LINKING SCHOOL SCIENCE AND TECHNOLOGY TO EVERYDAY LIFE THROUGH THE KENYAN 8:4:4 SECONDARY SCHOOL PHYSICS

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ABSTRACT
Science and technology, as an integrated system, has increasingly been recognised as essential in the struggle for relevance in science education. But, as indicated by Layton (1986), curriculum should be reflective of indigenous needs and values.

In the context of developing countries like Kenya, the linking of school science and technology to everyday life has increasingly been recommended as one of the approaches in achieving this relevance.

The aim of this document is to contribute towards this move in the context of the Kenyan 8:4:4 secondary school physics. Chapter I highlights on the current nature of science and technology. Because, teachers can only link what they know. The second chapter discusses the rationale for the linking of school science and technology to everyday life. The later part of this chapter discusses the problems related to its implementation. In chapter III, basing on the linking of school physics and technology to local technology of making clypots, suggestions for implementing the approach are made.
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This work is dedicated to my wife, Phyllis and children: Michael, Marion, Lindah, Kennedy, Joan and Timoth.
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INTRODUCTION

Linking school science and technology to everyday life is a recent call in the struggle for relevance, especially in developing countries. It has been realised that science and technology have become an integrated system. And, a curriculum becomes relevant if it imparts knowledge and skills useful in the real world of work we live in.

The aim of this document is to contribute towards re-orientating science teachers, especially in physics, towards this new development in science education. Chapter I of the paper provides some highlight on the current nature of science and technology. Chapter II discusses the rationale for linking school science and technology to everyday life in the context of the Kenyan 8:4:4 physics. The later part of this section dwells on some of the teaching problems in implementing this new approach. Chapter III provides some suggestions on how the linking of school physics and technology to everyday life through the local technology of making claypots could be achieved. But, this is only an example of the numerous linkings of school science to local technology that can be achieved. A lot more can still be achieved.
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CHAPTER I

1.0 THEORETICAL REVIEW OF SCIENCE AND TECHNOLOGY

1.1 Meaning and nature of science and technology

Firstly, the 1980s appear to be emerging as the decade of the birth of the technology approach in the struggle for relevance in science education, especially in developing countries. Some of the recent international and national conferences associated with this move include: 'International Congress on Science and Technological Education and Development (UNCSTD)', held in Vienna in 1979 (Lewis and Kelly, 1987,7); 'Science and Technology Education: A Conference to Develop Policy for Science and Technology Education in Zambia' (ME,1982); 'Second International Symposium on World Trends in Science Education: Technological Application and Social Relevance of the Science we Teach (NCST,1982)'. In all, one of the major recognitions made is that, "science and technology are essential for social-economic and cultural development" (Lewis and Kelly, 1987).

School science is seen as a central actor in this curriculum relevance drama, in most of these countries. Indeed, science more than any other subject in the school curriculum has been the most associated with the development cited above (Knamiller,1984,60).

The irony is that, this view rests on the assumption that scientific method is universally powerful and applicable. Eastman (1969) describes this assumption as "scientism". It
is propagated by the traditional lack of drawn clear distinction between science and technology in the school science. In essence, it is the advancement in technology that contributes directly to these developments: socio-economic and cultural. In the later part of this paper, this relationship between science and technology will be made clear.

Basing on Knamiller's analysis of higher degree dissertations relating to science education in developing countries completed in United Kingdom between 1978 and 1982, only 13 out of a total of 47 made reference to technology being linked with science education in schools. It is evident that educators have not been strongly pursuing this issue of school science and technology.

It is therefore, no mere academic exercise to try and define science and technology, because it is with proper meaning of these terms that educators can see their place in the school curriculum, hence contribute to this issue, and the course of this paper.

Foremost, as observed from the discussion above, among the confusions of meaning of science and technology include:

- equating technology with applied science;
- claims like: 'training a pupil to be a scientist' or 'a pupil as a scientist';
- equating technology with machinery.

As Naughton(1986,2) indicates, equating technology with machinery (sometimes spoken of as hardware) is very common
nowadays. This vague meaning of the term is evident from expressions like: 'Isn't technology very beautiful?'; 'technology of the home', or referring to 'a house as a piece of technology'.

Crucially, misconception of the nature of science may lead to the thinking of 'novel ideals' like 'school science can produce young physicists who would work like Sir Isaac Newton or Albert Einstein', and so on. Consequently, the role of science education in school curriculum would be adversely affected. It has therefore, been found necessary to dedicate the first part of this chapter on the meaning and nature of science and technology so as to provide a sound base for the arguments made in this paper.

1.11 Meaning and nature of science
For a start, science can be regarded as a continuous process by which individuals or groups develop an understanding of what they observe (making sense of the observations) (DES, 1988, 7). By this process, reliable knowledge about the world is progressively established from sense data through the generation and testing of ideas and theories. It therefore involves, a certain rigour of thought about the problems involved, and careful and controlled experimentation during the testing (ibid.). In short, it is concerned with pursuit of reliable knowledge about the physical and biological world.

That is why in describing science, Ingle and Turner
(1981,365) have stressed that it involves intellectual exercises that lead to aesthetically satisfying and logically deduced framework by which natural phenomena may be understood. Entities that are used, in most cases, in this process of science include: facts, theories, laws, and models.

Science may also be defined simply, as the activities of scientists: What scientists actually do. In this view, science is seen as a progressive human endeavour that develops into a culture. This means, scientists as members of a culture, form a community of scientists who have a characteristic way of thinking, planning, and working, that is referred to as scientific method (or processes).

It is strongly believed that these characteristics make scientists distinct from the rest of the people. Besides, the importance of the purpose of the scientific enterprise distinguishes it from many other activities. It is to achieve control over nature, so that it can be manipulated to suit the needs of mankind (Richardson and Boyle, 1979, 13).

While science exerts a strong reciprocal influence by promising power for control over natural forces the community of scientists, in both direct and subtle ways, affects the development of science and its application. Discovery in any branch or sub-branch of science is recognised in the light of the community of scientists. This is in line with Kuhn's (1970) notion of the community of scientists (the
'invisible college') that the members share a set of believes of what counts as acceptable science (or disciplinary matrix). For instance, the recent discovery by a group of Kenyan scientists of what has been claimed to be the world's most effective cure for AIDS. Kemron (Machua, 1990, 36) awaits such a recognition.

Sociologists of knowledge have taken this further by suggesting that "not only the area of scientific activity or the form of theoretical speculation but even the facts of science are social constructs" (Barnes and Edge, 1982; Collins, 1982). This is a challenge to the science teachers because it calls for their "teaching of consensus without turning it into an orthodoxy" (Driver, 1983, 5).

For a new proposal to be accepted by the community of scientists, it must first of all, be well supported by empirical evidence. It must also 1) impress the scientific community as being interesting enough to publish, and get passed the referee system; 2) be taken by others, discussed, and subjected to further investigation; and then 3) be declared genuine by the establishment of relevant branch of science (Selley, 1989, 88). This means, scientific knowledge far from being objectively true, has to be seen as that which scientists have consensually accepted as true. But, who are the scientists?

Layton (1986, 159) has suggested that, "many who are termed scientists to-day work in industrial and military
organisations". In emphasising this fact, Hurd (1990,431) points out that "58% of all research scientists are located in industry...and research is more social rather than theory driven". Evidently, the centres of financial support for research in science education have shifted to senior faculty members in the cognitive sciences, social psychology, cultural anthropology and in policy institutes (ibid.). This is encouraged by the fact that research which is a key determinant of knowledge produced is frequently influenced by socio-economic considerations. As a result science has remained entangled with this type of human value-bias. It has become impossible for science to be value-free: independent of personal, social, and cultural values. Science is no longer free from contamination by contextual preferences external to the discipline. It has a 'human face'. And, this human significance has become a vital ingredient of the current nature of science.

By experience, these contextual preferences could be broadly categorised as 'laboratory or professional' and 'consumer' sciences. Where laboratory science is characterised by the existence of a common solution to a problem that is arrived at through hypothesis generation (by creative speculation), hypothesis testing (by critical experimentation) and the social process of acceptance and recording of scientific knowledge.

Consumer science (or science in society) is simply born out
of the extension of the laboratory science into real life of the consumer, by interested parties. Such science is usually addressed as 'advice of the expert'. Usually, such advices are highly charged with value-bias or humanised. Commercial advertisements are often dressed up in such consumer science. Consequently, human value has increasingly influenced policies and decisions based on expert's (or technical) advice. Currently, issues such as: use of nuclear fuel, micro-waves, damping of nuclear waste, the green house effect, and most recently 'mad cow'disease (BSE), hang by such a thread.

In consumer science there is never any outright correct solution. Agreements on issues involved are based on compromises between the interested parties. Indeed, there is a growing feeling that consumer science has tended to lead into more ignorance and increased human mistrust of technology.

On this account, current science should be seen as that which has shifted from the 19th century dominant mode where scientific knowledge was regarded as 'neutral', applicable equally to both good and evil purposes, but remaining value-free to the current mode where it has a 'human face' (Layton, 1986, 2).

The style of practising science has also changed. In actual sense, and traditionally, scientists are not paid for the papers they write in recognised journals; neither can they
buy space to express their views (Boyle, 1979, 19). Scientific knowledge as incorporated in papers is regarded, as in the terms of communism, as goods for common ownership. They submit their research papers for publication freely as gifts in exchange for recognition. To them to be frequently cited, is to be honoured. Kuhn (1970) describes the advantages of this mode of practising science as follows:

...this freedom of to work without regard for societal values enables scientists to concentrate on problems of their own choosing and ones they had good reason to believe they would solve.

In otherwords, early scientists considered themselves at liberty to work on whatever problems they chose. They had no paymasters as in the case of other professionals like doctors, architects, lawyers, and engineers who are paid for the services rendered; they practised as gift-givers.

Because, of the recent developments that undermined the communication in science there has been a shift towards project based science and technology with a clear view of utilitarian ends (Boyle, 1979, 19). As a result, vast amounts of research done by modern scientists (in industry and military organisations) has tended to be treated as high level secret.

The effect of this development in the practising of science is that, for many of the controversial issues of to-day, there is increasing scepticism about the advice of the experts as consumers are repeatedly faced with conflicting recommendations from opposing experts. Examples include:
conflicting advices over: the advisability of eating fats, fluoridating water, and sending children to schools in which asbestos contaminates the air. Gaskell (1982, 39) has attributed this to the fact that the advice "tends to reflect the value assumptions of the principal investigator", as per the funding of the project.

The above discussion has attempted to show that scientific knowledge has distinct characteristics from other forms of knowledge. Therefore, understanding of the nature of scientific knowledge, its possibilities, and limitations is necessary before combining it with other knowledge to make practical decisions on how to act.

Furthermore, available literature (HMI, 1978; ASE, 1979; Finniston, 1980, and Hodson, 1985), suggests that the image of science portrayed through school science, as impersonal and lacking social responsibility, is a major contributor to the persistent low recruitment in science and the related gender imbalance. This image is no longer in harmony with the current trend in science, as highlighted above.

Providing school science with a 'human face' would increase its relevance and make it more girl-friendly. As argued by Hodson (1985, 27):

neglect of social and humanitarian considerations, and the consequent adverse image of science, is detrimental to the production of future scientists, considerably more detrimental to the production of scientifically literate citizenry.

To a large extend, teachers' inadequate understanding of the
current nature of science would lead to projection of an unfavourable image of science and the activities of scientists through the hidden curriculum. For instance, diabasing the regard for value in science education would lead to an invalid assumption of a 'neutral' science in a highly competitive technical world.

In practice, Binnie (1978) has pointed out that explicit teaching of science in school for value outcomes is rare. Furthermore, it has been realized that opportunities to explore and develop the value related aims of science, where they exist, seem to be ignored or even officially discouraged. Indeed, the (UK) Association for Science Education has stated the view common to majority of science teachers, about the nature of science as follows: science is regarded by the majority of its teachers as an international study, with no particular national bias, and with its neutral terminology, which is also culture-free.

There is therefore a dire need for teachers especially in physics, to re-orientate their view on the nature of science as a whole. This will enable them to provide a proper base on which young physicists would develop, hence improve recruitment in physics. Further reflection on this problem is made in the following part of this section of the paper.

1.111 How science progresses
Progress of science is closely associated with how scientific knowledge develops and how individuals become scientists. As
regards the development of an individual to a fully-fledged scientists: people who are actively engaged in scientific research and who publish their papers in recognised journal, one has, first of all, to progress from an undergraduate study of science to a post-graduate level. However, there have been isolated cases of men of genius in the past who were exceptional.

It is through the apprenticeship at the doctorate (Ph.D.) level, under a qualified scientist that a student becomes familiar with the 'mythology and ritual' of the scientific community. If his work is judged as satisfactory, he is admitted into the community of scientists. Most important is the fact that all along he is continuously subjected to social constraints. In summary Boyle (1979) has emphasised that:

In practice the educational barriers that have to be surmounted by aspiring scientists put science as a career beyond the reach of the great majority of the inhabitants of the earth...Scientists take what they are given by school educators and are indeed highly selective even then.

It is therefore, impossible to achieve scientific universality. Worse still, is the low recruitment of women scientists. As a result, Versey (1990,9) has described the image perceived (and thus generally presented ) of science as "a predominantly male pursuit in which role models are predominantly male". And, because of the relatively small number of women in positions of influence, the examples presented are predominantly examples which engage interest
and motivation in boys and men. This is attributed to gender-bias. In essence, acceptance into the community of scientists is culturally determined. It can not and will never be free from value and gender-bias.

Progress in scientific knowledge is by theories, models, and explanations changing and evolving. In doing so, the understanding of such knowledge passes through distinct stages described by Kuhn (1970) as: pre-scientific, emergence of paradigm, normal science, and extra-ordinary (or revolutionary) science. In this sequence new theories are sometimes born when anomalous facts are discovered. That is why Kuhn describes scientific change as follows:

Science does not simply advance by accretion but science advances by each new conceptual scheme embracing the phenomena explained by its predecessors and adding to them (Richardson, 1979,9).

This means that old theories are not simply falsified and rejected when anomalous facts are discovered. Something more than the existence of anomalous facts is necessary before a theory is considered to have been falsified and before a new theory replaces an old one.

However, Karl Popper (1972) has argued that scientists should verify theories by carrying out experiments that falsify them. Theories for which no experiments that can falsify them can be devised, are accordingly unscientific. In practice, a theory is only rejected when a better one is ready to take its place. Or else, there will be nothing to work with and research can come to a halt.
popper's view of the progress of science seem to be applicable to parts of the physical sciences and the periods of extra-ordinary science. But, it is evident that there are different views of the criteria for acceptance or rejection of scientific theories. From a sociological perspective, the criterion for acceptance is its withstanding the scrutiny and approval of the community of scientists.

On this note, it should be realized that since the 1960s major changes have taken place in our society resulting in a new standing for science. Some of the features as indicated by Hurd (1990,413) are in summary as follows:

- the expansion of traditional disciplines to over 50,000 distinct research fields; 58% of all research scientists are located in industry, as indicated above;

- science and technology have become an integrated system and research is now more social rather than theory driven;

- our cultures have become increasingly diversified, making equity a major educational issue;

- the culture of the school has changed: more drop outs, and more students aspiring to a college education; science has lost favour with students;

- knowledge has become a basic factor determining the nation's gross national product giving rise to an 'information age' and fostering 'learning to learn' as goal of science education. Skills in utilisation of knowledge outrank those characteristic of inquiry;

- the centres and financial support for research in science education have shifted to senior faculty members in the cognitive sciences, social psychology, cultural anthropology and in policy institutes.

The implications of the above is that we have to be keen in facing the challenges of modernising our views of science education to those that are in harmony with recent social
changes, cultural shifts, and the changes in nature (or features) of science.

1.112 School science in view of the nature of science

Basing on the discussion made above, school science should be seen, in the light of the nature of science, as 'normal science'. That is, a science in which those involved work within a paradigm (Ellington, 1981, 18). In this phase of science the scientist is testing his own ingenuity to solve problems within the paradigm. A paradigm is "the basic generally accepted theoretical model that underlies a particular branch or sub-branch of science at any given time" (ibid.). Working within it does not necessarily amount to becoming a scientist.

Crucially, it is evident that school science rests on very shaky foundation of assumptions that lead to questions like, whether 'teaching pupils to behave like professional scientists is the best way of providing them with scientific education'. In essence, the process skills like: observation, classification, inferring, hypothesizing, and designing investigation have been found to be dependent upon both content and context. For instant, observation is influenced by the theoretical perspective of the observer (Driver, and Bell, 1986). As a whole, they have clarified that learning science involves construction of meanings. And, meaning constructed by students from what they see or hear may or may not be those intended. Because, construction of meaning is influenced to a large extend by our existing
knowledge. This is in line with the espistemological view that 'reality is mind constructed'.

On this basis, Koetge (1969) points out that children cannot be seriously regarded as undertaking severe tests of scientific theory in the school laboratory context. In fact, it has been found that when expected result in practical work does not emerge, it has been always more realistic to assume that the experiment is on error and not the theory. This is evidenced by the emphasis on the calculation of errors or accounting for them in physics practicals, especially at higher levels. Indeed, as Collins and Shapin (1984) observe, the ability to get expected results is the only means the teacher (or pupil) has of knowing that the experiment has been performed correctly. Yet, it is impossible to 'reproduce' an experiment.

David Layton (1986) has also pointed out that predominantly the aims associated with school science are cognitive ones: knowledge, scientific skills and techniques. Such aims are bound to emphasize 'intellectual training' at the expense of acquisition of techniques and attitudes for solving everyday life problems. A such, we are likely to end up with physics graduates who know science and can do science but can not use it in solving their everyday life problems. For example, they may not be able to even replace a fuse in an electrical a domestic appliance.

Generally, this has contributed towards the current attitude
of lack of appreciation of the 'do it yourself' (DIY) recent approach to solving everyday life problems. Instead, they resort to entrusting their expensive gadgets (watches, radios, cars) with 'technicians' who never did or passed school physics. In the Kenyan setting, such technicians are commonly known as 'jua kali' (open-shade) technicians. Currently, inspite of their being school science drop-outs they are still the house power behind service and repair of domestic and all sorts of machinery in the country.

On this basis, the science going on in schools is a mere 'appreciation of science'. There is therefore, need for re-orientating it to increase the pupil's appreciation of the discipline by making school science more interesting and motivating, and more like the real (or professional) science. The vehicle to achievement of this reform is the linking of school science and technology to everyday life of the learner.

This will enable teachers to establish a link between the school classroom and laboratory and the pupil's local environment. And, the scientific knowledge will be presented in the context relevant to the everyday life needs of the pupil. Thomson (1989,79) has added that in this approach "he will realize that his own everyday existence is surrounded by enigmas which science can solve for him".

In a general outlook, Hodson (1985,26) has stated that a science education programme is incomplete if it neglects any
of the following, in relation to real or professional science:

- a concern for the process and methods of science; that enable children to think and work in ways that are broadly similar to those of a good scientific practitioner,
- direct experience of scientific and technological activities;
- appreciation of the complex relationship between science and technology;
- the fostering of positive attitudes towards science and technology.

Science education curriculum should therefore provide:

- training in scientific and technological investigation, both at school and outside, and
- show pupils what science and technology are like.

To achieve this in schools where there are no separate provision for technology education, it has been suggested that flavouring the science education with elements of technology would be most appropriate (Knamiller, 1984, 63).

1.12 Meaning and nature of technology

For a start, technology can simply be seen as a creative human activity that brings about change through design and application of knowledge and resources to the problem involved (DES, 1988, 7). In doing so, it focuses on the optimisation and balancing cost and benefits in any solution to a problem. It has been described by Woolnough and Allsop (1985, 64) as a 'disciplined process' involving:

the open-ended design in which a problem is established and analysed, possible solutions considered and the optimum solution selected, implemented and evaluated.

In other words, it should be seen as being similar to the investigational approach that is is emphasised in science process. And, to be matching closely with the scientists approach to problem-solving investigation.
Reverting to the common confusions of the meaning of technology, it can seen that equating it with science or machinery does not lead to a valid meaning of the term. The process of technology encompasses more than this: people, knowledge, practical skills, and social organisation. These 'ingredients' have to be combined to give a wider definition of the term.

But before coming to this wider definition, it would be useful to be born in mind that technology draws knowledge on science as well as on other forms of human knowledge, such as: art, history, public administration, music, design, economics, religion and so on. A pictorial mapping of these forms of human knowledge on which technology draws may be represented as in figure I, below:

![Diagram](image-url)

Fig. I: Human knowledge mapping

(Archer, 1986, 55)
To illustrate this point, it would be useful to consider design which, as per the definition, is the key aspect of any technology activity. Archer (1986, 54) has defined it as: "an area of human experience, skill and understanding that reflects man's concern with appreciation and adaptation of his surroundings in the light of his material and spiritual needs". In particular it has been argued that design, though not exclusively, relates with configuration, meaning, value and purpose in man-made phenomena (ibid.). It is therefore, directed towards practical tasks, solutions or action.

In dealing with these, a designer makes use of a variety of kinds of knowledge: from scientific knowledge of the properties of materials to the ineffable craft knowledge (derived from apprenticeship, experience, trial and error and so on) which enable a skilled practitioner to say that a given design solution 'feels' right (or wrong). This is a common practice in commercial and any organisational framework.

Although a lot of physics knowledge goes into such designs, for example, that of a car, there is no scientific theory a designer may draw on in dealing with important problems related to distinct features of the car - configuration, colour and so on. For instance, how it feels to the driver: Is it lively, responsive, stable? The designer has to draw on other forms of knowledge, in this case, his experience, craft and his own feelings in determining the
rightful configuration for the car. This invalidates the equating of technology to applied science or machinery.

On this account, there is need for science teachers to encourage their pupils to draw on other forms of knowledge in furthering their technology education.

It would also be useful to realise that exposing pupils to purposeless application of science does not necessarily contribute to advancement in their technology education. To achieve purposeful application of science there will be need for a proper link of the school science and technology to society (everyday life of the learner). In doing so, it should be born in mind that science though vital to technology, it is not enough. And, a wider definition of technology would be the most appropriate guide.

1.121 Application of kinds of knowledge in technology

Consideration of how a technologist combines different forms of knowledge would lead to a better understanding of a wider definition of technology.

It is evident that hierarchial structure is used to organise finished parts of a practical tasks into a whole final product. For example, finished parts of a car have to be organised into a whole car through a hierarchial structure that specifies what comes first, next, and so on. Such an organisation involves resolving conflicts over resources, design, linkages, that arise between those who are working on individual portions of the task.
Technology should therefore be seen as social process. And, the hierachial forms of social organisation is an element of its definition. Although, there are technologies such as crafts, like pottery, that have minimal or no element of social organisation. They are simply, applications of human skills and knowledge, and simple machinery to practical tasks. But, still such technologies are still implied in the wider definition of technology stated as follows:

Technology is the aplication of scientific and other forms of knowledge to practical tasks by hierarchially ordered systems that involve people and machines (Naughton, 1986,8).

The definition above indicates that a wide scope is entailed in trying to define technology. As a result, there are various 'technicalities' involved in trying to interpret technology in various contexts. Coupled with this is the fact that, in global context, the impact of technology upon the individual is variable, and widely uneven as between the richer and the poorer countries of the world.

Therefore, although many people have witnessed the advent of various products of technology: live satellite communication, T.Vs, digital watches (and clocks), technology has had meaning to very few of these people. This is mainly attributed to the missing link.

At school level pupils should be involved in technological problems-solving investigations that provide them with experience and skills, in their local context, in organising scientific knowledge (and other forms of
knowledge) to practical tasks by hierarchically ordered systems that involve their fellow pupils and simple machines that are locally available. This approach closely matches the definition of technology stated above.

In short, Cross, N., et al. (1986, 27) has quoted Ferguson's (1977) clarification of the place of technology as follows:

"...many objects of daily use have clearly been influenced by science, but their form and function, their dimensions and appearance, were determined by technologists: craftsmen, designers, inventors and engineers, using non-scientific modes of thought."

1.122 Nature of technology

There is, as yet, no developed 'philosophy of technology' that may be analogous to the philosophy of science (ibid.). It is therefore, not yet possible to construct an exact model of the nature of technology. However, basing on the definition stated above, technology as a process could in a model form be described as in the diagram in figure II below:

![Diagram: Process of Technology](image)

Fig. II: Process of technology

(Woolnough and Allsop, 1985, 65).
From this model of technology there is a clear indication that technology has relevance to science practical work. But, it is important to draw a distinction between technical and scientific investigations.

The two main distinction between these investigations are that, while technical investigations are set in the context of some specific human need, those of science are "followed purely to satisfy curiosity" (ibid.). Technical investigations are more likely to involve making of some device than scientific ones, which may well use standard apparatus.

And, therefore to provide experience and practice involvement with process of technology at school level, the following approaches may be useful:

- technology and hobbies club;
- science fairs or industry sponsored competition;
- specific technology courses;
- Craft-Design-Technology course;
- science lessons becoming 'technically' flavoured (as suggested above).

A second important nature of technology, as mentioned above, is that it takes place within the constraints of commercial and organisational framework. This is why organisation constraints are sometimes cited as explanations of why ingenious designs fail to be implemented or effective. This is analogous to when human value influences what is accepted as science.
To provide a simplified and unified picture of the world of technology it would be useful to categorize technologies broadly as follows:

-traditional technology; that is orally handed down from one generation to the next. It consists of technologies based on simple principles. The Prince of Wales in a T.V programme, 'Earth in Balance' referred to it as the technology that is "sustainable with nature" (BBC, 1990). Examples include, the traditional plough, grinding stone, pottery and so on.

-appropriate technology; that aims at improving the available technologies. It includes what has been referred to as "rural technology" (Swift, 1983, 1).

-Modern technology; which refers to more sophisticated types of technologies and the rest of the 'high tech'. Examples include, modern communication systems, latest surgical and molecular biology techniques and so on.

All these categories of technologies are important in that they have a common effect on society. Mesthene (1968, 135-143) has described the effect as follows:

Technology brings about both social and value change by creating new physical possibilities and thus altering the mix of social choices... new technology may produce a restructuring of the hierarchy of values.

This is a caution to the effect that, in this age of pervasive change that we are in, more attention should be paid to the process of technology than the structure. Emphasis should be shifted from "values to valuing" (ibid.) In other words, in school physics, for example, the creating and transmitting the elements of technology should be geared towards enabling the young physicists to develop a valuing (choice and preference process) that promote sustainability with nature.

Otherwise, the increasing distrust of technology will
continue to work for discontinuity between man and 'machine'.
In fact, there is a growing feeling that man has isolated
himself from nature and has failed to live in harmony with
mother earth. Young physicists should be equipped for the
development of an industrial world that is in harmony with
nature.

The linking of school physics and technology to everyday life
would contribute to the reversing of the worsening
relationship between man and nature. In doing so, the
following activities may be useful in making the linkage:
- practical problem solving;
- designing and making (or implementing a system);
- using experience, knowledge and skills from other
disciplines;
- investigational problem-solving, innovation and evaluation.
These activities would provide a firm base for pursuit of
modern technology at tertiary and industrial levels.

1.13 Relationship between science and technology
Traditionally, as evidenced by school science curricula,
there have been no clear distinction between science and
technology. Currently, science and technology have become an
integrated system (Hurd, 1990, 413). Consequently, the label
science and technology has become fashionable, especially at
international conferences. This current relationship between
science and technology is reflected in the earlier UNCOD
statement that: "science and technology are essential for
social-economic and cultural development"
However, at school level, the scientism effect discussed at the start of this chapter, is highly attributed to lack of distinction between the two. There is, therefore, a danger of this integrated system relationship leading pupils to vague and confused understanding of the place of each in their everyday life.

At this point, basing on our earlier discussion of the nature of science and technology it is evident that they serve different purposes. That is, whereas science is concerned with pursuit of reliable knowledge about the physical and biological world, technology is led by human needs and involves meeting those needs or solving identifiable problems (DES, 1988,7). Simply, while science deals with making sense of our observations, technology deals with "ways of doing things" (Boulding,1969). Basing on these descriptions, their relationship could be described as follows:

- science draws on technology in developing its instrumentation and techniques of inquiry, such that significant discoveries have depended on the development of particular tools, materials and techniques (DES,1988,7). For example, the invention of a laser tube has enabled scientists to carry out studies of laser light that have culminated into the development of the alternative to tape cassettes, the compact disc.

- conversely, technology in attempting to solve a problem to meet a need, to a large extent, it draws on and uses scientific knowledge. Reverting to the compact disc, technologists used the scientific information about laser light to make compact disc player(other forms of human knowledge were incorporated).

On this account, Brian Chapman (1988) argues that physics for example, and technology have "bootstrap" relationships. That is, technological progress is built on physics which
develops directly from advances in instrumentation. And, the advances in instrumentation follow on the improvement in technology. This same view is reflected in Tsuma's (1988,68) suggestion that "science provides the intellectual infrastructure for technology".

It is further argued that a science gap may lead to a technological one. That is why it has been pointed out that, "developmental gap between the rich North and the poor South is not only technical but it must be viewed as a science gap also..." (ibid.). What this means is that the world to-day is actually made and powered by science.

Indeed, the temptation to assume that science is conceptually accessible to everyone has strongly been made irresistible by this relationship: between science and technology. The ability to link science to technology has also been highly assumed. In this connection, Lewis and Kelly (1987,vii) have emphasized that:

...in the world to-day, mastery by society of scientific and technological knowledge is an essential condition for the assertion of cultural identity and independence and for promotion of effective participation by the people in determining and implementing collective action for development and thus ensuring better national control of its results.

All this expresses the importance of the link between science, technology and society in our present world for survival sake. This would be best achieved through the use of familiar local contexts of the learners science and technology to teach the school physics. Local technology of making claypots should be seen as one of the many contexts.
CHAPTER II

2.0 CREATING AND TRANSMITTING THE LINKING OF SCHOOL SCIENCE AND TECHNOLOGY TO SOCIETY THROUGH THE 8:4:4 PHYSICS

2.1 Rationale for the linking

The rationale for the linking stems from the national objectives of the Kenyan 8:4:4 physics that emphasises in totality "technical and vocational oriented approach" (ME, 1987) to the curriculum. Quoting the physics syllabus (1988,iii), the main objective of this subject is to "prepare the learner for self-reliance, training and further education". It has therefore, been emphasised that school physics should ensure that those graduating at every level have some scientific and practical skills that can be utilised for either self-employment, salaried employment or for further training - useful citizenship after leaving school (Ndungu, 1987,54). This view is in line with the suggestion made in Di Bentley and Watts (1989,2-3) as follows:

Pupils should be learning subject matter which consists of information, skills and attitudes, at the same time they should be helped to recognise their increasing competence, feel better about themselves as individuals, develop more responsibility, increasing problem-solving ability, prepare for the world of work and develop independence.

These reiterations indicate that developing countries needs are more of technology than science. Kenya, for example, has to aim at achieving most of her needs through her technological development. The curriculum materials may reflect this, but there is still a major bottleneck: the
traditional science teaching approaches that are characterised by rote learning and practical work aimed at mere verification and confirmation of physics theories. Such approaches provide pupils with a lot of scientific information at the expense of providing an understanding of science and its contribution to the physical, intellectual and spiritual aspects of our lives. It is a major attribute to lack of delivery of the intended 'goods' of the school science, as per the national goals—a serious mismatch.

On this account, it will be useful for the physics teachers to pigeonhole their course objectives to those that are more realistic and relevant in the light of most of the school leavers "becoming future consumers rather than producers of science" (Gaskell, 1982, 34). In other words, the aim should not be to produce school leavers who will only 'talk' physics; instead they should be able to use physics as well to solve their real life problems—self-reliance. In doing so, it will be useful to classify the physics course objectives into three groups that deal with:

* content—covering the subject matter;
* training—that caters for whether the student will be able to transfer the training to other studies or to life in general;
* understanding—that caters for intellectual or cognitive aspects of the curriculum (Rogers, 192, 5).

According to psychologists, the transfer of training is easier to occur when there is a common ground between the the field of training and the field to which we wish to transfer; or when there is similarity between the influencing
and influenced functions (ibid.). Inescapably, linking school science and technology to the influencing factors in the everyday life of the child is a way of influencing his functioning in society. The influencing factors are mainly human needs which by definition, can only be met through technology that is linked to society.

There are therefore, some special circumstances in which we can achieve extensive transfer of the learning of school physics. Basing on liberal education (or 'education for all'), Rogers (1962,7) has made some suggestions that include:

**emotional attachment**, in that far reaching transfer occurs when the pupils develop the extend to which they associate feelings of enjoyment, interest, inspiration with their study of physics. The more they enjoy the their physics and they are inspired by their skills and methods, the more they like discussing its philosophy, the more likely they retain and generalise the teaching. For example, a student who develops delight in accurate measuring through weighing accurately in a physics laboratory may well extend the technique and attitude of seeking accuracy far and wide in his everyday activities - particularly, if he has been made aware of the possibilities and value of his wide transfer.

**conscious efforts towards transfer can help;** that is, we can make transfer more likely by making a student aware of his gains in one field and pointing out their applicability to other fields - 'hopes of transfer'.

**general intelligence;** there are suggestions to the effect that ease and extensiveness of transfer of training increases with increasing general intelligence (ibid.). This means that, brighter pupils may not be disadvantaged by the pegging of the 8:4:4 physics at the level of the majority of the pupils in the face of the increased demand for 'physics for all' (or general education), so long as the course is well planned.

These circumstances can be best created through the linking school science and technology to everyday life of the
Kenyan pupil. As a result, the mismatch between the national goals and the products of the school science and technology can increasingly be reduced.

To go with this, is the fact that the gender-bias stereotyping in school physics that has continued to contribute to scanty recruitment of girls and women in the pursuit of the discipline at tertiary levels, would also be broken through this linkage. Gender-bias is a source of a mismatch that has frequently not considered seriously enough to warrant attention in the Kenyan context. The excuse has been that 'We still have more serious problems than this'.

But, in view of the current national objective of 'physics for all', there is a need for physics teachers to encourage girls in doing the subject as well as changing their attitude towards the subject. Physics has to be presented in a way that is girl-friendly. As indicated by Versey (1990, 9), the image perceived (and thus generally presented) is that which disadvantages girls and women in their pursuit of career in this field. The subject is "predominantly male pursuit, role models are predominantly male; and because of the relatively small number of women in positions of influence, the examples presented are predominantly examples which engage interest and motivation in boys and men".

This calls for physics teachers to engage the interest and motivation of a wider range of pupils. One way of achieving this is widening the range of teaching techniques,
learning experiences and relevant starting points. Because, pupils should be recognised as individuals, with a wide range of interest and learning needs.

Linking school science and technology to girls' everyday contexts has a significant role in enhancing the effectiveness of any of the teaching strategies adopted in popularising the subject.

Creativity is an essential element of the self-reliance that has strongly been emphasised in the 8:4:4 curriculum. It can only be enhanced through the provision of creative activities to the young physicists. The traditional fact-jammed physics, as indicated above, starves pupils of this commodity. Evidently, many school graduates in physics have emerged with no memory of creative experience in school. Rogers (1962,8) points out that "without such an experience, civilised man is a dull fellow and school has little chance to make him better". Some of the glaring manifestations of this weakness in Kenya include, the vast unemployment, massive rural to urban migration, and inadequate production of goods and service among the poor. Yet, children can do creative activities in physics through linking school science and technology to their everyday contexts.

Furthermore, emphasis on design, as the 'heart' of technology, may increase pupils' confidence in their ability to manipulate materials, apply scientific principles, and understanding some of the constraints on the design of
technical solution.

Along the same line, physics pupils should be helped to develop a firm foundation for social and moral development for their positive contribution in making decisions on the problems they will be faced with in their future. School physics should foster awareness of science, technology, and society issues by encouraging pupils to grapple with the complex arguments—scientific, economic, political, religious, and moral—which are often associated with the proposal for social use of science and technology (Layton, 1986, 171). Activities to this effect include simulation exercises on a variety of topics, for example, the siting of and choice of fuel for a new power station in their locality. This calls for the linking of school science and technology to society through the following aspects of the physics course: technological, philosophical and cultural nature of science; science and social issues (Gaskell, 1982, 37). This would provide pupils with the appreciation of the significance of the power, and limitation of science and technology in their wider social and moral context.

Such a pupil will be well equipped to deal with the scepticism about the advice of experts that is seriously facing developing countries like Kenya. Damping of nuclear waste, for example, in such countries has increasingly become a lifetime concern. Also included, are technological
products banned in the developed world that continuously find their way into these countries. The linking of school and technology to society is an effective spring board for reversing the situation.

Basing on the current perspectives on the learning of science it has been realised that local peoples' knowledge and practice of science and technology inform the science that is taught in schools (Knamiller, 1988, l). This means, pupils' conception in science may be influenced by his local peoples' cultural believes about the natural world (Odhiambo, 1972; Horton, 1967; Claxton, 1987; George and Glasgow, 1988).

It is therefore evident that local science and technology provide a fertile ground for extending children's knowledge for helping them to raise questions, challenge the current views, and to learn skills of investigation.

In practice, this fact has always been ignored; as expressed in the constructivist view on learning in science, that is, children come to school with prior-knowledge. Which in the context of Kenya, is mainly acquired from their local science and technology. George and Glasgow (1988) have referred to those that are related to school science as "street science".

To enable such a child to reconstruct his alternative mental frame in the light of conventional science, the linking of school science and technology to the child's environment provides the necessary familiarity.
Traditionally, the flow of information has often been in the direction: from school to the society. The aim has been to benefit the society from the school point of view. In essence, a two way flow, as shown below, if encouraged would open way for the school to benefit from the society as well.

```
SCHOOL
\------\ INFORMATION \------\ SOCIETY
\   /                       /   \
\ /                        /     \
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**Fig.III: Information flow**

Through this type of flow of information physics teachers would be able to equip the young physicist with the relevant learning experiences. Such experience will provide pupils with the skills and knowledge base that can be applied in copying with the immediate problems in his society – unemployment, environmental problems, and those of industrial development, in both agriculture and the manufacturing sectors, as indicated in above.

Last but not least, the introduction of the 8:4:4 curriculum in Kenya secondary schools was accompanied with the introduction of separate technical subjects in schools. They were grouped as: agriculture, industrial education, home science, business education, art and design and music (ME,1987). Since physics is a compulsory subject to all pupils, its linkage to everyday life would cut across these subjects and provide pupils with a firm base on which to build their technical subjects - transfer of training.
Furthermore, the introduction of the 8:4:4 curriculum resulted into the upgrading the former technical secondary schools to technical institutions that cater for the 'o' level school levers. A ministry of technical education and applied technology was created to manage all the related institutions. Therefore, linking school science to everyday life would expose pupils to the world of technology and encourage more of them to pursue technology through these institutions, hence directly contribute towards the development of technology in the country.

In short, the rationale for the linking of school science and technology to everyday life centres on, the national objectives demand for vocational and technical orientation in the curriculum; engaging the interest and motivation of the leaners, boys and girls; encouraging the practical use of local science and technology; and increasing 'innovations' in the pedagogy of physics.

2.2 CURRENT TEACHING PROBLEMS

Current teaching problems could be categorised into two main groups, namely, public attitude to technology and those related to the actual teaching process. A brief discussion on each of the groups is as follows:

2.2.1 Public attitude and understanding of technology

The major snag in the development of technology education in a developing country like Kenya is the persistent traditional inferiority image accorded to the available local indigenous
technology in such a country. Yet, it is the type that is most locally available in abundance, in most of the developing countries. Besides, it is based on simple principles and made out locally available materials. In essence, it is a low cost technology that is free from problems of technology transfer at this level. In fact, practical reforms "emphasize in particular on teaching science in conjunction with simple technology, based on traditional technologies" (Eshiwani, 1974).

Therefore, one of the major tasks of science educationists is to break this value-biased stereotyping in the society that disadvantage the use of indigenous science and technology as a base in equipping the youth for the future world of technology. It is through such a re-orientation of the public that developing countries, like Kenya, will be able to meet the national requirement for technologists and technicians. It calls for popularisation of technology education in the country. For it is doing the best with what is locally available that progressive advancement can easily be achieved in these countries.

Kenya government's effort to this effect as indicated earlier include, in summary:

- phasing out parallel system of specialized secondary schools for technical education (8) running against the conventional ones, in the whole country and up grading the technical schools to institutes of technology, to serve 'O'level school leavers.
- introduction of separate compulsory applied subjects at secondary level: each exam candidate has to be examined in at least one of them.
the launching of the ministry of Technology Education and Applied Technology to cater for the related institutions all over the country - colleges and institutes, smallscale enterprises ('Jua Kali'), and industries.

- introduction of the 8:4:4 system of education that strongly emphasize vocational and technical orientation for self-reliance and national development.

It is worth noting that, Kenya is currently blessed with various levels of technical institutions. They range from village polytechnics at grassroot level, provincial institutes of technology, to the national polytechnics (in Nairobi and Mombasa), and the Kenya Technical Teachers College in Nairobi.

As regards the employment of the graduates of technology, the government has encouraged the smallscale enterprise referred to as 'jua kali' by provision of work areas in all parts of the country under the district focus national planning. It is expected that development in technology through school science will enable school leaver to make effective use of these provisions.

It is therefore necessary for teachers, as the key information technology disseminators, to inculcate positive attitude and the right understanding of the nature of technology, through the 8:4:4 science curriculum.

2.22 Problems related to actual teaching process
As indicated in chapter I of this paper, the traditional science curricula have not emphasised on clear distinction between science and technology. The little content of
technology that was inexplicitly implied was just regarded as 'applied science'. Coupled with this, is the fact that the recent call for science and technology in the 1980s emphasised on an integrated perspective of science and technology at the expense of a separate understanding of each of them. Hurd (1990,413) has emphasises this fact as in our previous chapter.

Secondly, as the 8:4:4 physics syllabus emphasises technical skills, in practice pupils in schools have shown lack of science process skills (Okere, 1988,67). Consequently, they have shown lack of technical problem-solving investigation skills. Without these skills they can not become useful citizens.

Evidently, the inherent value-bias seeem to foster pre-professional training at the expense of the vocational and technical orientation that is wholly advocated for in the 8:4:4 rationale. There is an open bias towards pre-professional training evidenced by the mushrooming of university places in the country at the expense of the latter. But, as indicated by the director of education, the physics curriculum is "designed to cater for the majority of the students for whom secondary education would be terminal"(Waithaka,1988,iii). His emphasis is on technology and not the theoretical science that is meant for the minority who may pursue tertiary studies in science. Kenya's situation urges for a shift towards a science or physics that is more personally and socially relevant.
Basing on the fact that the perspective of science and technology being an integrated system is still new, teachers will require effective re-orientation to it. And, therefore the major problem facing these teachers has to do with the re-orientation of their teaching styles to entailed integrated system approach. This has been worsened by the lack of explicitness to this effect in the stated course objectives. Especially, with regard to the stress on linking the system to everyday life of the learner.

It has therefore been left to the teachers, for example, in physics to interpret the course objectives in the light of the national emphasis on "learning for life and creative productivity" (ibid.), through vocational and technical oriented education and training. In the face of this, most teachers have been faced with the following problems in their attempt to link physics and technology to everyday life in Kenya:

- inaccurate interpretation of physics course objectives;
- lack of facilities and curriculum support materials;
- pressure of time;
- lack of expertise in technological aspects of the course;
- gender-bias, racism and social-class-bias (Stima,1988).

2.221 Interpretation of the course objectives

Poor interpretation of the 8:4:4 physics objectives has contributed to inaccurate gauging of pupil's level of understanding of the subject. Most teachers at form one, for
example, pegged the level high. Evidently, they resorted to 'talk and chalk' modes of teaching for the sake of covering the syllabus at the expense of the learner. There was no emphasis on practical approach, leave alone, flavouring the physics with technology and linking it to everyday life contexts.

Such teachers expressed their views of teaching physics in terms of 'verifying theories', 'restating the laws' 'conveying physics ideas', or 'putting over physics ideas'. These views leave no room for technology and hardly caters for the course objectives expressed above.

Project work is one area where gross misinterpretation has been made by most teachers. Such teachers have shown vague and confused ideas of how to implement project work. Consequently, instead of creating opportunities, and encouragement for pupils to develop creativity in technology, they have concentrated on the theory aspects of the course because, project work is not yet examinable in the national examination. And, in attempt to offer project work they have ended up encouraging pupils to simply copy prototype products, at the expense of developing their originality and creativity in technology (MED,1987).

This misinterpretation has given most teachers the image that project work is a mere reproduction of the available designs and devices. This is contrary to the definition of technology. And, it can not enable the Kenya 8:4:4 physics to
equip the youth with "appropriate and constructive base which they can take with them into their particular form of employment", where they can most appropriately acquire the specific job-oriented skills required (Woolnough, 1983, 66).

2.222 **Lack of physical facilities and support materials**

Most secondary schools in Kenya have limited physical facilities and curriculum support materials for the teaching school science. Technology being a practical oriented field it increases demand on the already over-stretched teaching facilities. This situation has been worsened by the imbalance in the availability of teaching and resource materials for technology education in the country. This means that, those schools that had traditionally been offering technical subjects such as metal work, wood work and agriculture, may be at advantage in coping with the increased demand on teaching facilities and materials.

But still, it is only through creativeness that these facilities could be best utilized to further the linking of school physics and technology to everyday life. Most teachers have hardly shown creativity to this effect.

In general, according to the 1987 Inspectorate (Physics) Annual Report, the average percentage of inavailability of laboratory space in these schools, per province, in Kenya was about 52 percent. This indicates that slightly more than half of the schools in the country have no laboratory space. There is no guarantee of the situation improving overnight.
A worthwhile alternative, as advocated by the Commonwealth Organisation is the promotion of improvisation in our schools. Lack of physical facilities should be seen as a global problem and not as one associated specifically with Kenya. Besides, improvisation has already succeeded at primary level in Kenya. It is a common feature at this level of the 8:4:4 system of education. The challenge to teachers is to extend it to the secondary level.

Physics teachers have to take initiative in the extension improvisation to the secondary school level. This will enable them to adequately cater for the teaching of their subject and related technologies. Technology education should, in this case, be geared towards the provision of some of these facilities through project work.

Furthermore, studies have shown that there are several benefits derived from the improvised apparatus and equipment and in promoting the link of physics and technology to society. They include:
- reduction in the cost of apparatus;
- pupils learn that scientific ideas can be demonstrated using homely as well as sophisticated materials;
- successful improvisation would bring both pleasure and a powerful stimulus for creativity;
- exposes pupils to meaningful and resourceful use of locally available materials and resources in problem solving: technology.
In this connection, in furthering the link of school science and technology to everyday life, the involvement of pupils in 'laboratory practical work is a basic requirement'. As well as being one of the ways of reducing pupils perception of difficult in learning physics concepts it provides them with "hands on" experience of the real world of technology (Woolnough, and Allsop, 1985, 2).

In addition, as indicated above, Kenya is blessed with polytechnics at both village and national levels, where technology is practised. Besides, there is a centre for the appropriate technology at Langata in the city of Nairobi that is similar to the one at Machynlleth in Wales in UK. Schools should develop links with these institutions in order to 'practically' further the link of science and technology to everyday life. There is a lot to be learned from such institutions as regards the acquisition of teaching equipment and apparatus, and support materials for technology education. In view of this, a modular approach to technology would be most appropriate.

2.223 Pressure of time

The pressure felt by teachers to complete what they see as a crowded 8:4:4 secondary school physics syllabus in a limited time is one of the major constraints in the implementation of the course. In addition, they believe that pupils need a lot of guidance to carry out experiments successfully. This has, as per the interview with teachers and pupils, led
to haphazard coverage of most of the physics topics.

At the curriculum development level, physics was allocated two periods per week, at forms I and II and only three periods per week at forms III and IV (ME, 1987, 56-57). This allocation is half of the traditional one which most of these teachers were used to. A glance at the content of the syllabus indicates a wider coverage and the need for the linking of the school physics to everyday life.

Physics teachers have therefore, found it difficult to adjust to these new directions in their teaching of the new curriculum. Any of their attempts has been accompanied with a rush to cover the syllabus, as explained above, for the sake of the national examinations. The 'talk and chalk' approach has highly been attributed to this rush. Hence, the linking of school physics to everyday life has in most cases been ignored or haphazardly covered.

On this account, there is need for the Kenya National Examination Council (KNEC) to set examinations that are in harmony with the goals of linking of science and technology to everyday life. Examinations should play a leading role in re-orientating teachers towards the current trend in science education.

Furthermore, there is need for teachers to plan their work properly in the light of the limited time allocated to the physics and the related technology topics to be covered. It
will also be found useful to introduce some aspects of some of the topics at lower forms. For example, the idea of semi-conductors could be first introduced under topic 12.00: Current electricity - conductors and insulators, at form II level. This would provide some extra time for the main topic: semi-conductors, at form IV level; instead of waiting for the material time. Such a hierarchical stratification of the subject content would be most useful.

In addition, proper gauging of pupil background knowledge and language development will increase the relevance of the planning - schemes of work.

2.224 Expertise in technology education

This is a problem that is common to most of the schools in Kenya. Because, there is not yet a programme for training of physics teachers specifically, in technical education in the country. Therefore, there is a common feeling among teachers that they are ill-equipped for handling the technological aspects of the physics curriculum. They see technology content as that meant for special schools and teachers. And therefore, they face the technology aspects of physics with a lot of incompetence and doubts.

In essence, this seems to be most attributed to the misconception of what technology is all about. It will therefore, take sometime to re-orientate such teachers towards the current perspectives of science and technology as an integrated system. It is hoped that through their proper
understanding of the nature of both, science and technology through inservices, workshops and seminars, they will be adequately equipped to contribute towards effective linking of school science to everyday life.

2.225 Gender-bias and racism

Gender-bias and the rest of value-bias are some of the factors that highly affect pupils pursuit of a course such as physics. It must first of all be argued that school physics and technology that is free from such a bias is that which is equally accessible to all children, black as well as white, girls as well as boys, working class as well as middle class.

In practice there has been a polarization of boys and girls preferences between biological and physical sciences at secondary schools, in particular the rejection by girls of physics has been extensively evident (Brown, 1989, 138). Indeed, Everlyn Fox Keller (1985) and Jenny Versey (1990) in their contending with a masculine bias in the ideals and values of science have pointed out that:

science through its association with objectivity, is inherently masculine. According to this theory women who enter science do so at considerable cost to their psyches...

The 8:4:4 secondary school physics is not immune from this bias, as indicated above. This problem has hardly received priority attention in Kenya. The physics course is still presented as a male dominated and Westernised discipline. It has continued to be shaped by values that are labelled 'masculine', 'white' and 'middle class'.

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The masculine bias is still depicted in most of the teaching materials and even the examination questions. For example, in the recently published form I and II pupils' book, the photograph illustrating activities involving pushing and pulling, as in figure IV below gives the impression that there are no parallel female activities to this effect.

Fig. IV: Push and pull activities

Regarding racism, some attempts have been made to alleviate the situation. But, there is still room for improvement, especially as regards the inclusion of the contribution of the black and women scientists in the curriculum. Because, curriculum materials that dominantly portray images of only white, male, and middle-class scientists contribute to the propagation of a racist, and sexist physics and technology. This has contributed to the rejection of the school physics by girls, and the general African young scientists prejudice against the subject.

As Christine Brown (1989,138) has suggested, attitude to scientific activities are polarised by gender-bias and the racism involved. In most cases, pupils' view of the worth of such activities in terms of what they intend to be in their later life.
Experience show that the polarisation has strongly been flavoured by the very different leisure activities of young boys and girls out of school. Boys activities have tended to offer greater opportunities for development of practical skills and to acquire appropriate grounding for later conceptual learning in physics (ibid.). It is therefore evident that, linking school physics to everyday life would greatly increase these opportunities for the development of their potentials in a familiar background as well as enable the teachers to cater for the desrepancies between boys and girls in their performance in physics.

Otherwise, available statistics indicate that not enough science students, especially girl-physicists, were being produced to fill the available 'A' level places in the Kenyan secondary schools. It is the root cause of this low recruitment of physics students, especially girls and women at the tertiary levels in the country.

According to the Inspectorate Annual Report (1987), it was evident that of the 22,000 'A' level places that were available in secondary schools, a little over 5,000 were science places, yet the total number of candidates who had qualified for these places (at grade 4 and above passes) were as few as 1,442. The table I below provides some useful analysis of this performance (Stima, 1988, 68-9).
<table>
<thead>
<tr>
<th>Division</th>
<th>Number of candidates</th>
<th>Percentage pass (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Division I</td>
<td>4,687</td>
<td>3.9</td>
</tr>
<tr>
<td>Division II</td>
<td>15,524</td>
<td>12.9</td>
</tr>
</tbody>
</table>

Grades 4 and above:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical science</td>
<td>314</td>
<td>1.3</td>
</tr>
<tr>
<td>Physics</td>
<td>181</td>
<td>3.2</td>
</tr>
<tr>
<td>Chemistry</td>
<td>542</td>
<td>7.1</td>
</tr>
<tr>
<td>Biology</td>
<td>405</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,442</td>
<td></td>
</tr>
</tbody>
</table>

Table I: Performance in science (1987)

The table above shows that physics has the lowest enrolment, but ranks second to chemistry in percentage passes. It shows that only the few 'bright' students who were sure of passing the subject are the ones who enrolled for it. Most of them were boys. In fact, the performance in physical science might have been weighed down by poor scores emanating from the physics section of the paper.

According to the current views in education, science in society needs women not simply as a potential supplementary work force, but as a complementary work force to redress the imbalance that exists in terms of influence, power and care of the world (Versey, 1990, 9).
CHAPTER III

3.0 LINKING SCHOOL PHYSICS AND TECHNOLOGY TO EVERYDAY LIFE THROUGH THE 8:4:4 SECONDARY SCHOOL PHYSICS

3.1 OVERVIEW OF THE LINK

By everyday life, this section of the paper refers to the 'context' of the learner and in particular the science and technology that he or she interacts with in his or her environment and that which the learner has developed through experience and interaction with society. All these constitute to what may be referred to as 'children's science and technology'.

In the Kenyan context, this type of science and technology has been evidenced through children's success in making interesting models of leisure (or playing) equipment such as cars from wires, bicycles from pieces of wood, and even simple radios from old radio parts. Indeed, it is widely accepted that such children are technologists in one way or another. However, when such children come to physics lessons these potentials are hardly exploited by teachers; instead they are suppressed in such away that, most of them on leaving school, they no longer exhibit any technology.

The key attribute to this is the lack of linkage of school science and technology to the everyday life of the child. The "science and technology out there in the real world that a child may bring to the classroom" (Knammiler, 1984, 3) is always ignored.

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To alleviate the situation, the linking of school science and technology to everyday life, in a two way flow, should be focused on developing these potentials of the Kenyan children. In reality, Kenya is blessed with a vast variety of technologies and science. They range from 'energy converters', 'brewery', 'pests control' 'claypots' to those used in carrying loads: carts, and on heads. The government, as indicated earlier, has played its role by providing an infrastructure for the promotion of these potentials: technology centres and polytechnics.

The everyday life, as stated above, encompasses a wide scope of the learners environment. It will therefore be worthwhile, in this section of the paper to narrow the scope to local science and technology. Furthermore, we shall mainly be concerned with the ways in which a physics teacher may develop the link of school physics with the local science and technology. This would be best achieved through the flavouring (or grafting) their physics lessons with local science and technology.

In this case, the activities that would be useful in the linking of school physics and technology with that in the pupils' environment would be categorized in terms of: those already in the 8:4:4 physics syllabuses and those outside the syllabuses (or school). Those in the 8:4:4 physics syllabuses include,

- laboratory (or practical work): class experiments, teacher's demonstrations, and project work;
- reading, including contribution of black and women scientists;
- essays and discussions.

The main aim of these activities is to provide pupils with opportunities of developing their creativity. But, special circumstances have to be created to enhance the process of equipping pupils with creativity. It has been realised that laboratory work can provide a sense of creative work in science to the majority of the pupils if linked to their everyday life (Rogers, 1962, 8). Besides reading with some free choice can give creativity, if the linking is also catered for. Essays and discussions would be useful if geared towards thought provoking questions that are linked to the everyday life contexts of the learner.

Out-of-school activities also play a vital role in linking school science and technology to everyday life, because they take place out there, within the real world of the learner. They include all those listed under 1.122 of this paper.

Secondly, local technology refers to that which uses traditional methods and locally available resources for production of essential goods (Amara, 1987). Characteristics of such a technology includes: meeting local needs, based on simple principles; it is adaptable, and affordable.

Local technology would therefore, contribute to a better linking of school physics and technology to everyday life because it centres around the problems and issues which are
meaningful to the learner and derived from the real situation in the community.

An example of such a technology is the making of claypots. This section of the paper is addressed to this type of technology. Because, in developing countries, Africa in particular, most people use claypots for cooking food, and storage of drinking water or even their harvested grain. It is a technology that is accessible to every pupil in these countries. Such a technology is a source of familiarity that facilitates the learning of various areas of science; provides confidence in the subject, as well as contribute to the development of science and technology in the country. Boyle (18974,33) has expressed this same view as follows:

It is only when the way relationship between science and society is already understood that science will be able to help solve the problem of society that it helped to create.

The understanding of the relationship between science and society would, in this context, be enhanced by the linking of the school science and technology to the technology of making claypots. The resulting science and technology will be in harmony with the country's traditions, development plan and modernisation. It has been shown through the initiatives of appropriate technology that local technology although regarded as primitive, can be certainly be improved. As indicated in chapter I, the local technology of making claypots should be seen one of the familiar local contexts that may be used in teaching the school physics. There are
many other contexts that may be used to achieve the same. Such a context should be regarded as a base on which the understanding of related concepts in physics could be developed with a lot of familiarity to the pupils. It also forms a base for the exploration of the related technologies. They include, the making of building blocks and roofing tiles from locally available materials, improved charcoal stoves and so on. Familiarity as a whole engages interest and motivation in a wider range of pupils, boys and girls. And, leads to the solutions to our immediate local problems.

In a wider context, the physics knowledge acquired through this technology should be transferable to other areas of materials physics. Furthermore, it would be easily transferable to other technologies and industries. In this way, the link caters for a wider range of pupils' interests on leaving school: self-employment, salaried employment, and further studies, especially in materials physics. It also caters for ambitious young people who may not want to continue staying in 'rural' communities by providing them with a base for salaried employment.

3.2 Making the link: local claypot technology

The following areas of the 8:4:4 secondary school physics could be easily linked to this context of everyday life:

<table>
<thead>
<tr>
<th>Topic No.</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.00</td>
<td>Energy</td>
<td>3</td>
</tr>
<tr>
<td>8.00</td>
<td>Thermal properties of matter</td>
<td>4</td>
</tr>
<tr>
<td>9.00</td>
<td>Mechanical</td>
<td>4</td>
</tr>
<tr>
<td>10.00</td>
<td>Heat transfer</td>
<td>5</td>
</tr>
</tbody>
</table>
Some of the useful ways of creating and transmitting the link include:

- identifying the aspects of the technology and relating it to the science processes;

- encouraging and providig opportunities for pupils to discover principles that were used by their ancestors and those that are still in use;

- providing tasks for developing problem-solving investigations through the claypots technology.

These activities could be divided into two groups: out-of-class and class activities. They all require proper planning and organisation in order to accomplish them successfully. Suggestions to this effect have been provided in the following part of this section.

3.21 Class room activities

Under topic 10: Heat transfer, a teacher would introduce the idea of pots through an investigation such as the one described as follows:

3.211 'How does the outer surface of a pot affect the boiling rate of its content?'

Introduction

You have probably observed some cooking using a pot. When the pot is used for a long time its outer surface changes. It gets covered with black soot.

Pupil's task

You have been given two pots of similar sizes, one with a sooty outer surface and the other with a shiny one. You are also, provided with two similar charcoal stoves to use
in heating water in each of the pots to boiling point. The arrangement may be as shown in the diagram in figure V below.

![Diagram showing arrangement of the apparatus]

**Fig. V: Arrangement of the apparatus**

Your job is to determine the pot, A or B that boils the water faster.

### 3.212 Follow up exercise

The following questions would be a useful exercise for the pupils:

i) What are the precautions that should be taken while investigating the 'efficiency' of old and new pots?

ii) Suggest reasons for your observations made during the experiment. Which of the pots, A or B would cool faster?

iii) How would you ensure, before the coating of the pot with soot, that the soot is easily removable from its surface?

iv) How would the covering the top of each of the pots with a lid affect the results of the experiment?

v) How do your results compare with the traditional verdict about the new and old pots?

vi) Basing on your results of the experiment, suggest a colour of clothing for a hot day. Reasons?
3.213 Follow up tasks

These tasks would be used to set out a basis for the technology of making claypots, before the actual practical modelling of the pots. They are as follows:

'What is the effect of soil type or mixture of soils on the quality of a claypot? (investigations using clayblocks)'

The 'clay' used in modelling of pots is usually collected from rivers far away. It is usually a mixture of soil, clay, as well as gravel or sand. The purpose of this activity is to determine the proportions of these soils that would be mixed to provide the best 'clay' for moulding pots. Success in determining the appropriate ratio would be a solution to the problem of going to collect the 'clay' far off in rivers.

Thought provoking questions would be useful in the setting of pupils' mind to the problem. This may include questions like, predicting: 'What would happen to a claypot made out of very high or low amounts of either clay, sand, or garden soil?' Through the discussions it might be revealed that although clay gives soil its cohesive characteristics, it swells when wet, but shrinks and cracks when dry.

With different proportions suggested by different pupils, they should embark on planning how to go about testing their hypothesis in group work. One of the useful suggestions may be the use of cubes of different mixtures of soils in their experimentation. Besides, some related information from the local technology of making claypot would be useful.
'What is the effect of the amount of water on the soils mixture for moulding claypots?'

One of the conditions of the soil mixtures that has to be considered in making pots is the amount of water. For example, too much water may lead to less compaction that may result into the cracking of the claypot. Too little water may not allow for proper cohesion in the 'clay'.

The aim of the activity would therefore, be to determine the optimum amount of water for a given amount of soils mixture. Pupils should be able to design their own methods of determining this optimum. It will be useful to use cubes of soils mixtures, instead of actual pots in testing their hypothesis in the laboratory. Because, the making of the pots should only be useful after their determination of the of all the necessary conditions.

One of the ideal tests for this that is based on the traditional technology of making of claypots is the 'dropest'. In this test, the soil mixture, after adding water to it is rolled into a ball. The ball is then left to drop from a height of about 2 metres onto a smooth ground. The criteria of this test is as follows:

- if the ball stays in one piece then the soil is too wet;
- if it shatters into many tiny pieces, it is too dry;
- if it contains the right amount of water it breaks into 4 or 5 pieces. i.e.

![Too wet](image)

![Too dry](image)

Suitable
'What is the best way of drying pots: to avoid cracking and exploding, during the burning?'

According to Knamiller (1988,9), the biggest problem in making of claypots is controlling the drying process during the modelling as well as the burning. As stressed, cracking and 'exploding' are constant concerns.

The task provides a link of school physics under topic 8.00: Thermal propertis of matter, to the local technology of claypots. It is also envisaged that a visit to a related technolgy such as the making of clay bricks for building houses like the one at Kasarani in Nairobi, would be helpful. The visit would provide a concrete base for the investigation.

It will therefore be necessary to assess pupils' design for the investigation in a laboratory setting as they use their 'claycubes' made of a variety of soils mixtures.

3.214 Other conditions of the soil mixture that may also be investigated in the laboratory setting include:

- the effect of adding either cement or lime to the soils mixture on the quality of the claypot;
- determining the effect of compressional and extensional forces on soil mixtures of different portions;
- determining the porousness of claypots made out of different soils mixtures;
- designing simple devices for conserving heat from cooking pots.
Assessment of pupils' performance

In assessing pupils' performance in the laboratory investigations and the exercises above, the following marking scheme would be a useful guide.

**MARKING SCHEME**

**Investigations**

i) Identifying key variables

To alter: surface of the pots

To measure:
- time to boil water
- using same amount of water

ii) Effective procedure

- creating steady supply of heat
- measuring time up to when the water just boils
- tabulation of the results

iii) Validity

- accuracy: repetition of experiment
- conclusion: matching the results obtained and providing solution to original problem.

**Exercise**

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Score/Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. i) Keep off breezes/draught;</td>
<td></td>
</tr>
<tr>
<td>ii) Give the stove a steady burn.</td>
<td>2</td>
</tr>
<tr>
<td>2. i) Dull surfaces are better absorbers of radiant heat;</td>
<td></td>
</tr>
<tr>
<td>ii) Pot A.</td>
<td>2</td>
</tr>
<tr>
<td>3 i) Cover the outer surface with a layer of ashlike material before using it.</td>
<td>1</td>
</tr>
<tr>
<td>4 i) It hastens the boiling.</td>
<td>1</td>
</tr>
<tr>
<td>5 i) White colours are better reflectors and poor absorbers of radiant heat.</td>
<td>2</td>
</tr>
</tbody>
</table>

---

**TOTAL** 8

61
3.22 Out-of-class activities

These are practical investigation activities that would be best carried out as group project work. Each of the tasks involved require longer periods to accomplish.

On this account, the project work assessment guide lines, as provide by the ministry of education (1987,83), would be useful in the assessment of these out-of-class activities. And therefore, the assessment would be based on individual performance and behaviour at the following stages: Planning and discussions, experimenting and discussions, and the presentation of the written report. Besides, the grading of the project could be based on: originality, creativity, simplicity, and workability of the project. This grading could be on a simple five-points scale as shown in table II below:

<table>
<thead>
<tr>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Excellent</strong></td>
<td><strong>Above Average</strong></td>
<td><strong>Average</strong></td>
<td><strong>Below Average</strong></td>
<td><strong>Weak</strong></td>
</tr>
</tbody>
</table>

Table II: Five points scale

The weighting of marks at each stage of the project assessment is summed up as follows(ibid.):

* Planning and discussion (20%), awarded for:
  - fundamental knowledge of the topic;
  - ability to propose a plan for the project;
  - willingness to raise questions and ability to answer questions from fellow students;
  - capacity for originality and creativity.

* Experimental stage(30%); the criteria being:
- possession of appropriate manipulative skills;
- cooperation with other members of the group;
- willingness to consult the teacher, community, and accept help from other students;
- ability to work effectively and independently;
- attitude to practical work and economical use of material and available resources;
- skills in observation and data collection and recording.

* Post-laboratory discussion (25%); which should allow pupils to:

- become familiar with the role of science and technology play in creating and solving social problems, experimental uncertainties and with the developing of a sense of responsibility to influence the resolution of the issues involved;
- know the limitation of generalisation from such data;
- evaluate his work with that of his peer physicist.

*Final report (25%); which should be comprised of the following qualities:

- proper organisation;
- good communication of the ideas;
- proper depth of treatment and supporting evidences;
- scope and neatness.

3.221 Tasks for out-of-class activities

A brief outline of some of the tasks is as follows:

i) Involving pupils in making of claypots using the laboratory results obtained using the 'clay' cubes. This includes, the soils mixtures ratios, the appropriate amount of water added to the soils mixture, drying and the addition of other 'ingredients' for improvement of the pots.

This could be followed by their making improved charcoal stove ('jiko'), using discarded aluminium cans.

This entails some problem solving out-of-class investigation and research on the available technology in these areas to
backup their designs and action in each project. As a result, a link between the school physics and the real life in their community will be established.

ii) After making the claypots and the 'jikos' they will be in a position to determine quantitatively the efficiency of the new and the old pots, as well as that of various charcoal stoves available in their community. An illustration of the possible varieties of jikos in Kenya is provided in the diagram in figure VII shown below.

![Fig.VII: A Variety of 'jikos'](image)

iii) Construction of a device for burning claypots would be an interesting project to most of the pupils. It is also a motivative way of enabling the pupils to link their school physics to their everyday life through problem-solving investigation on local technology involved: equipment and procedures.

They might find that traditionally, open fires have been used in burning claypots. Such fires require the use of lots of firewood. Currently, it is difficult to come by such amount of firewood. Besides, it is an inefficient way of doing it.
The investigation should therefore, be geared towards the determination of improved devices and methods of burning claypots. Pupils would be required to make their designs of the device and evaluate the whole project.

A visit to a related project such as the claybricks furnace, as indicated above, would also be useful.

If all is a success pupils will be eager to burn their claypots in their new devices. They might be tempted to do so before testing the efficiency of these devices. It will also be useful to restrict them to using 'clay' cubes in testing the efficiency of the device before risking their pots. Such an approach to evaluation of their technology should be encouraged through such tasks.

When it comes to the burning (or firing) of the claypots it will be useful to link the activity to traditional procedures through: simulations, role play, story telling and even dramatization.

iv) Other useful activities may include:
- devising a simple test for quality of claypots that could be used in shopping for them or in a market place;
- essay and discussion on why claypots have round shapes
- relating the various claypots in their locality to their traditional usage (or importance). For example, in the diagram under appendix I, such a suggestion has been made.

3.3 IMPLICATIONS

3.3.1 Teacher training
As indicated in the first chapter of this paper, the emphasis on the teaching of technology in schools in developing countries, Kenya included, is a very new development in the struggle for relevance in the school science curriculum. For it to succeed the teacher trainer has to cater for it.

Coupled with this is the recent shift of emphasis in practical work in science, from the traditional approach of verifying and confirming of theories and principles towards the problem-solving investigative approach. This current approach is in conformity with the process of technology. It is therefore a basis for furthering technology in school science.

Furthermore, the recent call for school science free of value, gender, and social-class bias and racism require linking of school science and technology to everyday life context in a broader perspective.

Basing on the demands above on a science teacher, the training of a physics teacher for this decade and years to come require a wider and deeper consideration of these aspects, to create relevance in the trainees curriculum.

For those who are already in service there is a dire need to re-orientate them to cope with these new demands. This calls for well planned inservice training, workshops, seminars, and conferences at different levels in the country. This should be accompanied with an adequate supply of support materials.
and increased exchange of ideas through journals.

3.32 Involvement of industry

Involvement of industry in school physics and technology is a vital support in the promotion of the linking of school science to the real world of work. As indicated earlier, the school provides as base for "contribution that spreads outside immediate and technical training" (Rogers, 1962, 7). The involvement of industry provides special circumstance for transfer of training. It is in industry where real science and technology is actually taking place.

A functional link between school and industry would lead to productive vocational and technical orientation of the school science as per the national objectives. This type of relationship that is most evident in the developed nations should be highly encouraged by their counterparts. Some of the approaches to establishing the link may include: visits, video tapes, photographs, films and publications.

Another aspect of the linking of school physics to industry may involve visits of experts in industry to schools, and the sponsorship of science activities like fairs, congresses, and any other competitions at different levels. Support of school science by industry remain a vital contribution in nation building.

For example, industry could sponsor physics students for a national competition in designing and making a low cost, 67
efficient, solar powered car to be used on Kenyan roads. Such a competition could start from grassroots levels at each school and be narrowed down to the best candidate at the provincial level. In essence, school participation would be the key factor in the stimulation of such a venture. This would highly contribute to the creation of awareness of need for a better management of our environment - ozone layer.

As a matter of encouragement and assurance to the industry in Kenya, the recent production of three prototype cars (MFAIC, 1990), in a similar sponsorship should be seen as an opener of a new phase of industrial development in the country. This sponsorship that was at university level can still be extended to secondary school level.

The ministry of education has a role to play in encouraging industry to link up with schools through most of these avenues.

3.33 Support materials

As indicated above, curriculum support materials from industry alone would not suffice. And, in most cases such materials tend to further the value-bias of interested parties. Free choice of reading materials entailed could only be achieved if alternative supplies are made, especially from curriculum developers, like the Kenya institute of education (KIE) in Kenya. A look at materials like SATIS used in Britain would be useful in KIE's accomplishment of such a task: producing support materials relevant to the needs of
the country.

In addition, there will be need to use a modular approach in designing the support materials for effectiveness. Possible modules would include technology in: mechanics, light (optics), sound and waves, electricity and magnetism, electronics, materials, and radiations.

4.0 Conclusion

Linking school science to everyday life is one of the recent developments in the struggle for relevance in science education. It is one of the ways of using familiar contexts to create familiarity and confidence in the learning of the subject. At the same time, it engages interest and motivation of a wider range of the learners in learning the subject: a problem that is most serious in physics.

Success in using this method entails practical approach and the understanding of the current views on the nature of science and technology and those of learning science.

It is envisaged that such a method if given support, especially from industry, would contribute highly to our achievement of the vocational and technical orientation required by the future scientists in Kenya and any other developing nation.
APPENDIX I

(c): Small size wide mouthed pot for cooking fish.

(d): Large size wide mouthed pot for cooking maize or millet meal (Ugali)

Cooking stone

fire

(e): Medium size pot for keeping water

(6): Smaller size pot for fermenting flour for porridge.

(e): A giant size pot for storing grains.
BIBLIOGRAPHY

ASE (1979), Alternatives for Science Education. A consultative document, Hatfield.


Archer, B.,(1986), The three Rs: Reading and writing; reckoning and figuring; wroughting and wrighting. In Cross, A., and McCormic, B., (Eds.) Technology in schools: Exploring the curriculum, OUP.


BBC, TV,(1990), Earth in Balance: Prince of Wales talk about the environment, June.


Di Bentley and Watts, M., (1989), Learning and teaching in science: Practical alternatives, OUP.


Richardson, M., and Boyle, C., (1979), What is science? An introduction to aspects of the philosophy and sociology of science, ASE.


Swift, D.G., (1983), Physics for rural development: A sourcebook for teachers and extension workers in developing countries, John Wiley and Sons Ltd.


