

TITLE: A STUDY OF THE RELATIONSHIP BETWEEN
THE MASTERY OF FACTS AND CONCEPTS IN
SCIENCE AMONG STANDARD SEVEN BOYS AND
GIRLS OF NZELUNI EDUCATIONAL ZONE,
MWINGI DIVISION, KITUI DISTRICT.

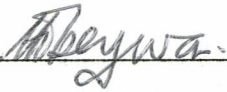
INITIATION: MUSUSYA J. MAKUTHU

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SUPERVISOR:


DR. H.E. EMBEYWA
LECTURER,
DEPARTMENT OF EDUCATIONAL
COMMUNICATION & TECHNOLOGY
KENYATTA UNIVERSITY

A PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE DEGREE OF MASTER OF EDUCATION
(P.T.E.) OF KENYATTA UNIVERSITY

Mususya J. Makuthu
*A study of the
relationship between*



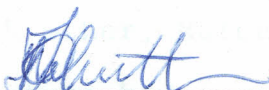
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DECLARATION

This research project is my own original work and has not been presented for a degree in any other University.



MUSUSYA JOSEPH, MAKUTHU

This research project has been submitted for examination with my approval as a University Supervisor.



DR. H.E. EMBEYWA

(iii)

DEDICATION

This project is dedicated to my beloved wife P. Mbula Makuthu whose sacrifice, consolation and understanding were instrumental to its completion during that trying moment.

To my beloved brother, Mutunga Mususya, who sacrificed almost what he had towards my education.

To my mother, Nzasu Mususya, who understands my ambitions.

To all my friends who have encouraged me, time and again, to pursue further education.

ACKNOWLEDGEMENT

For this project to succeed several individuals contributed in various aspects.

Firstly, I am deeply indebted to my supervisor, Dr. H. Embeywa, who saw to it that the project was successfully completed.

Secondly, I am very grateful to the A.P.S.I. Nzeluni Zone, Mr. Mwang'ele and the entire zonal teaching staff for the assistance they gave me.

I wish to thank all the pupils who participated in the examination for their co-operation.

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CHAPTER ONE

1.0 BACKGROUND TO THE PROBLEM

The objective of the 8:4:4 system of education is to provide a practical oriented curriculum that should offer a wide range of employment opportunities. Of the subjects offered presently, science is compulsory for every primary school pupil. Learning science helps children to develop ways of understanding the world around them. For this they have to build up concepts which help them link their experiences together; they must learn ways of gaining and organizing information and of applying and testing ideas. This contributes not only to children's ability to making better sense of things around them, but prepares them to deal more effectively with wider decision-making and problem-solving in their lives. Science is as basic a part of education as numeracy and literacy; it daily becomes more important as the complexity of technology increases and touches every part of our lives.

Learning science can bring a double benefit because science is both a method and a set of ideas; both a process and a product. The processes of science provide a way of finding out information, testing ideas and seeking explanations. The products of science are ideas which can be applied in helping to understand new experiences. There are two important

points which underline the value of including science in primary education. The first is that whether children are taught science or not, they will be developing ideas about the world around them from their earliest years. If these ideas are based on casual observation, non-investigated events and the acceptance of hearsay, then they are likely to be non-scientific, 'everyday' ideas (see page 27).

All these ideas could easily be put to the test; children's science education should make children want to do just that and should provide them with the skills to do it. Then they not only have the chance to modify their ideas, but they learn to be sceptical about so-called 'truths' until these have been put to the test. Research findings show that the longer the non-scientific ideas have been held, the more difficult they are to change.

The second point about starting to learn science, and to learn scientifically at the primary level is connected with attitudes to the subject which is not the concern of this research and hence shall not be elaborated on.

Kenya is not an educational island detached from the rest of the world. It needs science education for the production of an informed citizen. Other

areas included in this sphere of the need for science education are areas such as further education, the world of work and individual development. The manpower required in industries, different government ministries, etc. can only be available if any generation of children is educated.

The performance in science has been poor compared to other subjects as per KCPE newsletters. For example the 1990 KCPE newsletter showed performance to be 56.55%, 55.33%, 48.56% and 39.95% for the years 1986, 1987, 1988 and 1989 respectively.

The newsletter shows that performance is better placed on questions testing for recall of knowledge and analysis and comparatively poor on questions testing other abilities. One can, with confidence, conclude that concepts in the science syllabus are not being taught in a way facilitating clear understanding by the pupils. The trend, besides the many trained teachers there are, seems to be that of pumping factual knowledge into the minds of the pupils.

1.1 STATEMENT OF THE PROBLEM

The 8:4:4 system of education, adopted in 1985 lays emphasis on education for self-reliance. It is therefore expected that the standard eight graduates

will be in a position to apply the scientific knowledge gained during their primary school course to solve their everyday problems. It is imperative to note that for this knowledge to be useful it should be somewhat linked with technology. This link, as is very well known, is being applied in the jua kali sector where the skills learned in school are applied.

Acquisition of scientific concepts at the basic level is very important for those pupils who continue with their education after sitting the KCPE. These are the future scientists and technologists and they need to have a firm base of scientific knowledge. Consistent poor performance in science at the KCPE indicates that this base does not have a strong foundation. Secondary school teachers are having problems in expanding concepts which have been introduced at the primary level because they were either not grasped or the wrong concepts were formed. These teachers assume that proper concept formation took place at the primary level only to find they were not. The consequences are that the students get even more confused and this leads to pupils' negative attitudes towards science. The impact is that they abandon the sciences under the pretext that it is a difficult subject.

The researcher is not aware of any local studies that have been done on the relationship between the mastery of scientific facts and the mastery of scientific concepts. The poor performance in science at primary level in Kenya as a whole is also prevalent in Nzeluni zone of Mwingi Division, Kitui District. Teachers have expressed their concern about this poor performance. This problem has therefore prompted the researcher to find out which of the two—scientific facts and concepts - the teachers stress in their teaching. The main task will be to find out the relationship between the mastery of scientific facts and scientific concepts. The study will apply to standard seven pupils of Nzeluni educational zone of Mwingi Division.

Facts are statements such as 'matter is made up of particles the smallest of which it can be broken into is called an atom. A factual question on this would be: What is the name of the smallest particle that makes up matter? To answer this question the pupil has to recall that the name given to such a particle is atom. The knowledge of how the atoms are spaced when matter is in different states would enable a pupil to explain why pressure in a car tyre increases during a journey. This will involve the concepts of pressure force and velocity of the atoms when the air

in the tyre is heated. A concept in this study is described as a perceived regularity in events or objects designated by a label, usually a word.

The researcher wishes to find out whether pupils with mastery of scientific facts will have a comparable mastery in scientific concepts and whether this relationship holds for both boys and girls.

1.2 RATIONALE

Looking at the examinations set for primary school pupils before and after independence, one notices that there has been a change in what was to be tested. Before independence the emphasis was on testing the pupils' ability to recall facts. After independence, however, pupils were tested on both the ability to recall facts and the ability to apply scientific principles in novel situations. Presently the testing is on:

- (i) Recall of facts;
- (ii) Comprehension;
- (iii) Application;
- (iv) Analysis;
- (v) Synthesis and;
- (vi) Evaluation.

Most of the items set require that the pupils be able to recall and comprehend, implying that a big percentage

of the items are still testing the pupils' ability in the mastery of scientific facts.

Researchers in science education contend that the ability to use scientific knowledge in explaining phenomena depends on a sound formation of the relevant concept. The importance of teaching science subjects has been emphasized worldwide. This has been due to the link that exists between science, technology and national development. Rabinowitch (1975) has this to say on science, technology and national development:

Rapid advances in science and technology in developed countries are making technological domination the major form of domination of underdeveloped countries by developed ones in the second half of the twentieth century. A country which does not develop a scientific and technological capacity of its own will necessarily be technologically dependent and dominated by more advanced countries!

There cannot be technologists without science learning. It is therefore important that the learning of science should be organized in such a manner that should lead to concept acquisition by the pupils. A pupil who masters the scientific concepts is likely to apply scientific knowledge in novel situations than the one who memorises the scientific facts.

The KNEC newsletters have consistently shown that performance in science by primary pupils has been poor. The reasons put forward for this trend in performance have included such reasons as lack of teaching and learning resources; inadequate qualified teaching staff; lack of enough time to prepare the learners adequately using the recommended methods; misunderstanding the question; teachers' failure in relating what pupils learn in class to real life situations outside the classroom; and inadequate coverage of the syllabus.

All these contribute to the poor performance in science but this study contends that poor performance is also due to poor concept formation by the learners due to either inefficient instruction leading to inadequate concept formation or due to teachers' use of the traditional methods of pumping scientific facts into the learners' minds without regard to enabling the pupil to think whenever a novel situation arises: The truth is that if a scientific fact cannot be recalled during examination time the pupils will score wrongly in that item. On the contrary if the pupil had acquired the correct concept about the scientific knowledge then the pupil can think and finally find the correct answer to the item.

It was recently claimed (Daily Nation of 27/6/1992), that girls have improved in science subjects. This was said by the chairman of the Students Science Congress on science and technology. He said;

There is no doubt that girls have become a force to reckon with. They are a threat to their male counterparts. I can tell you today that the proportion of entry is one to one.²

This study aimed at establishing the truth about such statements by comparing the scores obtained by boys and those obtained by girls.

There was need, therefore, to investigate the relationship between the mastery of scientific facts which lead to recall during examinations and mastery of concepts which lead to application of reasoning in solving problems during examination times. This would enable the determination of the nature and degree of the relationship between the two aspects.

1.3 PURPOSE OF THE STUDY

This study focussed on the relationship that exists between the mastery of scientific facts and the mastery of scientific concepts as measured by the scores obtained in a test comprising these two categories of scientific knowledge. This achievement

test was set by the researcher assisted by selected few primary school teachers. This test was administered to standard seven pupils in the named educational zone.

The study dealt with two main areas:

- (i) What relationship there is between the achievement scores on factual questions and the achievement scores on conceptual questions.
- (ii) Whether these achievement scores are different for girls and boys.

1.3.1 THE HYPOTHESIS OF THE STUDY

There is no significant difference in achievement by pupils in factual questions and conceptual questions in science.

From this main hypothesis, the following subhypotheses were generated.

HO₁ There is no relationship between achievement by pupils in factual questions and conceptual questions in science.

HO
2

There is no relationship between the achievement by boys and achievement by girls in both factual and conceptual questions in science.

1.4 RESEARCH QUESTIONS

During the study, the researcher tried to answer the following questions from the findings:

1. How does the knowledge of scientific facts affect the pupils' knowledge of scientific concepts?
2. Is there a significant difference between girls and boys in mastery of facts and concepts in science?

1.5 ASSUMPTIONS OF THE STUDY

- (a) Reading and comprehension abilities of the pupils are the same.
- (b) The pupils have had an equal chance of learning science and to the same level
- (c) The test items have some validity and reliability since they are taken from past examination papers.

1.6 SIGNIFICANCE OF THE STUDY

The main consumers of the results will be national researchers in science education; decision-makers in the Ministry of Education and teacher training institutions.

Teachers will also be beneficiaries because the results may influence their approaches in teaching science. The results will shed light on whether they will put stress on teaching of facts or on teaching of concepts.

1.7 LIMITATIONS OF THE STUDY

Only four primary schools out of the eleven schools with standard seven classes were included in the study. This is because of the large numbers of pupils in the standard seven classes per school and finances would not allow the researcher to cover all the eleven schools. This is a small sample to make any generalizations and the results can only be used for remedial purposes in the zone.

1.8 DEFINITION OF TERMS

- (a) Educational zone: This is an area under the administration of an Assistant Primary Schools Inspector or Zonal Inspector of schools.

- (b) K.C.P.E.: Kenya Certificate of Primary Education: Is a national terminal examination which pupils sit for at the end of the eighth year of education.
- (c) Correlation: This is a statistical measure of the relationship between a pair of variables. The correlation coefficient lies between +1 and -1. The extreme of +1 represents perfect agreement, while the extreme of -1 represents the opposite, perfect disagreement. Intermediate values represent imperfect agreement or disagreement, except for the 'half-way' value of zero, which would represent the complete absence of both agreement and disagreement.
- (d) Chi-square: The basic concepts behind the use of Chi-square are that (i) we have a theory of any kind concerning how our cases should be distributed; (ii) we have a sample showing how the cases are actually distributed; and (iii) we wish to know whether or not the differences between the theoretical and the observed frequencies are of such size that these differences might reasonably be ascribed to the operation of chance.

CHAPTER TWO

2.0 REVIEW OF LITERATURE

2.1 SCOPE OF PRIMARY SCIENCE SYLLABUS(8:4:4)

The 8:4:4 syllabus for standard four (4) to eight (8) covers the following areas of study:

- (i) Weather and astronomy
- (ii) Living things
- (iii) Energy
- (iv) Making work easier
- (v) Properties of matter
- (vi) Health education
- (vii) Soil
- (viii) Balancing and weighing
- (ix) Construction
- (x) Environment

Some of these topics are included in all the class levels in a cognitively hierarchical manner. Examples of such topics are:

- (i) Energy
- (ii) Properties of matter.

2.2. AIMS OF PRIMARY SCIENCE TEACHING

The main aims of teaching science in primary schools are:

- (a) To enable children to acquire and preserve certain useful ATTITUDES about themselves and the relationship with the environment.
- (b) To enable children to acquire manual and thinking skills which help in solving practical problems.
- (c) To enable children to acquire a basic scientific KNOWLEDGE.
- (d) To enable children to acquire ways of seeking further knowledge and of using this knowledge to solve problems they meet in life.

2.3 OBJECTIVES OF TEACHING SCIENCE

The general objectives of teaching science in the primary school are that the learner should better be able to:

1. Apply a problem solving approach to all investigations.
2. Identify the major factors of, and develop and use appropriate skills and technologies for solving the problems relating to:
 - (a) Water utilization in their environment.

- (b) Conservation and utilization of energy and other resources.
 - (c) Use of communication
 - (d) Public health and hygiene in the community.
3. Collect, record, interpret and communicate information for a rational decision making.
 4. Develop flexibility and adaptability in solving problems.
 5. Adopt solutions to problems of management and conservation of available resources.
 6. Promote, preserve and evolve their national heritage for their cultural, spiritual and economic development.
 7. Identify and utilize opportunities for productive work in the home and community.

2.4 CONCEPT FORMATION IN SCIENCE

What are concepts?

Smith and Medin (1980) in their text "categories and concepts" have this to say about concepts:

Without concepts, mental life would be chaotic. If we perceived each entity as unique, we would be overwhelmed by the sheer diversity of what we experience and unable to remember more than a minute fraction of what we

encounter. And if each individual entity needed a distinct name, our language would be staggeringly complex and communication virtually impossible. Fortunately, though, we do not perceive, remember and talk about each object and event as unique, but rather as an instance of a class or concept that we already know something about. When entering a new room, we experience one particular object as a member of the class of chairs, another as an instance of desks, and so on. Concepts thus give our world stability. They capture the notion that many objects or events are alike in some important respects, and hence can be thought about and responded to in ways we have already mastered. Concepts also allow us to go beyond the information given: for once we have assigned an entity to a class on the basis of its perceptible attributes, we can then infer some of non-perceptible attributes. Having used perceptible properties like colour and shape to decide an object is an apple, we can infer an object has a core that is currently invisible but that will make its presence known as soon as we bite into it. In short, concepts are critical for perceiving, remembering, talking and thinking about objects and events in the world.³

A concept may be embodied in a world or phrase and this has sometimes been called the concept in its purest form.

Simple definitions of concept can be made which tell us what we need to know.

A concept is the amount of meaning a person has for a thing, person or process.

A concept is a suggested meaning which has been detached from the many specific situations giving rise to it and provided with a name.

A concept is a word or other symbol which stands for the common property of a number of objects or situations.

A concept is a synthesis of events experienced and of the conclusions drawn about these experiences. The list is not exhaustive.

Concepts grow and develop through experience, by reflection upon experience, by abstracting from experience and interrelating various phases of experience.

How Do Concepts Develop?

The following are the principles of concept development.

1. Concepts grow out of experience in pursuit of a problem or purpose of some sort.
2. Opportunities for observation, handling, experimentation and discovery are necessary. (There is a lot of emphasis put on this aspect in the 8:4:4 education system).

3. Concepts may be derived from various experiences instead of direct experiences for example role playing in learning science.
4. Concepts may be clarified and extended through reflection, analysis, and discrimination.
5. Concepts are not achieved quickly at a given time. They are never fixed or final. The process goes on continuously.
6. Concepts gradually evolve, are refined, and change. They evolve from questioning previous concepts.
7. Concepts to be developed should be carefully selected and then presented through many and varied learning experiences.
8. Accidental discoveries sometimes produce concepts.⁴

2.5 SCIENCE PROCESS SKILLS

A skill is seen as a specific activity which a learner can be trained to perform.

A process is a rational activity involving the application of a range of skills.

The main function of science process skills is to generate scientific knowledge. Some authors have

referred to them as scientific vehicles. Process skills tend to create favourable climate and attitudes for learning science. The other uses of skills have been found in everyday life. There is a maximum of fifteen process skills. Some skills are referred to as individual skills that is those that involve one step in application. Other skills are referred to as composite skills that is those that involve more than one step in application.

The process skills are very much interdependent each skill will lead to another and will depend on two criteria namely prior knowledge and experience. In primary level these criteria are very important.

The following is the list of the science process skills:

1. Observation

To observe something is to direct one's senses and perceptive powers to objects, events or circumstances. This can be done by the use of the five senses.

The following are some recommendations in training pupils to observe.

- (i) Train them to observe details and help them to refine their observations.

- (ii) Help them to observe similarities and differences, that is, help them to compare two things.
- (iii) Help them to observe events and sequences.
- (iv) Help them to observe to detect patterns in the system.

2. Discussion

This skill involves talking to others in meaningful ways about something of scientific nature. It involves talking and listening. This process skill encourages learners to use correctly the technical terms in science. The teacher should encourage discussion by ensuring that every member of the group has the chance to participate. This becomes useful in training the learners to be patient, to give constructive criticism and to appreciate each others viewpoints.

3. Classification

Classification is the process of arranging things into similar groups but using some criteria. The criteria which have been used commonly are colour, size, shape, smell and function.

4. Planning

In planning one makes a decision on how to carry out certain activity. In planning the learner should be clear about the intention or objective of the activity. The next step is to consider the method or the procedure to be used. It is important to consider whether certain constants are to be varied. The safety of the experiment is important and should be planned for.

5. Recording

Recording is hierarchical because charts, tables, cameras, video cameras etc can be used. At primary level tables which are fairly simple and well structured should be used. At very low levels tables which require single information e.g. yes or no, should be used. At higher levels the table can be more detailed. A good record will give useful interpretation.

6. Presenting the Results.

This can be considered as verbal presentation in form of discussing the results or drawing a graph from data recorded.

7. Interpreting

Interpreting involves giving meaning to the data recorded. At primary level it is useful to interpret in groups. It is useful to emphasize the critical points e.g. what a straight graph means. In interpreting, scientific or technical terms should be used. All the conventional words should be brought in at this time.

8. Application

Application is regarded as relating prior knowledge to a new situation, for instance, classifying a bat after learning the characteristics of animals and birds.

9. Experimenting

This is a composite process skill because it involves many steps and many other skills. The experimenter makes a hypothesis from observations that have interested him, and then he devises a way to test his hypothesis. At primary level there should be a lot of experimentation.

10 Hypothesising

This skill involves making educated guesses or ideas about what is going to happen. Hypotheses are ideas about things which

always happen. In primary level hypotheses should be very simple and should be put in a form that can be tested. The teacher should lead the learners to make meaningful hypotheses i.e. that are testable.

11 Infering

This is another kind of guess, a subjective explanation for observations. One can infer from tables, graphs, charts etc.

12 Questioning

It is the onus of the teacher to provide an atmosphere where learners should ask questions. The teacher should guide the learner on how to ask meaningful questions. It is also useful to distribute the questions in the class such that the slow ones are encouraged to make attempts.

14 Predicting

Science being much more than description of observations, the intelligent guess, or prediction, is an essential part of the scientist's work. He plans a path of investigation by asking, 'what would happen if?', making his guess and then proceeding to test it. Children should know that their teacher is anxious for them to

ask 'what would happen' questions, and then to make their own predictions, and that it does not matter if they guess wrong, since this is always happening to scientists. In predicting one makes use of the knowledge he already has.

14 Investigating

During investigation one has to gather information about a topic. It may involve the use of senses, instruments, talking to people, identifying and controlling variables. Investigating takes a long time to carry out.

16 Evaluating

This is the process of judging the activity that one has carried out in terms of its quality to see whether it is fair or can be improved.

2.6 CONCEPTS AND PROCESS SKILLS

Process skills play a central role in concept development. They help in modifying or inventing concepts. The combined effect produced by process skills and concepts can be considered in two main aspects.

- (a) Categorization: A pupil who is able to categorize has the ability to see that a certain problem is a case of a particular concept. Such a pupil will solve, say, a physics problem by using the right concept instead of "wondering around" their collections of concepts trying to use each in turn.
- (b) Transformation: This involves using the permanent properties in the selected concept in order to make predictions, to invent procedures for solving a problem. This needs clear understanding and firm grasp of the properties ascribed to the concept.

Children hold informal concepts which need to be changed by developing the critical powers exercised in process skills so that they can break the tendency to hold onto old ideas and start the uncomfortable process of accomodating ideas to new evidence. This argument suggests a possible strategy for effecting concept change. There are two features:

1. Such change involves critical use of process skills.

2. It may be essential to understand children's informal ideas before one can start.

In some cases change will involve blocking a categorization to one concept (the wrong one) and opening a new categorization to another (the correct one) so that the wrong existing concept is curtailed and the correct one is added.

2.7 CHILDREN'S OWN CONCEPTS

Research conducted by Wynne Harlen has shown that:

1. Children have views about a variety of topics in science from a young age, and prior to learning science.
2. Children's views are often different from scientists' views, but to children they are sensible, useful views.
3. Children's views can remain uninfluenced, or be influenced in unanticipated ways, by science teaching. Interviews of the same children surveyed established that many children consider animals to be only the larger land mammals, such as those found on a farm, in a zoo or jungle, or in the home as pets. The reasons used by many children to categorize something as an

animal included number of legs (animals have four), size (they are big), habitat (they live on land) and skin covering (animals have fur). Surveys were designed to establish what percentage of children at various age levels consider a cow, a person, a whale, a spider and a worm to be an animal. The results showed that children have ideas about what an animal means when they enter school.⁵

The following are some other examples of children's own ideas.

Force and Motion

Many children consider force to be something which is in a body, acting in the direction of motion. A physicist considers a force as acting on a body causing changes in motion; force can be acting in a direction opposite to that of the motion (for example frictional force).

Friction and Motion

Many children associate friction only with motion and do not consider frictional forces exist if two surfaces are not moving relative to each other. To a physicist frictional forces can exist in these stationary situations (static friction).

Plants

Children tend to restrict their view of plants to things planted in the vegetable or flower garden. They tend to exclude a number of things that biologists would consider to be plants, e.g. mature trees.

Light

To many children, and to scientists, light travels away from a source. However, to children, how far it travels is considered to depend on how far from the source the visible effects of the light can be observed e.g. does it appear to illuminate a wall? Hence many children consider light from a candle travels only about a foot in daylight but travels farther in the dark! To a physicist the light continues in a straight line until it is absorbed or reflected by some object.

These children's ideas and many others differ at different age levels. Children can hold their ideas strongly. Many ideas would appear to develop, as young children attempt to make sense of their physical environment and of the language used by the people about them. The ideas thus developed are sensible, plausible and useful to them, within their experience. If they encounter experiences conflicting these ideas, then the children may either appreciate some limitation on the applicability of an idea

or they simply consider that their senses have been tricked. It is, therefore, not enough to show children examples which conflict with their ideas; the children must reconstruct their ideas for themselves.

Teachers are often unaware of children's non-scientific ideas. With vast numbers of pupils per class and the pressure of time, teachers hardly find time to spend in finding out these non-scientific ideas held by children. All in all teachers should be aware of the fact that when teaching some topics they should not assume that children have empty heads waiting to be filled up with knowledge. They should not assume that if children have ideas prior to teaching these will be rapidly lost and replaced by taught ideas. It is of paramount importance to note that children do have prior ideas, which do have considerable influence on their learning.

There is often a severe problem of lack of communication between teacher and pupils. A teacher may have some ideas which he or she hopes to convey by putting them into words, diagrams or symbols. The child may take note of the words, and so on, but from these has to build up a meaning for them. There is clearly a strong possibility that this meaning created by the child is not the meaning intended by the teacher. This possibility is very high if the type of language

used by the teacher, or textbook writer is not familiar to the child. The outcome of this lack of communication may be that:

- (i) The child ignores what the teacher is saying.
- (ii) The teacher ignores what the child is saying.
- (iii) The teacher insists that the pupils use the correct words and so sound scientific.

2.8 CONTENT ACQUISITION

When concepts are directly taught the result is meaningless rote learning. The content in which the concepts are embedded should engage the interest of the children. This is not to say that children should always be taught what interests them but the aim is to expand the children's interests by introducing new things or new ways of looking at familiar ones. Children should be provided with the opportunities to explore, question and find out what intrigues and puzzles them about the objects or phenomena that have been introduced.

The range of content should be such that emerging concepts are seen to have relevance and meaning to the children. Content should be simplified to such a degree that the children's ability to

categorize is enhanced. This criterion places emphasis on relevance as seen by the children and acknowledges that this will vary with the children and their past experience.

The content should be so related to children's everyday experience that change in their everyday explanations is possible and can be planned. Where the teacher recognizes differences between children's everyday ideas and more useful concepts, it will be useful to design and test teaching which either challenges or expands the categorization that children use and the transformations to which these are linked. The content should be presented so as to give an opportunity for the development of science process skills. To change the children's existing ideas in light of new evidence requires that adequate ways are used to reveal the need to change ideas. Recognising the conflict between ideas and evidence requires skills and attitudes which everyday experiences do not necessarily foster and which, therefore, demands particular attention in school experience.

2.9 THE ROLE OF TECHNOLOGY IN SCIENCE LEARNING

The main reason of teaching primary technology is to develop the ability to plan and decide on the best approach to problem-solving. In general, infant

children cannot 'think through' actions which they have not experienced. There is, therefore, a need to do things and to experience situations at the earliest possible opportunity. While this can apply to older children it is recognized that, as children develop, the ability to 'think things through' becomes more firmly established. In primary education however, the dominant method is to try things out, see what happens and to proceed in small steps, rather than plan a sequence of actions. The ability to solve problems comes from practical experience. The skills and attitudes to be developed through such practical work are many and include the following.

A. SKILLS

(i) Thinking

Questioning, testing, analysing, making decisions, comparing and classifying, predicting.

(ii) Communication

Reporting, listening, arguing, expressing ideas, drawing.

(iii) Mathematical

Estimating, measuring, relating quantities, computing, scale drawing.

(iv) Manipulation:

Translating 2 dimensional to 3 dimensional, using tools, working with materials.

B. ATTITUDES(i) Social Attitudes:

Co-operation, tolerance, respect, discipline.

(ii) Personal Attitudes:

Curiosity, perseverance, originality, enthusiasm, self-confidence.

Through the teaching of technology many concepts will also be introduced.

(i) Materials

Materials possess different properties which determine how they are used. These properties provide ways of classifying materials, for example hard or soft, rigid or flexible, or into groups: metals, woods, plastics.

(ii) Force and Energy

Force is needed if an object is to be moved. The force can be supplied from a wide range of energy sources: wind, electricity, spring, magnet, elastic band: energy can be changed from one form to another, but

it never disappears. Energy can be stored in a number of ways: batteries, petrol.

It is clear from above that technology enhances the teaching of science by helping to develop skills, concepts and attitudes necessary for the individual development of the learner.

Designing and making are the key elements in primary technology. Technology is practical problem-solving. Technology exercises skills of modelling, constructing and communicating and enables children to apply scientific concepts. Problem solving demands that the teacher and the pupils adopt different roles to those associated with traditional practice. It is a more collaborative process with the teacher helping the child to acquire such knowledge, skills and concepts as are needed in a particular situation rather than prescribing them through a text or exercise.

CHAPTER THREE

3.0 RESEARCH DESIGN

3.1 SAMPLE

The sample to be used in this study consisted of four (4) primary schools with standard seven. All standard seven pupils from each school in the sample were included in the study.

The criterion for selecting four schools from the eleven schools was by use of simple random sampling method. This kind of sampling involved blindfolding pieces of paper with the names of all the schools written on them. The first four papers to be picked constituted the sample.

3.2 RESEARCH INSTRUMENT

The research instrument comprised fifty (50) multiple choice items. Twenty five (25) of these items required the respondents' recall only. These are the items which required the pupils to remember facts. The remaining twenty five (25) required the pupils to apply the concepts learned. Some of the items required the pupils to use a combination of concepts whilst others required the knowledge of only one concept. The factual and the conceptual items were scored equally for comparison purposes. The items were set in such a way as to include all the topics as much as possible.

3.3 ADMINISTRATION OF THE INSTRUMENT

The researcher administered the test items with the assistance of the teachers. Due to the vast distances between the schools the researcher was not able to visit every school the same day the test was administered and therefore this responsibility was given to the head-teachers in the schools. The test was done the same day and same time to avoid possible leakage. The examinees were required to put a tick against the correct answer. The test took one and a quarter hours. The pupils were required to indicate their gender in the answer sheet.

3.4 COLLECTION OF ANSWER SCRIPTS

Collection of the answer scripts was done by the researcher who then proceeded to mark them and grade them accordingly.

CHAPTER FOUR

ANALYSIS OF DATA.

4.10 DATA PROCESSING AND PRESENTATION:

All the data collected were presented on a master sheet before analysis. The scores for each individual pupil for both Factual and conceptual items are shown in Appendix B.

4.11 SCIENCE ACHIEVEMENT TEST

As already mentioned the science test comprised two parts. The first part carried factual items whilst the second part carried conceptual items. The raw scores of both items were used for analysis without any transformation.

4.20 DATA ANALYSIS AND INTERPRETATION:

The strategy adopted for the analysis of the data collected was divided into three different stages on outlined below:

4.21 TABLE OF MEANS:

4.22 CHI - squared (χ^2)

4.23 CORRELATION CO EFFICIENT (r)

4:21 TABLE OF MEANS.

TABLE 1: Means of scores in both factual and conceptual items for boys and girls .

	BOYS	GIRLS
Factual items	29.87	24.31
Conceptual items	21.55	19.94
	51.42	42.83

The formula used to get the mean is

$$M = \frac{\sum X}{N}$$

Where M = Mean

\sum = Sigma or sum of

X = raw score

N = Number of pupils

The means were tested for significance using the t-test formula.

$$t = \frac{M - \mu}{S} \sqrt{N}$$

Where t = figure obtained for t-test

m = sample mean

μ = assumed population mean (25 marks)

s = Standard deviation

N = Number of pupils.

The standard deviation, S is given by the formula $S = \sqrt{\left(\frac{N\sum X^2 - (\sum X)^2}{N(N-1)} \right)}$

Where the symbols have their usual meaning.

Table 11: Table of standard deviations for both boys and girls

	BOYS	GIRLS
Factual items	6.59	7.03
Conceptual items	6.31	5.24

The calculated standard deviations for both girls and boys for all the items in the test are as follows:

Boys: S = 11.45

Girls S = 11.07

TABLE 111: calculated t - figures corresponding to the means obtained previously (Table 1)

	BOYS	GIRLS
Factual items	4.96	-0.79 N.S
Conceptual items	- 3.67	-9.97

$\alpha = 0.05$

The calculated t - figures for both boy and girls for all the items in the test are as follows:-

Boys t = 0.832

Girls t = -5.22

4.22 The chi-squared (χ^2).

The chi-squared was used here to determine the direction of relationship as concerned .

- (i) Achievement in factual items for boys and girls;
- (ii) Achievement in conceptual items for boys and girls.

The formula used is

$$\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e}$$

where: f_o = observed frequency

f_e = expected frequency

χ^2 = Chi - squared

TABLE IV: Achievement, factual items for boys and girls.

	Pass	Fail	Totals
Boys	37	8	45
Girls	25	40	65

Totals 62 48

Computed chi - squared

= 20.72

Significant at = 0.05 (C.V. = 3.84)

TABLE V: Achievement, conceptual items for boys and girls

	Pass	fail	totals
Boys	13	32	45
Girls	6	59	65
Totals	19	91	110

$$(\sum XY - \frac{(\sum X)^2}{N})(\sum Y - \frac{(\sum Y)^2}{N})$$

achievement in factual items
 - achievement in conceptual items
 - the total number of pupils
 product of X and Y
 The computed correlation coefficient was
 0.83

The value of correlation coefficient was proved highly significant when;

computed chi - squared = 7.20

significant at = 0.05 (C.V. = 3.85).

Table VI:

Achievement in science for the whole group.

	Pass	Fail	Totals
Boys	29	16	45
Girls	19	46	65
Total	48	62	110

Computed Chi - Squared = 13.67.

Significant at = 0.05 (C.V. = 3.84).

4.23: Correlation coefficient (r) calculated between the variables (scores in factual items and scores in conceptual items) for all the pupils was carried out using the Pearsons correlation coefficient.

$$r = \frac{N \sum XY - \sum X \sum Y}{\sqrt{([N \sum X^2 - (\sum X)^2] [N \sum Y^2 - (\sum Y)^2])}}$$

X = achievement in factual items

Y = achievement in conceptual items

N = the total number of pupils

XY = product of X and Y

The computed correlation coefficient was

$$r = 0.63$$

The result of correlation coefficient was proved significant when;

- (i) The calculated correlation coefficient was more than the tabulated correlation coefficient at a certain percentage level for that; or;
- (ii) The calculated t - test figure was more than the tabulated t-test figure, at a certain percentage level for that sample.

Notes on interpretations of correlation coefficients

(r)

- (i) Correlation coefficients only show the relationships between variables. Hence there are no causal connections
- (ii) Results of correlation coefficients may be positive or negative, indicating the range of relationships between the variables, positive one (+1) indicates the extremely close or perfectly positive relationship; Zero indicates no relationship; and negative one (-1) indicates perfectly negative relationship.
- (iii) The Null Hypothesis (H_0), is often that "there is no relationship between the variables", and the Alternative Hypothesis (H_a), is often that "there is relationship between the variables".
- (IV) The Null Hypothesis is NOT REJECTED, when the correlation coefficient is NOT SIGNIFICANT, and thus the Null Hypothesis is rejected when the correlation coefficient is significant.

- (IV) The Null Hypothesis is NOT REJECTED, when the correlation coefficient is NOT SIGNIFICANT, and thus the Null Hypothesis is REJECTED when the correlation coefficient is SIGNIFICANT.
- (V) When the Null Hypothesis is REJECTED, then the Alternative Hypothesis is Accepted; i.e. " there is relationship; but when the Null Hypothesis is NOT REJECTED, then the Alternative Hypothesis is NOT ACCEPTED.
- (VI) When the Null Hypothesis is NOT REJECTED, it does NOT mean that it is accepted i.e that " there is no relationship" Hence usually the Null Hypothesis is NEVER ACCEPTED On grounds that there may not be enough evidence for rejecting it at that moment, so the Alternative Hypothesis is accepted.

PRIMARY CONCLUSION

The aim of this study was to find out the relationship between the anxiety of facts and concepts in the design standards between boys and girls. It was mainly aimed at answering the following ques-

CHAPTER FIVE

CONCLUSIONS, SUMMARY, IMPLICATIONS AND RECOMMENDATIONS

5.0 INTRODUCTION

This chapter summarises the findings of the study. The findings lead either to the rejection or acceptance of the null hypotheses under investigation.

Conclusions based on the analysis in chapter four are also drawn. The drawing of the conclusion is done in consideration of each research question and hypothesis.

Implications are discussed as they relate to mastery of factual and conceptual items in science.

Finally recommendations for further research are given.

5.1 SUMMARY, CONCLUSION

The aim of this study was to find out the relationship between the mastery of facts and concepts in science among standard seven boys and girls. It specifically aimed at answering the following questions:

1. How does the knowledge of scientific facts affect the pupils' knowledge of scientific concepts?
2. Is there a significance difference between girls and boys in mastery of facts and concepts in science?

5.2 FINDINGS OBTAINED FROM THE RESEARCH

1. From the means of achievement scores in factual and conceptual items, the following interpretations could be made:
 - (i) The mean of scores in factual items for boys was higher than that of girls.
 - (ii) The mean of scores in conceptual items for boys was higher than that of girls.
 - (iii) The mean of the overall achievement in science for boys was higher than that of girls.

Hence the results for the sample indicate that boys performed better in both factual and conceptual items. It can also be interpreted that boys performed better in science than girls.

2. The computed Chi-squared for achievement in factual items for boys and girls ($X^2 = 20.72$) was significant at $\alpha = 0.05$. This means that the difference in the proportion of passes between boys and girls in factual items is significant at the 5 percent level.

The computed Chi-squared for achievement in conceptual items for boys and girls ($X^2 = 7.20$) was found to be significant at the 5 percent level (i.e. $\alpha = 0.05$).

The computed Chi-squared for achievement in science among girls and boys was found to be significant at the 5 percent level ($X^2 = 13.67$ $\alpha = 0.05$).

3. Correlation Coefficient (r)

The correlation coefficient computed between scores in factual items and scores in conceptual items was found to be positive ($r = 0.63$).

5.3 CONCLUSION

The Null Hypothesis that 'there is no relationship between achievement by pupils in factual questions and conceptual questions' was rejected at the 0.05 level.

Therefore it means that pupils tend to score more in questions involving the recall of facts learned than they score in questions requiring either application or the knowledge of certain concepts.

The other Null Hypothesis that there is no relationship between the achievement by boys and achievement by girls in both factual and conceptual questions in science" was also rejected at the 0.05 level. It was found that boys score more in both factual and conceptual items than girls do.

The findings show that, generally, boys are more superior in science achievement to girls, as far as this sample is concerned. Since this sample was drawn from a longer population, it would be statistically logical to conclude that the same behaviour pattern, i.e. the superiority in science achievement of boys over girls exists in the population.

5.4 RECOMMENDATIONS

1. Teachers should find ways and means of encouraging girls to take science learning more seriously. One way of doing this would be to appoint girls as leaders of their group activities in science classes,

2. From the research findings it can be construed that teachers put more emphasis on rote learning. This should be discouraged. The teachers should teach for the pupils to understand scientific concepts so that the pupils can apply the knowledge so gained in novel situations.
3. The educational administrators and head-teachers should encourage more participation by female teachers in the area of science teaching so as to act as models to the girls.
4. The teaching of science should be more practical oriented to avoid the temptation of pumping factual knowledge into the pupils' heads. This should also help to remove the misconceptions held by children before they go to school or even during school.
5. The Kenya National Examinations Council should try to include a greater proportion of testing for understand rather than for recall.

5.5 RECOMMENDATION FOR FURTHER RESEARCH

1. This research was done on a small sample. It is recommended, therefore, that a

similar research be done on a larger sample preferably in different educational zones.

2. A similar research should be undertaken to include all levels of the primary school.
3. Research should be undertaken to find out the sections of the science syllabus where majority of pupils find difficulty in understanding them.
4. Research should be undertaken to establish the role the science teachers play in their pupils' performance in science. By this it is meant finding out the factors that may deter or enhance pupils performance in science as contributed by the teachers.

APPENDIX A

RESEARCH INSTITUTE TIME: 1½ hrs.

NAME: SCHOOL:

SEX:

For each of the questions four answers are given. The answers are lettered A, B, C, D. In each case only ONE of the four answers is correct. Encircle (put a circle) the letter whose answer you have chosen.

EXAMPLE

The process by which water is lost in the atmosphere from the soil is called:

- (a) Condensation
- ⓑ Evaporation
- (c) Distillation
- (d) Transpiration.

The correct answer is B. On the answer sheet encircle B as shown above.

RESEARCH INSTRUMENT

1. Most plants have a green colouring matter in their leaves whose function is to:
 - A. Help in photosynthesis
 - B. Help in food storage
 - C. Decorate plants
 - D. Attract insects
2. The main function of the kidney in the body is to:
 - A. Break down dead red cells
 - B. Emulsify fats
 - C. Remove waste salts and water from the body.
 - D. Combine oxygen with the parts of the body.
3. Plants absorb mineral salts from the soil by the process called.
 - A. Osmosis
 - B. Plasmolysis
 - C. Hydrolysis
 - D. Diffusion
4. Food moves along the intestines by contraction and relaxation of muscles. This is known as:
 - A. Swallowing
 - B. Peristalsis
 - C. Absorption
 - D. Digestion

5. The bodies of living things are composed of many structures called:
- A. Cells
 - B. Organs
 - C. Bones
 - D. Systems
6. One of the following is NOT an airborne disease- which one is it?
- A. T.B.
 - B. Cholera
 - C. Whooping cough
 - D. Measles
7. Animals which eat only meat are called
- A. Herbivorous
 - B. Carnivorous
 - C. Omnivorous
 - D. Browser
8. A grasshopper uses - for breathing
- A. Stomata
 - B. Spiracles
 - C. Nose
 - D. Wings.
9. Magnets are stored using pieces of metals known as:
- A. Iron rods
 - B. Keepers
 - C. Steel holders
 - D. Magnetic bars

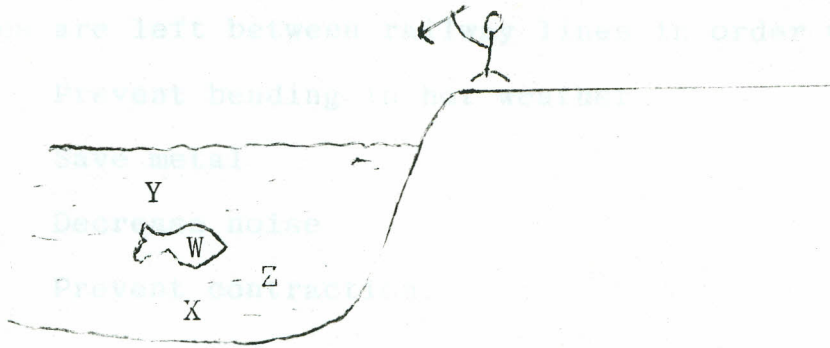
- 10 The name given to a pattern of stars is a
- A. Galaxy
 - B. Constellation
 - C. Solar system
 - D. Milky way
- 11 The temperature of melting ice is
- A. 32°C
 - B. 132°F
 - C. 0°C
 - D. 212°F
- 12 An image formed from a pinhole camera is always
- A. Bigger than the object.
 - B. Upside down
 - C. The same size as the object
 - D. Laterally inverted.
- 13 Which of the following statements is true
- A. Boiling point of a liquid increases as the pressure decreases.
 - B. Boiling point of a liquid decreases as the pressure decreases.
 - C. Dissolved impurities decrease the boiling point of a liquid.
 - D. Boiling point of all the liquids is more or less the same.

- 14 A torch battery or dry cell contains energy. Which one of the following best describes the type of energy it contains?
- A. Magnetic energy
 - B. Mechanical energy
 - C. Light energy
 - D. Chemical energy
- 15 Milo wanted to see and study the stars at night near his father's compound. Which one of the following instruments should be used?
- A. Periscope
 - B. Microscope
 - C. Kaleidoscope
 - D. Telescope
- 16 Which of the following mixtures is wrongly matched with the separating method.
- A. Sand and water-filtering
 - B. Iron and water-using magnet
 - C. Sand and fine clay particles - sieving
 - D. Salt and water - decanting
17. Which one of the following is NOT an acid?
- A. Orange juice
 - B. Vinegar
 - C. Milk butter
 - D. Magadi soda

- 18 A std. 6 class of Mumbuni Primary School were dissolving sugar in water. Their teacher, Kilundi, listed some scientific words: Solute, solvent and solution. What scientific name did he give sugar in the process?
- A. Solution
 - B. Solvent
 - C. None
 - D. Solute.
- 19 Good charcoal is made by burning wood in a:
- A. Rainy day
 - B. Hot air
 - C. Very little air
 - D. Warm night.
- 20 A group of children observed a candle burning and saw that some parts of the flame were of different colours. Which part was blue?
- A. The top.
 - B. The centre
 - C. The bottom
 - D. The sides.
- 21 Mammals like the monkeys, baboons, apes, lamur and man have highly developed brains and are known as:
- A. Laying mammals
 - B. Flying mammals
 - C. Primates.
 - D. Invertebrates.

- 22 Which one of the following foods would you recommend to a person suffering from bleeding gums?
- A. Oranges
 - B. Liver
 - C. Eggs
 - D. Milk.
- 23 Malaria is caused by parasites which are carried by:
- A. Male anopheles mosquito
 - B. Culex mosquito
 - C. Female anopheles mosquito
 - D. Tiger mosquito.
- 24 Water enters the seed during germination through:
- A. Hilum
 - B. Testa
 - C. Micropyle
 - D. Radicle
25. The point about which a lever turns is called
- A. Mechanical advantage
 - B. Effort
 - C. Fulcrum
 - D. Load.

26.



A fisherman looks down into a lake and sees a stationary fish as shown above. At what point should he aim his spear in order to have the BEST chance of hitting the fish?

- A. W
- B. X
- C. Z
- D. Y

27. Cleaning a metallic tool with oil is one of the maintenance practices. What does this prevent?

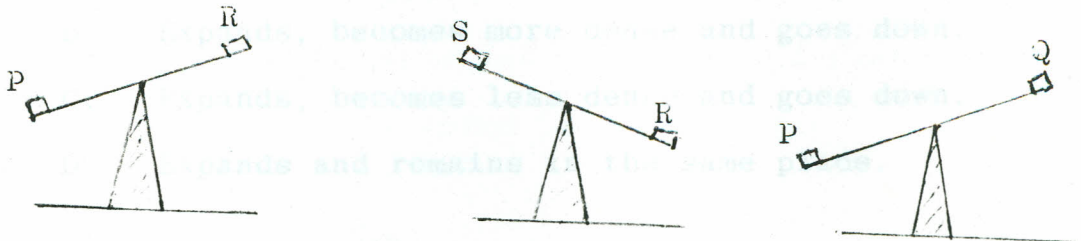
- A. Weaving out
- B. Becoming blunt
- C. Rusting
- D. None of these

28. Rainbow is always seen in daytime. Which of the following times of the day don't we usually see it?

- A. Midday
- B. Morning
- C. Afternoon
- D. None of these

- 29 Gaps are left between railway lines in order to:
- Prevent bending in hot weather
 - Save metal
 - Decrease noise
 - Prevent contraction.

- 30 Which of the following objects is heaviest?



- P
 - Q
 - R
 - S
- 31 A pit is enected close to a river bank. Which one explains the best why this is dangerous.
- A person using the latrine might fall in the river.
 - There is risk of soil erosion along the river bank.
 - The river water might become polluted with disease carrying organisms.
 - Person using the latrine risks being infected from pollution in the latrine.

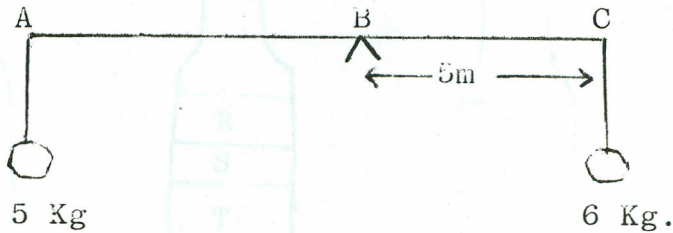
32 A 20 cm metallic cube has a mass of 6 kg. What is its density.

- A. 750 g/cm³
- B. $133 \frac{1}{3}$ g/cm³
- C. 800 g/cm³
- D. 0.75 g/cm³

33 When water is heated it

- A. Expands, becomes less dense and goes up
- B. Expands, becomes more dense and goes down.
- C. Expands, becomes less dense and goes down.
- D. Expands and remains in the same place.

34



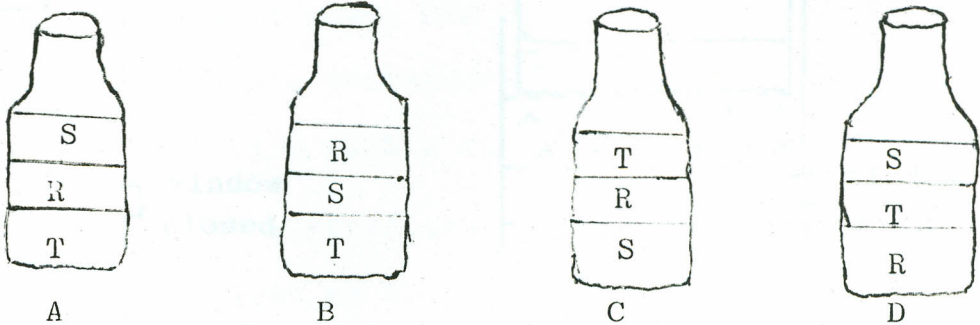
In the above diagram the distance AC is

- A. 10m
- B. 11m
- C. 5m
- D. 6m.

- 35 Three liquids R, S and T have densities shown in the table below.

<u>Liquid</u>	<u>Density</u>
R	2.5 g/cm ³
S	0.8 g/cm ³
T	1.1 g/cm ³

The liquids were poured into a bottle. They formed three separate layers. Which of these diagrams shows the three layers in order.

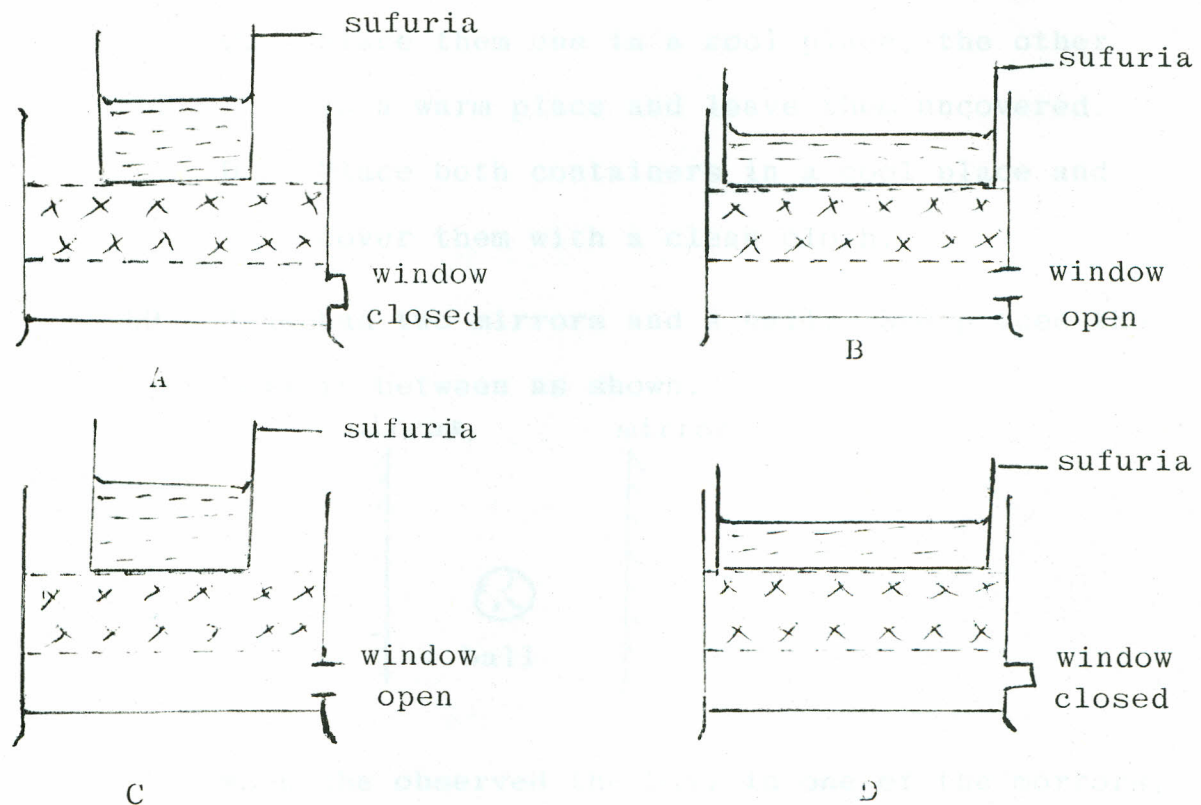


- 36 Mailu was sent to buy salt. On his way back the salt fell and was mixed with sand. He collected the mixture in order to recover the salt. Which one of the following is the correct order to carry out the separation?

- A. Adding water, filtering, stirring, evaporating.
- B. Filtering, stirring, adding water, evaporating.
- C. Stirring, adding water, filtering, evaporating.

D. Adding water, stirring, filtering, evaporating.

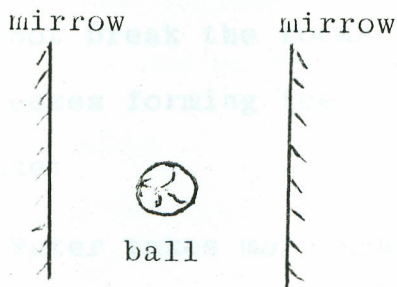
- 37 The diagrams below show how a jiko can be used in different ways to heat the same amount of water to boiling point using the same amount of charcoal. Sufurias of different shapes but same thickness were used as shown in the diagrams. Which diagram shows the arrangement where the water will take the longest time to start boiling?



38 Kilundi wanted to know if fresh milk went sour more quickly in a cool place than in a warm place. As an experiment he took two identical containers with equal quantities. Which of the following would be his best experiment?

- A. Place both containers in a warm place and cover them with a clean cloth.
- B. Place one container in a warm place and the other in a cool place and cover them with a clean cloth.
- C. Place them one in a cool place, the other in a warm place and leave them uncovered.
- D. Place both containers in a cool place and cover them with a clean cloth.

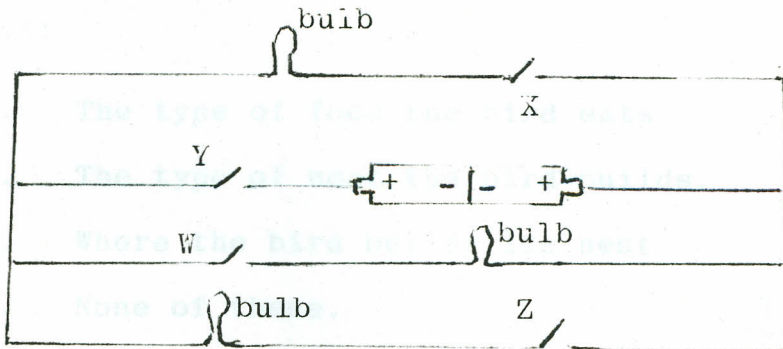
39 Jane had two mirrors and a ball. She placed the ball in between as shown.



When she observed the ball in one of the morrors, she saw:

- A. 4 balls
- B. 6 balls
- C. 2 balls
- D. Many balls.

- 40 The diagram below shows a simple circuit



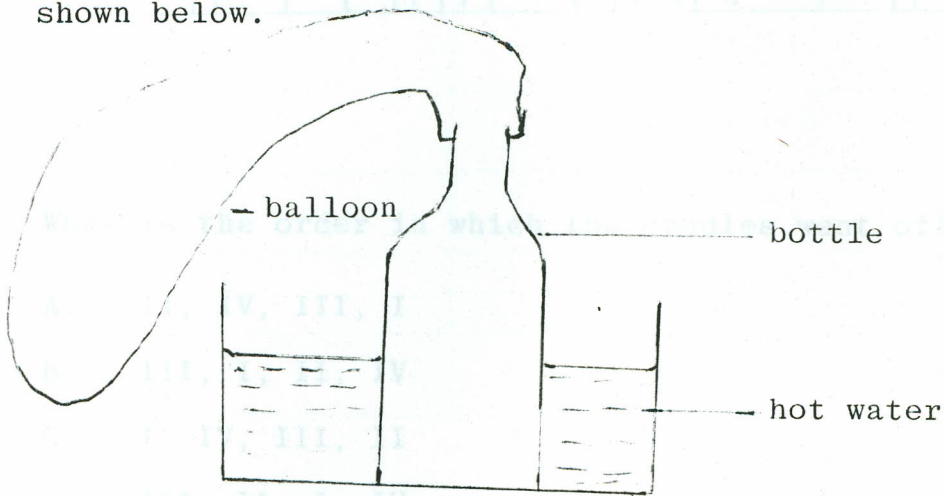
Which switches must be closed to light only the middle bulb?

- A. X and W
 B. X, Y and Z
 C. Y and W
 D. None of them.
- 41 When water collects in the cracks of rocks it does not break the rocks but breaks them when it freezes forming ice. The rocks are broken because:
- A. Water takes more space than the ice
 B. Ice takes up more space than water
 C. Ice is more acidic than water
 D. Ice, unlike water, cannot stay in a rock.

42 From the shape of the beak of a bird we can find out:

- A. The type of food the bird eats
- B. The type of nest the bird builds.
- C. Where the bird builds its nest
- D. None of these.

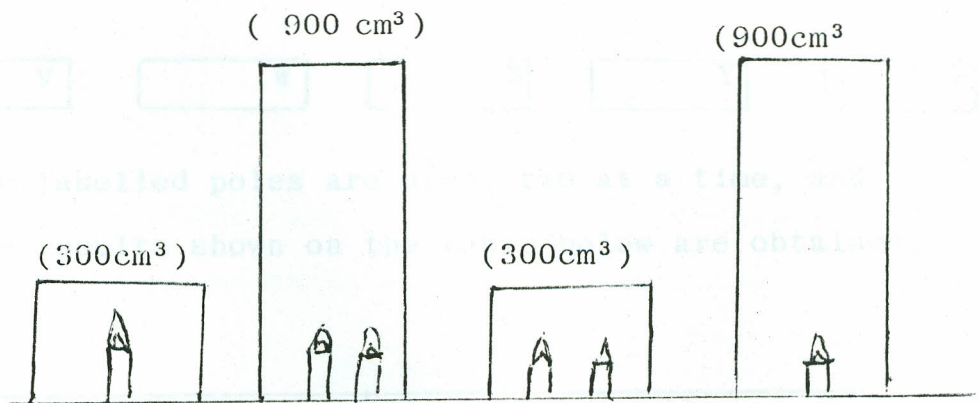
43 A balloon was fastened to the neck of a bottle and the bottle was then placed in hot water as shown below.



Which of the following statements describes what happened to the balloon? The balloon.

- A. Expanded
- B. Remained the same
- C. Melted
- D. Shrunk

- 44 Six identical candles were lit and covered at the same time with glass jars as shown below.



What is the order in which the candles went off?

- A. II, IV, III, I
 B. III, I, II, IV
 C. I, IV, III, II
 D. III, II, I, IV
- 45 A turbine is rotated by steam produced as a result of heating water using firewood. Which one of the following shows the correct order of energy changes that take place from the time of lighting the wood until the turbine turns?

- A. Heat Kinetic Chemical
 B. Chemical Heat Kinetic
 C. Chemical Kinetic Heat
 D. Heat Chemical Kinetic

- 46 Five magnets are shown below. One pole of each magnet is labelled as shown.



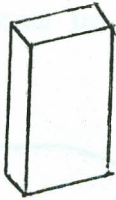
The labelled poles are used, two at a time, and the results shown on the table below are obtained.

Poles Used	Results
V and W	Attracted
W and X	Repelled
X and Y	Attracted
Y and Z	Repelled

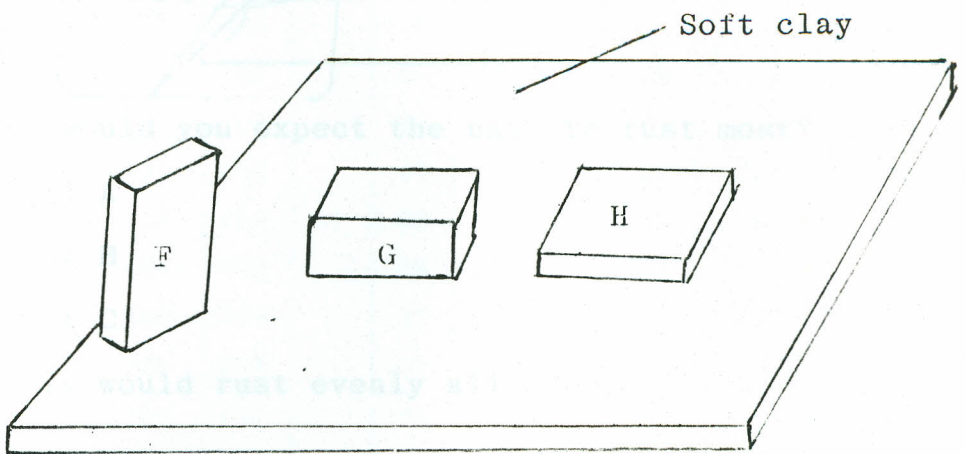
If V is the south pole then which of the following is a correct statement?

- W is south and X is south
- W is south and Y is north
- X is north and Z is south
- Y is north and Z is north.

- 47 There are three identical blocks of wood like the one shown in the diagram below.

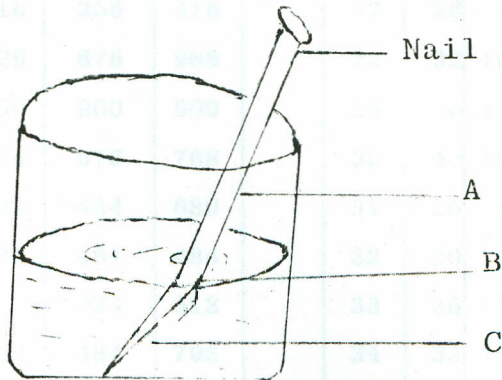


The three blocks are placed on the same piece of soft clay as shown in the diagram below.



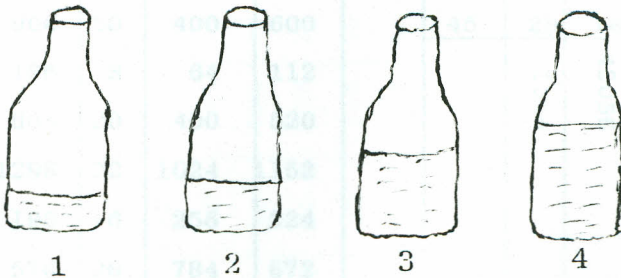
- Which one of the following statements is correct?
- A. F would make the deepest mark in the clay
 - B. They would all make marks of equal depths in the clay.
 - C. H would make the deepest mark in the clay
 - D. G would make the deepest mark in the clay
- 48 Which of the blocks was the heaviest?
- A. F
 - B. G
 - C. H
 - D. None of them.

- 49 A bright, shiny iron nail was left for a few days in a jam jar half-full of water, as shown in the diagram below.



Where would you expect the nail to rust most?

- A. At A
 B. At B
 C. At C
 D. It would rust evenly all over.
- 50 Water was put in identical bottles as shown below:



Serah blew across the top of each bottle. Which bottle produced sound with the highest pitch?

- A. 4
 B. 3
 C. 2
 D. 1

APPENDIX B

MASTER SHEET OF SCORES OBTAINED IN THE TEST

BOYS

NO.	X	X ²	Y	Y ²	XY	NO.	X	X ²	Y	Y ²	XY
1	26	676	16	256	416	27	26	676	20	400	520
2	38	1444	26	676	988	28	32	1024	22	484	704
3	30	900	30	900	900	29	36	1296	26	676	936
4	32	1024	24	576	768	30	40	1600	28	784	1120
5	30	900	22	484	680	31	26	676	26	676	676
6	22	484	22	484	484	32	20	400	20	400	400
7	34	1156	18	324	612	33	36	1296	30	900	1080
8	36	1296	22	484	792	34	32	1024	28	784	896
9	32	1024	22	484	704	35	40	1600	24	576	960
10	26	676	20	400	520	36	36	1296	24	576	864
11	18	324	12	144	216	37	30	900	18	324	540
12	42	1764	20	400	840	38	28	784	18	324	504
13	18	342	10	100	180	39	32	1024	26	676	832
14	26	676	20	400	520	40	32	1024	22	484	704
15	28	784	22	484	616	41	40	1600	28	784	1120
16	32	1024	40	1600	1280	42	32	1024	18	324	576
17	34	1156	26	676	884	43	32	1024	22	484	704
18	24	576	16	256	384	44	30	900	12	144	360
19	30	900	20	400	600	45	28	784	16	256	448
20	14	196	8	64	112		1344	42056	970	22660	3004
21	26	696	20	400	520						
22	36	1296	32	1024	1152						
23	14	196	16	256	224						
24	24	576	28	784	672						
25	30	900	20	400	600						
26	34	1156	22	484	748						

Key: X = Score in factual items
 Y = Score in conceptual item

$$\sum X = 1344$$

$$\sum Y = 970$$

$$\sum XY = 30024$$

$$\sum X^2 = 42056$$

$$\sum Y^2 = 22660$$

MASTER SHEET OF SCORES OBTAINED IN THE TEST

GIRLS

NO.	X	X ²	Y	Y ²	XY	NO.	X	X ²	Y	Y ²	XY	NO.	X	X ²	Y	Y ²	XY	NO	X	X ²	Y	Y ²	XY	
1	24	576	10	100	240	21	42	1764	24	576	1008	41	24	576	24	576	576	61	22	484	24	576	528	
2	22	484	16	256	352	22	30	900	22	484	660	42	16	256	18	324	288	62	34	1156	22	484	748	
3	14	196	12	144	168	23	12	144	14	196	168	43	32	1024	20	400	640	63	20	400	20	400	400	
4	20	400	10	400	400	24	18	324	16	256	288	44	22	484	14	196	308	64	28	784	16	256	448	
5	20	400	22	484	440	25	26	676	12	144	312	45	24	576	22	484	528	65	24	576	16	256	384	
6	18	324	14	196	252	26	18	324	16	256	288	46	24	576	22	484	528							
7	22	484	20	400	440	27	28	784	12	144	336	47	30	900	20	400	600							
8	20	400	16	256	320	28	24	576	14	196	336	48	32	1024	22	484	704							
9	28	784	16	256	448	29	12	144	16	256	196	49	20	400	16	256	320							
0	20	400	10	100	200	30	24	576	24	576	576	50	32	1024	32	1024	1024							
1	30	900	20	400	600	31	18	324	24	576	432	51	20	400	20	400	400		1580	41568	1296	24060	30728	
2	14	196	14	196	196	32	16	256	10	100	160	52	14	196	10	100	140							
3	20	400	12	144	240	33	32	1024	18	324	576	53	28	784	20	400	560							
4	22	484	12	144	264	34	12	144	12	144	144	54	20	400	20	400	400							
5	44	1936	26	676	1144	35	20	200	16	256	320	55	34	1156	20	400	680							
6	24	576	12	144	288	36	28	784	26	676	728	56	30	900	22	484	660							
7	42	1764	34	1156	1428	37	32	1024	22	484	704	57	30	900	22	484	660							
8	20	400	18	324	360	38	24	576	24	576	576	58	20	400	18	324	360							
9	30	900	26	676	780	39	30	900	28	784	840	59	28	784	18	324	504							
0	24	576	10	100	240	40	28	784	24	484	616	60	20	400	14	196	280							

FOOTNOTES

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