Fig. 7

5. The motion picture can enlarge or reduce the actual size of an object:

By the close-up technique, objects which are visible to the naked eye can be very much enlarged. The lens of the motion picture camera can be brought so near to an object that the whole screen can be filled with a tiny mosquito injecting the germs of malaria into the blood stream of a victim. Attaching a microscopic lens to the camera will increase the size of a one celled animal or plant to two or three feet in height. The class can then see cells divide and follow the life cycles of protozoons.

Sometimes the object to be visualized by a film is too large to be photographed. In this case the technique of miniature photography that usually combines the advantages of the model and the motion picture is applied. Scaled down models of mountains and rivers are constructed in the laboratory so that the finished film will show the audience the work of erosion and other physical processes of running river waters that may take place in hundreds of years.

6. <u>The motion picture can influence attitudes</u>:

Though this item is not directly concerned with the advantages of the film for improving the learning of general science, it is one of the most important contributions of the motion picture that makes it unique. This advantage can be a virtue as well as a danger of the motion picture depending upon what attitudes it builds. Because the concomitant learnings are at times even more important than the subject matter itself, the science teacher should try to use the motion picture to develop the healthy attitudes that usually arise with the teaching of general science.

<u>Some of the limitations of the motion picture are</u>:

1. <u>Cost</u>

The motion picture projector is a relatively costly piece of equipment; but the film is the most expensive of all visual materials in its initial cost. Even with the best of care the motion picture films will only last for a few years.

2. <u>Administrative difficulties</u>

When the school does not have its own library of science films, the problem of asking for the film in advance from a central library, its distribution to the school's administration, and its availability in class at the time scheduled may create much trouble.

3. <u>Possible misinterpretations</u>:

Because of its attention-compeling nature, the motion picture may be misinterpreted by the students. At times the instructor may look at it as a form of entertainment or a time-filling device. The students may get wrong concepts of time and size from films. The science teacher should make sure that telescoping processes of a few years into a few minutes, time-lapse photography, the illusion of slow motion and blowing a microscopic animal to the size of a giant should not result in incorrect concepts of time and size.

<u>Some sources of motion picture films are</u>:

1. American Petroleum Institute, 50 W. 50th St., New York 17, N.Y.

2. Council on Atomic Implications, Inc. Box 296, University of Southern California, Los Angeles 7.

3. Encyclopedia Britanica Films, Inc., 1150 Willmette Ave., Willmette I ll.

4. General Electric Company, Visual Education Division, 1 River Rd., Schenoctady 5, N.Y.

5. McGraw-Hill Book Co., Inc., Text Film Dept., 330 W. 42nd St., New York 36, N.Y.

6. Scientific Film Co., 6804 Windsor Ave., Berwyn 1, I 11.

7. Young America Films, Inc., 18E 41st St., New York 17, N.Y.

Some sources of motion picture projectors are:

1. Eastman Kodak Co., Dept. 8-V, Rochester 4, N.Y.

2. Educational Services, Dept. Q-31 Radio Corporation of America, Camden, N.J.

3. Technical Service, Inc., 30865 Five Mile Road, Livonia, Michigan.

4. Bell and Howell, 7117 McCormick Road, Chicago 45, Illinois.

F. Projected Still Pictures

1. Filmstrips and 2" x 2" slides:

A filmstrip is a related sequence of transparent still pictures or frames (typically from 20 to 50 frames) on a 35 mm. film. A filmstrip may be in colour or black and white, animated drawing, photographs, or a combination of both; sound or silent, and single or double-frame. A double frame filmstrip, or even at times a single frame, can be cut into individual pictures or frames. If these frames are placed between two plane glasses with the standard size of 2" x 2", they are called 2" x 2" slides. Filmstrip projectors can be adapted to project single and double frame strips as well as 2" x 2" slides.

Narration, music or sound effects in a sound filmstrip are produced by a disk recording which is played during projection. A faint bell-ring or click may tell the projectionist when to change a frame. Sound filmstrips are very valuable in conveying scientific technical or industrial information.

Silent 2" x 2" slides or filmstrips are usually accompanied by explanatory captions printed on the picture itself or in the teacher's manual. It has been found that when the "sound" is produced by reading these captions loudly in class, the strip or the slide becomes at times even more effective than the sound filmstrip, because it is adapted to the speed required.

Filmstrips and slides are excellent aids in teaching science. They may be even more effective than the motion picture itself when detailed studies and discussions are required, since a particular frame can be projected on the screen for as long as necessary. Many companies now produce single frame filmstrips keyed with science textbooks. Examples of photographs and animated drawing frames of scientific filmstrips and slides are shown on page 49 and page 50 respectively.

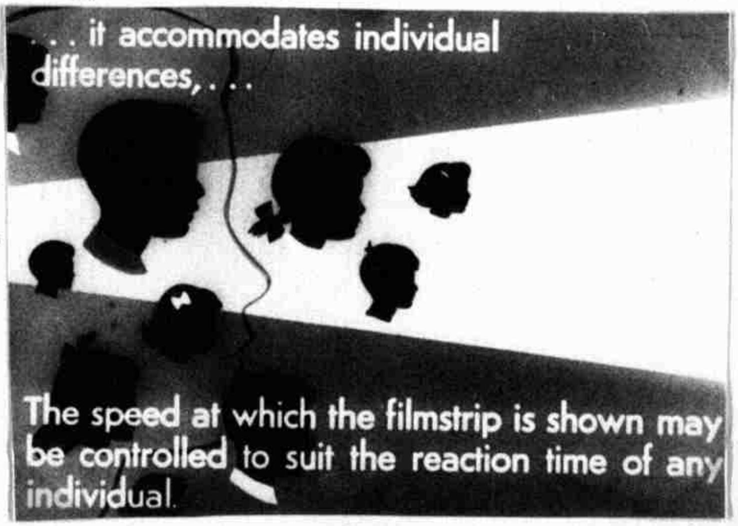


Fig. 8

Some advantages of filmstrips and 2" x 2" slides[1]

1. They can be photographed by any 35 mm. camera.

2. They can be easily filed and stored.

3. Projection of slides and filmstrips is very easy, and their projectors are light weight, compact and relatively inexpensive.

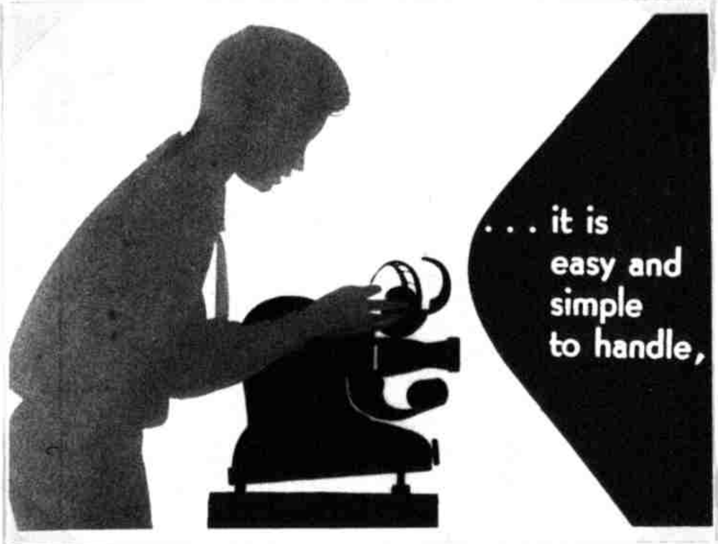


Fig. 9

4. By adapting the speed of projection to the needs of the class, filmstrips and 2" x 2" slides can compensate for individual differences and facilitate student participation.

5. Filmstrips and slides are inexpensive.

Some limitations of filmstrips and 2" x 2" slides

1. They are a still motionless media.

2. Filmstrips are in rigid order, they can be easily damaged, and are difficult to repair. These limitations

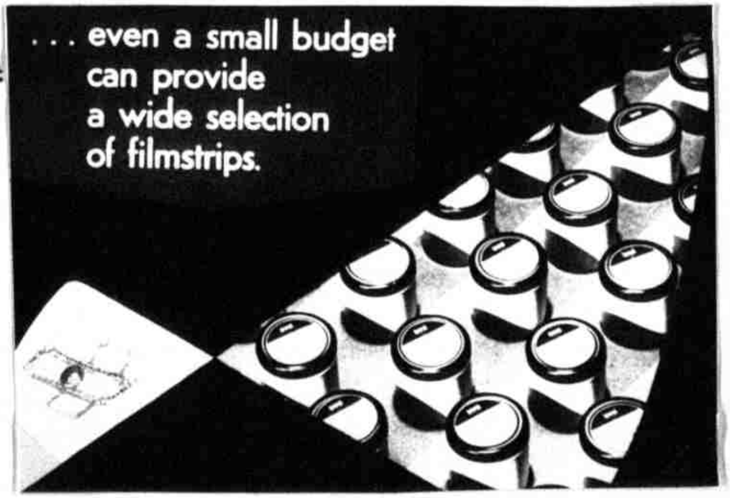


Fig. 10

1. The illustrations in Figures 8, 9 and 10 are taken from the filmstrip Enriching the Curriculum with Filmstrips produced by the Society for Visual Education, Chicago.

could be avoided by cutting the strip into slides.

3. Compared to filmstrips, 2" x 2" slides are more expensive and more difficult to store.

Sources of filmstrips and 2" x 2" slides

1. The General Scientific Co., 1700 Irving Park Rd., Chicago 13.

2. Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago 40.

3. International Screen Organization, 609 Philadelphia Avenue, Washington 12, D.C.

4. Society for Visual Education, Inc., 1345 Diversey Parkway, Chicago 14, Illinois.

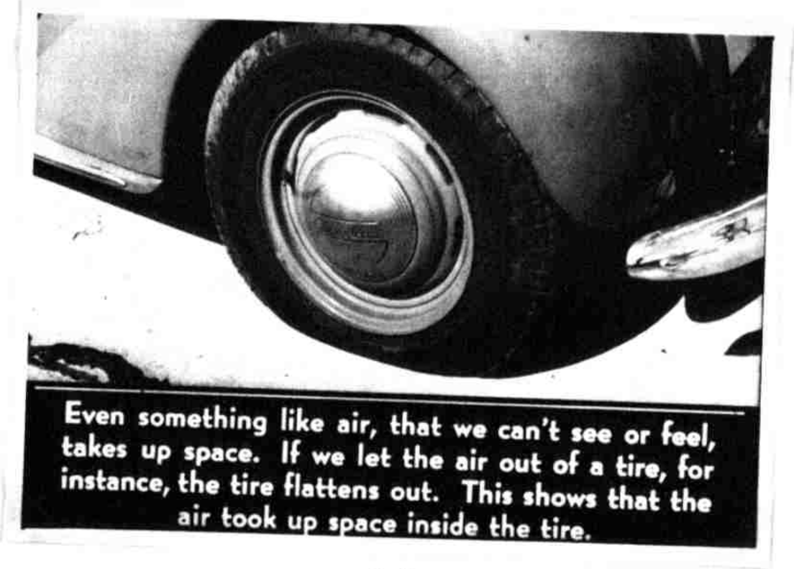
5. Young America Filmstrips, Inc. 18 East 41st Street, New York 17, N.Y.

Lantern Slides:[1]

Lantern slides were the first projected materials used for educational purposes. After the new developments in the audio-visual field, lantern slides were beginning to lose much of their popularity because of their heavy and bulky projectors and the difficulty of storing their glass slides when compared with the newly developed filmstrips and 2" x 2" slides. But due to their effective and unique characteristics, lantern slides have been regaining popularity during the last few years. New, lighter, and more protable projectors were invented and better photographic slides prepared.

---

1. Adapted from: Richardson and Cahoon, op.cit., pp. 85-94.



(A)

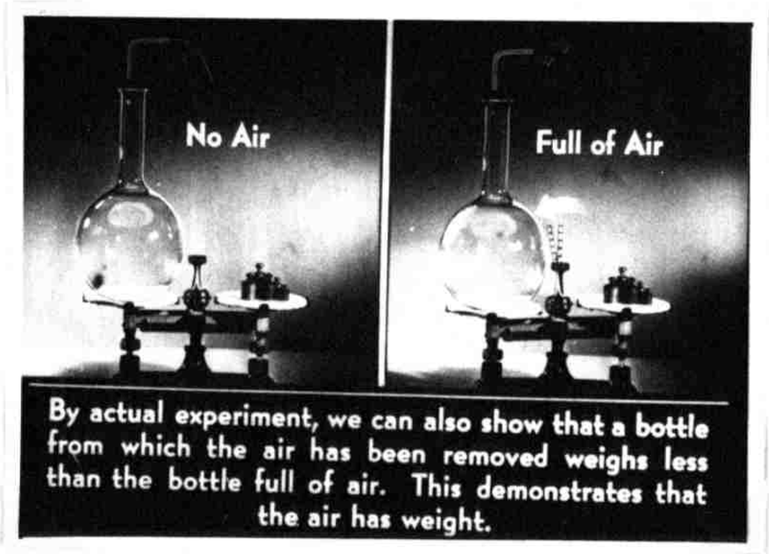
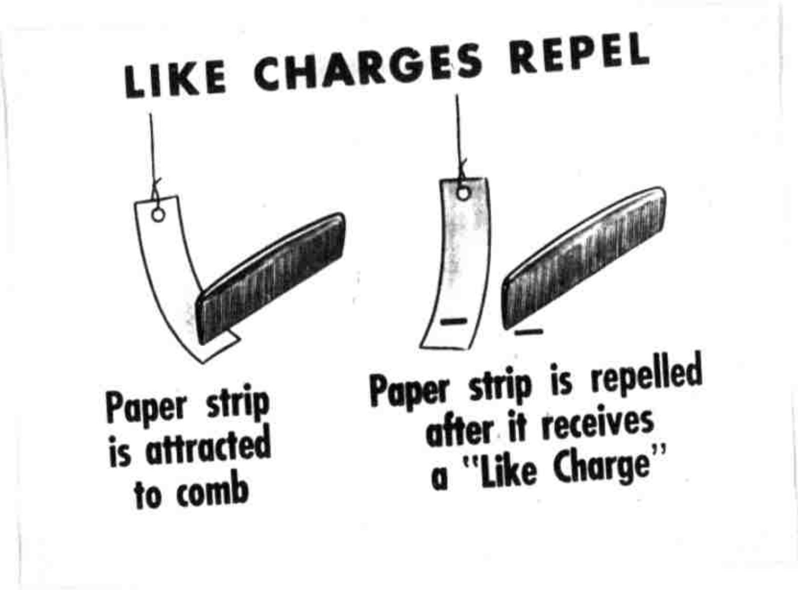


Fig. 11 (Reproduced from the filmstrip General Properties of Matter, produced by Jam Handy Organization).



(A)

(B)

Fig. 12 (Reproduced from the filmstrip Electronics an Old Science with a New Dimension, produced by the Radio Corporation of America).

Many of the advantages of the $3\frac{1}{4}$" x 4" lantern slides are still overlooked by science teachers. These aids commend themselves to science teaching because of the wealth and variety of materials they provide. Commercially produced lantern slides are found in abundance. When the problem to be visualized by the science teacher is not found in any filmstrip, 2" x 2" slide or any other instructional projected material, the hand-made lantern slide will prove advantageous in science teaching. Pencils, India inks, slide crayons or slide inks applied to etched or gelatin coated glass will produce wonderful coloured slides. Silhouettes, typewritten cellophane and transluscent paper slides can all produce charts and diagrams in a few minutes.

Other than projecting ready-made and hand-made lantern slides, an overhead or a horizontal lantern slide projector can be used by the science teacher to project onto the screen experiments involving transparent, transluscent and even opaque objects. By placing a glass dish containing steel ball bearings on an overhead lantern slide projector, and agitating them in a rotary fashion, the kinetic theory of molecules can be visualized by watching the shadow images of these balls on the screen. Similarly magnetic fields can be demonstrated to the whole class by the use of iron filings. Other transparent and transluscent experiments involving chemical reactions or physical phenomena like surface tension and capilearity can easily be projected by a horizontal or an overhead projector.

<u>Accordingly the advantages of lantern slides are</u>:

1. They can adapt existing study to the needs of the students.

2. They can produce chalkboard outlines quickly.

3. The projection equipment is easy to manipulate, and the slide can be kept on the screen as long as required.

4. They can be easily made even by students.

5. The etched or plane glass used can be washed and re-used.

6. They are inexpensive. Coloured hand made lantern slides are probably the least expensive coloured slides.

7. Due to their large size, they can produce very well focused images on the screen.

8. Especially valuable for detailed matter like maps or fine biological drawings.

<u>Some limitations of the lantern slides are</u>:

1. The glass slides are breakable.

2. Lantern slide projectors are not always available.

3. Compared with filmstrips, lantern slides are more difficult to store and file, because they are bigger and heavier.

<u>Sources of lantern slides</u>:

1. Keystone View Co., Meadville, Pa.

2. Radio - MAT Slide Co., Dept. V, 222 Oakbridge Blvd., Daytona Beach, Fla.

Overhead Projection:[1]

One of the most valuable recent developments in the field of audio-visual education is the overhead transparency projector. Other than the advantages of the overhead projector in projecting scientific experiments, already discussed in the section about lantern slides, the field of overhead projection has other significant advantages to science teaching. Modern overhead projectors have a projection area of up to 10" x 10". Accordingly, to produce an appreciably large image on the screen, the projector can be placed in front of the room. While facing his students, the science teacher can draw, write or point to the transparency, and the material is projected onto the screen as he does so. The transparencies are cellophane, carbon or plastic sheets and tracing on them is done by a China wax marking pencil. Shades are used to project slides or other transparencies less than 10" x 10" in size.

Hence the advantages of overhead projection are:

1. By standing in front of the class during projection, the science teacher can maintain direct communication at all times.

2. Due to its large projection area, and its intense illumination, the overhead projector can produce brilliant images even when only little darkening of the room is possible. This advantage enables the science students to take notes during projection.

---

1. Abridged from:
 a. Wittich and Schuller, op.cit., pp. 348-354.
 b. Richardson and Cahoon, op.cit., pp. 86-106.

3. The projection transparency is very inexpensive. A one hundred foot cellophane roll will produce more than one hundred diagrams or charts which can be rolled in the projector.

4. Its projection is very simple. If the focusing is correct, nothing more than placing the transparency on the stage, as one would read it, is required. Pointing at any subject of interest on the transparency can be done even by one's finger.

Some sources of overhead projectors are:

1. Viewlex, Incorporated, 35-01 Queens Blvd., Long Island City, N.Y.
2. American Optical Co., Projector Div., Chelsea 50, Mass.

Opaque Projection:[1]

The opaque projector puts enlarged images of opaque materials on a screen. It is one of the most potentially useful pieces of equipment in science teaching. Flat materials like book illustrations, charts, diagrams, student's work, newspapers and magazine clippings, photographs and laboratory manuals can easily be projected by merely placing them on the stage. Even objects and specimens, small electric instruments, chemicals and nearly anything within the areas of $8\frac{1}{2}$" x 11" can be used in an opaque projector.

Chemical reactions involving change of colour will give very effective results in opaque projection. For example the fractional

---

1. Some of the ideas in this part are taken from:
   a. Richardson and Cahoon, pp. 102-106.
   b. Wittich and Schuller, op.cit., pp. 348-350.

precipitation of white silver chloride and red silver chromate. By adding silver nitrate solution to a mixture of dilute solutions of potassium chloride and potassium chromate, first the white precipitate silver chloride is seen first and then, when more silver nitrate is added, the whole screen is changed to the red colour of silver chromate. Putting some of the freshly precipitated silver chloride on a filter paper and placing it inside the opaque projector, will show the effect of light on the white precipitate as the surface of the filter paper darkens.

To get the best results out of opaque projection, first the material should be as flat as possible and second the background should make a good contrast with it. Hence chemical reactions can best be visualized when placed in shallow dishes. Dark materials like green leaves can best be shown by putting a white paper or a mirror under them.

Another advantage of the opaque projector is that it can be used in drawing charts, diagrams or maps on the chalkboard or on paper. A diagram from a book can be placed in the opaque projector, and the image, which is focused on a chalkboard or on paper, can be traced by chalk or a pencil.

The disadvantage of the opaque projector is that, of all projected audio-visual aids, it requires the darkest room. Another limitation is that the projector is bulky, heavy and expensive.

<u>Sources of opaque projectors</u>:

1. Projection Optics Co., Inc., 330 Lyell Ave., Rochester 6, N.Y.
2. Squibb-Taylor, Inc., Dallas, Texas.

Microprojection:[1]

By the technique of microprojection, microscopic slides and other similar materials are intensely illuminated to form images large enough to be seen by all the students. The microprojector utilizes the lens system of the microscope, to project on a screen an image of two or more feet in diameter depending upon the intensity of the light used. Anything that can be viewed under the microscope by transmitted light, may be microprojected. Hence, all biological slides of animal and plant tissue and the usual mounted slides of living culture can be used. In the field of physical and chemical sciences, the microprojector is utilized to show crystals of different chemical compounds, cotton, woolen and silk fibers, and physical phenomena like the Brownian movement and the Tyndal effect in colloidal solutions.

The advantages of the microprojector are:

1. It brings the problem of buying expensive microscopes to every individual in the class to a minimum. Figure 13 taken from the filmstrip The Demonstration as a Teaching Technique, produced by Wayne University, gives an approximate comparison between the price of purchasing individual microscopes for every student and the price of a microprojector.

2. It gives a greatly enlarged picture of the microscopic object projected.

---

1. Condensed from:
   a. Richardson and Cahoon, op.cit., pp. 107-110.
   b. Wittich and Schuller, op.cit., pp. 354-55.
   c. McKown and Roberts, op.cit., pp. 316-17.

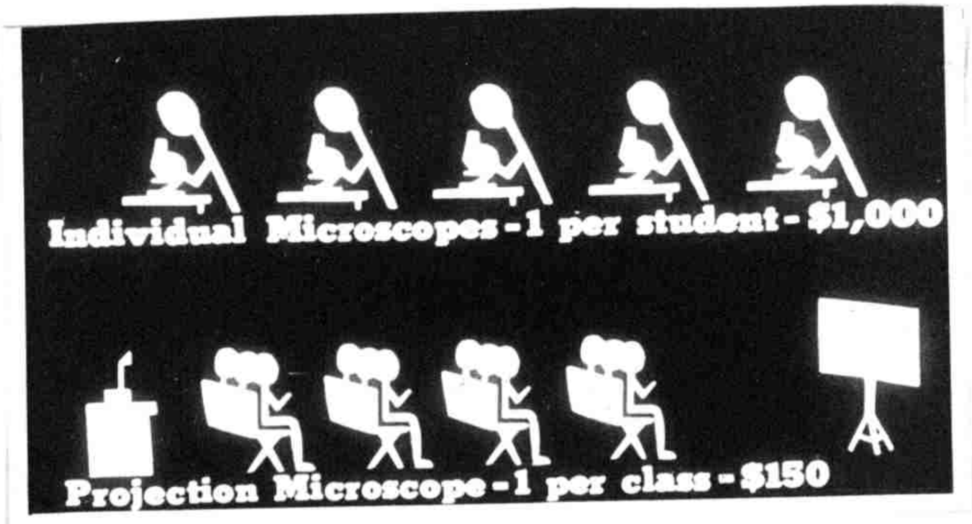


Fig. 13

3. It serves to centre the attention and interest of the whole class on the point studied.

4. The science teacher is sure that his students see what he sees. This item is of very great importance because it is difficult to achieve even when individual microscopes are given to every student; this is especially true when fast moving protozoa are to be studied.

5. Every student is given ample time to view the microprojected material. This is not possible when other students are awaiting their turn while he is using a microscope.

<u>Limitations of the microprojector</u>:

1. The size of the image microprojected depends upon the intensity of the light; in many instances, a large class is forced to watch a very

small image, since increasing the size of the image will decrease its optimum brightness. This limitation is at times solved by taking coloured 2" x 2" slides of microscopic materials and projecting them by a slide projector; but again this technique will be of little use when materials in motion are to be microprojected.

2. Another limitation is that, due to the ease of teaching with the microprojector, the students are at times deprived from their right in learning how to utilize the microscope.

Sources of microprojectors:

1. Bausch and Lomb Optical Co., 80122 St. Paul St., Rochester 2, N.Y.

2. American Optical Co., Projector Div., Chelsea 50, Mass.

G. Flat Unprojected Still Picture:[1]

Flat pictures and photographs speak a common language. Ever since the days of Comenius's Orbis Sensualium Pictus, the value of this common language to education has been established. Photographs and illustrations, due to their concrete appeal, arouse great interest in the learner. Before beginning to read a book, the young student begins by looking over the photographs and illustrations in it, because unillustrated pages of solid text are most discouraging to the learner. This fact has urged

1. Adapted from:
   a. McKown and Roberts, op.cit., pp. 109-112.
   b. Wittich and Schuller, op.cit., pp. 73-88.

textbook writers to increase the quantity and quality of their textbook illustrations. Photographs are no more thrown in textbooks to decorate or embelish them. They are excellent materials that clarify the meaning of new devices and ideas.

Flat pictures can be of great help to the science teacher. They are very inexpensive and they can be shown to the whole class or individually. They can save the teacher the problem of darkening and projection and hence they can be shown at the psychological moment. However, if darkening is possible, the opaque projector may be used. In fact, adding captions to still photographs explaining some scientific concepts, and projecting them by the opaque projector may be as valuable as a filmstrip, since a filmstrip is made by making positive transparencies of such photographs.

When using the still picture, the science teacher should remember its limitations to avoid possible misconceptions. The flat picture is two dimensional, and they are not always true in size or colour.

H. Graphics:[1]

Graphic materials like posters, maps, charts, diagrams, and cartoons are visual symbols which communicate ideas and facts clearly and forcibly through a combination of drawings, words and pictures.[2] Different

---

1. Some of the ideas in this division are shortened from:
   a. Wittich and Schuller, pp. 108-145.
   b. Richardson and Cahoon, op.cit., pp. 112-116.
   c. Dale, op.cit., pp. 316-335 and p. 91.
   d. Heiss, op.cit., pp. 361-370.
   e. Saunders, op.cit., pp. 207-209.
2. Modified from a definition by Wittich and Schuller, op.cit., p. 108.

graphic materials differ in their degree of concreteness and hence their educational functions; however, their chief value lies in the fact that they can attract attention and convey information in a condensed form.

The poster:

A poster is a dynamic medium that has a purely motivational function in catching immediately the eye of the passer by, holding his attention, and impressing on him an idea, a fact or a story. Accordingly the poster must have one simple idea that should be put across directly, boldly, and with the help of colour and design. Advertising billboards, in store display and travel pictures are all good examples of the poster.

The poster can be an effective visual aid in teaching science especially when the student project method is used. Posters dealing with astronomy, animal biology, clothing, diets, foods, health and safety are easily made. The teacher may need to display some posters in the laboratory to emphasize some key points and captions such as "Don't pour water over concentrated sulphuric acid" or "Don't look at heated test-tubes and beakers from above".

The map:

Although maps and globes have been monopolized by history and geography for a long time, the modern teaching of general science has necessitated their importance as general science aids as well. Maps showing the distribution of economic and industrial resources, the arteries of communication and transportation, the types of products of science and industry and maps showing climatic and regional conditions are all very essential visual aids to physical and biological sciences.

The chart:

The main function of the chart is to summarize, compare and contrast subject matter. Hence, contrary to the poster, the chart is a medium of close and detailed study. There are many types of charts, but those that lend themselves most to science teaching are the flow or organization and charts, the tree and tabular charts.

The tree chart is used most in the field of genetics to compare the effect of dominant, recessive and lethal genes in human and animal families. In fact another name for the tree chart is the genealogy chart. In classroom situations, crossing white and black rabbits, drosophila flies, or red and white roses will make a good application of the tree chart.

Flow charts are very valuable in teaching physical and chemical sciences. Industrial processes like the refining of crude oil, the change of iron ore to steel or the Chamber process in chemistry can all be nicely concretized by the help of an organization chart visualized by pictures and visual symbols.

The tabular chart is probably the most utilized in all fields of education. A good illustration of its use in general science teaching is the periodic table of atoms.

The diagram

The diagram is a graphic material which is made up of lines and geometric forms. In every high-school laboratory, diagrams of electric circuits, of different apparatus used in the lab., of cross-sections of leaves and roots, of reflecting mirrors and refracting lenses are seen and drawn every day from chalkboards, from science textbooks, from commercially made diagrams or from actual apparatus. The diagram is one of the most abstract graphic materials, but the teaching of general science would have been very difficult without its help.

The graph

Graphs are visual forms of numerical data. They present highly abstract numerical calculations in concrete and interesting representations. Hence they are very valuable in the analysis, comparison and interpretation of data. There are many types of graphs which vary in their degree of accuracy. The line graphs are most abstract, the bar and pie graphs more concrete, and the pictograms or pictorial graphs the most interesting of all.

Graphs find many applications in physical and biological sciences. All physical and natural phenomena showing periodic or regular variations commend themselves to graphic representations. For example the average monthly or annual rainfall or temperatures and other weather records, the declination of the sun and the moon, and the repetitive influence of seasons can all form valuable graphs that require a good deal of student observation. Many classroom experiments in heat, mechanics and botany can best be illustrated by graphs.

The Cartoon and Comic Strips:

The cartoon is a graphic illustration emphasizing or dramatizing a fact by the help of fantasy, satire, or humor. In comic strips, the same characters are used in a series of cartoons to tell an interesting story. Cartoons and comics are very popular forms of visual aids. Witty and Sizemore[1] estimate that there are over 100,000,000 comic strip readers in the United States and that some 95,000,000 copies of comics are sold every month.

Fig. 14

1. Paul A. Witty and Robert A. Sizemore, "Reading the Comics: A Summary of Studies and Evaluation", Elementary English, p. 502. As quoted by: Wittich and Schuller, op.cit., p. 139.

Because of its universal appeal, the cartoon can be very effective in teaching certain phases of science. Some comic strip makers and industrial companies like the General Elective have produced excellent comics containing valuable scientific information. An example of a science cartoon is shown in Fig. 14. It is reproduced from the filmstrip General Properties of Matter which is produced by the Jam Handy Organization.

The Chalkboard:[1]

The chalkboard is the commonest of all audio-visual aids. As a matter of fact it has become so commonplace in classroom teaching, that it is difficult to think of its advantage as an audio-visual material. The chalkboard can be a very effective visual aid if properly utilized. The following advantages are only some of its contributions to science teaching:

1. It allows for quick change and reorganization of materials drawn or written.

2. It is an excellent medium for demonstrations and illustrations. Without the help of the chalkboard it is doubtful whether any effective science demonstration will be successful. The teacher needs to put his outline and key points on the board before beginning the demonstration lesson. Small models and objects should be coupled by large coloured

---

1. Condensed from:
   a. East, op.cit., pp. 199-207.
   b. Wittich and Schuller, op.cit., pp. 58-61.
   c. Saunders, op.cit., p. 203.
   d. Wayne University Filmstrips, Making Your Chalk Talk (A filmstrip).
   e. Young America Films, Chalkboard Utilization (A film).

chalkboard diagrams so that even the students at the rear of room can follow the demonstration.

3. It is available in every class.

4. It is inexpensive and easy to make when compared with other audio-visual aids.

5. It can serve as a good medium for group projects; for example in planning a scientific field trip by the teacher and his students.

6. It can be used for student motivation.

7. All audio-visual materials can be followed by the chalkboard. For instance, after seeing a scientific film, a science teacher will automatically find himself going to the board to explain some of the problems and points of interest asked by the class.

8. It can be a medium for evaluating the work of the students.

Some of the limitations of the chalkboard are:

1. When viewed from sharp angles, the problem of glares will hinder the student from seeing the materials on the board.

2. When the drawings are done during the class session much time will be wasted. The science teacher can avoid this limitation by preparing his drawings beforehand.

3. The chalkboard is less motivating than other audio-visual aids.

4. It is a two dimensioned material.

Modern trends in improving chalkboard utilization:

Audio-visual education has offered two important contributions in improving chalkboard utilization. First, an effective set of rules and techniques for bettering the utilization of the chalkboard were developed. Some of these techniques will be discussed in Chapter Five. Secondly, after a good deal of research, new chalkboards that eliminated most of the traditional limitations of the chalkboard were invented.

Research has proved that black chalkboards absorb much light, and they do not reflect much of it to facilitate reading. White and green will give a much better contrast which is more easy on the eye. Hence, white, green and yellow chalkboards have replaced the old blackboard. Glare, which is a traditional limitation of the chalkboards, was overcome by modern satin-surfaced, glass, plastic or enamelled glareproof chalkboards.

To make the chalkboard a three dimensional teaching aid, modern chalkboards may have a sheet of soft iron or steel fixed at their backs. Ready-made colourful arrows and other objects, with little magnets fixed on them will stick on the surface of the board. These magnetized objects can be used to support a chart, a photograph or a diagram on the board, thus, other than making chalkboard teaching more visual, colourful and three dimensional, the board can serve as a three dimensional bulletin board as well. These magnetized chalkboards can offer the science teacher a wealth of three dimensional materials that will concretize highly abstract ideas in physical and chemical sciences. Figure 15 reproduced from Wittich and Schuller[1] shows a teacher utilizing a magnetic chalkboard.

---

1. Wittich and Schuller, op.cit., p. 61.

Sources of chalkboards and chalkboard instruments:

1. New York Standard Blackboard Co., Inc., 144 W. 18 St., New York 11, N.Y.

2. Teaching Materials Service, 914 North Ave., Beloit, Wis.

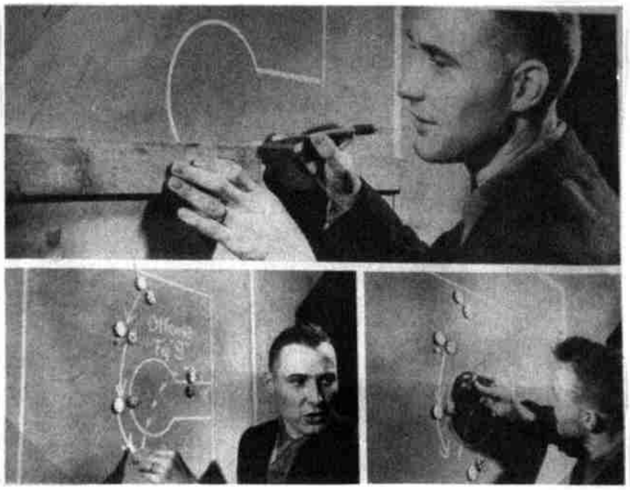


Fig. 15

Summary:

Modern audio-visual aids can help in making classroom teaching and extra-curricular activities of general science more effective and interesting. Audio-visual aids can help to vitalize and improve scientific teaching methods like the lab., the demonstration, and even the lecture method by the wealth of the direct and vicarious materials they provide.

The more realistic the learning situation is the better it will be; but at times audio-visual aids can make science teaching more effective than life itself. The motion picture can control the time factor and use animation to explain processes that cannot be seen by the human eye, and the mock-up or working model can reduce distracting details to give the learner an understanding of a motor-car engine that will not be acquired even by studying the real engine itself.

Chapter One has shown the value of audio-visual instruction from a psychological, a historical and a philosophical point of view, and has indicated its advantages to education as a whole. By taking these contributions of the last chapter as a general base, this chapter has made an attempt to show the importance of audio-visual aids to the teaching of general science in the modern classroom.

CHAPTER III

AN INVENTORY OF THE UNDERSTANDING AND UTILIZATION OF AUDIO-VISUAL AIDS TO SCIENCE TEACHING IN SUDANESE SECONDARY SCHOOLS

Introduction

It has been seen that audio-visual aids can offer a variety of effective tools that can improve the teaching of general science. To what extent these aids are utilized and appreciated in Sudanese secondary science education is the problem of this chapter.

The study begins with a quick survey of audio-visual aids to science teaching in the elementary and intermediate schools. The Sudanese educational ladder is composed of three stages or steps, each four years in length. It begins with the elementary level from the first to the fourth grade , the intermediate from the fifth to the eighth and the secondary stage from the ninth to the twelfth grade. Other than the yearly and half-yearly school tests, students are promoted from one stage to the next by centralized competitive state examinations given at the end of the fourth, the eighth and the twelfth grades, after which the successful candidates are eligible for entrance to the University of Khartoum.

It is not irrelevant to refer to the first eight grades of Sudanese education in a thesis about the secondary school, because first the interests and habits developed at this early stage will remain with the pupil as he proceeds to the secondary school, and secondly, the problem of the science curriculum in this long period of elementary and intermediate education has very much affected, and will continue to affect the teaching of general science in the secondary level.

The following sections of the chapter are devoted to a detailed study of audio-visual aids to science teaching in the secondary schools of the Sudan. After a survey of the teacher's understanding and appreciation of audio-visual aids to science teaching, a general study evaluating the various secondary schools in terms of their use to audio-visual aids to science teaching is given. Then a detailed survey of audio-visual materials and equipment used and how they are utilized and stored is presented, and the chapter is concluded with a discussion about the use of audio-visual aids in scientific extra curricular activities.

This part of the study is distilled from a variety of sources; the following are the most important:

1. Questionnaires and Interviews.

a) Questionnaires[1] for teachers and principals developed by the Audio-Visual Centre of the American University of Beirut to survey the utilization of audio-visual aids in secondary schools were used as guides for interviewing science teachers and principals of a number of government

---

1. See Appendix A.

and private Sudanese secondary schools. It was found that such guided interviews are more efficient than merely sending the questionnaires to the Sudan, first because the teachers and principals know very little of audio-visual education, and they need explanations before they can understand the questions, and; secondly because these questionnaires were primarily made for Lebanese secondary schools and hence they need some adaptations, and; thirdly because by actual interviews one can make sure to collect the information required. No answers were received from some of the questionnaires sent to the Sudan in November 1957. The knowledge acquired from these questionnaires was concretized by actual visits to secondary school laboratories and the attendance in science classes.

b) Information was collected from interviews and specially constructed questionnaires for government administrators and advisors working in science education, like Ahmed Saad the Chief Science Inspector of Sudanese Secondary Schools; Mutwakil Amin, the Head of the Sudanese State Examination Council; Nasr El Haj Ali, the Director of Education and Johnson, the Head of Science Education in the Institute of Education of Bakht-er-Ruda. These questionnaires are found in Appendix B.

2. Books and Pamphlets

a) An important reference is the Report of the International Commission appointed by the Sudan Government to appraise and comment on secondary education. The members of this committee, for example Saiyidain, the Additional Secretary of the Indian Ministry of Education; Morris, the Vice-Chancellor of the University of Leeds; Mohammed Farid Abu Hadid, the Educational Advisor of the Egyptian Ministry of Education (at the time in which the committee met); Abdel Aziz Elsaid, the President of the University of Cairo (Khartoum branch), and; Wilsher, the Principal of the University of Khartoum, are all distinguished educators. They met from January 15th, 1955 to February 28th. Much of what they have written about audio-visual aids and science teaching is still up-to-date.

b) Some of the pamphlets, magazines and yearbooks prepared by the Institute of Education of Bakht-er-Ruda and the Sudanese Education Ministry have also been used especially as references to the section about audio-visual aids to science teaching in the elementary and intermediate schools.

Though this chapter is supposed to analyze the problem without giving suggestions for a remedy, (as this task is left for chapters four and five), at times some recommendations are offered when it is felt that the context of the discussion is most suitable for them.

A Survey of Audio-Visual Aids to Science Teaching in the Intermediate and Elementary Schools

Education in the Sudanese elementary and intermediate schools is generally highly verbal. Though the young learner needs a good deal of audio-visual aids to enrich his limited experiences before abstract information is presented to him, the poor elementary and intermediate school pupils suffer from learning an enormous quantity of knowledge by heart without understanding what it means.

A typical class in an elementary or intermediate school will be in a room crowded with forty or fifty children seated in heavy long benches that can at times accommodate up to seven children per bench. The only visual aid, which is very much misused, is a blackboard constructed from plywood or is simply a black wallboard made by applying black paint to a cemented portion of the wall facing the class. These wallboards usually suffer from cracks and loss of colour. In front of the class there is a high platform on which the teacher stands to give his lecture. The only 'visual aid' which the teacher usually takes with him to class is the whip; an important aid in killing any form of socialized class procedures.

Usually the class session begins by a set of detailed oral questions asked by the teacher to make sure that the boys have mastered the information given in the last class period. The good hard working pupil is the one who gives a mechanical parrot-like recitation of the facts dictated. Those who cannot stand learning their drab studies by heart, or those who have a weak memory, will have to suffer from an application of the theory of extrinsic motivation, since a few lashes from the teacher's whip, or in happy occasions a few words of scolding, will most probably be the result.

The next step taken by the teacher is a lecture free from any demonstrations, specimens or any other motivating audio-visual material. In fact the utilization of any audio-visual aid in a darkened room is only known in the model schools of Bakht-er-Ruda Training College. At present, the best teacher is the one who will use some verbal illustrations and coloured chalkboard diagrams. After the lecture is over, the children will open their notebooks to put down a dictated summary that must be very well studied and at times recited for the next session.

Bakht-er-Ruda Combats Verbalism in Elementary and Intermediate Education

The Institute of Education of Bakht-er-Ruda, which is the Sudan's largest training college for elementary and intermediate school teachers, has done a lot to improve the content and methods of education in the Sudan. For twenty-four years Bakth-er-Ruda has been combating verbalism in the elementary and intermediate through the introduction of modern methods of education adapted to Sudanese environment. Since nothing can defeat empty verbalism more than its traditional enemy, audio-visual aids, Bakht-er-Ruda has made wonderful efforts to further their utilization. The cartoons on page 75, taken from the Elementary Education Handbook[1] prepared by the Sudanese Ministry of Education, shows the main contributions of Bakht-er-Ruda in fighting parrot-like teaching and concretizing education by the use of visual materials like models, specimens, demonstrations, dramatizations and bulletin boards, together with some principles of effective utilization of these aids. All the curricula and school textbooks used in the elementary and intermediate schools of the Sudan are produced in Bakht-er-Ruda. Attached to this educational institution, are special experimental and model schools for teacher training. They also try out

1. Ministry of Education, Handbook to Elementary Education for Boys' Schools and Boys' Clubs in the Sudan, pp. 39-42.

A boy is not a blackboard on which to write information.
Nor is he a water jar in which to pour knowledge.
He is an active human being who grows in mind, body and spirit if given the right menta physical and spiritual food.
Let him feed from these.
Too Much
Give him his educational food in small portions which he can digest.
The Wrong Kind
Give him things he can understand and activities that attract his interest and stimulate his endeavours.
Badly Cooked
Give him things to learn and do which are well prepared and well thought out.
But just as the body needs exercise, as well as food, in order to grow strong and healthy, so does the boy's personality need the exercise of activities, as well as mental food, in order to develop.
Acting history plays.
Preparing an Arabic wall magazine.
Making an experiment about flies.
Making a model of a kind of transport.

Fig. 16

newly-made textbooks and teaching methods before they are assigned to all the intermediate and elementary schools of the country.

Until 1956 audio-visual instruction was not taught as a separate course to student teachers in Bakht-er-Ruda; it was integrated in the teaching methods of different subjects. Though this procedure has the advantage of teaching audio-visual aids in an instrumental functional way, it also had the disadvantage of failure to present audio-visual education as an essential whole. Hence no audio-visual centre exists in Bakht-er-Ruda up to now, and some of the most valuable audio-visual equipment and materials like motion picture projection, overhead projection, lantern slides and microprojection are not yet introduced. A motion picture film to any elementary or intermediate school child, even in the model schools of the Training College, would only mean a feature film show down town.

This educational lag was lately discovered and some attempts to introduce the teaching of audio-visual instruction as a separate course has been started. One of the first trials in this line was taken by Shafiq Shawqi, the Head of the Art Department in the Two Years Training College for Intermediate school teachers. He capitalized the basic natural relationship between art and audio-visual education to further the understanding and utilization of visual materials. With the help of other teachers, he prepared a set of mimeographed sheets summarized from various visual education and art books to tell the student teachers about the value of the impulse furnished by the eye and how to produce simple graphic materials and to improve chalkboard utilization. For example the bottom of page four of the first set of mimeographed sheets prepared tackles the problem of chalkboard use as follows:

> "Always have in mind, when preparing a lesson that the blackboard is there, and prepare your blackboard work at the same time. Drawings and any large amount of written work should be thought about. Sometimes they may be drawn or written... before the lesson."1

Because Shafiq Shawqi did not take any courses in audio-visual education, most of his efforts were limited to drawings, charts, posters and similar materials that lend themselves to art work. Thus the utilization of audio-visual aids in a darkened room was not introduced until Johnson was appointed as the head of science teaching in the Training College. By taking over the field of visual instruction from Shafiq, Johnson, who had some courses in audio-visual aids, was the first to bring the filmstrip into the classroom. He also made plans for introducing the motion picture and the formation of an audio-visual centre.

Bakht-er-Ruda and Science Education:

As far as science education is concerned Bakht-er-Ruda has made very valuable textbooks for the second, the third and the fourth grades of the elementary schools. Though some of these textbooks need to be improved by increasing the quantity of verbal and concrete illustrations and experiments from the local Sudanese environment, their authors have made good trials to utilize audio-visual aids. For example, the teacher's handbook for the fourth year textbook presents the various topics of the

---

1. Two Year Training College, Visual Education for I.T.T.C. Students, p. 4.

book in the form of class-sessions and it gives a list of the suitable audio-visual aids that can concretize, and add interest to the lesson, together with the simple experiments that the pupils can perform themselves. The audio-visual materials suggested for the thirteenth class-session about the study of bones are fresh and old bones, and a part of a bicycle metal tube;[1] the tenth lesson about "How to save a drowned person" can be visualized by a ten meters long rope, a candle and a cup of water.[2] The children are taken to an actual swimming pool for demonstrations and the cup and candle are used in the classroom to demonstrate the value of oxygen for internal combustion. The fifteenth to the eighteenth class periods are a scientific play visualized by the dramatization method.[3]

Another important innovation of Bakht-er-Ruda, to the teaching of elementary school science through the use of audio-visual aids, is the introduction of the project method in the fourth grade. Various simple nicely-visualized projects that have great appeal to children, are published in small pamphlets. Each project is ended by a culminating audio-visual activity like the making of a model, the collection of specimens and objects, the acting of a play, or the construction of an exhibit. The Handbook to Elementary Education[4] states that six periods a week are given to these

---

1. S.B. Owen, and Abdel Rahman Diab, Simple Science for the Teacher, pp. 75-80.
2. Ibid., pp. 62-66.
3. Ibid., pp. 85-94.
4. Ministry of Education, Handbook to Elementary Education, op.cit., p. 24.

project activities, and that some of the project pamphlets in which the scientific side is given prominence are: Tahir and Locusts, A Meal for my Guest, First Aid, The Locomotive, Story of Aeroplanes, Hellow Exchange, Why I Learn Science, Omdurman Calling, and Soil Conservation. But despite all these efforts, Bakht-er-Ruda should do still much more work before the majority of elementary schools in the Sudan can be able to teach science in the richly visualized manner seen in the model and experimental schools of its training college.

Contrary to the elementary level, Bakht-er-Ruda has contributed very little towards improving science teaching in the Intermediate level, though some other subjects like geography have been improved through visual aids. The reason for this unfortunate situation is that from 1941 up to this date, Bakht-er-Ruda could not succeed in making a suitable science syllabus or textbook for the Intermediate schools of the Sudan. General science is neither included in the final examinations for entrance to the secondary schools nor regularly taught in most intermediate schools.

Brown, the previous headmaster of Hantoub Secondary School was one of the first to make a science syllabus for the intermediate schools. His work was too difficult and it presented much overlapping with the secondary school general science course. Thus when Owen was asked to make a suitable science textbook, he discarded what Brown did, and he made another unseuccessful attempt, which was also cancelled by his successor Hobson and so on. To put an end to this problem, the administration of Bakht-er-Ruda has lately appointed, Johnson, an English expert helped by Etom Fawzi, a Sudanese teacher to do the job.

Johnson worked hard for several months to produce a skeleton of his book Science and Civilization, which is a textbook with a biological bias divided into units. His work is definitely more suitable for intermediate school children than all previous attempts. Being himself the person responsible for visual education in Bakht-er-Ruda, he made appreciable efforts to visualize his work with charts, diagrams, specimens and other materials.

Johnson's book is not yet completed, but it is the opinion of some educators like Ahmed Saad, (the Chief Inspector of secondary school science teaching), that the detailed outline of the book shows that the final textbook will include very little chemistry and physics. A committee of science educators from the Ministry of Education, Bakht-er-Ruda Training College, and the University of Khartoum met in February 1958 and discussed the first part of the proposed textbook with Johnson. It was decided that some of the biological topics should be cancelled and that some elementary physics and chemistry be introduced. The committee shall continue its meetings, and it is hoped that a suitable science curriculum for the intermediate schools, free from unnecessary overlapping with the elementary and secondary school syllabuses, will be made.

Such a balanced science course for the intermediate schools will solve a very important obstacle to the use of audio-visual aids in the secondary schools. A good portion of the general science curriculum now taught in the secondary section will be transferred to the intermediate level, reducing the overcrowded science syllabus of the secondary school.

This will give the exhausted teachers more time to plan and use audio-visual materials.

A Survey of Audio-Visual Aids to Science Teaching in the Secondary Schools

A Survey of the Science Teacher's Understanding of Audio-Visual Aids:

Though some projected audio-visual aids are at times used in the secondary school level, still it is the most verbal stage of Sudanese education, and the percentage of trained teachers in it is very much less than either the intermediate or the elementary. Up to now there is no educational institution for the training of secondary teachers, and the work done by Bakht-er-Ruda in this line is negligible. It is hoped that a Faculty of Education will be started soon in the University of Khartoum to take this responsibility.

The problems of overcrowded curricula and the great importance given to state centralized final examinations have urged the secondary school teachers to stick to passive stereotyped methods of teaching science, usually free from the help of visual forms. The students are now more mature, and they have been trained to be taught through drills and recitations in their intermediate education; so the science teacher finds no trouble in giving them abstract knowledge purely via the lecture method, and he will be sure that they can master what he dictates.

Audio-visual aids to science teaching are neither understood, appreciated, nor properly utilized in Sudanese secondary schools. In answering the audio-visual questionnaires,[1] some science teachers have either put a question mark in front of the mock-up, the diarama, the flip-chart, the flannel board, the electric board, the lantern slides, the 2" x 2" slides and the overhead projection, or they simply did not answer the questions about these aids. When these questions were coupled by interviews and oral explanations, some science teachers were wondering how materials like the blackboard, the fieldtrip and the demonstration could be considered as audio-visual aids like the cinema. The misconception of audio-visual instruction as being synonymous with the motion picture and at times the filmstrip is common even among school principals and ministry administrators. Some of the teachers who are skeptical about the value of audio-visual aids will say, "These things like the cinema, the tape recordings and filmstrips are of help to young children. The boys of the secondary level should be trained to work with abstract things." It is fortunate that the supporters of this disciplinary attitude are quite a minority.

Of course there are some teachers who have studied audio-visual instruction in their university education. The results of the questionnaires show that such teachers are very few. Nasr El Haj Ali, (Director of Education), comments that it is only a matter of chance that the Ministry may at rare occasions get a non-Sudanese teacher who is well informed in audio-visual instruction.[2]

---

1. See Appendix.
2. Information given by Nasr El Haj Ali in answer to a special questionnaire. See Appendix B.

To what extent the Sudanese science teachers understand audio-visual education will be clarified in more details as later sections of this chapter are read.

An Evaluation of Secondary Schools in Terms of Their Use to Audio-Visual Aids to Science Teaching:

Though the secondary schools of the Sudan are generally poor in audio-visual materials and equipment, there is a still great difference in the quantity and the utilization of these aids in various schools. As far as audio-visual aids to science teaching are concerned, the Sudanese secondary schools could be roughly grouped under three divisions: the rich type, for example the old government schools like Wadi Saidna, Hantoob or Tagat; the very poor like the Ahlia Secondary for boys, and the Ahfad Secondary School for girls, and the newly formed government schools; and a few average schools like the Congress and the Ahfad for boys.

Usually there is a strong positive correlation between the richness of the laboratory equipment and the audio-visual aids found in a school. For example a school like Wadi Saidna has two comparatively well-equipped laboratories. One is for physics and chemistry, containing a good supply of chemicals and necessary instruments and balances for demonstrations and individual experiments; and the other, an adequate biology laboratory supplied with twenty large microscopes and some models. It is also one of the wealthiest schools in audio-visual aids. It has a 16 mm. motion picture projector, an epidiascope, a filmstrip projector, a lantern slide projector, a microprojector, a good supply of filmstrips, charts and diagrams and an average supply of films and models. It has a magnificent auditorium and a 35 mm. cinema projector that can be used to project commercially produced feature films.

At the other extreme stands the Ahlia Secondary School. There is a small store for the laboratory equipment of the three streams of the school. It is also the office of the head of the science department. The Ahlia laboratory is so poor that in many instances the teacher will not find enough apparatus for class demonstrations. Thus the boys are not only deprived from doing the experiments themselves, but they are also at times deprived from seeing the teachers doing them. Williams, the head of the science department, states that the Ahlia students have become experts at imagining apparatus and equipment from the spoken word of the teacher! He says that after teaching the whole secondary school syllabus of electricity by chalkboard diagrams and imagined instruments, he borrowed all the necessary electrical equipment from a near by school and showed them to the class. The boys could recognize the electrical instruments with great difficulty though they can readily produce diagrams of every instrument included in the curriculum. Williams could have avoided this problem by showing the electrical equipment before presenting abstract chalkboard diagrams. As far as biology is concerned, the Ahlia has only one microscope for all the 450 students of the school.

Likewise the laboratory is also very poorly equipped with audio-visual aids. Williams, the head of the science department, sarcastically boasts, "Our rich audio-visual centre is composed of three blackboards!"

In fact, other than these three chalkboards in the three science classrooms of the school, there is practically nothing other than a few biological charts and a micro-projector which is out of order. Since no projected materials are used, there are no facilities for darkening. Unfortunately most, if not all, of these inadequately equipped schools do not make use of free, inexpensive, or teacher and student made audio-visual aids.

That the quantity of audio-visual aids to science teaching varies directly as the richness of the science laboratory, is probably due to the fact that the head of the science department or the principal of the school will not ask for any audio-visual materials until his laboratory is well equipped from the point of view of chemicals, electrical instruments and other scientific apparatus. This attitude is at times taken to the extreme when the principal agrees to pay a lot of money to buy a costly but unnecessary sensitive instrument or elaborate equipment that may be used only once or twice per year, and refuses to buy a motion picture or filmstrip projector which can be used throughout the year to visualize all branches of science as well as other subjects.

Sometimes a school may be very well equipped with apparatus and audio-visual materials only in one branch of general science; but comparatively poor in other branches. This is usually due to the head of the department being biased towards biology, chemistry or physics. For example, Wadi Saidna School was adequately supplied with physics and chemistry appliances and visual materials but comparatively poor in biology. This weakness was overcome by Eltylib the new head of the science department.

Because Mohammed Salih the head of the Hantoob Secondary School's science department is a biologist, the laboratories of his school are rich in biological equipment and biological audio-visual aids but not as rich in physics and chemistry.

<u>What Audio-Visual Aids to Science Teaching Are Used?</u>

Table I shows the various types of audio-visual aids arranged in the degree of their use to make the teaching of science in Sudanese secondary schools concrete. The materials used most are placed at the top of the list. The data in this table is collected from the results of the questionnaires in Appendix A. Twenty-four teachers were asked to rate the list of audio-visual materials provided in terms of their frequency of use in class by checking in columns headed "Regular", "Rare" or "Never". It is quite natural to find that the chalkboard and graphic materials are used most to visualize science teaching. The chalkboard has become a logical part of any classroom. Charts and diagrams are used in every school since science can hardly be taught without their help. Except for the drawings the students make in their notebooks and teachers make on the chalkboard, no student-or-teacher-made charts and diagrams are used in visualizing science teaching in the classroom. Most of these aids are imported from England.

In poorly equipped schools, the teacher demonstration method is at times the only motivating visual aid performed. At times, a dictated lecture coupled by a chalkboard illustration will be the rule. In richer schools, demonstrations are more frequent. There are special classrooms arranged in

TABLE I

Audio-Visual Aids to Science Teaching Used in Sudanese Secondary Schools

Materials & Equipment Arranged in the Degree of Their Use	Number of Teachers Checking Their Frequency of Using Visual Aids				
	Regular	Rare	Never	No Answer	Total
Chalkboards	24	0	0	0	24
Diagrams, Charts & Graphs	22	2	0	0	24
Demonstrations	19	5	0	0	24
Models & Mock-ups	10	12	2	0	24
Motion Pictures	8	14	2	0	24
Objects & Specimens	7	13	4	0	24
Filmstrips	5	11	8	0	24
Still pictures	4	8	12	0	24
Bulletin Boards	3	7	14	0	24
Opaque Projection	3	5	16	0	24
Exhibits & Displays	2	4	18	0	24
Microprojection	0	5	19	0	24
Fieldtrips	0	2	22	0	24
2" x 2" slides	0	0	17	7	24
Lantern slides	0	0	18	6	24
Dioramas	0	0	18	6	24
Flannel Boards	0	0	19	5	24
Electric Boards	0	0	21	3	24
Flip Chart	0	0	22	2	24
Cartoons & Comic drawing	0	0	23	1	24
Overhead Projection	0	0	23	1	24
Tape & Disc Recording	0	0	24	0	24
Posters	0	0	24	0	24

tiers so that each student can see the experiment demonstrated. The teacher will perform the experiment to the class before they do it in the lab. This process is most advantageous when the experiment is complicated or when it requires special skills; but, if the students see a demonstration of simpler experiments before doing it themselves, it will have the disadvantage of depriving them from the joy of adventure and the training in discovering things for themselves.

Models are rarely used. In some of the richer schools there are big models of the human body which can be taken apart to show the internal organs, thus concretizing all the biological systems of mammals studied in the secondary school. Cutaway models of flowering plants or microscopic animals and plants are very scarce. Though plastic tehnology has reduced the price of scientific models, some schools do not have any form of these effective teaching aids. Teacher-or-student-made models and mock-ups, which can help the poorer schools are never used. Other than globes which are found in almost every school, working models and mock-ups are found in only two or three secondary schools. The high price of these teaching aids is given as the reason for their dearth.

Because the motion pictures are a costly audio-visual aid they are not found in most non-government and all newly-formed government schools. Inspite of the fact that most of the old government secondary schools have motion picture projectors, the use of the film as an audio-visual aid to science teaching is greatly handicapped by the absence of a central library for films, the lack of science films in individual schools, the problem of room darkening, and the fact that most projectors are now out of order. Some of the plans to improve and increase motion picture utilization have been planned by Ahmed Saad the Chief Science Inspector.[1]

The International Commission[2] on Sudanese secondary education has recommended the filmstrip as a better aid for Sudanese schools than the moving film itself. Inspite of this, the filmstrip is still very much underestimated as an audio-visual aid. Most of the old government schools and some non-government schools have epidiascopes which can be used to project filmstrips, but some of these schools do not have a good supply of filmstrips. Some schools have an epidiascope but not a single filmstrip, others have neither the projector nor the filmstrips. The light inexpensive filmstrip projector is not generally found in secondary schools, though the International Commission[3] has recommended that schools should be supplied with them, and that the poorer schools can afford to purchase inexpensive battery projectors.

Opaque and microprojection which are almost never used could have improved science teaching in all Sudanese secondary schools. Many schools can use the epidiascope for projecting opaque objects, chemical reactions, biological specimens or charts, photographs and diagrams. The inadequately equipped schools can make the teaching of biological and physical sciences

---

1. See Appendix C - "The letter from Ahmed Saad to the Director of Education."
2. Ministry of Education, Report of the International Commission on Secondary Education, p. 59.
3. Ibid.

much more concrete by the help of the microprojector, which can save them the problem of buying expensive microscopes for every student.

If some science teachers give their poorly equipped schools as a reason for not using films, filmstrips and models they cannot be excused when even inexpensive materials are infrequently or at times never used at all. Still pictures and photographs, objects and specimens, bulletin boards, exhibits and displays, museums and fieldtrips are all very rarely used. Scientific magazines, some government associations and even private collections of photographs can make a good file of still pictures; nevertheless a science teacher will make the funny statement, "I utilize the still picture whenever the textbook I use presents one." Teaching the respiratory system by the help of distorted chalkboard diagrams will make a very poor presentation when the lungs and heart of a sheep or a bull would cost only a few piasters.

A science teacher in Tagat secondary school, which lies in a desert in the extreme west of the Sudan, says that some of his students who have taken their intermediate schooling in the same area have not seen many of the common fishes of the Nile. An aquarium presenting a variety of these fishes and other water animals can add great interest to science education in such schools. Not a single school is regularly keeping a rich aquarium up to now. The lack in the use of objects is not limited to the field of biology. Most students can recite a comparison between the images formed by the convex lenses of the eye and the camera, but only a few of them can explain if they are furnished with a real camera and a model of the human eye.

What they have seen is merely a chalkboard diagram of an eye and a camera. The exhibits and displays are usually utilized once a year on the parent's day or the annual 'science fair' in which some showy experiments are demonstrated by the teacher to some of the brighter students a few days before the show. These lucky students are asked to cram the necessary information in order to recite it in the exhibit.

The fieldtrip which is an inexpensive and most effective audio-visual aid is scarcely utilized. The answer, "I have never used the field-trip" is heard from many teachers even in poorer schools which ought to have utilized valuable and inexpensive audio-visual aids like the fieldtrip to compensate for their abstract teaching methods. Some schools like Wadi Saidna which is twenty-five miles from Khartoum, the capital of the Sudan, Elfashir which is found in a comparatively underdeveloped area, and Tagat which is far from Elobied the major city in its zone, are handicapped in taking fieldtrips to factories and industrial areas; but they have a wealth of biological and geological trips in their nearby surroundings. Science teachers of schools like the Congress, Khartoum, Ahfad and Portsudan, (all situated in big cities), cannot be excused from visiting museums, factories, gardens and other public places of interest to the learner.

As it is clear from Table I some audio-visual aids like lantern slides, dioramas, flannel boards, electric boards, flip charts, cartoons and comic drawings, 2" x 2" slides, tape and disc recordings, and posters are never used at all in any secondary school. In fact some of these materials, for example the flannel board, the electric board or the lantern and

2" x 2" slides, will need much explanation before most science teachers can form a vague idea about the material.

It is unfortunate to find that some of these materials are probably the most suitable for the Sudan. The 2" x 2" slides, in which the filmstrip is cut into individual frames placed between two glasses, are better than the strip film for the Sudanese secondary schools. Their projectors are easier to operate, and they have a much longer life than the film strip which is easily misused by untrained science teachers. The hand-made lantern slides are probably the least expensive and the most valuable in producing colored hand drawn slides on science topics based on the local Sudanese environment. Wadi Saidna School has a lantern slide projector but it is not used since the School has no slides. Lantern slides and chalkboards can be excellent mediums for the utilization of cartoons and comic drawings which use fun and satire to communicate abstract scientific information to the learner. Flannel boards, dioramas and posters are very valuable aids in classroom teaching and in annual school science exhibits.

The tape recorder does not lend itself to the teaching of general science as much as it does to the teaching of languages and history; yet it could be effectively used to make concrete some scientific subjects like the difference of pitch and musical instruments in the study of sound. By preparing a suitable tape recorded narration, the science teacher can use the tape recorder to add sound to his silent filmstrip or motion picture. This is most helpful when he is supposed to teach more than one class of the same grade, (as is the case in most large secondary schools in the Sudan).

How Are These Materials and Equipment Utilized?

Most audio-visual materials and equipment are misused by most science teachers in the Sudan. Like the intermediate schools, chalkboards, usually made from plywood, slate or merely wallboards, are badly utilized. Chalkboard tools and coloured chalk are infrequently used. Illustrations drawn too small on a clean part of the board without erasing the material left from the previous class-session is typical of science teacher's utilization of the chalkboard. The least expensive type of chalkboard is definitely the cemented wall, but, other than its disadvantage of cracks and loss of colour already mentioned, it usually consumes much more chalk as its surface is rougher than slate and wooden boards. The wallboard of the laboratory of the Ahfad Secondary School for Girls will give a very good illustration of this phenomena.

Likewise demonstrations are poorly utilized. The elements of motivation and "showmanship" are greatly overlooked. The richer schools that have special classrooms in which the chairs are arranged in tiers give the students a good chance to see what happens at the demonstration table, but in most other schools, the demonstration table is placed on a high platform in front of the class. The students are seated on normal stools.

This situation hinders the class from clearly seeing the experiments performed. In the Ahlia School, the demonstration table is so high that it obscures the lower part of the chalkboard as well. Proper lighting of the table and the use of large apparatus is also neglected. Yearly exhibits and displays can be much more improved through the use of audio-visual devices like colour, motion, sound, unusual figures and audience participation.

The general steps to proper utilization of audio-visual aids given in chapter two can improve the use of all the materials and equipment utilized. Models filmstrips, films and charts are presented to the students without preparing the student nor following up after the exposure. This attitude makes the student take motivating aids like the motion picture and the filmstrip as a form of entertainment that breaks the monotony of abstract teaching.

Of all the audio-visual materials and equipment used in the Sudan, motion pictures and the filmstrips are probably the most misused during presentation. In one school an Egyptian science teacher was seen pulling the filmstrip along the projector with his hand though there was a special nob in the projector for this purpose. By so doing, the sprocklet holes of the filmstrip will be spoiled by the sprocklet teeth of the projector. Another Sudanese teacher used to project the image from a motion picture projector onto the dark yellow wall of the classroom inspite of the fact that he could have told the lab boy to fetch the white canvas screen from the geography room. The problems of epidiascope bulbs melting, and its wire connections short circuited because of excessive heat and misuse is well known to heads of science departments.

Occasionally the misuse of audio-visual aids is not the responsibility of the teacher alone. At times, the school administration or even the ministry administrators share the responsibility with him. For example, in one of the schools visited, the geography room has a triple outlet which is different from that of the laboratory. To use the projector, the geography teacher has to pull out the plug and support the wire in the outlet by the help of match sticks. When the projector is taken back to the lab, the science teacher carelessly replaces the plug. This situation created some difficulties like short circuiting of the electric current and the shortening of the life of the projection bulb.

In another school a similar incident was witnessed. To economize, the enthusiastic principal of the school has wrongly purchased an epidiascope for all the filmstrip and opaque projection for the 1000 boys and girls in his school. He encouraged his teachers to use projected audio-visual aids. He was very successful. This initiated the problem that sometimes, during the same hour, a science teacher may want to opaque project a small specimen, the geography teacher a filmstrip, and the history teacher some photographs. This is of course impossible since one projector cannot be used for three different purposes at the same time. This problem could have been avoided if the principal bought a small inexpensive filmstrip projector and an opaque projector, because combination projectors are disadvantageous for large schools.

Similarly some architectural building problems and darkening facilities may retard the effectiveness of projected audio-visual aids. In one school, darkening is accomplished by closing the blackened glass windows of the laboratory. When the room is darkened so much heat and perspiration are generated, that the crowded students often lose interest in the show. The absence of window shutters, and the failure of inexpensive black curtains to bring about room darkening was given by the head of the science department as the reason for darkening by blackening the windows. This difficulty could have been avoided by doubling the thickness of the black curtains so that the windows could be opened during projection, or otherwise ventilating the room by the help of ceiling fans; but anyway, ventilation should not be overlooked for the sake of perfect darkening.

Another problem of darkening facilities is reported by a teacher in Wadi Saidna school. He says that the only room that can be fully darkened is the big auditorium of the school. On some occasions when a science teacher thinks of showing a filmstrip or a microprojected material, he will take the class from the lab to the auditorium to find that it is occupied by a lecture or an entertainment 35 mm. film show. In such cases darkening the laboratory itself will save the teacher much trouble and will give him a chance to produce his projected visual aid in its natural context and at the psychological moment.

A problem of misutilization in which the ministry administration shared the responsibility with the teacher is given by Ahmed Saad the chief science inspector. He believes that the fact that most of the British B.T.H. motion picture projectors, once ordered for old government secondary schools, are now out of order, should not be attributed solely to the careless handling of the teachers and lab boys. These projectors, he continues, are very sensitive and require great care and maintenance facilities. Therefore it is a mistake of the ministry administration to purchase such projectors for a great majority of untrained teachers. He intends to import a more durable type of German projectors to substitute for the old ones.

How Are Audio-Visual Materials and Equipment Stored and Maintained?

Generally the storing of equipment and materials does not create a serious problem in poorly equiped schools. Their audio-visual aids are too scanty to create such a problem. But in comparatively well equiped schools, storing may initiate a real obstacle to the proper utilization and maintenance of audio-visual aids; visiting the laboratory store and the science teacher's room of most richer schools will illustrate this problem.

When filmstrips are sometimes used, the filmstrip library may be distributed in teacher's table drawers, cupboards and laboratory stores. In more serious cases, a filmstrip may be taken out of its tin and placed carelessly between the science books on the teacher's table. Placing the filmstrip in the wrong tin, so that when the next teacher is ready to show it, it turns out to be the wrong one is also not uncommon. After the filmstrip show, a filmstrip may be 'stored' in the projector for months.

Tins of film reels placed on the floor, in the corner of the room nearest to the head of the science department's table, or placed side by side near chemicals, instruments and bottled specimens in the store is typical of storage in adequately equiped schools. After the film show, the films are frequently placed without rewinding in their tins. Rewinding the film takes a few minutes from the next teacher's class-session. If the next teacher has the time and the initative to use a film, he may have no time for previewing, to make sure the film is suitable or not or needs rewinding. The projectors are placed in their cases only when they are first brought to the school, or when they are to be carried for long distances; they are generally placed on the floor between cupboards in the laboratory store.

Models are likewise poorly treated and stored. To visualize a lesson on the excretory system, a science teacher, may take the kidney out of the life size model of the human body usually owned by the rich schools. After the class-session, the teacher finds that he did not finish his lesson, so, instead of opening up the big model and placing back the kidney, he will simply 'store' it in the drawer of the demonstration table for the next time. The kidney may remain in the drawer until another teacher asks the lab boy about it. The poor lab boy will have to bear the curses of the impatient science teacher, though he might have been sent to buy some chemicals or collect some flowers when the first teacher has taken the model of the kidney himself.

Occasionally, very valuable audio-visual materials and equipment are locked up in a wooden cupboard and left there to collect dust. The only people who know about them will be the head of the science department and the lab boy. The rest of the teachers, in good cases will be told that a new chart or piece of equipment was purchased; but of course every one is too busy to ask for the keys of the cupboard to see these new aids or use them. A very vivid example of this case was told by the principal of one of the schools visited. He says that he ordered a life size model of the human body from England. After a few months, he received the model and gave it to the head of the science department who locked it up in the laboratory store. Neither he nor anyone of the science teachers used it until the day of the annual 'science fair' came. To exhibit the rich equipment of the school and the good conditions in which the students study science to the fathers, the model was taken out and students were trained in taking it apart and assembling it again to display the internal organs of man. The principal states that the students of the school and even some teachers were more interested than the visitors in seeing the model.

Another more serious problem of storing is caused by the fact that in all secondary schools there is a competition between the science and geography departments to keep the projectors and other visual aids which can concretize both subjects. Usually the science teachers are more capable than the geographers in handling and maintaining projectors and other equipment as their courses of study make them more familiar with electrical and optical appliances. In this connection, Ahmed Saad, the chief science inspector, writes to the director of education saying "... Cinema equipment should be the responsibility of the science, rather than the Geography department as is the practice in some schools."[1]

Misuse and careless storage of audio-visual materials and equipment in the Sudan makes a much more difficult problem than in other more advanced

---

1. See Appendix C.

Arab countries like Egypt or Iraq, since at times a projector may be kept out of use for many months because a spare part has been ordered from England. For example the microprojector of the Ahlia school has not been used for the last two years because its bulb has melted and the school has not yet ordered spare bulbs from Europe. On some occasions, the projector itself is sent abroad. The heads of the science departments in government schools are sometimes discouraged from asking for spare parts because they know beforehand that the routine of the highly centralized administrative system may take months before their problems are solved. These difficulties, however, can be brought to a minimum if the Sudan could seek the help of more advanced nearby Arab countries.

Audio-Visual Aids and Scientific Extra Curricular Activities:

It should not be understood from this survey that all science education in Sudanese secondary schools is verbal and that audio-visual aids are rarely used. In some schools where there is a science society of some sort, audio-visual aids find good application. The membership of the science society is usually very small as compared to the crowded classes of the secondary school, and the teacher who volunteers to be responsible for such a society is usually enthusiastic and interested. The teacher's understanding of extra curricular scientific activities is to a great extent synonymous with the true meaning of audio-visual instruction - viz. taking trips, showing films, giving student demonstrations, drawing charts and scientific illustrations, collecting specimens and objects, making a museum and building up a picture file.

Few schools have extra curricular science activities, though the students show great interest in being members of science societies. This is mainly attributed to lack of science teachers who will assume such responsibilities. The head of the department of the Ahlia secondary school gives lack of equipment as the cause for not having a science club, which does not seem to be an acceptable reason. A good deal of the activities of a science club can be performed with the help of community resources and inexpensive aids.

In some schools the science society has had appreciable success in making the science syllabus concrete and interesting to its student members through the use of audio-visual aids. For example the science society of the Ahfad secondary school for boys has taken some fieldtrips that resulted in the collection of different objects and the preservation of animals and insects. The students made excellent diagrams and coloured illustrations that could have been used by their science teachers to improve their teaching methods. With the help of a science teacher who had some courses in audio-visual instruction, the members of the club, in collaboration with the photography club, produced a scientific filmstrip some frames of which are shown on page 171 of this thesis. It was found that the activities and success of the science society can be very much increased by the introduction of the popular hobby of photography. The science societies in Hantoob and Tagat schools have made photographic dark rooms with teacher and student made enlargers.

These science clubs can be of very great help in furthering the cause of audio-visual aids in Sudanese secondary schools. First of all, the interesting audio-visual activities introduced and the enthusiastic way in which the students learn science can help to convince the skeptical teachers that audio-visual aids can make the students learn more, in less time and in a more interesting manner. The science society can act as a 'model class' within the school, and can help to improve the teaching methods of the teachers sponsoring them. They can get to know the hobbies and innate interests of their students and the tools that can capitalize upon these interests to make classroom teaching more effective. For example if the science teacher finds that the fieldtrip he took with the science club to a public museum or a factory was successful, he may take the class to it. Hence the science society may act as an experimental small class within the school. The science club can help in the production of valuable audio-visual materials like charts, diagrams, photographs, specimens, objects, etc., which can be of very great help to poorly equiped schools.

Summary

The methods and content of general science in the Sudanese secondary schools are very much affected by what goes on in the first eight grades of elementary and intermediate schools. The Institute of Education of Bakht-er-Ruda has helped a great deal in improving upon the verbal, parrot-like teaching methods in Sudanese elementary and intermediate schools at large, and in developing a nicely visualized science curriculum for the elementary school in particular. It is hoped that the intermediate science textbook will be made soon to reduce the overcrowded secondary school science syllabus, thus giving the secondary teachers more time to plan and use audio-visual aids.

Up to now there is no training college for secondary school teachers and so science education in the secondary school is most verbal. Secondary schools are generally poorly equipped with audio-visual aids for science teaching. Science teachers and school administrators do not understand and appreciate, nor properly utilize and store, audio-visual materials and equipment.

Chalkboards, graphic materials, and demonstrations are the audio-visual aids most used in science education in the Sudan. Materials and equipment like models and mock-ups, films and specimens, filmstrips, still pictures, fieldtrips and opaque and microprojection are rarely utilized while other valuable aids like lantern slides, 2" x 2" slides and feltboards are never used in secondary science teaching.

The only activities in which audio-visual aids to science teaching find good expression in some secondary schools is the science club. Poorly equipped schools do not make use of student-and-teacher-made materials that can be produced in such clubs, nor do they seek the help of free and inexpensive audio-visual aids and community resources.

CHAPTER IV

OBSTACLES TO THE USE OF AUDIO-VISUAL AIDS TO SCIENCE TEACHING IN SUDANESE SECONDARY SCHOOLS AND SUGGESTIONS FOR OVERCOMING THEM

Introduction

Like Chapter III, this study depends mainly upon the questionnaires developed by the American University of Beirut Audio-Visual Center, the special questionnaires and interviews prepared for Ministry administrators and educators working in science teaching in the Sudan and the books, pamphlets, reports and yearbooks produced by the Ministry of Education. Some recommendations were given in Chapter III; but its main function was to give a descriptive survey of audio-visual aids to science teaching. It has shown that Sudanese secondary schools are poorly equipped with audio-visual aids, and that materials and equipment are neither appreciated nor properly utilized and stored.

This chapter is intended to show the main reasons for the lack in these aids, the causes for their poor utilization, and to give suggestions and recommendations for overcoming the major obstacles to their widespread use.

The Results of the Questionnaires

The results of the check list questionnaires[1] about the obstacles to the use of audio-visual aids prepared for teachers and administrators are condensed in Table II and Table III. The major and minor obstacles are arranged in the degree of their relative importance as sighted by twenty-four teachers and ten school and Ministry administrators. Major and minor obstacles checked by less than five teachers or two administrators are not included. It is evident from these tables that the lack of funds and high cost of equipment was reported to be the most important hinderance to audio-visual aids. The second major obstacle seems to be the problem of overcrowded curricula and the preparations for general exams, because they are the only other major obstacles checked by both teachers and administrators.

A critical study of all these major and minor obstacles given will show that they are very much interrelated. In fact, some of them can be considered as corrolaries of others. Hence, the whole list of obstacles reported can safely be condensed and discussed under the three following headings:

1. Lack of Funds
2. Crowded curricula and preparation for general exams
3. Lack of understanding the value of audio-visual aids.

---

1. See Appendix A

TABLE II

OBSTACLES TO USE OF AUDIO-VISUAL AIDS TO SCIENCE TEACHING AS REPORTED BY SCIENCE TEACHERS

Major Obstacles	Number of Teachers Who Checked Them	Minor Obstacle	Number of Teachers Who Checked Them
1. Lack of Funds and High Cost of Equipment	24	Lack of properly trained audio-visual personnel	18
2. Crowded Curricula and Preparations for General Exams	20	The lack of facilities in architectural building plans	12
3. Lack of time	18		
4. Lack of Administrative Support	10	Equipment too Complicated to Learn how to Use	7

TABLE III

OBSTACLES TO USE OF AUDIO-VISUAL AIDS TO SCIENCE TEACHING

AS REPORTED BY ADMINISTRATORS

Major Obstacles	Number of Administrators Who Checked Them	Minor Obstacle	Number of Administrators Who Checked Them
1. Lack of Funds and High Cost of Equipment	10	Lack of central Audio-Visual Department	6
2. Lack of Teachers Understanding the Value of Audio-Visual Aids	8	The Lack of Properly Trained Audio-Visual Personnel	4
3. Crowded Curricula and Preparations for General Exam	7		

1. Lack of Funds

The Ministry of Education do not give government schools any funds for purchasing audio-visual materials, since the term "audio-visual aids" is not yet recognized as an item of secondary school budgets. The large old government schools get an annual maximum sum of 5000 Sudanese pounds for the books and lab equipment of all the subjects for all the students of the school. Other than the visual aids occasionally ordered for schools by the Inspectorate, some school administrators at times purchase a few audio-visual aids under the title of "materials and lab equipment".

As far as non-government secondary schools are concerned, there is no budget at all for audio-visual aids. When these schools are aided by the government, their administrators cannot increase their annual budget by simply putting audio-visual materials under the item of "laboratory equipment and materials" as some government school administrators sometimes do. The annual aid to such schools is fixed and is always very much less than what the school needs. In many instances, revenues are covered by increasing the school fees that the students pay.

Other than secondary schools, when money is paid for audio-visual instruction proper, the budget given is usually too small. For example Ahmed Saad, the Chief Science Inspector, states that the whole budget of audio-visual education assigned to the Teachers Training College of Bakht-er-Luda is fifty-one Sudanese pounds, while the Budget for the Technical secondary school is only nineteen pounds.

For these reasons many schools have limited themselves to chalkboards, charts and diagrams; the poorer schools have deprived their students from doing many experiments themselves and have even at times deprived them from seeing teacher demonstration; valuable audio-visual aids like lantern slides, opaque projectors, microprojectors, 2" x 2" slides, and overhead projectors are either scarcely or never used; old worn out motion picture projectors are not yet renewed; and that no school as yet has a respectable film or filmstrip library. All these facts can now be explained as being attributed mainly to lack of funds which hinders the use of audio-visual aids in Sudanese secondary schools.

Some of the obstacles reported like "the lack of administrative support" can be partly attributed to lack of funds. An enthusiastic teacher who plans to take his class for a trip sixty or seventy miles away, or who writes an application to the principal or the head of the science department asking for a motion picture projector, will definitely be discouraged by the administrators of most schools. He will most probably be told that the school does not have funds for such luxuries and that he should limit himself to less expensive activities.

The lack of facilities for room darkening and poor architectural building plans is another obstacle reported by teachers which can be partly attributed to lack of funds. To get the maximum value from the use of audio-visual materials and equipment, the classroom should be built and prepared for their use. It should be a classroom in which large black curtains are drawn to darken the room or hide a part of the blackboard without being poorly ventilated. A classroom should have light-weight seats which can be moved around to get the best view from a projected material; to make a semi-circle so that everybody can see the model or demonstration shown; or, to be easily packed away so that the traditional class period changes to a work lab. A classroom supplied with electric outlets, water supply, electric fans for the summer of the Sudan and ample space for the storage of materials and equipment.

The science classrooms of the Sudan, due to tradition and lack of funds are far from this ideal situation. There is the high platform for the teacher and at times heavy fixed seats for the students. When building new schools, especially non-government schools, the most important issue of minimum funds will definitely defeat any suggestions for making the classrooms large and student-centered so that they become most suitable for the utilization of audio-visual aids. For example, to save building funds, some newly-built private schools have tended to use glass windows without window-shutters. This has increased the problem of darkening in these schools.

Suggestions for Overcoming the Problem of Limited Funds:

The Ministry of Education should recognize audio-visual aids as a separate item in the secondary school budgets, and the annual funds should be increased. The science inspectorate system should be supplied with more money in order to purchase equipment and materials for schools or to produce inexpensive materials locally at the Headquarters. Ahmed Saad, the Chief Inspector, considers the problem of lack of funds a chief obstacle to his proposed audio-visual activities.

Science teachers should be encouraged to use inexpensive audio-visual aids. Students and teachers can make many materials like charts, maps, diagrams, models and mock-ups, lantern slides and even filmstrips and inexpensive opaque and lantern slide projectors. They can collect specimens and objects of great value. A good deal of expensive lab equipment may be substituted by materials that the students bring from their homes or the teacher purchases at a low cost from garages, grocery houses and pharmacies. Occasionally students get much more value from making their own visual aids from such inexpensive materials than when ready-made elaborate equipment is purchased for their use. Other audio-visual aids like free distribution materials and nearby fieldtrips do not cost anything.

In the Sudan, the production of inexpensive audio-visual aids is wrongly considered an extra-curricular activity of the science club. Ahmed Saad has made good efforts to further these production activities in the science club of Tagat Secondary School, but generally the work of his Inspectorate system in encouraging the utilization and the construction of inexpensive aids in Sudanese secondary schools is still very limited. It can be safely said that up to now no school is making any appreciable use of these aids. Because this problem is of very great practical significance to the understanding and utilization of audio-visual aids to science teaching in the Sudan, it shall be discussed in a more detailed form in Chapter V of this study.

1. The Problem of Overcrowded Curricula and the Preparation for General Exams:

This problem creates another major hinderance to the use of audio-visual materials in the secondary as well as the intermediate and the elementary sections. Many Sudanese educators give this obstacle as the main reason for the passive stereotyped teaching methods prevalent in all levels of Sudanese education. Ahmed Saad believes that all the secondary school syllabuses, with the exception of mathematics, are very much overcrowded. Williams the head of the science department of the Ahlia School states that the general science taught in Sudanese secondary schools is the most crowded of all subjects. He says it is three separate subjects of physics, chemistry and biology overcrowded in one.

The great importance that the teachers and students give to the yearly final examinations within each level of education, and the competitive centralized state examinations held at the end of the final year of the elementary; the intermediate and the secondary stages to transfer the successful candidates from one stage to the next, add to the complexity of the problem of overcrowded curricula. These centralized competitive examinations form one of the greatest educational problems in the Sudan because it is known beforehand that the number of successful students is far more than the number of vacancies in the next stage of the Sudanese educational ladder. This fact can be clarified if the total number of student population in the three levels of education is compared. The 1957 statistics of the Ministry of Education[1] shows that there are 234,806 boys and girls in all the elementary schools of the country, 28,094 pupils in the intermediate level, (or nearly one tenth of the elementary school population), and only

---

1. Ministry of Education, Ministry of Education Statistics - 1957, Schedule I.

7,511 students in the secondary section. The 1956 Annual Report of the Ministry of Education[1] indicates that of the 684 secondary school students sitting for the school certificate examinations of 1955 for entrance to the University of Khartoum, only 340 (49%) candidates passed while the rest, (344 students), have failed.

The International Commission on Secondary Education[2] believes that the competition in final centralized examinations is much more intensified in the intermediate and secondary sections because the students become more mature, and the parents take part in increasing the tension. In fact the results of these examinations do not only affect the students and their parents. To a very great extent, the promotion of the teachers, and the evaluation of various schools is also affected by them. The teacher is expected somehow to pour the content of the school subjects into the craniums of his students. His main aim is to prepare the learners academically to reach the standard of the state examinations for entrance to the second level of education. At times, the final examinations are not valid. They do not measure how much the student understand of the content of his school subjects but how good he is at memorizing them. Hence, secondary school students frequently press their science teachers for the dictation of material and 'spoon feeding'.

---

1. Ministry of Education, Ministry of Education Annual Report July 1955 to June 1956, p. 5.
2. The Report of the International Commission on Secondary Education p. 56.

Lack of time, (which is given by science teachers as a major obstacle to the use of audio-visual aids), can be considered as a corrolary of this problem of overcrowded curricula and the preparations for general exams. Occasionally science teachers may come in the afternoons for extra classes in order to finish the science syllabuses. A harmful method is sometimes followed by many science teachers to overcome the problem of overcrowded syllabuses without giving extra classes. The practical laboratory work done by the students, (and even on rare occasions the teacher's demonstrations), are overlooked to cover more material verbally.

This system of highly centralized competitive exams has developed another equally serious obstacle to audio-visual aids to science teaching in the secondary school. In many schools, the three old poorly illustrated general science series of books[1], namely, <u>Introduction to Biology</u> by Wyeth, <u>Elementary Physics</u> by Nightingale, and <u>Simple Chemistry</u> by Fairbrother, assigned for the general science course in 1942 are still being used. Like most old British books, these texts give solid scientific information in a concise summarized form free from attractive illustrations and visual forms. They are most discouraging to the student. They do not give suggestions for the teachers or urge them to use audio-visual materials.

Some Suggestions for Overcoming the Problem of Overcrowded Curricula and General Centralized Exams

It is hoped that the obstacle of overcrowded science curriculum will be partly reduced when the proposed science textbook for the intermediate

---

1. This series of the three science books are published by G. Bell and Sons Ltd., London.

schools is completed. If the intermediate science teaching committee could succeed in making Johnson, the author of the textbook, increase the quantity of physics and chemistry in all grades of intermediate education, a good quantity of the elementary general science now taught in the first year of the secondary schools will be transferred to the intermediate, thus reducing the tension caused by the crowded secondary science curricula.

A proper understanding of audio-visual aids, and what they can do, will help greatly in overcoming the problem of overcrowded curricula as an obstacle to audio-visual instruction. In fact, considering crowded curricula as a major obstacle to the use of audio-visual aids is a sign of a lack of understanding of what audio-visual instruction as a mass media can do. When asked about this problem Mutwakil Ahmed Amin the head of the Examination Council of the Sudan says:

> "... the majority of teachers tend to lecture and cram notes rather than teach. With the use of audio-visual aids it is expected that a great deal of time wasted in talking will be saved and the teachers will feel that the obstacle is not in the syllabus but in the way they teach it."[1]

Many research studies[2] have proved that audio-visual materials can help the teacher to teach more in less time and in a more interesting and effective manner; but the science teacher in Sudanese secondary schools need to be convinced by practical demonstrations. Bringing up-to-date adequately illustrated textbooks with practical suggestions to the teacher may help the

---

1. See the special questionnaire developed for Mutwakil Ahmed Amin in Appendix B.
2. See for example the research studies given in the Encyclopedia of Educational Research. 1952, pp. 84-85.

science teachers to use audio-visual aids and the students to have a better outlook to general science.

The obstacle of competitive general exams is more difficult to overcome because it is a part of other more serious problems like the great deficiency of schools, and the centralization of the Secondary School Certificate Examinations for entrance to the University of Khartoum, (in a combined collaboration between the University of Khartoum, the Examination Council, and the University of Cambridge). The majority of candidates do not intend to follow university education; but they take this highly academic competitive examination merely to prove that they have completed their secondary education satisfactorily. It helps them find better jobs.

A possible suggestion for reducing the tension given by these centralized exams is to make another separate, less academic, examination for the majority of those who do not want to join the University. By so doing the teachers and most of the students will relax and find more time for making their secondary science curriculum more concrete and meaningful. It will be much better still if the examination for the completion of the secondary stage, and the examination for entrance to the university, are separated by an academic year or six months during which the candidates applying for entrance to the university may have special academic preparation.

The present system of examinations should be improved by bringing the quantity of memory questions to a reasonable minimum, since the method of education is very much affected by the type of questions expected. Practical examinations in science should be introduced to make sure that direct experience will not be overlooked.

3. Lack of Understanding of the Value of Audio-Visual Aids:

Though the teachers and administrators have given the lack of funds as the greatest hindrance to the use of audio-visual aids in the Sudan, a more critical approach will reveal that the lack of understanding of what audio-visual aids are and what they can do is the biggest of all obstacles. Most major and minor obstacles like "the equipment is too complicated to learn how to use", "the lack of administrative support", "the lack of teachers understanding the value of audio-visual aids", and "the lack in properly trained audio-visual personnel", are caused by the lack in appreciating the role of audio-visual instruction.

If the problem of lack of funds itself is analyzed, it will be found that it is largely due to a lack of awareness of what audio-visual aids can do. Had the Ministry administrators appreciated audio-visual aids, the negligible budget given to them would have automatically been raised. The misconception that audio-visual instruction is limited to the sphere of motion pictures has caused many teachers and school and Ministry administrators to think of the price of visual materials in terms of motion picture projectors.

Even Ahmed Saad, the Chief Inspector of Secondary Science Education himself, has partly drifted with this misunderstanding that the scientific audio-visual program in secondary schools should be started with motion pictures. In his letter[1] of the twenty-third of October 1957 to the

---

1. For more details see a copy of the letter in Appendix C.

Director of Education he says:

> "A central science film library is to be set up at the Headquarters. A small sum of money (200 to 300 Sudanese Pounds)[1] is to be budgeted annually for the buying of films from U.K."

From the detailed inventory given in the previous chapter, (and the problem of limited funds sighted earlier in this study), it is clear that if a successful audio-visual program for science teaching it to be initiated in the Sudan, it should be started with simpler and less expensive aids. The motion picture should be brought into the classroom after it is made sure that teachers have already used more concrete and direct materials like the fieldtrip, the exhibit, the specimen and the object, and that they have really appreciated the value of audio-visual instruction, so that when costly equipment is purchased, it will not be misused or locked up and left there to gather dust.

If the science inspector finds it necessary to initiate the audio-visual program by some form of projected materials, then he ought to have taken the recommendations of the International Commission on Sudanese Secondary Education.[2] The filmstrip was found to be a more effective aid for the Sudan than either the motion picture or the epidiascope. The price for one black and white motion picture is enough to purchase more than twenty-five black and white filmstrips. Hence the three hundred Sudanese pounds that Ahmed Saad has requested to begin his film library

---

1. A Sudanese pound is approximately equal to a sterling pound.
2. _The Report of the International Commission on Secondary Education_, p. 59.

by purchasing about fifteen films, can be used to start a filmstrip library of three hundred filmstrips.

Occasionally the lack of knowledge about what audio-visual aids are found, locally or can be inexpensively produced locally, may cause the unnecessary dissipation of large funds. For example the Ministry of Education has agreed to purchase expensive, elaborate equipment for making educational filmstrips for the Adult Education Center without making sure that there is an expert available who can make these filmstrips. After the arrival of the equipment, a candidate was sent to England to study filmstrip production while the equipment gathered dust. If the Ministry of Education had made a thorough survey of its different departments, and what other ministries have got, before ordering this costly equipment, they would have known that Newbould of the Ministry of Social Affairs can make the limited number of filmstrips they want by inexpensive methods; and Johnson of Bakhter Ruda has already begun to produce educational filmstrips for the intermediate schools of Bakht-er-Ruda.

A lack of understanding of what nearby Arab countries have done in the line of audio-visual aids to science teaching also increases the problem of limited funds as an obstacle to the use of audio-visual instruction. For example, Egypt has found that her inspectorate system has failed to further the use of audio-visual aids in schools, so they have initiated a very large audio-visual center for all the country in which materials are produced locally at low cost, and equipment maintained and repaired. Mohamed Mahmoud Abu Shadi[1], (the filmstrip expert at this center), says that they have a filmstrip library of 1,397 filmstrips from different parts of the world, and that they are now producing filmstrips at a cost of twenty Egyptian piasters per strip. In other words, the three hundred Sudanese pounds proposed by Ahmed Saad for starting his film library could be used to purchase 1,500 scientific filmstrips from the Egyptian Government. The materials produced in the Arab world are not only less expensive but they are frequently more valuable than those imported from Europe since they have been produced in an environment quite similar to that of the Sudan.

As far as school administrators are concerned, the lack of familiarity with, and appreciation of, audio-visual instruction makes them hesitate to buy an inexpensive filmstrip projector as they think it is a luxury; but they purchase very sensitive galvanometers, analytical balances, and other costly equipment which is too sensitive to be used more than once or twice a year in the secondary school. Some school principals do not believe that students really gain anything from fieldtrips or film shows. They think that any deviation from the traditional class teaching is only a waste of time and an attempt to substitute real teaching by useless intertainment. A science teacher tells of a discouraging incident. The Headmaster of his school refused to allow him to take his class on a fieldtrip to a near-by factory and told him that a better and more 'educa-

---

1. Special interview with Tantawi the head of Audio-Visual Center and Mohamed Mahmoud Abu Shadi in Cairo.

tional' plan would be for the teacher to take the trip himself in the afternoon and describe what he has seen to the boys during the next morning. Hence lack of understanding of the value of audio-visual education may become the main cause for lack of administrative support.

The dearth of teachers understanding what audio-visual aids can do is probably the greatest hindrance to the direct utilization of these materials in the classroom. Only few schools have motion picture projectors in good conditions, and yet fieldtrips, models, still pictures, objects and the specimens are used less than motion pictures is enough to visualize the extent of this obstacle. It is only the lack of familiarity with audio-visual instruction that makes science teachers put problems like "overcrowded curricula", "lack of funds" and "the equipment is too complicated to learn how to use" as obstacles for using visual materials in the classroom. Inexpensive aids can help the teacher to teach more material in less time and in a more effective methods.

Some Suggestions for Overcoming the Obstacle of Lack of Understanding of the Value of Audio-Visual Aids

To overcome this problem, audio-visual programs should be started in the Ministry of Education's Science Inspectorate Headquarters to train science teachers by demonstrations, talks, workshops, equipment labs, summer institutes and proper audio-visual courses. Some government institutions like the Ministry of Social Affairs motion picture and still photography units, the Adult Education and the UNESCO center, the proposed

Faculty of Education and other science faculties in the University of Khartoum, the Art Department of the Khartoum Technical Institute, the Two Years Training College of Bakht-er-Ruda and other foreign agencies can be of great help in this line. Ahmed Saad has already made a suggestion[1] for training laboratory assistants to become projectionists in the Ministry of Social Affairs, and he started to get some assistance from Sandon, the Head of the Biology Department in the University of Khartoum, in training a secondary science teacher to further the work of the science club in Tagat Secondary School; but Nasr El Haj Ali,[2] the Director of Education, believes that no long range plans have yet been made to make full use of most of the above-mentioned institutions, and that the audio-visual activities in various departments of the government need more coordination.

To be successful all the suggested audio-visual programs should grow out of the needs and capabilities of the secondary science education in the Sudan. Emphasis should be given to simple inexpensive materials which are expected to be found or produced in the majority of schools. Valuable audio-visual materials like flannel boards, 2" x 2" slides, lantern slides, dioramas and flip charts are never used in the Sudan. They should be introduced in these training courses for teachers and ultimately in all the secondary schools of the country. Most of the suggested activities for such an audio-visual program are given in chapter five of this thesis.

---

1. Ahmed Saad gave this suggestion in his letter addressed to the Director of Education, a copy of which is found in Appendix C.
2. Nasr El Haj Ali gave this information in answer to the special questionnaire found in Appendix B.

A study of the psychological basis of audio-visual instruction will also be of great help to the trainees.

At least one teacher in every school should receive some form of intensive training in audio-visual education, in order to act as an audio-visual coordinator in his school. Such science teachers should be helped by reducing the number of hours they teach per week so that they will find time for giving demonstrations before teacher groups in the proper utilization of audio-visual materials and equipment, for storing and distributing equipment, for helping individual teachers, for helping in school exhibits and the activities of the science clubs, for solving problems of repair of equipment or darkening facilities, and for keeping the link between the central Headquarters of the Science Inspectorate and their schools. Such teachers can be of help very much in solving the problems of misunderstanding, misutilization and inadequate storing of audio-visual materials and equipment discussed in Chapter Three.

After a general knowledge of audio-visual aids in established, and the teachers begin to use them extensively in science teaching, then an audio-visual center should be initiated in the Headquarters for lending filmstrips, models and mock-ups, films and other audio-visual aids, and the production of simple materials on a large-scale basis. Audio-visual materials explaining known scientific facts and principles like levers, magnetism, convection currents, and the life cycle of a frog may be purchased from outside the Sudan; but materials visualizing concepts of local Sudanese environment should be produced locally or purchased from the Arab world. For example, a filmstrip about the local Sudanese diet, what foodstuffs it contains and how it is digested, or photographs illustrating the life cycle of Usher (a local Sudanese plant) should be made locally. Filmstrips can now be produced at the UNESCO and Adult Education Center in Khartoum, and photographs taken by the photography unit of the Ministry of Social Affairs. Even scientific motion picture films and radio programs can be produced in future by the help of the Cinema and Radio Units of the Ministry of Social Affairs.

Newsletters, pamphlets, and resource units should be developed by the Inspectorate to give the science teachers rich ideas about fieldtrips, demonstrations, films and community resources they can utilize in teaching specific units of the general science course. In other words, a detailed survey of the possible audio-visual experiences in different parts of the Sudan should be made and integrated in the curriculum of general science. An attempt to give a list of the possible fieldtrips is given in chapter five of this study.

SUMMARY

The major obstacles to the use of audio-visual aids in science teaching in Sudanese secondary schools are lack of funds, lack of understanding of the value of audio-visual instruction, overcrowded curricula, and the preparations for centralized general examinations. These obstacles are very much interrelated.

To remedy the problem of lack of funds, the Ministry of Education should increase its negligible budgets for audio-visual aids, and science teachers should be encouraged to use free, locally produced, and inexpensive teaching aids. A better understanding and appreciation of audio-visual education by the school and Ministry administrators will help to reduce the problem of lack of funds.

It is hoped that the overcrowded secondary science curriculum will be decreased when the general science textbook for the intermediate schools is completed, and general science starts to be officially taught in the intermediate level. To minimize the effect of centralized State examinations in the secondary level, a less academic examination for the completion of the secondary education should be made. It should be separated from the highly academic examination for entrance to the University of Khartoum, since the majority of the secondary school students do not enter the University. (They take its entrance examination merely to be certified for various jobs recruiting secondary school graduates). A better understanding of what audio-visual aids can do will convince science teachers that crowded curricula and general exams should not stop them from using visual aids since these materials can help the science teacher to teach more in less time and in a more effective and interesting manner.

To help the science teachers to gain more familiarity and appreciation of audio-visual instruction, audio-visual programs should be started in the Headquarters of the Science Inspectorate system. Through demonstrations, talks, workshops, equipment labs and summer institutes the science teachers can get proper training in audio-visual education. An audio-visual center should also be started for the distribution, production and maintenance of audio-visual materials and equipment.

CHAPTER V

SUGGESTIONS FOR IMPROVING THE TEACHING OF GENERAL SCIENCE IN SUDANESE SECONDARY SCHOOLS BY THE USE OF INEXPENSIVE AUDIO-VISUAL AIDS

Introduction

Chapter III has shown that audio-visual aids to science teaching are scarcely used in Sudanese secondary schools. Chapter IV has indicated that the lack of funds and the lack of understanding the value of audio-visual instruction are the greatest obstacles to their use. It was suggested that the use of free, inexpensive, and locally-produced audio-visual materials will be a good remedy for both obstacles. Because of the importance of this issue, this chapter is being devoted to giving practical suggestions to the science teachers.

It is a poor science teacher who gives the lack of equipment and materials as an excuse for allowing his students to revert to passive learning and monotonous note-taking. On the other hand, the practical science teacher will find this situation a challenge to his skill. Winds, stars, changing seasons, local plants, birds, fishes, frogs, lizards, insects and even the human body itself can give a wealth of free and inexpensive visual aids. Fruit and cigaret cans, old motor-car engines and storage batteries, iron nails and locally purchased chemicals can enrich the science curriculum before proper equipment are bought. Charts, diagrams, models, mock-ups, still pictures, bulletin boards, filmstrips and slides can be easily improvised to make a good deal of abstract scientific information concrete.

The Sudan is a very large country of 1,000,000 square miles of different climatic and vegetational regions. Some schools are built in large cities and others are situated in underdeveloped areas and deserts. Therefore the suggestions given in this chapter are by no means exhaustive. The science teachers in underdeveloped areas are definitely much more handicapped but still the ingenuity and initiative of the science teacher can help him to visualize the science curriculum even in a very poorly equipped school in a most primitive area. El Rai El Am,[1] a Sudanese newspaper tells the story of Sheikh Babikir, an old Sudanese educator, who has set a very good example to such science teachers. Sheikh Babikir wanted to give his class a lesson in general science or geography about the earth, the sun, latitudes and longitudes. Because the school was a very poor one located in a primitive village, Sheikh Babikir could not find any visual material other than the chalkboard; but he did not give up. After some thinking, he came to class bearing a water-melon. He demonstrated the shape of the earth by this 'globe', and the formation of day and night by the light coming from the window of the partly darkened classroom. With the

---

1. "The Death of Sheikh Babikir" El Rai El Am, July, 1954.

help of a knife, he visualized how the angles of latitudes are measured from the center of the earth. Then he cut the water-melon into lines of longitudes and latitudes. At the end of the class session, the pupils ate the 'globe' and digested the lesson as well as the water-melon. Thus the list of inexpensive substitutes for costly laboratory equipment and audio-visual aids can be very short if the teacher is skilled and ingenious.

Most of the suggestions given in this chapter can also be of great help to the activities of the science clubs and the proposed audio-visual programs of the inspectorate system recommended in Chapter IV. As a matter of fact the title of this chapter might well have been "How to start an audio-visual program with limited funds". An effort has been made to arrange the audio-visual materials in the degree of their cost; the least expensive aids are tackled first and the more costly ones in later parts of the chapter.

How to Improve Chalkboard Utilization

Because the chalkboard has become a commonplace in the classroom, it can be considered as one of the least expensive visual aids. Though wallboards are very inexpensive, they should be avoided whenever wooden or slate chalkboards can be substituted for them. The chalkboard is very much misused in Sudanese secondary schools. It can be a much more effective audio-visual aid if the science teachers take the following rules into consideration:

a) The chalkboard should be kept clean; all unrelated material left from the previous class session should be erased.

b) The chalkboard should not be crowded with too much material.

c) Complicated chalkboard illustrations that consume much time should be prepared ahead of time. This will save time in the class session.

d) Written work and illustrations should be made in large pattern. The science teacher should remember his short-sighted students and those in the back rows. (See Fig. 17).

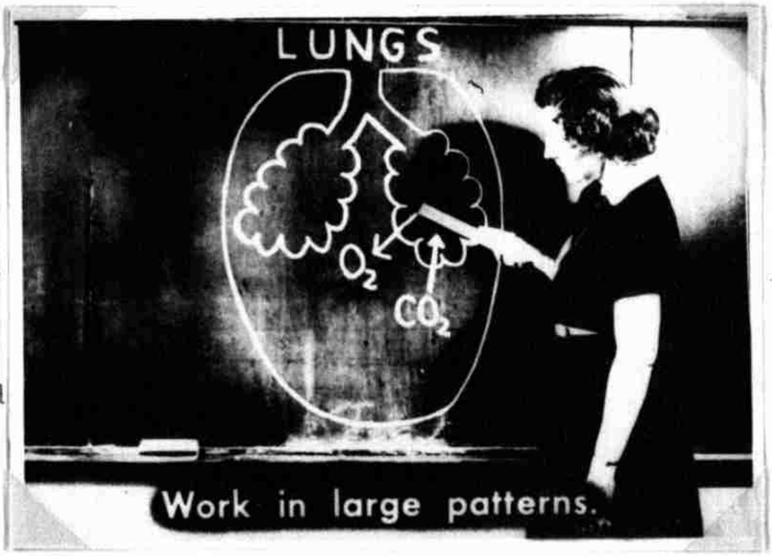


Fig. 17

(Reproduced from the filmstrip Making Your Chalk Talk, made by Wayne University).

e) The chalkboard illustrations and written material should be as simple and neat as possible. In fact the teacher's chalkboard work should be up to the standard he hopes to build in his student's notebook work, because the student is usually affected concomitantly by the neatness or carelessness of his teachers chalkboard work. To this end the teacher should use the ruler, the compass and other chalkboard tools.

f) When explaining chalkboard illustrations, the science teacher should stand to one side of the board and use a pointer to focus attention. Occasionally the science teacher may obscure a chalkboard illustration from some students and they may be too shy to interrupt the lesson and ask him to step to one side.

g) The science teacher should always watch for proper lighting of the chalkboard without increasing chalkboard glares.

h) The science teacher should always have a good supply of colored chalk. Color can be used for clarifying complicated illustrations, for emphasis and for making chalkboard drawings more life like; using a yellow color for the human alimentary canal, a red color for the heart and liver and an orange or pink color for the lungs will make the diagram clearer and more easy to remember. Light refracted by a triangular prism will be much more concretized if the refracted rays are drawn in the different seven colors of the spectrum. The teacher should minimize the use of dark colors because it is difficult to see them from the rear of the classroom.

Some Techniques for Improving Chalkboard Utilization

A. Repeated drawing techniques

There are many diagrams of bunsen burners, stands, round-bottomed flasks and beakers which the science teacher is expected to produce frequently and quickly. To this end the science teacher can use the following three techniques:

1. The pattern method. After making an accurate diagram of the required object on a large sheet of paper, the science teacher should then perforate the outline at approximately one inch intervals, by the help of a punch or a metal tube of about 1/8 of an inch in diameter. By holding the perforated sheet against the chalkboard, and rubbing it with the eraser, the chalk dust will form an outline of chalk dots on the board. Joining these dots will give the required chalkboard outline.

2. The template method. The template can be made by drawing the required illustration on any stiff lightweight material such as heavy cardboard, playwood, masonite or sheet metal and then cut out. By pressing this template against the board with one hand, the chalkboard diagram can be quickly drawn by tracing the chalk outline with the other hand as shown in Figure 18.

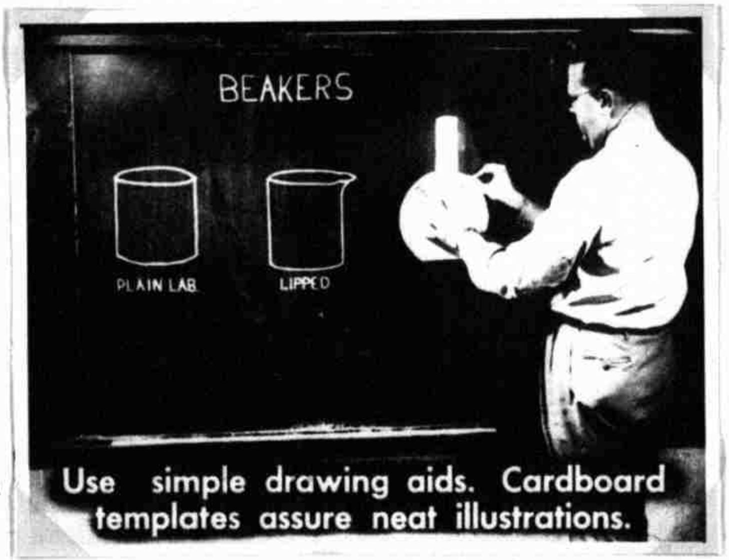


Fig. 18

(Reproduced from the filmstrip Making Your Chalk Talk).

3. The flip-chart technique. The flip-chart or droodle-board is another device with which a science teacher can save much time and energy by preparing all his complicated drawings or written summaries on inexpensive large blank newsprint or wrapping paper sheets. Felt pens, heavy marking

crayons and grease pencils are very good for this purpose. All his prepared illustrations and written work can be fixed at the top of a wooden or pressed board with the help of a couple of nails. Better still, the sheets can be held by a thin sheet of wood that can be firmly pressed against the newsprints by two screws and wing nuts, so that the papers hang freely. Thus when the science teacher finishes explaining the material in one illustration, he can easily move to the next by simply "turning the page", hence, instead of repeating his complicated illustrations and written summaries, the science teacher can save the sheets or pages in the flip-chart to be used again and again.

B. Enlarging techniques

Occasionally the science teacher may find it helpful to copy a valuable chart or a diagram from a book or a magazine on the chalkboard; but the problems of accuracy and lack of time will usually discourage him. The following chalkboard techniques can help to produce enlarged textbook illustrations quickly and accurately on the chalkboard. These techniques can be used to produce enlarged diagrams or charts on paper and hence they can be used in the flip-chart.

4. The grid method. By drawing small equal squares on the original drawing to be enlarged and marking off simultanious large squares on the chalkboard as shown in Figure 19, the small illustration can be easily reproduced on the chalkboard by copying one square at a time.

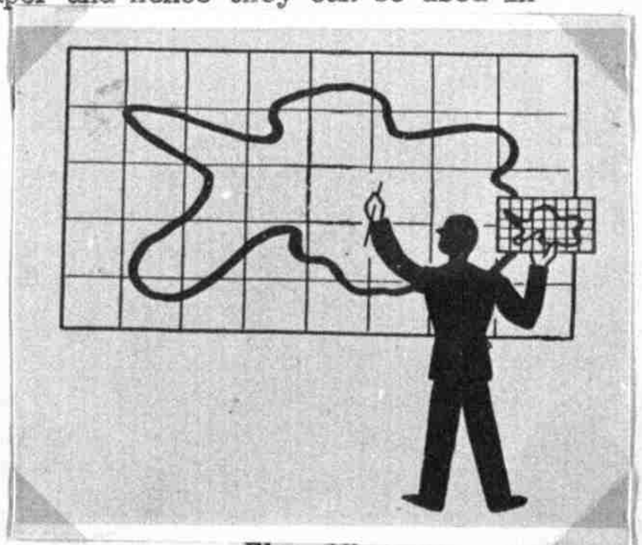


Fig. 19
The Grid Method (reproduced from Hass and Packer, op.cit., p. 68).

5. The projection method. By the help of the opaque projector, large images of small illustrations can be focused on the surface of the chalkboard or the newsprint, and directly traced in the color required. This method is very quick and gives the science teacher the chance to change the size of the illustration he wants by merely changing the distance between the opaque projector and the board. Other charts prepared on slides and filmstrips can be similarly reproduced on the board. Figure 20 shows how the projection method is used in producing a chalkboard drawings.

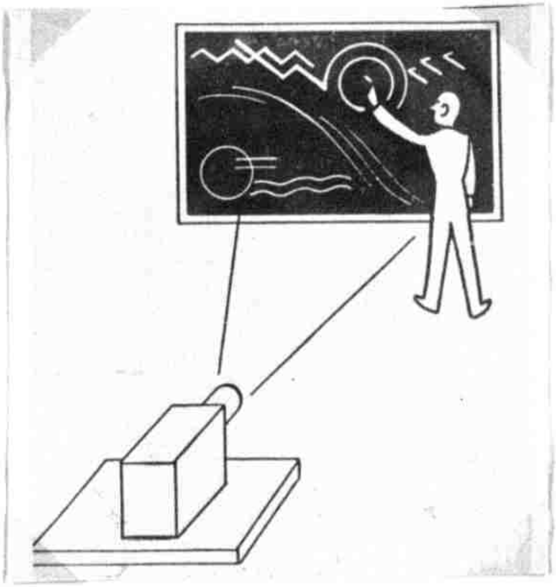


Fig. 20

The Projection Method
(Reproduced from Hass and Packer, op.cit. p. 131)

C. Other techniques

6. The hidden drawing method. When using the chalkboard as an aid to the demonstration method, the science teacher may prepare a series of sequential or developmental illustrations on the chalkboard. In such cases, it will be most effective if the chalkboard is covered by a curtain so that his chalkboard drawings will not be distracting to the students before he refers to them, and to concentrate the attention of the class on the material explained, hence maintaining the sequence required.

A wire stretched along the top of the chalkboard with some form of inexpensive cloth hanging from it will adapt the chalkboard for the hidden drawing technique. Even if this simple curtain is not available, chalkboard illustrations can be 'hidden' by means of large sheets of blank newsprints fixed on the board by the help of scotch tape.

7. The comic drawing technique. Many abstract scientific laws, principles and theories can be very necely explained by the help of chalkboard cartoons and stick figures. These drawings do not require that the science teacher be an artist. Stick figures are merely symbolic representations that can make the chalkboard a more pleasurable and effective aid for teaching science. A circle for the head, a long line for the body and shorter lines for the hands and legs will make a man. Figure 21 shows how stick figures are used to visualize the subject of levers.

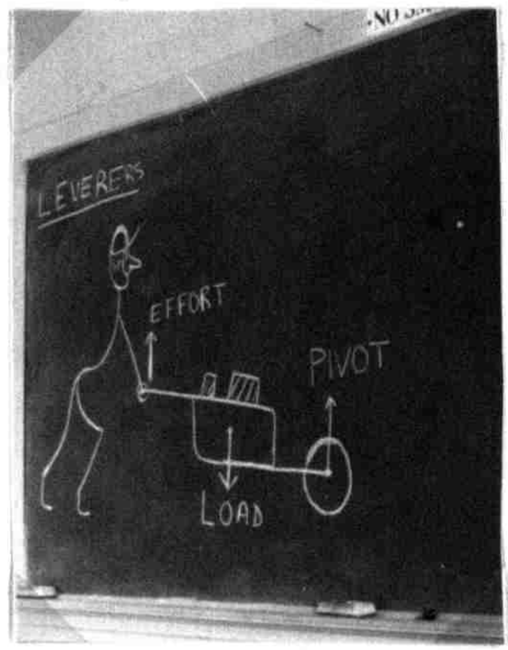


Fig. 21

The Comic Drawing Technique

8. How to make a chalkboard magnetic. Chapter II has shown how modern magnetic chalkboards have added a third dimension to chalkboard utilization. This effective modern innovation in improving chalkboard use

can be inexpensively adapted to 'magnetize' any chalkboard. By nailing a sheet of galvanized iron (which can be purchased locally at a low cost) at the back of wooden chalkboards, or by placing it into the wall in case of wallboards, the surface of the chalkboard can support light magnetized objects. Arrows and similar objects cut out of cardboard, celluloid or exposed x-ray sheets, with inexpensive little magnets stuck on them by Duco Cement can be used for the purpose.

How to Improve the Demonstration Method by Inexpensive Aids[1]

Enriching the Laboratory Equipment by Inexpensive Materials

As mentioned earlier in this chapter, the practical science teacher will not make science purely a chalkboard-textbook subject merely because the right type of equipment is not available. If the generator of the bunsen burner's gas is out of order, the practical teacher can improvise spirit lamps from ink bottles with cotton waste used as wicks. Every two or three students may have their own spirit lamp heater for individual laboratory work. Tin can charcoal burners can also be made for teacher demonstrations.

Similarly, a shortage in test tubes, beakers and flasks can be overcome by using cigarette and fruit cans for heating substances that do not react with their metal, otherwise, used electric bulbs of various sizes can be utilized. By separating the metalic part from burned out electric bulbs, they will act as excellent round buttomed flasks that can stand much

1. Some of the ideas in the section depend upon UNESCO, UNESCO Source Book for Science Teaching, pp. 31, 38, 109, 115 and 117.

heat. Cutting the bottom of large glass bottles will give bell jars of various sizes. Spring balances can likewise be constructed from rubber bands or automobile cushion springs fixed to old tin lids that act as scale pans. If the laboratory is not equipped with an exhaust pump, demonstrations about air pressure, liquid pressure, and many other chemical and biological experiments cannot be performed. The practical teacher can improvise his own filter pump from glass tubing and good work. The wheel and axle can be explained by chalkboard diagram but Figure 22 shows how a practical science teacher can remove the cover from a pencil sharpener and change it into a simple working wheel and axle, that can support a weight of several kilograms.

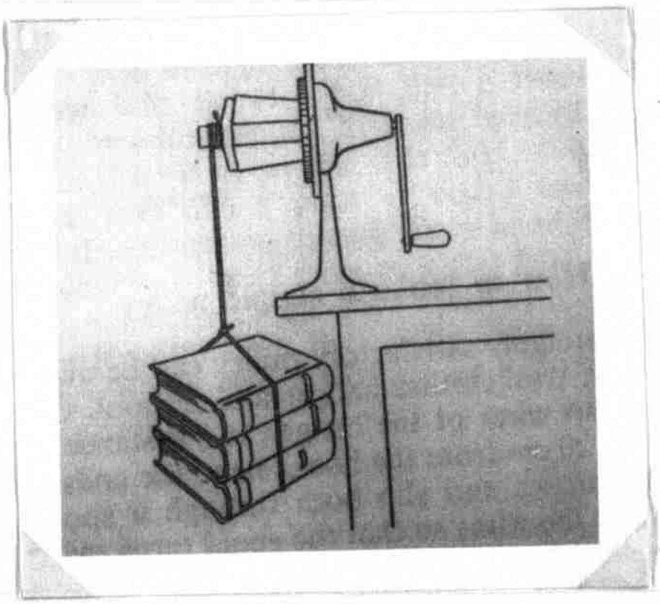


Fig. 22

A Simple Wheel and Axle
(Reproduced from the UNESCO Source Book for Science Teaching, p. 109).

A wealth of laboratory equipment can be made from materials the students bring from their homes or the science teacher purchases at a low cost from drug stores, bicycle repair shops, toy markets etc. The UNESCO has prepared a series of excellent books about the teaching of general science in Tropical and under-developed countries which every science teacher in the Sudan should read. The following chart of inexpensive materials and supplies that the science teacher can collect free of charge or at a low cost is adapted from the UNESCO Source Book for Science Teaching[1].

Inexpensive Materials and Supplies
for Enriching Laboratory Equipment

From Home

Old pans of various sizes	Flower pots
Basins and spoons	Clothes pins
Bottles and jars, various sizes	Leather, soft from old shes
Tins, various sizes	Old blades
Used electric bulbs	Old electrical appliances
Wire coat hangers	Musical instruments
Used tooth brushes	Aluminium milk bottle caps

From Hardware Markets

Nails, spikes and screws	Sheet metal
Bolts and nuts	Metal rods
Springs	Thermometers
Mirrors	Candles
Thumb tucks	Curtain rods
Window glass	Magnetic compasses

1. UNESCO, Ibid., pp. 13-18.

Flash light batteries and bulbs

Pulleys

Steel Wool

Neeldes

Wire, brass, copper and iron

Paint

Thermos bottles

Oil

Kerosene lamps

Lamp chimneys

Lantern globes and lenses

Funnels - metal and platic

Rubber and metal tubing

Scissors

Asbestos mats

Wicking for alcohol lamps

From Automobile Repair Shops

Old rubber tires

Old inner tubes

Valves from inner tubes

Battery acid

Safety glass from old cars

Spark plugs

Ammeters

Carborators

Fuses

Fueld pumps

Electric motor - from old self starters

Electric generators

Curved reflectors - from head lights

Headlight lenses and bulbs

Ignition coil

Engine

Rear view mirror

Used oil

Metal tubing

Gears

From Radio Repair Shop

Radio sets

Condensers

Wire from old coils	Rheostats
Transformers	Metal plates
Electrical instruments	Coils

From the Food Market

Ammonia	Sealing wax
Baking powder	Starch
Bleaching powder	Wood and cardboard boxes
Matches	Paper bags
Epsom salt	Turpentine
Mineral oil	Vinegar

From Lumber Market

Asbestos sheets	Wire screening
Plywood	Sawdust
Hardware	Lime
Insulating materials	Cement
Press board	Wood blocks
Paint	Varnish

From Machine Shops

Ball bearings	Brass rods
Gears	Iron rods
Sheet iron	Iron filings
Sheet brass	Scrab metals
Sheet copper	

From the Drug Stores

- Agar
- Copper sulphate
- Mineral oil
- Hydrochloric acid
- Nitric acid
- Sodium Hydroxide
- Silver nitrate
- Celophane
- Sheet rubber
- Powdered sulphur
- Boric acid
- Manganese Dioxide
- Marble chips
- Thermometers
- Dyes
- Iodine
- Medicine droppers
- Shaving mirrors
- Glass tubing
- Test tubes
- Rubber and cork stoppers
- Sponges
- Litmus paper
- Potassium Chlorate
- Plaster of Paris

From the Optical Shop

- Old cameras
- Old eye-glass lenses
- Reading glass lenses

From Electric Shop

- Batteries, dry cell
- Electric bulbs
- Insulated wire
- Switches
- Lamp sockets
- Electric meters
- Old electrical appliances
- Electric bells
- Push buttons
- Heating elements
- Magnetic compass

From the Toy Market

Small wagons	Steam turbine
Ping pong balls	Electrical toys
Mechanical toys	Rubber baloons
Colored chalk	Toy musical instruments
Steam engine	Plastic toys

From Bicycle Repair Shop

Used bicycle wheels	Bicycle pump
Spokes from bicycle wheels	Bicycle lamp and dynamo
Inner tubes and their valves	Sprocket wheels

In many instances the crude improvised materials and experiments an ingenious teacher makes, are more useful than costly, elaborate, equipment. The students of science are often afraid to manipulate expensive sensitive equipment; but find great pleasure in handling inexpensive locally made substitutes. The materials used in such experiments are usually very familiar to the students, and thus the laboratory work and teacher demonstrations tend to blend school work with the outside life of the learners. The experiment of producing electricity by inserting small pieces of zink and copper plates in a lemon, (as shown in Figure 23); and the experiment of preparing carbon dioxide from a bottle of Pepsi-Cola; or the addition of lemon juice to atron, are examples of inexpensive experiments in which materials familiar to the Sudanese student may be used. Atron, which is a weak carbonate that has an absorbant effect, when mixed with lemon juice, is used as a native medicine for stomach troubles and some skin diseases in the Sudan. Hence it is found in almost every Sudanese home. The construction of an electric motor from cork, wire, pins, and a natural magnet is an example of a most interesting inexpensive experiment which the students of science will not be afraid to manipulate.

The field of biology is also full of such interesting inexpensive experiments. A Sudanese science teacher in a poorly equipped school tells the story of a very successful inexpensive biological demonstration. He says that he wanted to teach the subject of digestion in the stomach. He knew that the laboratory had no powdered pepsin or renin, and that the nearest pharmacy was at least thirty miles away, (since the school is situated out of town); but, nevertheless, he decided to make an inexpensive and exciting demonstration.

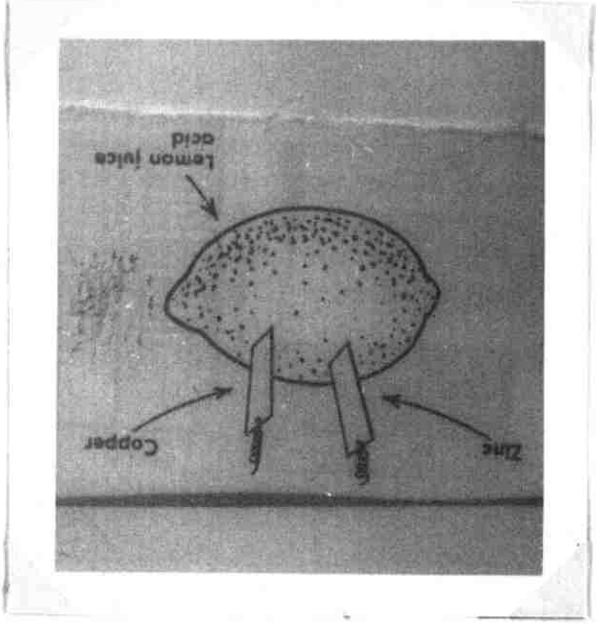


Fig. 23

Producing Electricity from a Lemon

(Reproduced from UNESCO Source Book, op.cit., p. 115)

He asked if one of the students would volunteer to come to the next class session without taking his breakfast in order to give the class some of his gastric juice. Two boys volunteered. The next morning, they went to the school doctor who extracted some juice from one of the students with the help of a long plastic tube. The other refused to swallow the tube, prefering to give his digestive juice by vomiting it out!

Some milk, cooked liver and eggs were taken from the school cafeteria and the freshly drawn gastric juice was used for demonstrations and lab. work. A little juice added to milk and a slight heat applied will curdle the milk due to the presence of renin. This experiment also shows that digestive juice will work most effectively at body temperature. A simple controlled experiment was also performed by putting a big piece of liver in a small beaker containing some juice and another piece of nearly the same size, but crushed into very small parts in a similar beaker containing the same quantity of gastric juice. The beakers were placed in a water bath to keep them at body temperature, but the one containing the crushed liver was shaken most of the time.

Though the reaction between the pepsin of the stomach to change solid proteins into soluble peptones is slow, it was clear towards the end of the double class period that the crushed stirred liver was effected more than the big solid piece. This fact proved to the students the importance of chewing to increase the surface of the reaction between solid food and digestive enzymes, as well as the importance of the perstaltic movements of the stomach in shaking its food content with gastric juice.

Though the main reason for this experiment was to use the least expensive materials, the science teacher says that, as far as the students were concerned, it was the most interesting experiment performed during the year. The juice was not brought in the form of tablets or powder, but was the liquid content of the stomachs of their fellow students. The success of the demonstration was considered by the class as a proof that the gastric juice of the volunteers was excellent! At the end of the lesson, the teacher thanked the volunteers and the news of their cooperation in making a successful demonstration was spread in the school. Had the teacher limited himself to the capabilities of the school laboratory, the only visual aid that he might have used would have been the chalkboard.

Inexpensive Methods of Enabling Every Student to See the Experiment Demonstrated

Most of the old rich government schools have special lecture rooms in which the benches are arranged in tiers so that each student is able to see what is happening on the demonstration table. Many other schools, due to lack of funds, do not have such ideal demonstration rooms. On the contrary, the demonstration table is usually placed on a high platform thus hindering many students from getting a good view of the teacher's demonstrations. To improve this situation, these platforms should be pulled down, and the demonstration tables must be decreased in height. This will also necessitate the lowering of the chalkboards. Saunders[1] gives the following inexpensive methods for a further solution of this problem:

a) If the students are allowed to put their laboratory stools on

---

1. Saunders, op.cit., p. 68.

top of their benches or tables, they can more easily see the experiment being carried out.

b) The science teacher can carry out the demonstration on one of the front student's tables. The students are then instructed to stand in a large semincircle around the table. This method has the disadvantage of putting the teacher at a greater distance from the chalkboard.

c) By placing a large mirror at an angle above the teacher's bench, the class can see what is going on by looking at the reflection in the mirror. This technique has the advantage of clearly showing the students the instruments which are laid flat on the table, or which have horizontal scales, such as magnetometers. The class can also look into heated test tubes from above, an action which is never permissible under normal conditions.

<u>The Fieldtrip an Effective Inexpensive Aid</u>

Though the fieldtrip is an effective inexpensive visual aid that gives meaning to science school work by blending it with community life, it is almost never used in Sudanese secondary schools. The fieldtrip is specially essential for the Sudan because the science curriculum planned by the Cambridge University Syndicate, still in use up to now, is far from being adapted to the local environment of the Sudan. Occasionally, Sudanese science teachers are embarrassed to say that they did not take their students to places of scientific interest which are less than one or two miles away from their school buildings. The slaughterhouse of the city of Omdurman can be seen from the window of the Ahfad Secondary School's laboratory, and yet not a single teacher has tried to concretize the subject of zoology by taking his class to see the hundreds of animals killed there every day.

By taking this slaughterhouse as an example, the following detailed steps will show how a fieldtrip can be planned, executived, and followed up to make science teaching in Sudanese secondary schools more effective and meaningful.

A Fieldtrip to the Slaughterhouse of the City of Omdurman

Purpose

A trip to the slaughterhouse can be utilized by the science teacher for various purposes. He may take the trip to introduce the biological systems of mammals to his students and arouse their interest, to give them specific information, or to review and follow up the study. For the purpose of this discussion it may be assumed that the teacher is planning to take the excursion to review the study of the internal organs of mammals and their various biological systems.

Previous Work

The class has studied the digestive, the circulatory, the respiratory, the excretory and the reproductive systems of mammals in a detailed form with the help of a large model of the human body, some charts and diagrams, a few specimens and intensive reading assignments. The teacher feels that the biological facts his students have studied are not very well organized and that they need to be arranged into larger wholes. Because the school term was divided into separate weeks for studying various organs and biological systems, many students developed the wrong impression that the body of a mammal is a collection of different independent systems, glands and organs, thus failing to perceive the connection and interdependence between them. Also, some organs have been seen in the human model and in flat diagrams but not in their natural form. Accordingly, the teacher and his students decide to visit the slaughterhouse in order to see the internal organs of mammals in large animals like cattle and sheep, and to study their organs in their natural context.

Planning

The success of the fieldtrip depends very much on this item of proper planning and preparations. The science teacher should make arrangements for the visit with the school's administrators and the managers of the place to be visited, and he should prepare his class for the journey.

a. Planning with School and Slaughterhouse Administrators

1. First of all the teacher gets the approval of the school administration. The trip is usually taken in the early morning, therefore arrangements in the teacher's schedule may be necessary. In case of poorer schools which are very far from the slaughterhouse, the approval of the principal will be much more expected if the students are told to pay for their communication expenses.

2. The teacher gets in touch with the veterinary doctor responsible for the slaughterhouse who welcomes the idea. The teacher tells him clearly about the purposes of the trip and the standard of the students so that he will not go into detailed explanations which are very much above the standard of the class, as is expected from such guides who are interested in their fields.

3. The most suitable time for the arrival and leaving of the class is fixed.

4. The teacher visits the slaughterhouse and decides about the points of interest and the difficulties expected.

b. Class Preparations

1. The purposes of the fieldtrip are discussed in details with the class.

2. The students are told what to look for and some possible difficulties explained.

3. A quick revision of the biological systems studied is made by the help of biological filmstrips.

4. The class is divided into two groups. The first group is supposed to go with the Chief Attendant of the slaughterhouse who shall give them a general talk about the administrative work of the slaughterhouse, and the steps taken to furnish the community with hygenic meat. The second group will go with the teacher and the doctor for a detailed study of the internal organs of cattle and sheep. After the Chief Attendant finishes from the first group he will send them to the doctor and the teacher, who will in their turn send him the second group.

5. The students are told to give respectful attention to the Chief Attendant and the doctor, and to show their appreciation of the services they render to the community. They are also instructed not to shift from one group to the other. If one of the group finishes before the other, its members are instructed to survey the place or study the animals in small groups until their turn comes. They are also trained how to sit around the dissected animal in such a way as to enable each one to see and hear.

6. The students are advised to bring their rough notebooks and pens in order to put down observations, evaluations and take notes.

7. The teacher brings his camera and he encourages those who have or can borrow cameras to bring them for taking some photographs in the trip.

8. The students are advised to come to the trip wearing old clothes because blood spots are likely.

In the Slaughterhouse

1. The doctor explains the internal organs and various systems of mammals in large bulls and he clarifies some differences between the body of man and cattle and sheep. The teacher takes up the lead from the doctor and he explains the interdependence and interconnection between the various organs, glands, tissues and systems.

2. The teacher discovers that before the trip, most of the members of the class did not know the difference between the splean and the pancreas while a few others have seen the diaphragm and the gall bladder,

for the first time since what they have seen in class was merely black and white diagrams of these glands and tissues.

3. Though the doctor says that the killing of pregnant female animals is considered big mistake in slaughterhouses, because it tends to reduce the cattle and sheep population, the students and their teacher find the study of various fetuses and embryos at different ages, the most exciting item in the trip. Seeing this great interest, the doctor tells one of the officials in the slaughterhouse to open the uteruses of as many cows and sheep as possible. Towards the end of the trip, a very valuable lesson in embryology is given and the class shows very great interest in the subject though they did not study it in class.

4. At the end of the specified time the teacher and his students thank the doctor, the Head Attendant and the officials of the slaughterhouse for their cooperation, the services they render to the community, and the specimens they presented to the class in order to be shown to other students of the same grade.

Follow-Up Activities

1. The next lesson, the teacher and the class evaluate the trip and review the biological systems studied in the light of the information and direct experiences acquired in the excursion. The model of the human body is restudied and the filmstrips shown again. Now the students can see the real experiences behind the plastic model and the symbols used in the filmstrips. A written objective exam is then given to test how much the students have really benefited from the trip.

2. A discussion of the lecture given by the Chief Attendant and the steps taken to insure that the community is supplied with hygenic meat results in a few suggestions for improving the work of the slaughterhouse. The teacher promises to send them to the doctor.

3. The class shows great interest in bringing various embryos and fetuses to the school, and the proposal of preserving them in bottles finds unanimous agreement. Thus student committees are formed to bring the fetuses and embryos from the slaughterhouse, to prepare preservatives and to collect and purchase large bottles.

4. Interest in the subject of embryology is shifted to the study of human fetuses and hence another trip to the University of Khartoum's Medical Museum is taken where some human embryos and fetuses are studied. The teacher gets in touch with an old friend working as a doctor in Omdurman Civil Hospital and he promises to preserve some human fetuses for the class.

5. The accumulation of fetuses and other specimens creates the problem of the place where they can be stored and exhibited and thus the idea of a scientific museum similar to that of the University finds full agreement. Plans are laid for enriching the museum by materials of interest students promise to bring from their home lands in different parts of the Sudan after the school vacation.

6. More interest in the subject of embryology also results in the study of chick's embryos and the construction of a simple inexpensive incubator for eggs.

<u>Other Possible Fieldtrips in the Sudan</u>

From the detailed steps discussed in the slaughterhouse excursion, it is clear that fieldtrips do not only concretize subject matter, but they occasionally result in other concomitant learnings and activities that may be of more benefit than the initial purpose of the trip itself. Fieldtrips are the most important source of inexpensive objects and specimens. The Sudanese science teacher can take many fieldtrips to visualize physical, chemical and biological aspects of the secondary science curriculum. The following list gives some of the most important possible fieldtrips in the Sudan:

<u>In Khartoum</u>

1. The Health Museum
2. The Natural History Museum
3. The Technical Institute
4. The University Museums
5. The Faculty of Agriculture and the Research Center of Shambat
6. The Sudan Light and Power Electrical and Water Stations.
7. The industrial area of Khartoum North
8. Aluminium light industry
9. The photography and motion picture units of the Ministry of Social Affairs.
10. Sudanese Broadcasting Station - Omdurman.
11. The Observatory of the University

12. International Airport
13. The Welcome Chemical Laboratories
14. Civil Hospitals
15. Glass Factories
16. Ice Plants
17. Garages
18. Newspaper Offices
19. Kafori Dairy
20. Khartoum Zoo

Outside Khartoum

21. Gezira Cotton Plantation, Ginning Factories, and steel works.
22. Marine Gardens of Port Sudan.
23. Docks of Port Sudan.
24. Salt crystalization factories of Port Sudan.
25. Meat factories of Kosti.
26. Steal and Railway Industry at Atbara.
27. Sinnar and Gebil Awlia Dams
28. Cement Factories of Atbara.
29. Gum collection centers in Western Sudan.
30. The vegetational areas of Gebel Marrah.

How to Make Inexpensive Graphics

By the help of the grid and the projection method described in the section about the chalkboard, diagrams, charts, maps, posters, graphs and cartoons can be enlarged and reproduced from scientific textbooks and magazines by the teacher or the students. Many secondary schools in the Sudan have rich Art Departments which can help in producing excellent colored graphic materials. The students of the science club can also assist in producing various graphics which aid in visualizing physical and biological sciences. For large scale production of these materials, the silk screen method utilized in the Khartoum Technical Institute can be an effective and inexpensive method. Graphic materials can be made more durable if the sheets of paper are wet mounted by sticking some kind of inexpensive cloth at their backs before drawing and coloring takes place.

Compiling a Still Picture File

The science teacher can build his own picture file by the photographs he can take himself, or those photographed by his students or prepared by the science clubs. All these types of photographs can be taken by an inexpensive box camera. Another source of excellent colored inexpensive pictures is those collected from magazines like the "National Geographic", "Life", and scientific magazines.

Though the efforts of the still photography unit of the Sudanese Public Relations Office are not yet capitalized upon for the production of scientific photographs for secondary science teachers, the practical teacher can find an appreciable collection of inexpensive documentary photographs about the "Gezira Cotton Scheme" or "Pest Control" which can be purchased to visualize the study of biology. On page 169 of this study are shown some of such photographs that were originally photographed for documentary purposes by the Public Relations Office; but they have been found to be very good for the production of a filmstrip visualizing secondary school botany.

A third source of free still pictures, graphic materials and even at times filmstrips that the science teacher should capitalize upon to enrich the science curriculum, is the free-of-charge visual materials distributed by many companies, governments, and other agencies for advertizing purposes. To get these aids, it does not cost the science teacher more than the price of the air mail stamps. Figure 24 shows an example of a free, extremely useful, diagram of the human ear illustrated by comic diagrams and cartoons. This graphic material is distributed by the Sontone Corporation, New York.

Fig. 24

The following are the addresses of some of the companies and other institutions that distribute free audio-visual aids to science teachers. These addresses are taken from the Educator's Index to Free Materials, published annually by the Educators Progress Services, Randolph, Wisconsin:

1. Bakelite Co., A division of Union Carbide and Carbon Corporation. Room 1604, 300 Madison Ave., New York 11, N.Y.
2. General Electric Co., Public Relations, Schenoctady 5, N.Y.
3. Shell Oil Co., 50 W 50th St., New York 20, N.Y.
4. Firestone Tire and Rubber Co., 1200 Firestone Parkway, Akron 17, Ohio.
5. Electric Storage Battery Co., Industrial and Public Relations Department, 42 South 15th St., Philadelphia 2, Penn.
6. U.S. Atomic Commission, Educational Services, Washington 25, D.C.
7. Vita Food Products Inc., 644 Greenwich St., New York 14, N.Y.

Making Bulletin Boards, Flannel Boards and Electric Boards

The Bulletin Board

To display his graphics, still picture collection and other flat and three dimensional materials in the classroom and school exhibits, the science teacher can make his own inexpensive bulletin boards and flannel boards as well. Bulletin boards improvised from cork, soft wood, masonite, or press-board are inexpensive, durable and can support heavy and three dimensional objects with the help of thumb tacks. Very inexpensive, less durable bulletin boards can be constructed from heavy brown wrapping paper, burlap cloth, monk's cloth, and numerous other fiber materials. Still pictures and graphics may be supported by pins or adhesives.

To be sure that the bulletin board can stand rough use, and to make it look more attractice, a wood or a metal frame must be made for it.

Student committees should be organized to prepare attractive scientific illustrations for bulletin board display, to make captions and to arrange the materials exhibited in an orderly and interesting manner.

The Flannel Board

With all its advantages, the flannel board is a very inexpensive audio-visual material. One or two yards of flannel or felt, a piece of plywood, heavy cardboard or masonite 60 x 100 cm., a few thumb tacks and scotch tape or glue are all that is needed to make the flannel board. The flannel is stretched over the board and fixed over the other side by thumb tacks. After making sure that the flannel or felt is tightly fixed, the glue or the scotch tape is then used to fix it permanently on the board.

Letters, words and other scientific symbols can be cut out of felt or any other woollen material. Still pictures and other paper materials can be backed by felt or sand paper. Stretching the felt over a sheet of iron or steel instead of the wooden board, will make the felt board magnetic. Like the magnetic chalkboard, small natural magnets attached to three dimensional objects can then be supported on the surface of the feltboard.

If the science teacher finds that two yards of felt are rather expensive, he can use an old blanket that a student may bring from his home to make an inexpensive flannel board. Even if sand paper is not available, a thin sheet of waste cotton glued on the backs of still pictures will support them on this extremely inexpensive board.

The Electric Board

The electric board can also be inexpensively improvised by any science teacher. A piece of masonite, cardboard or plywood, some push buttons, insulated wire, a dry cell, few flash light bulbs and the prepared chart or diagram are all what is required. The wire, dry cell and bulbs can be taken from the laboratory equipment for teaching electricity. The principle of the electric board has already been explained in Chapter two.

Making Models

Cutaway and working models are difficult to make and usually require the skill of expert model-makers; but simpler models and mock-ups can be locally improvised by the science teacher and his students. Occasionally very abstract scientific principles can be very nicely explained by inexpensive crude models. For example wire coat hangers and pingpong balls can make a simple planetarium that explains how the earth revolves in its own axis and still moves around the sun.

A Sudanese science teacher gives another vivid illustration of effective inexpensive models. He says that he wanted to explain the atomic theory of Dalton and the subject of valence to the third year of the Ahfad Secondary School. He knew that a set of ready made colored wooden balls supplied with metal springs could visualize the lesson; but the school did not have this set, and there was no time for getting wooden balls locally. To solve the problem, he told the class that every student was required to make mud balls with various specified diameters. Before the mud dried, every student was told to use a match stick in making four holes in the largest ball, six holes in the next one, two holes in the third and one hole in the smallest ball. While still wet, the largest ball was painted black by ink or soot, and the other balls by different colors of powdered chalk. The teacher prepared his own demonstration large scale balls.

The next morning, the dry colored balls stood for atoms of carbon, sulphur, oxygen and hydrogen. The number of match stick holes in very atom represented its valence, and their different sizes stood for their respective different atomic weights. By the help of match sticks, simple chemical formulae written on the board could be constructed by the students. Thus, a very abstract subject, that the students usually find great difficulty in understanding, became a very interesting activity by the help of crude mud balls.

Inexpensive models and mock-ups can be constructed from modelling clay, heavy cardboard, clay, plywood, paper mache, soap and several other materials. Figure 25 shows an example of a student-made cutaway model of a root tip improvised from paper and cardboard by an A.U.B. student, and Figure 26, reproduced from the UNESCO Source Book for Science Teaching,[1] gives an example of a teacher-

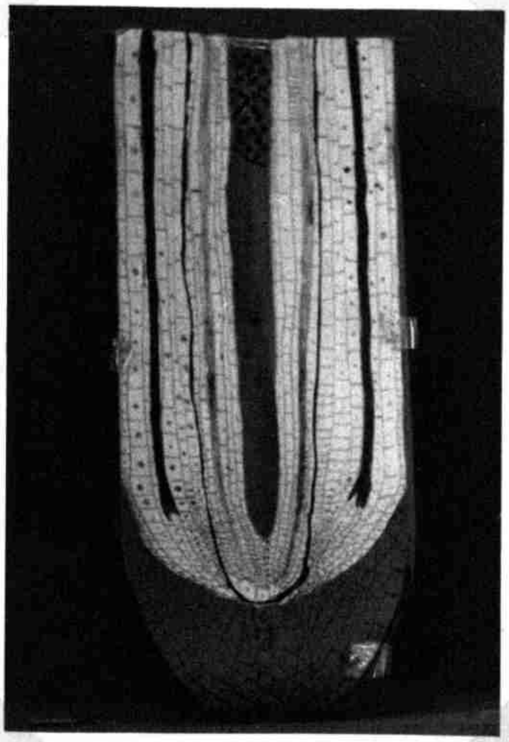


Fig. 25
A Student-Made Cutaway Model

---

1. UNESCO, UNESCO Source Book, op.cit., p. 141.

made mock up of a steam engine, constructed from plywood.

Plaster of Paris mixed with water and molten wax poured in prepared casts of plasticene and water clay respectively, can be utilized to reproduce commercially made models. Pressing the ready made model against plasticene or clay will leave its detailed impression on them. The plaster or melted wax poured on this impression will harden to give a duplicate of the model. When models needing some artistic ability are to be made, the ingenuity and imagination of the science student members of the art club and other gifted individuals in the school should be utilized.

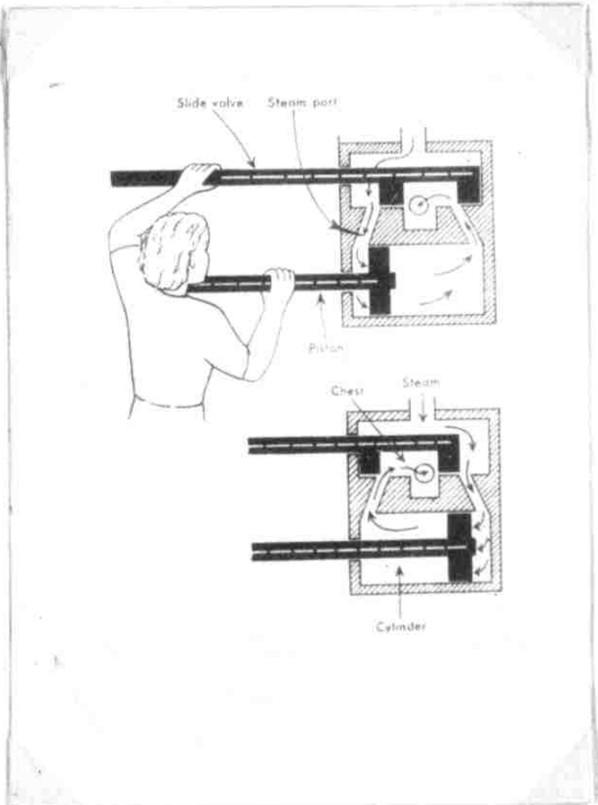


Fig. 26
A teacher-made mock-up

Improving Science Exhibits

If the science teacher utilizes the fieldtrip regularly, collecting a good quantity of objects and unusual specimens; and, if he seeks the help of his students and the members of the art, the photography, and the science societies to build-up a picture file, make graphic materials, models and mock-ups; and, if he makes use of free idstribution audio-visual materials, he will definitely have enough audio-visual aids to vitalize any classroom display or 'science fair'. By making his own bulletin boards, flannel boards and electric boards, he can make an attractive medium for exhibiting his flat and three dimensional objects. Showy student-and-teacher-made demonstrations similar to the ones described earlier in this study, can add elements of motion, light, sound and audience participation that adds to the success of school displays.

<u>How to Make Lantern Slides</u>[1]

To make inexpensive hand made lantern slides, ordinary window glass may be cut to the standard size of ($3\frac{1}{4}$" x 4"). If the glass is cleaned with soap, water and pottassium dicromate, if necessary, it will be possible to write on it with India ink, but to get better results, the glass should be coated with gelatin. A small amount of granulated or plain dessert gelatin, which may be purchased from any grocery, when dissolved in hot water will gelatin-coat any number of slides. The solution must be poured in a large vessel and the slides, held by their edges, are dipped in the solution. The slides are then supported at an angle on paper towels or blotting paper to drain and dry. After about ten minutes, the coated slides can take India ink and colored slide inks.

Etched or ground glass makes the most satisfactory type of lantern slides because it can be written or drawn upon with lead pencils, lantern slide crayons, India ink and slide inks. Ready-made etched glass

---

1. This section is paraphrased from: Richardson and Cahoon, <u>Methods and Materials for Teaching General and Physical Science</u>, pp. 97-101.

slides can be purchased. However, etching ordinary window glass is much cheaper. Fine emery or carborundum powder which is used to grind the valves of automobiles may be utilized. A small quantity of the powder placed on a smooth piece of iron with some water added to moisten it will make a good "etching" mixture. The glass slide is placed over this mixture and etched by a rotary movement. After making the required illustration on the slide, it can be protected by placing another clean glass over it, and the two bound together by adhesive tape.

Colored cellophane may be used to add color to lantern slides or for preparing typewritten slides. A ($3\frac{1}{4}$" x 4") piece of cellophane is placed between a double carbon paper which is cut twice the size of the cellophane and folded in the middle so that the typing will occur on both sides of the cellophane. After typing, the piece of cellophane is placed between two glass slides and bound by adhesive tape.

Lantern slides can be one of the most effective audio-visual materials for the Sudan. They are inexpensive, easy to make, and may be utilized to adapt the teaching of general science to the local needs and interests of the Sudanese students.

How to Make an Inexpensive Lantern Slide Projector

Richardson and Cahoon[1] give the diagram on Figure 27 as a suggestion for making an inexpensive overhead lantern slide projector. The projector is made from a sheet iron box lined with asbestos sheets and screwed on a

---

1. Richardson and Cahoon, op.cit., p. 81.

wooden base. A 500 watt projection bulb with a concave mirror clipped behind it will coverage the light on the first plano-convex condensing lens. The light is then reflected by a plane mirror placed at an angle of forty-five degrees on the second plano-convex condensing lens which is fastened below the opening of the projection area of the slide as shown. A metal rod bolted through the wooden base and braced against the metal box is utilized to support the smaller projection lens and the second plane mirror that reflects the image of the slide onto the screen.

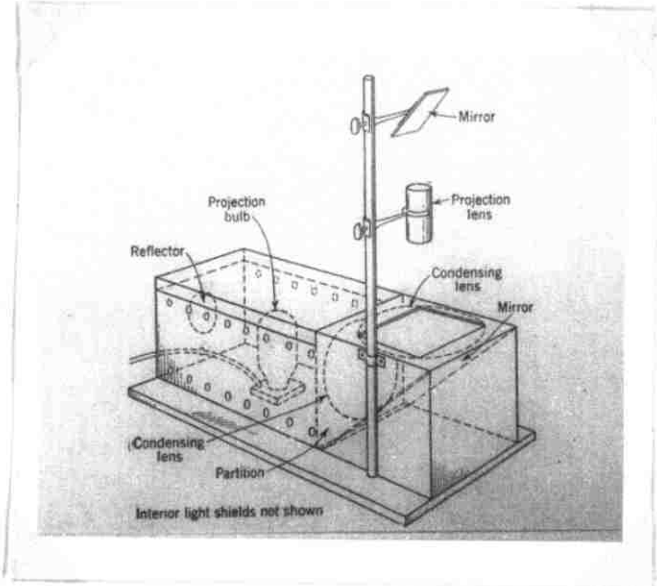


Fig. 27
How to Make an Inexpensive Lantern Slide Projector

It was found that though this projector is very inexpensive when compared with the price of a commercially made lantern slide projector, it is still somewhat expensive. The two condensing lenses which must be at least five inches in diameter cost at least thirty Lebanese Pounds (about four Sudanese pounds). Its construction needs great skill, since the concave mirror, the two condensing lenses, the two plane mirrors, and the projection lens should all be very well adjusted to have the same optical axis. The 500 watt projection bulb gives excessive heat and the convection currents passing through the holes at the top and bottom of the box are not enough to cool the projector.

A less expensive horizontal lantern slide projector that overcomes the problem of over-heating can be constructed. Figure 28 shows a photograph of this proposed projector which is illuminated by a 500 watt spot light bulb that throws a parallel beam of light cooled by an inexpensive piece of heat-absorbing glass before it passes through the slide. A projection lens fixed on a metal cylinder that fits exactly in another cylinder attached to the projector is adjusted till the image of the projected slide is sharply focused onto the screen.

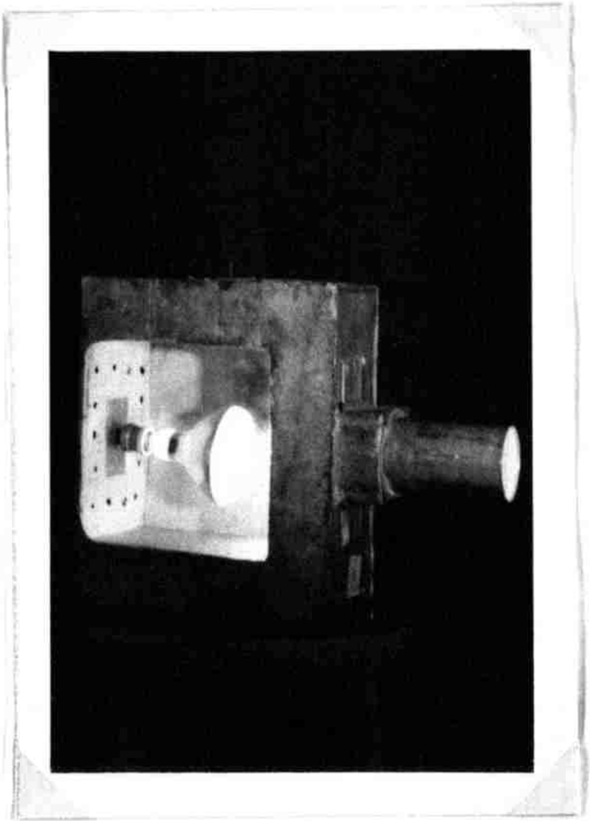


Fig. 28
An Inexpensive Lantern Slide Projector Cooled with a Water Jacket

This projector made of sheet iron is double-walled so that the heat generated by the projection bulb is minimized by the jacket of water that passes between the water-tight walls of the projector as shown in the photograph. The back wall on which the bulb is supported has large holes at top and bottom for convection currents.

Expensive commercially made projectors are cooled by electric fans that drives a continuous stream of air around the projection bulb. Similarly, the science teacher can cool his locally-made projector by blowing air in the projector by using a filter pump.

<u>How to make an Inexpensive Opaque Projector</u>

Richardson and Cahoon[1] give the diagram reproduced in Figure 29 as an inexpensive way of making an opaque projector. This projector is based upon the same principles discussed in the suggested methods for the improvisation of the lantern slide projectors. The science teacher can use this opaque projector for projecting his still picture collection as well as small objects and specimens. Both the opaque

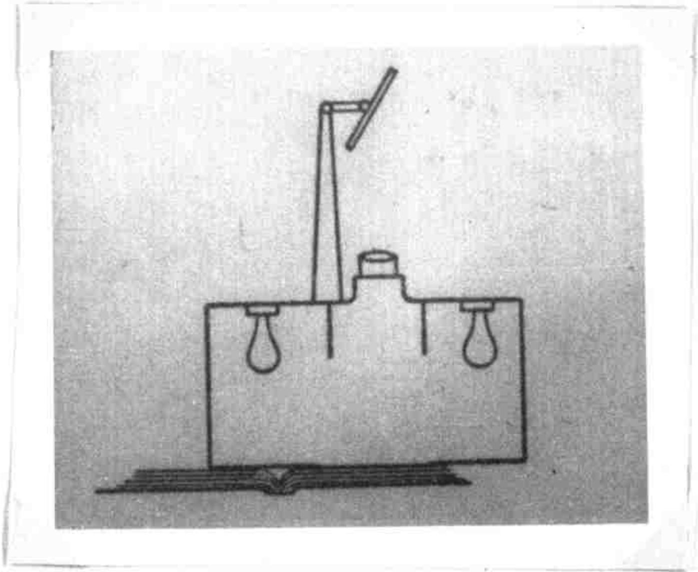


Fig. 29

An Inexpensive Opque Projector

and lantern slide improvised projectors can be used to project onto the screen a variety of opaque, transparent and translucent chemical reactions and other demonstrations as already explained in Chapter Two.

1. Richardson and Cahoon, p. 105.

Making Filmstrips and 2" x 2" Slides

By preparing a sequence of photographs or graphic materials and photographing them by any good quality 35 mm camera, the science teacher can make his own filmstrip and 2" x 2" slides. The average type of commercially made copying stands for the production of filmstrips and slides is usually about 350 Lebanese Pounds in price but the student-or-teacher-improvised stand shown in Figure 30, which gives very good results, costs only ten Lebanese Pounds.

Fig. 30
An Inexpensive Copying Stand

With some imagination, the science teacher can use the photographs in his still picture file or the free distribution photographs and graphic materials to prepare valuable slides and filmstrips. For example the illustrations in Figure 31 are reproduced from a scientific filmstrip made by a science teacher from a collection of photographs about cotton in the Sudan originally produced by the still photography unit of the Ministry of Social Affairs.

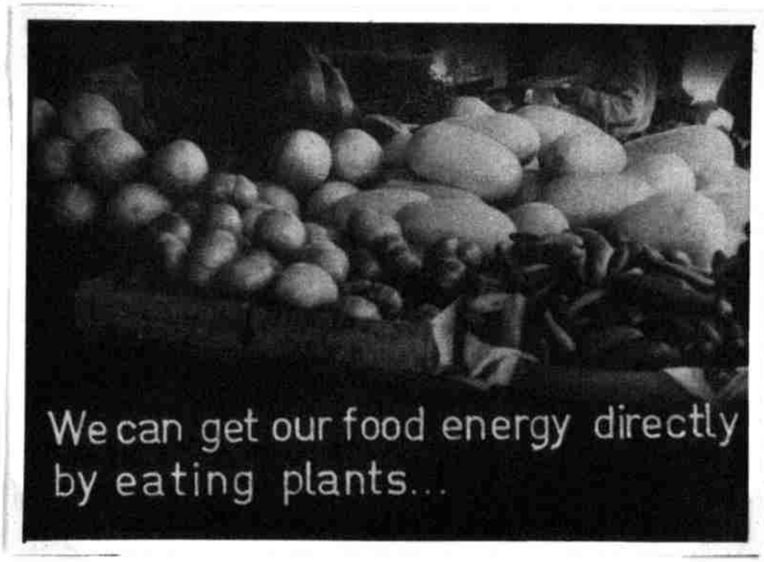
If he has a special filmstrip in mind, the science teacher can prepare his script, then take any box camera and shoot the photographs he likes. After developing and enlarging, captions may be added by lettering with white or black India inks directly on the photographs, or on a piece of paper that he can stick on the photograph by rubber cement. By arranging these pictures in the sequence required, the negative master copy of the filmstrip can be produced by copying these photographs with a 35 mm. camera, using Plus-X film. If a limited number of filmstrips are to be made, the negative copy can be reversed by some chemicals to give the positive transparency of the filmstrip, which is either cut into individual slides or placed in a small tin or box for direct use. For large scale production of filmstrips and slides, an inexpensive contact box can be easily improvised to produce positive filmstrips from the negative master copy. Figure 32 shows some frames reproduced from a filmstrip, "Energy and Food", which has been produced in the same inexpensive way. Colored filmstrips and slides, which give the positive filmstrip directly, may also be made by the teacher, but generally it is less expensive to purchase ready-made colored filmstrips. In rare cases, when the science teacher feels that color is very important for some projected drawings, he may prepare inexpensive, colored, hand-made lantern slides.

Filmstrips produced from graphic materials are very much easier to prepare and are less expensive than photographic filmstrips. The drawings are prepared on a standard size of paper and directly copied by a 35 mm. camera. To get good results, a special fine grain contrasty film should be used. Occasionally it may not be necessary to produce positive transparencies from the negative film used in copying. It would make little difference


الزراعيه في الجزيره .
ففي اول عام تزرع الارض بالذره . . .


وفي العام الثاني تزرع الارض باللوبيه
التي تزيد من خصوبة التربه . . .

Fig. 31


We can get our food energy directly
by eating plants...

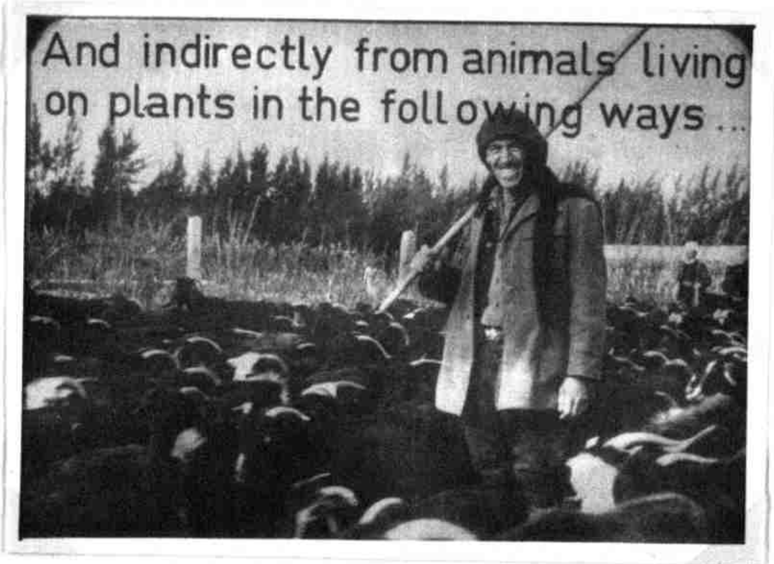

And indirectly from animals living
on plants in the following ways...

Fig. 32


ثاني اكسيد الكربون
يقابل التمثيل الضوئي في النبات عملية التنفس في الحيوان:
اكسجين + سكر = ماء + طاقة + ثاني اكسيد الكربون


اكسجين
ثاني اكسيد الكربون
وبذلك يتم التعاون بين الانسان والنبات

Fig. 33

whether the diagrams are white on a black background or black on a white background. The science teacher can reduce the cost of his filmstrip and slide production by making his own photographic dark room in the school, so that photographic materials may be inexpensively purchased in large quantities. The members of the science, art, and photography clubs can be of very great help in drawing graphic materials, in enlarging prints, and in developing films. Usually these students get much scientific information concomtantly. The frames shown in Figure 33 are taken from an animated filmstrip produced by the scientific and photographic societies of the Ahfad Secondary School for boys, helped by a science teacher who had some intensive study in audio-visual education. The production of this filmstrip shows what an audio-visual coordinator can do to improve the teaching of general science by utilizing the capabilities of the student body and the staff of his school.

By following the same principles utilized in making lantern slide projectors, the science teacher can improvise similar inexpensive filmstrip or 2" x 2" slides projectors; but usually this is not very important because inexpensive filmstrip or 2" x 2" slide projectors are now commercially made. For example the German Paximat 2" x 2" slide projector costs only ninety Lebanese Pounds, and it gives very good results.

Making an Inexpensive Microprojector

Schools like the Ahlia Secondary that has only one microscope for all the students in the school, can follow inexpensive methods of changing the microscope into a microprojector, thus showing all the class the microscopic slide at the same time. Richardson and Cahoon[1] give the diagrams shown in Figures 34 and 35 for adapting a microscope to serve as a microprojector.

A strong beam of light coming from an electric arc or a projection bulb is passed through a bottle with flat sides full of water so that it may act as an inexpensive cooling cell. This water cell is essential since the heat produced by the beam of light may kill microscopic animals and plants. After passing through the bottle, the light is converged by a convex lens, after which the condensed beam passes through the microscopic slide, the objective lens of the microscope, the eyepiece and onto the screen. Focussing by adjusting the objective and eyepiece lenses of the microscope.

For projecting dry materials, the cylinder of the microscope is placed in a horizontal position as shown in Figure 34; but, when a specimen is mounted in water, it is important to keep the stage of the microscope in a horizontal position. In this case, the plane mirror below the stage is used to reflect the light onto the objective lens, and a 45-degree-angle prism to reflect the light on the screen as shown in Figure 35.

<u>Utilizing the Motion Picture by Borrowing Films and Projectors</u>

Though the motion picture is in one way the most expensive audio-visual aid, it can be regularly utilized by most schools even if they do

---

1. Richardson and Cahoon, _op.cit._, pp. 109-110.

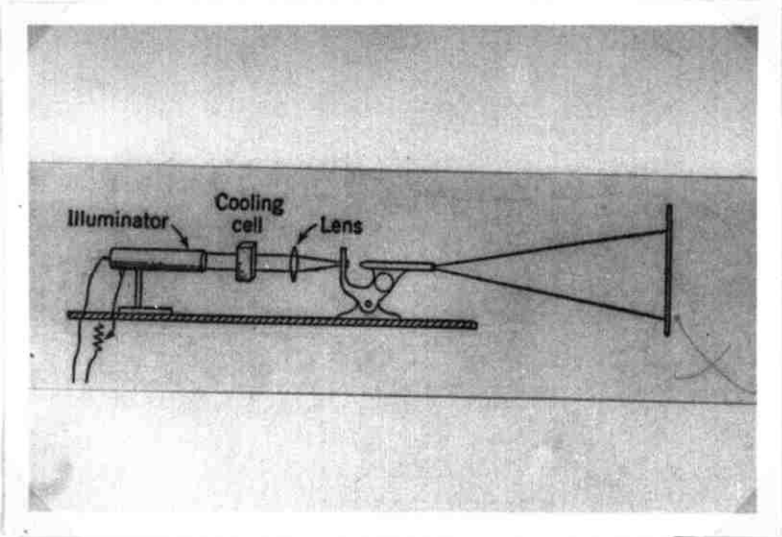


Fig. 34

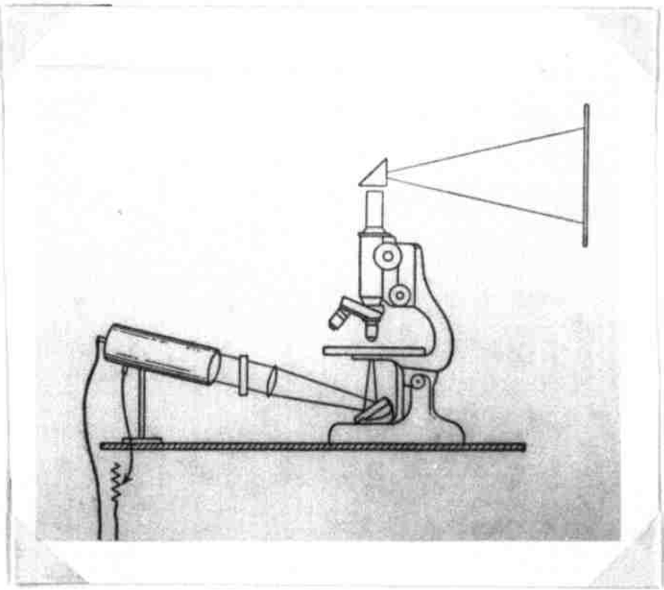


Fig. 35

not have motion picture projectors or film libraries. The Ministry of Social Affairs Motion Picture Unit can lend its motion picture projectors, its projectionists and its limited supply of scientific films to any school if the manager is contacted in advance. The University of Khartoum has an excellent scientific film library about sound, light, elementary electricity, pollination, fertilization, disperal of seeds and fruits, the amoeba and other prozoans, the hydra, moluscs and other valuable films. These are purchased to be utilized in the preliminary year, and are also very good for the higher classes of the secondary school level. At present, the university film library is kept in the physics and the zoology departments. Bashir, the head lab. assistant of the physics department, and the university projectionist, can help any secondary science teacher to preview films. The heads of the physics and zoology departments are willing to give films out to secondary schools in Khartoum and Omdurman if they make sure that they will be brought back the next day. Some secondary schools have very good scientific films which may be lent to other schools.

Other foreign institutions and embassies like the Shell Company, the British Council, and the American and Russian Embassies have a good supply of scientific films. Occasionally, they send the films with the projector and the projectionist with their own cars to the secondary school when required. It is essential for the science teacher to preview science films before showing them to his students so that he may differentiate between scientifically valuable films and mere intertainment or films primarily made for commercial and political propaganda.

It is hoped that Ahmed Saad, the Chief Secondary Science Inspector, will make an intensive survey of the science films that various institutions can lend to secondary schools, before the Ministry of Education builds its own film library.

SUMMARY

The practical science teacher does not give the lack of equipment and materials as an excuse for allowing his students to revert to passive learning and monotonous note-taking. He can enrich the school laboratory by improvising inexpensive substitutes for most elaborate equipment and apparatus with materials the students bring from their homes. He may also purchase, materials at low cost from drug stores, radio-repair shops, hardware markets, automobile and bicycle repair shops and toy markets. Occasionally the teacher and student-made materials are more educational than costly ready-made equipment. The chalkboard, which is an essential part of the demonstration method, can be changed into an effective audio-visual aid by techniques like the grid, the template and the projection methods. Any thin chalkboard can be inexpensively "magnetized", so that it may become a three dimensional teaching aid, thus serving as a bulletin board as well. The fieldtrip, which is a very valuable and inexpensive material, can be a good source for collecting objects and specimens and hence the production of a school museum. The Sudan is full of places of scientific interest that can add meaning to the physics, chemistry and biology taught in the secondary schools of the Sudan.

With the help of the science, the photography, and the art clubs, the science teacher can produce inexpensive graphic materials and can compile a rich still picture file. Many commercial companies and other agencies distribute free scientific graphics and still pictures that the science teachers must make use of. Bulletin boards, felt boards, electric boards and models can also be improvised from inexpensive materials like plywood, cardboard, old blankets, flash light bulbs and dry cells, burlap cloth, clay, soap, wax, and plaster of Paris. All free, inexpensive and locally made visual materials can be used to enrich school exhibits and displays.

Even projected still pictures and their projectors can be inexpensively produced. Window glass cut to the standard size of ($3\frac{1}{4}$" x 4") can be coated with gelatin or etched with fine emery or Carborundum powder so that it may be written or drawn upon with lead pencils, slide crayons, India inks, and slide inks. By making a photographic dark room in the school, filmstrips and 2" x 2" slides of all types can be locally made. Lantern slide, opaque and even filmstrip projectors may be constructed from sheet iron, convex lenses, projection bulbs, and asbestos sheets. An intense beam of light and a convex lens can also adapt the microscope to act as an inexpensive microprojector.

Though the motion picture is in some ways perhaps the most expensive audio-visual aid, it can be regularly utilized by most schools even if they do not have motion picture projectors or film libraries. The Ministry of Social Affairs motion picture unit, the University of Khartoum, and several other foreign commercial institutions and embassies can lend their motion picture projectors, their projectionists, and their scientific films.

The problem of lack of funds cannot hinder the science teacher from using audio-visual aids in the classroom or in scientific extra-curricular activities, nor does it stop the Inspectorate system from starting a successful audio-visual program for training science teachers. The Inspectorate system can even make an audio-visual center that distributes free and inexpensive locally produced materials to individual schools. The proposed school audio-visual coordinator suggested in Chapter Four can likewise make a small audio-visual center in every secondary school for in-service teacher education and for the production, the distribution and the storing of simple materials.

It is hoped that the recommendations and the suggestions given in this thesis will be of help to the science teachers, the school principals, and ministry administrators, so that the verbal and passive methods by which general science is now being taught in Sudanese secondary schools may be improved.

APPENDIX A

Audio-Visual Questionnaires developed by the Audio-Visual Center of the American University of Beirut to survey the understanding and utilization of audio-visual aids in secondary schools.

AUDIOVISUAL QUESTIONNAIRE FOR TEACHERS

Name in Full ____
(Name) (Grade and/or Subject)

Name and Address of School ______________________________________
(Name)

____
(Address)

1. What do you think the purpose of Education is? *

2. What brings about change in student behavior?

3. Do you think Audiovisual Teaching Materials and Methods can provide experiences to enrich student learning?

4. Do you believe that audiovisual can provide a variety of teaching tools making teaching fun for the teacher, learning fun for the learner?

5. Do you think audiovisual might appeal to different levels of intelligence and inclinations, thus helping to overcome the problem of individual differences?

6. Does audiovisual help the retention of material learned?

7. Would it be a loss of time on your part and on the part of the students if you were to use audiovisual methods and materials?

8. Can audiovisual capture the interest of the learner and thereby provide sufficient motivation?

9. Do you have ample space to plan for and use audiovisual techniques? eg. showings, production, storage.

* If you need extra space in answering any question, please use the reverse of these sheets. Put more than a yes or a no; answer as to how you believe on each point.

AUDIOVISUAL QUESTIONNAIRE FOR TEACHERS

Name in Full ____
(Name) (Grade and/or Subject)

Name and Address of School ________________________________
(Name)

____
(Address)

1. What do you think the purpose of Education is? *

2. What brings about change in student behavior?

3. Do you think Audiovisual Teaching Materials and Methods can provide experiences to enrich student learning?

4. Do you believe that audiovisual can provide a variety of teaching tools making teaching fun for the teacher, learning fun for the learner?

5. Do you think audiovisual might appeal to different levels of intelligence and inclinations, thus helping to overcome the problem of individual differences?

6. Does audiovisual help the retention of material learned?

7. Would it be a loss of time on your part and on the part of the students if you were to use audiovisual methods and materials?

8. Can audiovisual capture the interest of the learner and thereby provide sufficient motivation?

9. Do you have ample space to plan for and use audiovisual techniques? eg. showings, production, storage.

* If you need extra space in answering any question, please use the reverse of these sheets. Put more than a yes or a no; answer as to how you believe on each point.

[redacted]

10. Do you have sufficient time to plan for and use audiovisual techniques?

11. Who do you turn to for help in solving your audiovisual problems?

12. Is there a budget for audiovisual?

How much?

Where does it come from?

13. Answer the following by checking yes or no:

YES	NO		
___	___	a.	Do you have an auditorium?
___	___	b.	Do you have a central projection room?
___	___	c.	Can you show projected materials in your classroom?
___	___	d.	Can your classroom be sufficiently darkened?
___	___	e.	Can you classroom be well ventilated?
___	___	f.	Is there an electrical outlet in your room?
___	___	g.	Do you have proper amperage and voltage?
___	___	h.	Do you have sufficient lighting in your classroom?
___	___	i.	Do you have exhibit space in your classroom or in the hall?
___	___	j.	Do you have student operators?
___	___	k.	Do you have a Projectionists' Club?
___	___	l.	Do you have ample storage space in your classroom?

14. Has the community helped in any way in your use of audiovisual? If so, how?

15. How have you learned about audiovisual? Check the following list:

___ a. Demonstrations.
___ b. Talks.
___ c. Workshops.
___ d. Newsletter.
___ e. Audiovisual courses.
___ f. Teacher committees.
___ g. Using your talents (art, mechanical, etc.).
___ h. Equipment labs.
___ i. Audiovisual references.
___ j. Survey needs.
___ k. Others (please list).

[redacted]

16. What audiovisual references have you access to?

17. What material and equipment catalogs have you to refer to?

18. Do you have a picture file? Other files?

19. What materials do you have for simple production (poster board, paste, construction papers, paints, etc.) ?

20. Check ✓ for obstacles to using audiovisual;
Check ✓✓ for the major obstacles:

___ a. A lack of funds.
___ b. The high cost of equipment and materials.
___ c. A centralized prescribed curriculum.
___ d. The lack of time.
___ e. Preparation for the general exams.
___ f. The lack of properly trained a-v personnel.
___ g. The lack of a central audiovisual department.
___ h. The inadaptability to your subject matter area.
___ i. The lack of a-v specifically for the Middle East.
___ j. The lack of facilities in architectural building plans.
___ k. Equipment is too complicated to learn how to use.
___ l. The lack of administrative support.
___ m. Setting up to use a-v is too much bother.
___ n. Others (please list).

21. If you have no audiovisual program, with what materials and methods could you begin with in your teaching?

22. If you have a program, what audiovisual materials and methods would you wish to use in the future?

23. What audiovisual sources do you draw from?

24. Do you use student help in preparing audiovisual materials? How?

[redacted]

Equipment Check List:

KIND OF EQUIPMENT	HOW MANY	KNOW HOW TO OPERATE yes	no	FREQUENCY OF USE regular	rare	never
a. Motion picture projector						
b. Filmstrip and 2" X 2"						
c. Opaque projector						
d. 3 1/4" X 4" slide						
e. Vugraph overhead						
f. Tape recorder						
g. Wire recorder						
h. Disc recorder						
i. Record player						
j. Flashmeter						
k. Micro-projector						
l. Radio						
m. Portable screen						
n. Central sound system						
o. Others (please list)						

Materials and Methods Check List:

KIND OF MATERIAL	HOW MANY	KNOW PRODUCTION yes	no	FREQUENCE OF USE * reg	rar	nev	HOW VALUABLE * ve.	me.	no.
a. Chalkboard									
b. Bulletin Board									
c. Exhibit									
d. Display									
e. Field Trip									
f. Dramatization									
g. Demonstration									
h. Chart									
i. Graph									
j. Poster									
k. Diagram									
l. Map									
m. Model									
n. Mock-up									
o. Diorama									
p. Object									
q. Flip-chart									
r. Flannelboard									
s. Electric Board									
t. Handmade Lantern Slides									
u. Still Pictures									
v. Film									
w. 2" X 2" Slides									
x. Tape Recording									
y. Disc Recording									
z. Opaque Material									
OTHERS (Please list)									

* reg-regular; rar-rare; nev-never   ve.-very; me.-medium; no.-not

AUDIOVISUAL QUESTIONNAIRE FOR PRINCIPALS, AUDIOVISUAL COORDINATORS

Name in Full ____
(Name) (Position)

Name and Address of School ______________________________
(Name)

____
(Address)

1. What do you think the purpose of Education is ?

2. What brings about change in student behavior ?

3. What do you think the advantages of audiovisual methods and materials are ?

YES	NO	
___	___	a. To enrich the learning of students ?
___	___	b. To provide a variety of teaching tools ?
___	___	c. To provide for individual differences ?
___	___	d. To promote interest, to motivate ?
___	___	e. To aid retention ?
___	___	f. To save time ?

4. Number of teachers in school ______________________.

Number of students in school ______________________.

Number and type of grades in school ______________________.

5. Do you have a person in charge of the audiovisual activities ? Full or part time ? How much time is spent on audiovisual ?

6. Do you have ample space for audiovisual ? How much ?
a. For showings ?

b. For simple productions ?

c. For storage ?

[redacted]

7. Do you have a budget for audiovisual ? How much ? Where does it come from ?

8. YES NO

____ ____ a. Do you have an auditorium ?
____ ____ b. Do you have a central projection room ?
____ ____ c. Can the classrooms be darkened ?
____ ____ d. Can the classrooms be well ventilated ?
____ ____ e. Do you have proper voltage for running equipment?
____ ____ f. Are there ample electrical outlets in each room?
____ ____ g. Do you have movable furniture in the classrooms?
____ ____ h. Do you have sufficient lighting in your classrooms?
____ ____ i. Do you have ample exhibit space?

9. Do you use student operators?
Do you have a Projectionists' Club?

10. Are teachers provided time to plan for or produce audiovisual techniques? How much time?

11. Has the community helped in any way in the audiovisual program? If so, how?

12. What have you done to interest teachers in audiovisual? Check those you have used.

____ a. Demonstrations.
____ b. Talks.
____ c. Workshops.
____ d. Newsletter.
____ e. Audiovisual courses.
____ f. Teacher committees.
____ g. Use talents (art, mechanical, etc.).
____ h. Equipment labs.
____ i. Audiovisual references.
____ j. Survey needs.
____ k. Others (please list)

13. What audiovisual references (books, magazines, pamphlets, etc.) do you own?

[redacted]

14. What material and equipment catalogs do you have ?

15. What materials do you have for simple production ?

16. Check for obstacles to using audiovisual;
Check for the major obstacles:

___ a. A lack of funds.
___ b. The high cost of equipment and materials.
___ c. A centralized prescribed curriculum.
___ d. The lack of time.
___ e. Preparation for the general exams.
___ f. The lack of properly trained a-v personnel.
___ g. The lack of a central audiovisual department.
___ h. The inadaptability to subject matter areas.
___ i. The lack of a-v specifically for the Middle East.
___ j. The lack of facilities in architectural building plans.
___ k. Equipment is too complicated to learn how to use.
___ l. The lack of teacher understanding and appreciation of a-v.
___ m. Setting up to use a-v is too much bother.
___ n. Others (please list).

17. If you have no program, where and how would you start the audiovisual Program?

18. If you have a program, towards what are you aiming?

19. What audiovisual sources do you use?

[redacted]

Equipment Check List:

KIND OF EQUIPMENT	HOW MANY	KNOW HOW TO OPERATE yes	no	FREQUENCY OF USE regular	rare	never
a. Motion picture projector						
b. Filmstrip and 2" X 2"						
c. Opaque projector						
d. 3 1/4" X 4" slide						
e. Vugraph overhead						
f. Tape recorder						
g. Wire recorder						
h. Disc recorder						
i. Record player						
j. Flashmeter						
k. Micro-projector						
l. Radio						
m. Portable screen						
n. Central sound system						
o. Others (please list)						

Materials and Methods Check List:

KIND OF MATERIAL	HOW MANY	KNOW PRODUCTION yes	no	FREQUENCE OF USE * reg	rar	nev	HOW VALUABLE * ve.	me.	no.
a. Chalkboard									
b. Bulletin Board									
c. Exhibit									
d. Display									
e. Field Trip									
f. Dramatization									
g. Demonstration									
h. Chart									
i. Graph									
j. Poster									
k. Diagram									
l. Map									
m. Model									
n. Mock-up									
o. Diorama									
p. Object									
q. Flip-chart									
r. Flannelboard									
s. Electric Board									
t. Handmade Lantern Slides									
u. Still Pictures									
v. Film									
w. 2" X 2" Slides									
x. Tape Recording									
y. Disc Recording									
z. Opaque Material									
OTHERS (Please list)									

* reg-regular; rar-rare; nev-never

Equipment Check List:

KIND OF EQUIPMENT	HOW MANY	KNOW HOW TO OPERATE yes	-no	FREQUENCY OF USE regular	rare	never
a. Motion picture projector						
b. Filmstrip and 2" X 2"						
c. Opaque projector						
d. 3 1/4" X 4" slide						
e. Vugraph overhead						
f. Tape recorder						
g. Wire recorder						
h. Disc recorder						
i. Record player						
j. Flashmeter						
k. Micro-projector						
l. Radio						
m. Portable screen						
n. Central sound system						
o. Others (please list)						

Materials and Methods Check List:

KIND OF MATERIAL	HOW MANY	KNOW PRODUCTION yes	-no	FREQUENCE OF USE * reg	rar	nev	HOW VALUABLE * ve.	me.	no.
a. Chalkboard									
b. Bulletin Board									
c. Exhibit									
d. Display									
e. Field Trip									
f. Dramatization									
g. Demonstration									
h. Chart									
i. Graph									
j. Poster									
k. Diagram									
l. Map									
m. Model									
n. Mock-up									
o. Diorama									
p. Object									
q. Flip-chart									
r. Flannelboard									
s. Electric Board									
t. Handmade Lantern Slides									
u. Still Pictures									
v. Film									
w. 2" X 2" Slides									
x. Tape Recording									
y. Disc Recording									
z. Opaque Material									
OTHERS (Please list)									

* reg-regular; rar-rare; nev-never   ve.-very; me.-medium; no.-not

APPENDIX B

Special questionnaires developed for Ministry administrators and educators working in science education in the Sudan.

Ustaz Ahmed Saad,

Head of Science Teaching Section in Secondary Schools,

Ministry of Education, Sudan.

To answer:

1. Questionnaire for principals together with the following questions.
2. What are the steps you have taken (or have planned to take) to improve science teaching in the secondary schools of the Sudan through the use of audio-visual aids?
3. What are the main obstacles facing you?
4. To what extent are the science teachers in the Sudan using audio-visual aids?
5. Have you tried to get the help of any persons or institutions to help encourage the use of audio-visual aids?
6. What are your ideas about present day science teaching in the elementary and intermediate schools in the Sudan?
7. What is your opinion about what Bakht-er-Ruda Institute of Education has done in this line?

Ustaz Mutwakil Amin,

Head of Examination Board of the Sudan,

Ministry of Education, Sudan

To answer:

1. The questionnaire for principals together with the following questions:
2. What are your ideas about improving science teaching in Sudanese secondary schools through the use of audio-visual aids?

   Some teachers say that the general science course content is so extensive that it does not give them time to use audio-visual aids and lab work.
3. Do you think that this is a real obstacle? If so how can it be overcome?
4. Are there any governmental plans for changing the present curriculum of general science?

   The International Commission on Secondary Education said that the lab work of students is poor and that audio-visual aids are rarely used.
5. Could you develop some questions in the school certificate exams to insure that this weakness be eliminated?
6. Are there any suggestions for introducing general science as a major subject in the intermediate and elementary school curricula?
7. What do you think about the work done by Bakht-er-Ruda Institute of Education in developing science courses for the intermediate schools?

Mr. Johnson, (the specialist responsible for making a textbook
in general science for the intermediate schools),
Institute of Education of Bakht-er-Ruda, Sudan

To answer:

1. The questionnaire for principals together with the following questions:
2. What steps have you taken (or do you plan to take) to improve science teaching in the intermediate schools of the Sudan through the use of audio-visual aids?
3. What obstacles stand in your way?
4. How did the Sudanese teachers and educators react to your text?
5. Do you have an audio-visual center at Bakht-er-Ruda?
6. As the head of the science department at Bakht-er-Ruda, have you made any plans for improving science teaching in the elementary schools of the Sudan?

Ustaz Nasr El Haj Ali,

Director of Education,

Ministry of Education, Sudan

To answer the following questions:

The International Commission on Secondary Education said that the lab work of students is poor and that teachers rarely use audio-visual aids. Some secondary school administrators attribute this weakness to the lack of experienced teachers.

1. Do you think that this is the main reason?
2. If not, what other reasons could you think of?
3. What are the plans of the Ministry in solving this problem?

Many of the science graduates from the University of Khartoum avoid science teaching, mainly because of the difficult nature of the job and the comparatively low pay they get. On the other hand, the Ministry of Education, gives high salaries to ex-patriots who often do not stay in the Sudan long enough to get used to the environment. Some of these ex-patriots come to work as teachers even without appropriate training in education.

4. What are the plans of your Ministry in solving this problem?

The Audio-Visual Center of the Ministry of Education, helped by UNESCO, is mainly devoting its work to adult education; the photography and motion picture production unit of the Ministry of Social Affairs are devoting their work to governmental documentary films and photographs.

5. Are there any future plans for using these two important visual aids resources for helping to increase audio-visual materials for the secondary schools of the Sudan?

APPENDIX C

Miscellaneous

I.O/Sc-2A

OFFICE OF THE INSPECTORATE

MINISTRY OF EDUCATION

KHARTOUM

23rd October, 1957

Director of Education,

Khartoum

Central Science Film Library for Schools

Audio-visual aids are now recognized as of great importance in education all over the world. Of all such aids, the movie film is perhaps the most effective, because of its similarity to reality and the natural interest shown by boys in movie pictures.

Not full use, however, is made of this valuable aid in science teaching in secondary schools.

The reasons for this incoude:

1. The films are expensive, schools cannot get approval for all their requirements. An average film bought in U.K. may cost about LS. 20.
2. Schools do not know where to buy the right film from.
3. Few schools make use of the facilities offered by several embassies and certain companies (such as the Shell Co.) for the free loan of scientific films.
4. Projectors are largely misused due to insufficient training in their proper use. Very often they are out of order.

Occasionally, some films are borrowed from the Ministry of Social Affairs, more for entertainment than for educational purposes.

It is the opinion of the writer that arrangements should be made as early as possible so that this valuable aid to science teaching may be used extensively.

Other Inspectors may feel the same. The following suggestions may help in this problem:

1. A Central Science Film Library is to be set up at Headquarters. A small sum of money (LS.200 to LS.300) is to be budgeted annually for the buying of films from U.K. These films will be circulated to schools on request and afterwards returned to Headquarters. The film can be obtained from education foundations from Visual-Aids in London. This is an organization set up by the Ministry of Education in U.K. for the sole purpose of helping schools and educational authorities select visual material. They themselves stock many films which are available for sale. Films could be previewed in London during my yearly visit to that country in connection with The Award Committee of Cambridge.
2. The Ministry may request the embassies to send catalogues of scientific films available for loan to this office. This office will then select films for preview before sending them to schools. There should be no direct connection between the embassies and schools in this respect.
3. Laboratory assistants may be sent to the Films Section of the

Ministry of Social affairs to have a short course on the use and care of projectors. A few boys should also get some training to assist with projection.

Cinema equipment should be the responsibility of the science, rather than the geography departments as is the practice in some schools.

It is to be hoped that in this way, a Central Library of Scientific Films will be built up, and use will be made of this highly important aid in education.

(Sgd.)

AHMED N. SAAD

CHIEF INSPECTOR OF SCIENCE

AMS/Mirghani

AMERICAN UNIVERSITY OF BEIRUT

Department of Education — Cable Address: Amunos Beirut

December 13, 1957

TO WHOM IT MAY CONCERN:

Mr. Malik Badri is studying for his M.A. degree at the American University of Beirut. He is now collecting information for his thesis.

We will appreciate it very much if you will kindly give him the help that he needs.

(Sgd.)

Habib A. Kurani
Chairman
Department of Education

BIBLIOGRAPHY

Books

Carrol, Teacher Education and Visual Education for the Modern School. San Diago, San Diago County Schools, 1948.

Dale, Edgar, Audio-Visual Methods in Teaching. New York, The Dryden Press, 1954.

East, Majorie, Display for Learning. New York, The Dryden Press, 1952.

Encyclopedia of Educational Research, Walter S. Monroe, ed. New York, The Macmillan Co., 1952.

Gates, Arthur I., et al. Educational Psychology. New York, Macmillan Co., 1954.

Haas, Kenneth B. and Packer, Harry Q., Preparation and Use of Visual Aids. New York, Prentice-Hall, 1946.

Heiss, Elwood D. et al. Modern Science Teaching. New York, Macmillan Co., 1954.

Henry C. Ruark, "The Wealth of Materials Available for Instruction Through Audio-Visual Aids", Instructional Materials As Educational Potential in the Library and in the Classroom. Portland, The University of Portland, 1951.

Kinder, James S., Audio-Visual Materials and Techniques. New York, American Book Company, 1950.

Owen, S.B. and Diab, A., Simple Science for the Teacher. Khartoum, Publications Bureau, 1951.

Martin, W. Edgar, The Teaching of General Biology in the Public Schools of the United States. Washington, United States Government Printing Office, 1954.

McKown, Harry C. and Roberts, Alvin B., Audio-Visual Aids to Instruction. New York, McGraw-Hill Co., 1940.

Miller, David F. and Blydes, Glenn W., Methods and Materials for Teaching Biological Sciences. New York, McGraw-Hill Co., 1938.

Ministry of Education, Handbook to Elementary Education for Boys' Schools and Boys' Clubs in the Sudan. London, Green and Co., 1951.

National Education Association, The School Administrator and His Audio-Visual Program. Washington, Department of Audio-Visual Instruction, 1954 Yearbook.

The Republic of the Sudan, Report of the International Commission on Secondary Education. Khartoum, Publications Bureau, 1957.

Richardson, John S. and Cahoon G.P., Methods and Materials for Teaching General and Physical Science. New York, McGraw-Hill Co., 1951.

Saunders, H.N., The Teaching of General Science in Tropical Secondary Schools. London, Oxford University Press, 1955.

UNESCO, UNESCO Source Book for Science Teaching. Paris, UNESCO, 1957.

Wittich, Walter A. and Schuller, Charles F., Audio-Visual Materials, Their Nature and Use. New York, Harper and Brothers, 1957.

Films

Chalkboard Utilization, Young America Films.

Feltboard in Teaching, Wayne Univ., 1951.

How to Make Handmade Lantern Slides, Indiana Univ., 1947.

Filmstrips

The Demonstration - A Teaching Technique, Wayne Univ. Filmstrips, 1952.

Electronics An Old Science With New Dimensions, The Radio Corporation of America.

Enriching the Curriculum With Filmstrips, Chicago, Society for Visual Education, Inc.

General Properties of Matter, New York, The Jam Handy Organization, Inc.

Making Your Chalk Teach, Wayne Univ. Filmstrips, 1951.