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AN INVESTIGATION INTO RURAL AND URBAN PUPILS' ALTERNATIVE CONCEPTIONS OF THE CONCEPT "ANIMAL".

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LIST OF ABBREVIATIONS

R	Rural
STD	standard
U	Urban

ABSTRACT

This is a comparative study of the conceptions that rural and urban black pupils hold with regard to the concept "animal". The study recognises the fact that the concept animal is important to the study of biology and that effective learning of the subject may be hampered if pupils hold different conceptions from those accepted in the subject. It was envisaged that the pupils would, as a result of the different cultural milieu from which they come, hold different conceptions. This notion is based on the idea that one's conceptions are derived from one's conceptual ecology. It was also expected that pupils would have idiosyncratic conceptions based on their individual attempts to explain reality and that this would be a reflection of their cognitive development.

The method of interview - about - instances developed by Osborne(1979), was used in the study. This method is based on Piaget's method of clinical interviews. The subjects - 30 rural and 30 urban pupils, were presented with 19 cards depicting some familiar instances and non-instances of the concept "animal". They were then asked to classify each picture and state the reasons for their classification. They were later asked to choose four reasons from a list of 26 which they consider best for classifying an animal.

A science reasoning task designed by Shayer and Adey(1981) was administered to the pupils to measure their levels of cognitive decvelopment.

Results of the interview phase indicated the following forms of thinking:

i. Anthropocentrism, i.e. making judgements and giving reasons using the human being as the main point of reference.

ii. Animal-centredness, i.e. classifying instances and non-instances of animal on the basis of the characteristics of animals in general and not just human beings.

iii. Vacillating between anthropocentrism and animal-centredness, i.e. some pupils were uncertain about the framework they should use for classification.

A number of alternative reasons for classification were found among pupils who used animal-centred ways of thinking; for example, some pupils used reasons such as the ability to breathe and reproduce as distinguishing characteristics of animals. Most of these alternative reasons were similarly used by rural and urban pupils.

When analysed according to their Piagetian stages, the pupils' conceptions seemed to indicate an improvement in the quality of concepts held by pupils in higher stages.

In the discussion an attempt is made to account for the possible origin of anthropocentric thinking, for the similarity of the conceptions held by rural and urban

pupils and to analyse the nature of the pupils alternative conceptions and frameworks.

The study concludes with a discussion of :-

i. Alternative conceptions as possible causes of underachievement by black pupils in biology.

ii. The importance of cultural background as a determinant of teaching strategies and school performance.

CHAPTER I

1. ORIGIN AND BACKGROUND TO THE PROBLEM

This study is conducted in the context of increasing concern in Africa over the underachievement of black pupils in school science subjects. This concern is, for example, articulated clearly in the following statement by Seretlo(1973:3):-

> "The number of Africans who have made any notable achievements in science relative to the population from which they come is,to say the least, depressing. Such figures have even tempted some people to believe that Africans are inherently incapable of receiving meaningful training in science."

Many writers have attempted to account for this poor performance, and the reasons they advance fall into two main categories,viz:

1.1. Cultural deficiency, i.e. because of its non-technological nature, the African culture does not provide the conceptual framework for the effective learning of science in its traditional form.

1.2. Monistic African world-view, i.e.the African world-view does not distinguish clearly between inanimate matter and living matter and, because the spiritual element in it is so all-pervasive, it fails to build a basis for scientific study.

(Horrell 1968, Seretlo 1973, Abimbola 1977, Odiambo 1972.)

The foundation and validity of these assertions will be examined in more detail in the literature review.

Recently, however, science educators in many parts of the world have recognised the importance of the prior knowledge that pupils bring to school. Particularly in Africa the conceptions that children bring to the classroom seem to have been largely ignored or dismissed, mainly as a result of the entrenched views about the contribution that these concepts may make to the learning of science, i.e. these conceptions are regarded as irrelevant to the process of school learning. The present study suggests that, for effective learning and teaching of science, the concepts that children bring to school need to be examined and challenged by the pupils in the face of scientifically accepted alternatives.

2. Purpose of the investigation and statement of the problem.

Research findings from different parts of the world on children's understanding of scientific concepts reveal that:

a. Young children do have firmly held views about many science topics prior to being taught science at school.

b. These views are usually quite different from

those held by scientists.

c. The views of the world, and meaning of words held by younger children - and which differ from scientists' viewpoints - are also held by some older students who have had considerable exposure to science teaching. (Gilbert & Osborne 1982, Driver 1982, Nussbaum & Novick 1982, Hewson 1983)

Much research is currently being conducted on possible ways of changing children's original points of view so that they develop more scientific ones. Although there is yet no definitely accepted method for doing so, research seems to point out that effective learning of science will only be possible if conflict between experience-based prior conceptions and scientific ones is resolved.(Hewson 1981,Nussbaum & Novick 1982)

Effective learning of science seems, therefore, to call first of all for a determination of the nature of these preconceptions. This study thus adapts Bell's(1981) study <u>When is an animal not an animal?</u> to investigate the conceptions that black rural and urban pupils hold with regard to one example of scientific concepts, viz: "animal".

Investigating the kind of concepts that black rural and urban pupils hold with regard to the concept "animal", is particularly important to Bophuthatswana and the republic of South Africa because the joint matriculation board which serves both countries

stipulates that pupils should pass at least one science subject in order to qualify for matriculation exemption. Most pupils in these contries take biology as their sole science subject. Because the concept "animal" is central to the study of biology, this study postulates that alternative conceptions that pupils hold in this regard hamper the understanding of the subject and therefore impede good performance. It is hoped that the results of this study will point out some of the possible causes of underachievement in biology by black pupils.

3. Technique for exploring the problem and gathering data.

This study uses an investigative method developed by Osborne and Gilbert(1979) - the interview-about-instances approach. Following this method, a pupil's understanding of a single concept is explored in tape-recorded interviews. Up to twenty familiar situations are presented to the pupil, each depicted on a separate card by means of a line drawing. The details of this method will be discussed further in chapter 3. Suffice it to say at this stage that it is based on Piaget's method of clinical interviews. Piaget's clinical method provides a means of ascertaining the nature and extent of an individual's knowledge about a particular topic. It makes possible the identification of

conceptions held by the pupils and the relationship between these conceptions.

This investigation compares the responses of thirty randomly selected pupils from post-primary schools in a rural area in Bophuthatswana with those of another thirty in an urban area. Furthermore, Science Reasoning Tasks developed by Shayer and Adey(1981) are administered to determine the level of the pupils' cognitive development in order to establish whether their responses are in any way related to their cognitive stages.

4. Terminology.

The terms such as "rural", "urban", and "concept" are complex in their definition, so are discussed at length in chapter 2.

The South African terms standard 5, 8, and 10 refer to classes of pupils with 7, 10, and 12 years of schooling respectively.

5. Hypotheses.

The hypotheses investigated in this study are as follows:-

a. That there will be appreciable cognitive differences between rural and urban pupils with regard to:

- their understanding of the concept "animal"

and,

- their performance on a standardised test of science reasoning skills.

b. that as pupils grow older and advance through school, they acquire more scientifically sophisticated conceptions of the word "animal".

6. Procedure for treatment of the data.

6.1. Qualitative analysis

Taped interviews of pupils' responses will be analysed for alternative conceptions, i.e conceptions which differ from the scientific concept of "animal". Excerpts from the interviews will be presented to illustrate different ways of thinking.

6.2. Quantitative analysis

a. Frequency distribution of responses per group(total urban and rural) will be compared.

b. Frequency distribution of responses per sub-group(standards 5, 8, and 10) in each main group will be compared.

c. Frequency distributions of pupils' responses per cognitive stage will be compared in groups.

d. Should large, widespread differences occur between the groups, t-tests for

random samples may be employed to establish the statistical differences of such significance where necessary.

7. Importance of the Problem

a. Should no important differences be found between rural and urban pupils' conceptions of "animal" then methods of teaching biology can ignore the urban/rural factor in some respects.

b. Should many important differences be found, then clearly these variables should influence the teaching methods adopted by biology teachers.

c. Bell(1981) interviewed 39 pupils from New Zealand to discover their alternative conceptions of "animal," and the present study seeks to establish whether the 60 black pupils will have some quite different conceptions from their more westernised counterparts. The thesis will then try to account for these differences in terms of cultural origins and/or in terms weaknesses in the modern theory of alternative conceptions itself.

8. Summary of chapter.

The present study recognises the importance of a clear understanding of the concept "animal" for the effective learning of biology. Like Bell(1981), it also realises that pupils may have different conceptions of the

concept as it has both an everyday meaning and a scientific one. As pointed out already, most of the conceptions that black pupils bring to the clasroom have to a large extent, not been taken into account in the design of the curriculum and teaching strategies. The importance of these conceptions in the learning of new science concepts has also been shown.

This study thus sets out to find out the nature of the alternative conceptions that rural and urban black pupils hold with respect to the concept "animal". It is assumed that the two groups of pupils will hold different conceptions which they derive from their different cultural environments.

CHAPTER 2

LITERATURE REVIEW

This chapter is divided into four main parts. In Section A, a resume` and critique is made of traditional explanations for underachievement by black pupils in the sciences. In Section B, the literature on alternative conceptions in science education is reviewed, and conclusions relevant to the present study are drawn. In Section C the problems related to the definitions of "rural" and "urban" are summarised, and implications for the current investigation pointed out. Finally the term "concept" in school science is clarified in Section D with reference to the work of cognitive psychologists during the last ten years, and is focussed on the concept "animal" in particular.

Section A

A Resume and Critique of Traditional Explanations for Underachievement by Black Pupils.

1. Cultural Deficiency

Before an attempt can be made to examine the validity of the use of the cultural deficiency model to account for the low performance scores in science by African pupils one needs to look at the manner in which formal

schooling was introduced into Africa .

Formal schooling was introduced into Africa largely as a result of 18th and 19th century missionary endeavour.As with the Sunday school movement in Britain at the time, a large element of this endeavour was the desire to use Bible literacy as a means to conversion. Colonial governments later took interest in missionary schools, and subsidised some to produce personnel such as clerks, teachers, and other staff to fill the lower ranks of the civil service. What characterised African missionary-based education of the time was its apparent disregard for, or the non-acceptance, of traditional values, content, and approaches to educating the young. Altbach and Kelly(1972 :2) remark:

> "Schools which emerged in the colonies reflected the power and educational needs of the colonisers. While the educational systems that were established served some of the educational needs of the indigenous population simply as a result of the interaction between those making policy,the coloniser and the colonised, schools were primarily designed to serve the needs of the colonisers. The aspirations of the colonised, were for the most part,ignored."

Kgware(1955 :39) expresses this idea in stronger terms. He states that

> "the first Bantu schools came into being not for the purpose of transmitting traditional Bantu culture to successive generations of their descendants but, on the contrary,for the purpose of displacing pagan Bantu culture with Christian western culture. Thus, from the very outset,the Bantu school came into violent conflict with traditional Bantu life."

Because missionary schools established virtually no

dialogue with the indigenous culture, it might be said that the schools dismissed the culture as deficient from the outset. Although this characteristic was somewhat moderated by the time of the Phelps-Stokes Commission Reports of the 1920's, its vestiges persist in the nature and discourse of African education today. There is, indeed very little of the positive aspect of African culture in the literature. Most writers locate the reasons for the African pupils' underachievement in the nature of their cultural background. Horrell(1968:72) for example describes the African pupil's ability to learn science as follows:-

> "...most African children need an enriched programme in the sciences and mathematics classes, as is provided in some Negro schools in the United States under the aegis of the Ford Foundation and others. As compared with white children, African children have handicaps to overcome which result from their poorer cultural backgrounds and environmental experience. Educators find that many of them are lacking in three-dimensional perception,in abstract concepts and in the discernment of finer nuances of colour."

The findings by the educationists which Horrell mentions are contentious. In the first place, it is debatable that anyone can survive in this world if he lacks three-dimensional perception, i.e. if all he sees is flat and he cannot distinguish between near and distant objects. Also many westernized pupils fail tests on spatial visualization outright too. Secondly, there are many abstract concepts in the African culture. Did Horrell perhaps mean abstract scientific concepts? It is also

questionable whether ability to discern finer nuances of colour can determine general performance in science and mathematics. The imprecise statements that Horrell makes with regard to African pupils' problems in the learning of mathematics and science seem to stem mainly from her belief that African pupils come from a culturally deficient background.

It must be pointed out, however, that African culture is, indeed, different from western culture, and so movement from the one culture to the other may therefore entail deficits in some capabilities. But, because formal schooling generally dismisses the African culture, i.e. it does not consider both its strengths and weaknesses, most attempts at an objective description and criticism fail. The cultural input is usually seen as a negative one. The result of such a view is, as Torrey(1967)states, that

> "children come to school to find their experiences disvalued and discounted;they are treated as empty to be filled with knowledge rather than as experienced participants in a way of life that has its own validity." (Keddie 1967 :5)

Keddie(1967:7)states further in this regard that

> "the institutionalisation of the concept of cultural deprivation has increasingly put these children(from other ethnic groups and social classes)at a disadvantage in terms of what is expected from them from the day they enter school."

The dialogue between the school and African culture which the present study advocates should not be confused with the recognition of African culture that forms the basis of Bantu education. Bantu education was founded on the idea

of difference of cultures. Of note, however, is the fact that African culture, as described by Bantu education, was described by the other(in particular the white South African government. This description implied an ossified backward-looking culture which lacked a dynamic.

(Groenewald 1976:15) for example, describes the African socio-cultural environment as follows:

> "The traditional home environment of a black child is characterised by its simplicity and poverty.His daily life is uncomplicated and no particular intellectual exertion is demanded of him. The education of the child is aimed towards his integration in a static pattern of life and the maintenance of the existing order.Progress is not considered necessary."

Such a description of the African culture takes no account of the dimensions and aspirations that the culture developed as a result of the contact and conflict with western culture in the form of colonialism.

In the design of Bantu education the South African government saw African culture as a means to hold the African within a particular framework since, according to government plans at the time, there was no place for the African in the European community above a certain level of forms of labour(Horrell 1968).

The present study contends that effective schooling requires that the school should conduct a dialogue with African culture as it represents African reality now. It is, therefore, imperative that the dialogue should be with the African himself - not with a mediator. Fanon's(1967:181)

conclusion endorses this idea. He states that,

> "the native intellectual who wishes to create an authentic work of art must realise that the truths of a nation are in the first place its realities."

2. The African world-view

Fundamental to the whole issue of the acquisition of scientific concepts is the question of the world-view of the subjects. The literature contains many references to the differences between the African world-view and a western world-view. This difference is often interpreted as a major hindrance to the grasping of scientific knowledge. Abimbola(1977 :16) defines world-view as,

> "the body of beliefs, assumptions, and sentiments with which people confront organised life,for the universe has always presented man with a vast untidy mass."

Maquet(1954) states that,

> "the world-view of a people refers to a kind of reality which is not directly observable.We can observe things and behaviour but not ideas or mental attitudes."(Abimbola 1977 :16)

Odiambo(1972) characterises the African world-view as monistic and the western one as dualistic. He states with regard to the African world-view that,

> "the thread that constantly runs through the African world-view is one of life-force or vital force. All beings - whether human, animal, plant or inanimate -possess force of their own.The supreme being himself,the great Muntu or Jok possesses the greatest life force;other beings are arranged below Jok in a hierachical order according to the measure of their vital-force...The African view then,is that all things have something in common.Indeed he cannot distinguish between 'being' and

'force';force is not only a necessary element or aspect or dimension of being, but being itself."(P43)

Because of this belief that all beings possess vital-force, one being may influence the vital-force of another. Thus in the case of human beings, it is believed that one may affect the vital-force of another and cause illness or misfortune. The all-pervasive nature of the spiritual world in the African world-view has led some writers simply to refer to it as superstitious.

Odiambo(1972:44) contends that the African world-view as he describes it has far reaching implications for an African's education. These implications are:

- "all avenues of an African's knowledge - theology, psychology, medicine, sociology and many others - are so intertwined into one single thought-system that to subtract one part is to dismember the whole edifice."
- "reason and faith are mutually interdependent in the African's view.You cannot separate Jok from this monistic system."

Expressed in other words, it might be said that this monistic world-view does not distinguish the material world from the spiritual world and, since science is a study of the material world, such a world-view would impede the study of science.

The problem of science education in African societies thus seems to be to establish a bridge between the African world-view and the western scientific world-view. As Odiambo(1977 :45)states:

"An African must find a connecting link between

> the principles of natural science and the basic assumptions of his world-view or he is lost."

He states further that

> "if we wish the African to embrace more science than merely technology, then we must reach the basic root of the problem - his monistic world-view and modify it in a manner in which he can begin to regard nature apart from himself or other beings."

Thus Odiambo maintains that science education should aim at undermining the African world-view and replacing it with the western scientific view.

Biesheuwel(1977), on the other hand, maintains that the spiritual-material dualism actually exists in the western world-view as well, as is seen in western beliefs such as "what the stars foretell"or the belief by some scientists in divine intervention as in prayers for rain. He contends that the difference between western and African cosmology is only "one of degree and not kind."

He states that:

> "we should take care not to dub as superstitious that which we know to be contrary to the cause of natural events but which is not part of our cosmology and to ascribe faith to a similar contradiction which happens to fit with our own religious dogma and emotional needs."(p52)

He disagrees with Odiambo's view that science education should be used to eradicate the spiritualistic African world-view. He maintains that the two world-views should be allowed to exist side by side until one view is abandoned when faith in the other has developed.

In this regard he states that:-

> "The African will learn to live in two worlds,

> two realities, just as we did in our progress towards greater knowledge and more complete mental freedom. Gradually he, too, will widen the boundaries of factual knowledge and rational explanation to include more and more of everyday reality. Science education will greatly facilitate this progress but it should not be deliberately used to destroy African ideology."(p53)

Biesheuwel's approach is perhaps endorsed by Kuhn's(1962) idea that a paradigm shift occurs when anomalies in an existing theory can no longer be accommodated within it. Horton's(1982) theory that changes in ideological views are dependent on the existence of competing alternative frameworks also supports this approach.

From the above discussion it appears that the science educator in African societies is faced with the choice between an aggressive attack on African cosmology or the gradualist approach as recommended by Biesheuwel.

Horton(1967 &1982) maintains that, whilst there are sharp contrasts between the African world-view and western science, there are also continuities between them. He contends that the two world-views are characterised by two main levels of thought and discourse viz: primary theory, which he maintains is similar in all cultures, and secondary theory which he believes accounts for the major differences between the different cultures. According to Horton(1982:226), primary theory

> "gives the world a foreground filled with middle-sized(say between a hundred times as large and a hundred times as small as human beings), enduring solid objects.These objects

> are interrelated,indeed they are interdefined in terms of a 'push-pull' conception of causality,in which spatial and temporal contiguities are seen as crucial to the transmssion of change.They are related spatially in terms of five dichotomies: left/right, above/below, in-front-of/behind, inside/outside, contiguous/separate. And temporarily in terms of one dichotomy; before/at the same time/after.Finally primary theory makes two major distinctions among its objects: first that between human beings and other objects and second among human beings, that between self and others."

With regard to secondary theory, Horton maintains that it aims at explaining hidden meanings behind concepts developed in the primary theory. It expands causal-visionary explanations developed in primary theory, thus enabling prediction and control of contingencies arising from primary theory. Horton states that secondary theory "draws analogies with familiar experiences as described in primary theory". Thus "the African thought system builds secondary theory on the basis of experiences of human action and interaction" whilst, in western science,"ideas concerning atoms, molecules, elementary particles, electric currents, waves and rays are drawn from experiences with moving and colliding balls, water currents, water waves and so on."

Horton states further that:

> "ideas about entities are subjected to further development by way of fresh explanatory changes -the results of which include such bizarre entities such as gods who combine human and animal attributes and particles that are also wave-packets...hence the characteristic impression which secondary theory creates,is of an amalgam of the familiar and the strange."(pages 228-230)

If Horton's formulations are accepted, the following possibilities arise:

- that there exists in the primary theory of the African culture a basis for the study of the material world.In other words, the African world-view has a conception of the material world as separate from the spiritual world and this conception can form the basis from which science education can proceed.

- the interface between primary and secondary theory provides a point of intervention for science education in African societies. This intervention will be facilitated by the fact that African secondary theory is usually not transmitted in the elaborate form that Horton outlines, but rather in a finished form as rules and taboos. Transmission of scientific concepts requires that the nature of the concepts being taught be explained. Thus science education, if properly executed, stands a better chance of convincing the pupils about the nature of the world.

Finally it might be said that whether science education sets out to destroy the African world-view or to accomodate it as Biesheuwel suggests, it appears that the African world-view itself does not present an insurmountable obstacle to the effective learning and teaching of science, despite traditional attempts to

explain underachievement in science by black pupils in terms of such an African world-view.

Section B

1. Alternative Conceptions

Osborne, Gilbert & Fensham(1982:623)state that, in the past, science education has been guided by two main assumptions,viz:

a. The "Blank-mind" or "Tabula-rasa" appoach

According to this approach,it is assumed that the learner has no knowledge of a topic before he is taught it. The assumption is that the learner's 'blank mind' can be 'filled' with the teacher's science.

b. The teacher-dominance assumption

Here it is assumed that although the learner may have some conceptual view of a new science topic being taught, this understanding has little significance for learning and can easily be replaced.

However, over the last few years, there has been an increasing awareness about the importance of prior knowledge for the effective learning and teaching of science. There is a growing body of research which indicates that children bring to school concepts about some scientific topics taught in schools which differ from

the scientifically accepted ones. These concepts that children bring to school have sometimes been referred to as misconceptions, but Driver and Easley(1978)argue that they are not misconceptions in the true sense because pupils hold them even before they have been exposed to science teaching. Misconceptions, as the name implies, are conceptions that arise as a result of failure to understand properly the concept being taught. Or as Ausubel(1963) explains it, pupils misconceive when they fail to connect new knowledge to the correct subsumers or pre-existing knowledge. Thus Driver and Easley recommend that they be called "alternative conceptions".

Hewson(1983) agrees to the name "alternative conceptions" since he believes that these concepts,like other concepts, are functional units of thought in that they they "have both propositional(know that) and procedural(know how) aspects".(p 4)

Hewson lists the following characteristics of alternative conceptions:

- they are often held by students who have never had formal instruction in the subject.
- they often differ significantly from the generally accepted view of the subject.
- they are surprisingly resistant to change in response to traditional instruction.(p5)

Pines and West (1984:46) argue that alternative conceptions form part of that knowledge that may be called "intuitive

knowledge, gut-knowledge, or naive knowledge." They maintain that this knowledge is

> "influenced by language, by culture, by other individuals, and so on.It is the child's own sense making of the environment s(he) observes, tempered and manipulated by her/his interaction with parents, peers, television etc. Its primary characteristic is that it is the child's reality."

From their survey of the literature on alternative frameworks, Driver and Erickson(1983:47)suggest that alternative frameworks originate from two main sources, viz:

i. "kinaesthetic or sense experiences". They state that these include

> "experiences relating to a range of natural phenomena which impinge directly and regularly on human senses (such as pushing, pulling, lifting, sucking sensations, of hot or cold.)"

Strauss(1981a)maintains that " frameworks that have this perceptual basis are apt to be universal."(Driver and Erickson 1983:41)

ii. Language and available metaphor. Driver and Erickson (1983)state that:

> "faced with new situations, the available metaphor in language may be a source of ideas used to assimilate a new experience."

The existence of these alternative conceptions is particularly important to the teaching of science. Osborne and Gilbert(1980:376) point out that many teachers are not aware of their existence. Nussbaum and Novick(1982 :184)also indicate that a teacher who is not aware of

the existence of these concepts may interpret the failure of students to reproduce taught concepts as "not understanding". They argue that this failure is not always a result of "not understanding" but of "understanding differently". Novick and Nussbaum also state that when alternative conceptions are "at variance with scientific conceptions, they may play a crucial role in the learning of science".

Driver(1983 :44)also says in this regard that

> "in developing science teaching material, little attention has yet been paid to the ideas which children themselves bring to the learning task yet these may have a significant influence on what children can and do learn from their science lessons."

More specifically Bell(1981) found that most pupils she interviewed in her study <u>When is an animal not an animal?</u> - held views that were markedly different from those held by biologists. The younger pupils and some of the older ones(10 - 15 year olds) saw animals as mainly land animals such as those found on farms, at the zoo or in the home as pets. Older pupils used characteristics such as number of legs, size, presence of fur, and noise production to distinguish animals from non-animals. She states that

> "in our experience of observing lessons over a wide range of age levels, it is frequently assumed that pupils have a scientifically accepted concept of "animal" and the word is used without explanation."

It can, therefore, be argued that the more teachers know about their pupils' prior knowledge, the better able they

will be to structure their instruction such that the alternative conceptions can be modified.

Section C

Clarification of the terms "Rural" and "Urban".

1. Problems of definition.

Sorokin and Zimmerman(1969:13) state that a call for the definition of urban and rural aggregates(communities) appears at face value quite a simple task. A person responding to such a call immediately tends to use a single trait to define either of them. However, Sorokin and Zimmerman caution that no one trait is ever adequate to bring out a clear distinction between the two terms or to give a full definition of either of them. Definitions in terms of one trait are simplistic and even misleading. Sorokin and Zimmerman recommend the use of compound definitions which encompass a number of distinguishing traits.

However, while a compound definition is apparently the best, Sorokin and Zimmerman warn that it can also be abused. They state that compound definitions may be presented at times as an eclectic of traits which are not "bound together by causal or functional relations" - the formulation of such traits being merely "mechanical piling-together" of traits. Thus, according to these authors, a compound definition must be a "logical unification of traits which are functionally correlated with one another."(p14)

2. Problems of distinguishing between rural and urban communities.

Sorokin and Zimmerman state that, along with the problem of formulating a clear, unambiguous definition of rural and urban communities,there is also the problem of making water-tight distinctions between the two. They maintain that "the transition from a purely rural community to an urban one is not abrupt but gradual" and that "there is no absolute boundary line which would clearly cut a cleavage between urban and rural communities."(page14). In other words, the transition from rural to urban communities proceeds along a continuum - from an open farm through a settlement of agriculturists,a small hamlet with an admixture of a few non-farming people, a village, a small town to larger and larger towns and cities. Sorokin and Zimmerman maintain that each step along the continuum is represented by a

> "proportionally decreasing agricultural population and an increase of the proportion of the people engaged in other than agricultural pursuits."

Consequently they conclude that

> "many differential characteristics of rural and urban communities consist not so much in the presence of certain traits in rural areas and their absence in urban communities,as much as in a quantitative increase or decrease of these characteristics or in a positive or negative correlation with rurality or urbanity."(p14)

Given these problems, Sorokin and Zimmerman(p56)present the distinguishing characteristics of urban and rural

communities which are summarized in Table 2.1.

Table 2.1 The distinguishing characteristics of rural and urban communities according to Sorokin and Zimmerman.

	RURAL COMMUNITIES
Occupation:	A totality of cultivators and their families,usually including a few representatives of non-agricultural pursuits.They,do not,however, represent the proper object of rural society.
Environment:	Predominance of nature over the anthropo-social environment.Direct relationship of man to nature.
Size of community:	Open farms or small communities. "Agriculturism" and size of community are negatively correlated.
Density of population:	In the same country and at the same period, the density of rural communities is lower than in an urban community. Generally, density and rurality are negatively correlated.
Heterogeneity and homogeneity of population:	Compared with the urban populations, rural communities are more homogeneous in racial and psych-social traits.
Social differentiation and stratification:	Rural differentiation and stratification less than urban.
Mobility:	Territorial,occupational and other forms of mobility comparatively less.
System of interaction:	Fewer contacts per man. Narrower area of the interaction system of its members and the whole aggregate. A more prominant part is occupied by primary contacts. A predominance

	of personal and relatively durable relationships. Comparative simplicity and sincerity of relationships.

URBAN COMMUNITIES

Occupation:	A totality of people engaged in manufacturing, mechanical pursuits, commerce, professional, governing and other non-agricultural occupations.
	Table 2.1 cont/...
Environment:	Greater isolation of man from nature. Predominance of man-made environment over nature.
Size of community:	As a rule, in the same country and at the same period, the size of the urban community is larger than the rural community. In other words, urbanity and rurality are positively correlated.
Density of population:	Greater than in rural communities. Urbanity and density are positively correlated.
Heterogeneity and homogeneity of population:	More heterogeneous than rural communities. Urbanity and heterogeneity are positively correlated.
Social differentiation and stratification:	Differentiation and stratification show positive correlation with urbanity.
Mobility:	More intensive. Urbanity and mobility are positively correlated. Only in periods of social catastrophe is migration to the country more than from the country to the city.
System of relationships:	More numerous contacts. Wider area of interaction system per man and per aggregate. A predominance of impersonal and casual relationships. Greater complexity, manifoldedness, superficiality and standardised formality of relationships.

3. Application of the above traits to the Southern

African situation.

While noting the apparent continuum in the transition from rural to urban communities pointed out by Sorokin and Zimmerman, it must be stated that the differential traits that they mention better describe developed countries. Some significant deviations and additional traits which are characteristic of the Southern African situation should be set out, namely (i) poverty and (ii) resettlement:-

i. Poverty: In Southern Africa, and indeed in most developing countries, the incidence of rural poverty stands out as one of the distinguishing traits between rural and urban communities. Although rural communities in developed countries may be poor, the pattern of welfare and subsidy payments available in richer countries decreases the contrast between rural and urban.

Table 2.2, for example, illustrates the relative poverty levels between rural and urban communities in a developing state.

Table 2.2 An Economic Profile of Selected Groups in South Africa.

Indicator	Rural Africans	Urban Settled Africans		
	Men and Women	Men and Women	Men	Women
Average Income per Head 1975(1)	R100	R381		
Average Earnings per Worker,(1975)	R160	R1 335	R1 591	R822
Median Level of Education(1975) Economically Active	Nil	6,7yrs.	6,7yrs.	6,7yrs
Percentage in Top Jobs (1970)	2	5	5	5
Percentage in Low Level Jobs	69	28	12	76

(Rural incomes, estimated rural incomes in KwaZulu, 1975. Urban incomes, average incomes per head Multiple Bantu Households in Urban Areas surveyed by the Bureau of Market Research) Figures from Working paper prepared for study commission on U.S. policy towards Southern Africa - Jill Natrass. Oct. 1980.)

Rural people in South Africa, and in the independent states around it, supplement incomes obtained from subsistence agriculture by taking up jobs as migrant labourers in cities, thus reducing the number of people engaged in agricultural pursuits even further. It should be noted that urban poverty is also a feature of Southern African life, but the urban poor have more access to "networks" of financial support.

ii. Resettlement: As part of South African government policy of separate development, many villages have been removed from their areas of origin

and relocated in the 'homelands'. In some cases the villages were removed as whole units, while in other cases, they were split or smaller ones merged. The result of this translocation is that the original homogeneity and relational ties have been disrupted. Occupational relations are also affected by such moves with the result that subsistence agriculture ceases in some cases and the people depend solely on wages earned as migrant labourers. Graaff and Lawrence(19864:44), for example, point out that in most homelands agriculture accounts for only 10% of the family incomes.

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Noting the Southern African peculiarities, Smith(1984:24) suggests that

- "rural communities fall into a number of categories along the following dimensions,each dimension forming a continuum:
- isolated communities as opposed to accessible communities.
- poor as opposed to prosperous communities(in terms of amenities and employment).
- traditionally administered as opposed to modern administration.
- local employment the focus as opposed to commuter or migrant employment.
- resettlement communities as opposed to well-estabished communities."

4. Implications of definitions of Rural and Urban for the present study.

The definitions or distinguishing traits presented above serve to describe the milieu from which the subjects used in this study were drawn. This study assumes that each area,with its own particular characteristics, provides an environment which fosters the development of certain concepts. For example,it is assumed that a child from a rural environment, which is mainly traditional and in which agriculture is the main occupation, will have concepts that are tradition-bound and are also related to agriculture.

However, while this study makes these postulates, it also notes Mayer and Mayer's(1979) observation that definitions of rurality and urbanity usually make structural and functional distinctions only, and say nothing about the behaviour and values of the people in the two environments. In their study of urban black people in East London(South Africa), they found that movement to town is sometimes a mere physical change of abode and does not influence the values and behaviour of the people. They observed that some of the urban people re-create their rural worlds in town, i.e. they continue to uphold their rural values and behaviour(except at places of employment).

This study thus suggests that children from such tradition-bound families, even though they have been

born and bred in towns, may carry some of their parents' traditional concepts. Conversely,rural children of parents who are migrant workers and have aspirations of town life,may have more progressive concepts and values.

Section D

Clarification of the term "concept" in school science.

1.Different psychologists' views of the nature of concepts.

Schaeffer(1969 :88) states that

> "although some uncertainty exists among educationists and psychologists as regards the meaning of the word concept there is a general agreement that a concept has something to do with an abstract structure of properties that is characteristic for a class of objects, events, or phenomena."

Ausubel et al(1968 :88)define concepts as

> "objects, events, situations or properties that possess common attributes and are designated in any culture by some accepted symbol."

Gowin(1970),on the other hand, defines concepts as

> "regularities in events designated by a sign or symbol".(Novak 1973 :3)

Gilbert and Watts(1983:65), however, suggest that different definitions of concepts reflect the philosophical framework from which they were

made. They distinguish between the following frameworks which determine the definition of "concept":

1.1. The classical view of "concept."

Gilbert and Watts state that

> "this outlook supports the view that all instances of a concept, share common properties, and that these properties are necessary and sufficient to define the concept,"(p66)

They contend that this outlook has many drawbacks; for example, it does not recognise the idiosyncratic nature of conceptual activity and it prescribes that concepts should at all times conform to predetermined specifications. They argue that such an outlook gives "rise to the notion of misconceptions : a flaw in the system."

1.2. The action view of "concept"

Gilbert and Watts state that according to this view, conceptualization is "a kind of doing". This idea is also suggested by Fryberg and Osborne(1981) who define conceptualization as

> "ways of organising our experiences so that new experiences do not leave concepts intact but that all cognitive learning involves some degree of re-conceptualization of our existing knowledge."(Gilbert and Watts 1983:66)

Therefore, according to this outlook, each learner is recognised as an active agent in concept formation. Concepts held by different individuals will thus differ according to each individual's experiences and degree of

conceptualization. Gilbert and Watts state that, as a result:-

> "student errors are recognised as being natural developmental phenomena - personally constructive alternatives -rather than a result of some cognitive deficiency,inadequate learning, carelessness or poor teaching." (p67)

1.3. The relational view of "concept"

This outlook is intermediate to the classical and actional views of concept and is the view adopted in this present investigation. Gilbert and Watts(1983:67) define it as

> "a composite view of concept as containing both probabilistic and exemplar components.That is to say, that instances can be judged in terms of their degree of membership to a particular concept(their probability of membership)and the concept judged in terms of its relationship to other concepts.

Schaeffer's(1979)Buhr model of concept is an illustration of this view.

Gilbert and Watts, however, argue that, whilst this viewpoint is an improvement on the classical model in that it incorporates many other concepts and perhaps 'pre-concepts' as well, and "moves towards a more naturalistic consideration of concept development," it has the drawback that it relies on word-association tests, and such an approach does

not provide data concerning reasons for the associations.

Finally Gilbert and Watts state that

> "on comparing the three views presented above, it seems unlikely that a tight division can be maintained between."(p68)

From the above analysis it appears that Gilbert and Watts are making a case for a more flexible definition of 'concept' and for a greater awareness of the part that the learner himself plays in concept formation. However, it must be pointed out that scientific concepts derive from a particular context and are intended to convey a specific meaning. Thus, whilst the learner will actively have to make sense of his learning experiences and form relevant concepts, the idea behind this exercise is that the learner should ultimately hold scientifically accepted concepts.It seems therefore that the 'active view of concept' is not necessarily antagonistic to the 'classic view', and the approach developed in this thesis takes cognisance of the positive aspects of both views.

2. Concrete and abstract concepts

Concepts can be divided into the following main categories: - concrete and abstract concepts;

- everyday/spontaneous concepts; and
- formalised scientific concepts.

Concrete concepts are derived from direct observation or handling of events or objects. Ausubel et al(1968) refer to them as 'primary concepts' and they define them as

> "concepts whose meaning a given individual learns in relation to a genuine empirical experience."

Gagne(1977:44) however, calls them "concepts by observation since they can be denoted by being pointed at."

Examples of concrete concepts are: cat, tree, chair, and house.

Concrete concepts may be elaborated upon and organised to form higher level or abstract concepts. Ausubel et al (1963:88) refer to these as 'secondary concepts' and they define them as "concepts whose meaning a given individual does not learn in relation to a genuine empirical experience." Gagne calls them 'defined concepts since "they must be learned by definition".

3. Concepts in science

Everyday versus scientific concepts are distinguished by the relative ease with which they are attained. Everyday concepts are said to develop

spontaneously or intuitively, i.e. with minimum practice or as Shweder(1977) states, "without explicit instruction" (Hewson 1982:21).

Scientific concepts, on the other hand, require special instruction and are "associated with deliberate self-reflective intellectual activities." (Shweder in Hewson 1982:21)

Examples of scientific concepts are: density, speed, mass.

Ausubel et al(1963) state that, while concepts are an abstract representation of the real world, they do not present the total picture of the event or object they describe. The criterial attributes of the object or event are selectively represented. Ausubel et al maintain that they

> "reflect distinctive values, attitudes towards life, social and economic institutions and ways of institutionalising interpersonal relationships as well as sheer random decision, historical accident and patterning influence of earlier forms of language itself." (p91)

In other words, concepts bear relevance to the social, economic and cultural milieu from which they are developed.

The concept "animal" has properties of concrete concepts in that, as Gagne (1977) says, "it can be denoted by being pointed at" or as according to

Ausubel et al(1968), it is learned from direct experience. It also has some properties of secondary concepts in that some of its biological meanings cannot be obtained from immediate experience and have to be learned by definition, e.g. that animals feed heterotrophically whilst plants feed autotrophically. The present study thus envisages that pupils will have experience-based conceptions of "animal" as well as those that they learned by definition from school.

To conclude, the whole conceptual basis of the present investigation may be epitomized in Toulmin's (1972:49) idea of <u>conceptual ecology</u> in which he describes as follows:-

> "what concepts a man employs, what standards of rational judgement he acknowledges, how he organises his life and interprets his experiences; all these things depend - it seems - not on the characteristics of universal human nature or on the intuitive self-evidence of his basic ideas alone, but also on when he happened to be born and where he happened to live".

CHAPTER 3

EXPERIMENTAL DESIGN, SAMPLES AND DATA COLLECTION

1. Setting

This investigation was carried out in one rural and one urban area.

Rural area: Dinokana village is an old traditional village(about 200 hundred years old) situated in a region of Bophuthatswana called Lehurutshe. The village has enjoyed relative stability in the sense that it has not been subject to forced removals by the South African government as has happened to many villages. There has, however, been migration of people from villages that have been moved, to Dinokana. Despite this, the village has maintained racial and ethnic homogeneity. The life style of the people is also largely traditional and rural in the sense that administration of the village is by a traditional chief. Like most rural areas in Southern Africa, subsistence farming is no longer the most important occupation. Most able bodied adults work as either commuter labourers or migrant labourers in the urban areas. However, for the remaining people, life still revolves around agricultural pursuits.

Pupils used in this study were drawn at random from Dinokana Middle School and Ramatu High School,the only

Dinokana Middle School and Ramatu High School,the only middle and secondary schools in the village.

Urban area: Mmabatho is a newly established surburb of Mafikeng town. Mmabatho is about 5years old while Mafikeng is 100years old. The town is relatively small, with a population of about 50 000 people.The administration of the town is modern, by a city council, and the population is ethnically and racially heterogeneous even though the majority of the people are Batswana.

No agriculture is practised by the people of the town itself although it is surrounded by groups of farming communities. Most people are engaged in the public service and the modern sector of the town.

Pupils used in the study were drawn from C.N.Lekalake Middle School and Lapologang High School - a middle and secondary school situated in the centre of Mmabatho.

2. Populations selected

Three groups of ten pupils each were selected from each of the schools in the rural and urban area.The groups consisted of:

10 Standard 5 pupils i.e. pupils entering post-primary school.

10 Standard 8 pupils - pupils midway through post-

primary school.

10 Standard 10 pupils - pupils completing post-primary school.

Rural pupils were interviewed from September to October 1985, while the urban ones were interviewed from February to March 1986. Selection of the urban sample was adjusted to the fact that the investigation was done here at the beginning of the following year. Thus the urban sample was constituted as follows:

10 Standard 6 pupils

10 Standard 9 pupils

10 Standard 10 pupils (no adjustment was possible here)

Selection of pupils was carried out randomly by the class teachers, with the following restricting instructions from the researcher - that pupils selected be of about average intelligence and free to express themselves i.e. not shy. There was no particular age restriction except that the age of the population should be around the average age of the class. These conditions were set in order to enhance the viability of the chosen research method, which particularly depends on effective oral communication.

3. Selection of Research Method.

This investigation is an adaptation of Bell's(1981)study - When is an animal not an animal. The interview-about-instances method, used by Bell, was also employed in this study. This method was evolved by Osborne and Gilbert(1979). It is based on Piaget's method of clinical interviews.

Adopting this method, a pupil's understanding of a single concept can be explored during taped interviews. Nineteen familiar situations were presented to small groups of three pupils, each depicted on a separate card by means of a line - drawing. The cards included situations which contain both instances and non-instances of "animal". Pupils were then asked to consider whether each of the situations met their concept of the instance. The pupil's reasons for his/her answer were then elicited. Gilbert and Osborne state that the interviews allow for pupils to ask questions, for example, to clarify perceived or actual ambiguities, before attempting to classify a particular instance.

Osborne and Gilbert(1980:378) list the following advantages and limitations of the method:

3.1 Advantages

a. It is applicable over a wide age range.

b. It is enjoyable for the interviewer and the

interviewee.

c. It has advantages over written answers in terms of flexibility and depth of the investigation.

d. Classifying instances is more pertinent and penetrating than asking for a definition.

e. It is concerned with the pupil's view rather than merely examining if the pupil has the correct scientific view.

3.2. Limitations of the method.

a. There is the problem of choosing a limited but adequate set of instances.

b. The order of instances may influence the pupil's responses.

c. Interviews and the transcription and analysis of interviews are time consuming.

d. There are difficulties associated with the analysis of the interview data, e.g. it may be difficult to report succinctly.

However, Osborne and Gilbert(1980:379) feel that despite the above limitations, "the insights gained justify the time commitment, while the experience overcomes the difficulties pertaining to interviewing."

4. Execution of research method and data collection for the populations

4.1. Interview Phase

This consisted of taped interviews with each of the pupils in the population. Three pupils were interviewed at a time because a pilot study revealed that pupils were less free and more self-conscious in a one-to-one interview session.Each pupil was presented with drawings on cards which represented the following instances and non-instances of the concept animal in the order as shown:

cow

snake

fish

car

boy

fire

tree

bird

elephant

worm

butterfly

spider

lion

snail

frog

mushroom

grass

whale

cat.

The pupils were asked two main questions viz:

i. is this an animal?

ii. What tells you that? Give as many reasons as you can for saying whether it is an animal or not.

Further probing questions were asked when pupils seemed to be contradicting themselves. These questions were aimed at ascertaining whether the pupil was aware of the contradiction or not.

Pupils were allowed to use the vernacular (Setswana) when they were unable to express themselves in English. Hence all the interviews were conducted by the author who is not only fluent in both English and Setswana but who can also identify cultural nuances implied or expressed in pupils' responses.

4.2. The Survey Phase

Here the same pupils were presented with six cards, five of which depicted instances of animal and one card which depicted a non-instance. The instances depicted were cow, spider, person, fish and worm; while the non-instance was grass. Pupils were also

given a list of twenty-four reasons from which to choose the best four reasons for categorising an instance or non-instance. Some of the reasons were drawn from the pupils responses whilst others were the biologists' criteria which the pupils had not mentioned in the interviews, e.g cell structure.The full list of twenty-four reasons A - Z is set out in Table 3.1

Table 3.1 List of reasons A - Z from which Standard 5 pupils could choose the four best responses.

A. It can move.
B. It cannot move.
C. It can talk.
D. It cannot talk.
E. It eats other living things.
F. It manufactures its own food.
G. It has fur.
H. It has no fur.
I. It can breathe.
J. It cannot breathe.
K. It can reproduce.
L. It cannot reproduce.
M. It has a brain and can feel.
N. It has no brain and cannot feel.
O. It lives on land.
P. It lives in water.
Q. It has four legs.
R. It has many legs.
S. It can build its own home.
T. It cannot build its own home.
U. It has a mouth.
V. It has no mouth.
W. It has eyes.
Z. It has no eyes.

Table 3.2 List of reasons from which Standard 8s and 10s could choose the four best responses

A. It can move.

B. It cannot move.
C. It can protect itself from danger
D. It cannot protect itself from danger.
E. It eats other living things.
F. It manufactures its own food.
G. It has fur.
H. It has no fur.
H. It can breathe.
I. It cannot breathe.
J. It can reproduce.
K. It cannot reproduce.
M. It has a brain and can feel.
N. It has no brain and cannot feel.
O. It lives on land.
P. It lives in water.
Q. It has four legs.
R. It has many legs.
S. It has cells with cell wall.
T. It has no cells with cell wall.
U. It has a mouth.
V. It has no mouth.
W. It has eyes.
Z. It has no eyes.

4.3. Measuring Cognitive Development

The science reasoning task on Volume and Heaviness designed by Shayer and Adey(1981) was administered to all the pupils. This test purports to measure a range of cognitive levels which span from stages 1 to 3A. Shayer and Adey recognise the following stages among secondary school pupils:

Stage 1 = Pre-operational

Stage 2A = Early concrete operational

Stage 2B = Late concrete operational

Stage 2A/2B = Transitional

Stage 3A = Early formal operational

Stage 3B = Late formal operational

(A detailed description of stages appears in Appendix 1)

5. Hypotheses.

a. That there will be an appreciable difference between rural and urban children with regard to their understanding of the concept 'animal'.

b. That as pupils grow older and advance in school, they acquire more scientific conceptions of the word 'animal'.

c. That pupils' concept of animal as defined in terms of biological criteria will improve or become more refined with their increasing stages of cognitive development.

6. Procedure for Treatment of Data

- Data collected from the interview phase was analysed qualitatively for alternative conceptions while that from the survey phase was analysed quantitatively for the most common responses.

6.1. Format of the qualitative analysis

i. The perceived criteria which pupils use to categorise an instance or non-instance, together with excerpts from interviews, are presented. The excerpts highlight the reasoning that pupils use in order to make their decisions.

6.2. Format of the quantitative analysis

a. A statement about the pupils' ability to distinguish between instances of the concept 'animal' and non-instances, is made. The test

required the pupils to categorise each instance first and then choose reasons for their decision.

b. The responses made by each sub-group (Standards 5, 8, and 10) from each area (rural and urban) and for each instance are presented.

c. The four most common responses for each subgroup from each area are tabulated.

d. The most common responses made by pupils in the different cognitive stages for all instances are also presented in a table,

Any appreciable differences occurring between groups are highlighted, prior to drawing conclusions to the investigation as a whole.

CHAPTER 4

PRESENTATION OF RESULTS

1. Qualitative analysis

There were many similarities in the aspects of thinking exhibited by the two main populations (urban and rural). Essentially the following representative examples of thought were discerned:

1.1. Anthropocentric thinking i.e. regarding man as a point of reference for classification.

The following are examples of pupils' recorded responses:-

A snake is an animal because

- it does not eat cooked food
- it can't talk
- it crawls but human beings walk
- it has a forked tongue (David 18, Std 5, rural)

A snake is an animal because

- it is our enemy - it bites us
- it feeds its young ones on small birds but human beings give their babies food (Samuel 16, Std 5, rural)

A fish is an animal because

- it lives in water
Question: Do all animals live in water?
Answer: No, but no human being lives in water
- it does not eat cooked food.
(Cyprian 18, Std 8, urban)

A fish is an animal because

- it has fins and people do not have fins
- it has gills and people don't have them
(Mantshebo 18, Std 8, urban)

These pupils stated that a boy is not an animal for the following reasons:-

- because he is not afraid of other human beings.
- he has characteristics of human beings; he speaks, he has two hands,two legs and hair on his head only. (David 18, Std 5, rural)

-He is not an animal, he is a person because he has two feet, and two arms; animals have no arms.
-he has a tongue to swallow his food.

Question: Do all animals have no tongues?

Answer: No, animals have tongues.

Question: So this boy is like all animals?

Answer: No, because he eats different food. (Rebecca 13, Std 5, rural)

A boy is not an animal because he can think and do many things that animals can't do. (Mantshebo 17, Std 8, urban)

1.2. Vaccilating between anthropocentrism and animal- centredness

For example:

a. Samuel 16, std 5, rural.

A boy is not an animal, he is a person; he does not look like an animal. Animals have no hands and feet. A person has teats.

Question : Do all animals have no teats?

Answer : No, some have - like a cow, but they have four teats.

Question : So the difference between a person and an animal is that he has two teats and they have four?

Answer : No, there is no difference because animals like a cow which have four teats are mammals and a person is also a mammal.

Question : So a person is also an animal?

Answer : We can say he is an animal.

b. Boitumelo 17, Std 8, urban.

Question : Is a boy an animal?

Answer : You can say he is an animal because he is mammal. He is not really an animal. He is a human being but he is like some animals. But he is not really an animal because he has more sense - he is more intelligent and he does not walk like an animal.

c. Isley 17, Std 8, urban.

Question : is a boy an animal?

Answer : He is not an animal - some biologists say he is an animal but what I can say is that there are many differences between an animal and a human being - a human being can speak - he has two legs and arms and animals have four legs.Finally God didn't say that a human being is an animal. He gave him dignity. The Bible says that God created animals first and then man last.

1.3. Animal-centredness -not using a human being as a point of reference for classification. The animal itself is the centre of definition.

The following criteria were used by the pupils to categorise instances of animal:

a. Movement Almost all the pupils used movement as a criterion to distinguish animals from non-animals.

b. Habitat

A fish is an animal because it lives in water.
(Monyana 15, std 5, rural)

A bird is an animal because it lives in the veld.
(Queen 12, std 5, rural)

A snake is an animal because it lives on trees.
(Douglas 15, std 5, urban)

A fish is an animal because it lives in water.

Question : Do all animals live in water?

Answer : No. There are different kinds of animals - some live in water and others live on land.

c. External appearance/Possession of specific organs

Examples:

A cat is an animal because it has four legs, it has a tail, it has four teats.
(Monyana 15,std 5,rural)

A snake is an animal because it has eyes; it has a long slender body; it has a tail.
(Esther 17,std 8,urban)

A frog is an animal because it has four legs, eyes, reproductive organs, respiratory organs, it has a skin, muscles and blood.
(Priscilla 16, Std 8, rural)

A tree is not an animal because it has leaves, roots, and stem but animals have body. It has no ears or mouth.
(Wynand 16, Std 5, urban)

d. Sensitivity/Possession of brain/feelings/emotions.

Examples:

A mushroom is not an animal because it has no feelings. (David 18,std 5,rural)

- An elephant is an animal because it has a brain and can think. (Suzan 17,std 8 urban)

A snail is an animal because it uses its tentacle to feel. (Jasmin 14, std 5,urban)

A frog is an animal because it can react to unfavourable conditions, i.e. it has emotions.

Question : Do all animals have emotions?

Answer : No, I am referring particularly to a frog.(John 19, Std10, urban)

e. Body Functions

i. Respiration

Most pupils mentioned breathing as a characteristic of animals. Most saw it as a characteristic of all living things but felt that

breathing is different in animals because they use different organs or that plants take in different types of gases.

Examples:

A frog is an animal because it can breathe.

Question : Do plants breathe?

Answer : Yes, but they do not breathe through the nose. (Mary 18, Std 8, urban)

An elephant is an animal because it can breathe.

Question : Do plants breathe?

Answer :Plants take in carbon dioxide and give off oxygen. (Harriet 20, Std 10, rural)

ii. Reproduction

Most pupils mentioned reproduction as a characteristic of animals. They felt that plants use different methods to bear offspring.

Examples:

An elephant is an animal because it can reproduce. There is gender in animals - male and females- and they can reproduce through sexual reproduction, that is males and females come together to produce offspring.
(Peo 20, Std 8, urban)

A cow is an animal because it can reproduce.

Question : Do plants reproduce?
Answer : Yes, but they use seeds.
(Modiegi 17, Std 8, urban)

iii. Feeding/Eating.

Most pupils used this as a criterion for classification. However, they did not make a clear distinction between heterotrophic and autotrophic nutrition.

Examples:

A frog is an animal because it can eat.

Question : Do plants eat?

Answer : They absorb food from the soil; they don't eat through the mouth and absorbing is not eating. (Peter 17, Std 8, rural)

A tree is not an animal because it does not eat;it only lives on water.(Sara 15,std 5,rural)

f. Behaviour

A snake is an animal because it is afraid of human beings;it bites people.
(Kennedy 16, std 5, rural)

A bird is an animal because it can build its own house. (Boykie 17, Std 8, urban)

A snake is an animal because it behaves like an animal. Each snake behaves like another one. Human beings are different; some are kind; others are cruel. (Reginald 17, Std 8, urban)

2. Quantitative Analysis of Results

a. All but three rural standard 5 pupils classified instances of animal correctly. The three that did not classified a human being as a non-instance of an animal.

b. Most of the rural and urban pupils chose responses from the same restricted range as shown in Tables 4.1-4.5 on pages 61 to 65.

c. Although the popularity of responses chosen differs from instance to instance(Tables4.1- 4.5),a summary of the four most commonly chosen responses (Table 4.6 page66) shows that, for all instances,the most frequently chosen were:

A = Movement

I = It can breathe

K = It can reproduce

M = It has a brain and can feel.

A closer analysis of Table 4.6 indicates that a different pattern of responses occurs between the standard 5 rural and urban pupils. Whereas the rural pupils' responses tend to be diverse, the urban pupils' choices tend to cluster and concentrate around responses A, I, K, and M.

Even more interesting is that the response preferences of standard 8 and 10 rural pupils tend to reflect quite closely those of standard 5 urban pupils, which may indicate that rural pupils tend to adopt more uniform thinking patterns several years after urban pupils with reference to the concept "animal". This preliminary finding, however, needs to be validated in a much wider context using many more pupils and schools.

The following responses were not popular among all groups, but feature prominently for certain instances of animal among certain groups:-

Response R = It has many legs. Six of the nine urban standard 8 pupils who chose it, did so with regard to the spider. The other three used it in the case of the cow. It is possible that these three made mistakes in ticking responses in the answer sheet.

Response W = It has a mouth The rural standard 5's used it frequently in the case of a fish while the urban standard 10's used it for all instances.It seems that the rural standard 5's chose this response on the basis that the mouth is a prominent feature of a fish while the standard 10's chose it because the mouth is associated with feeding in all animals.
Response E = It eats other living things was used by

all groups in the case of the spider. The rural standard 5's also chose it in the case of the fish. Rural and urban standard 8's and rural standard 10's chose it in the case of the worm. It seems that the choice of this response was based on the type of food these organisms feed on, rather than on an appreciation of heterotrophy, which is what this response was meant to indicate.

Response F = It can manufacture its own food was used frequently by rural standard 5's and urban standard 8's in the case of a human being.This seems to indicate that the pupils interpreted the response as indicating manufacturing in the industrial sense rather than autotrophic feeding.

Response P = It lives in water was a popular choice for rural and urban standard 5s,and 8s in the case of the fish.

Response C = It can talk(in list of responses for juniors) was a popular choice for rural standard 5's in the case of a human being and cow. It seems that 'talking' is interpreted in two ways - as talking in the sense that human beings do and also as noise production as in the case of the cow.

d. The frequency of responses made by pupils in the different cognitive stages (Tables 4.7 & 4.8 page 67 to 68) shows a similar pattern of distribution to

that seen in Tables 4.1 to 4.5, i.e. higher frequencies occurring at certain points. The pupils at stage 2A show a more diffuse distribution of responses.It is also noteworthy that Response O =It lives on land is most frequently used by pupils at lower stages of cognitive development - stages 2A and 2A/2B whilst Response T = It has no cells with cell wall is used more frequently by pupils at stage 3A. Similarly Response E = It eats other living things, indicating heterotrophy, is used more frequently by pupils at stage 3A.

BLE 4.1 FREQUENCY OF RESPONSES FOR STANDARDS

5, 8, 10(URBAN & RURAL) FOR INSTANCE 1(COW)

Responses	5R n=8	5U n=8	8R n=8	8U n=8	10R n=8	10U n=8
A	6	7	6	2	8	6
B	1					
C	4	1	5	1	2	4
D		2				
E		2				
F		3		1	1	1
G	1	2	2	1	2	
I	3	5	4	3	4	4
J		1				
K	4	6	5	5	4	3
L						
M	4	3	4	5	4	4
N						
O	5	2	2			
P						
Q	5	3	1	3	1	1
R						
S						
T						
U	2		4	1	2	1
V	1			1		
W			3	2	2	4

TABLE 4.2 FREQUENCY OF RESPONSES FOR STANDARDS 5, 8, AND 10(URBAN AND RURAL) FOR INSTANCE 2(Spider).

Responses	5R n=8	5U n=8	8R n=8	8U n=8	10R n=8	10U n=8
A	3	4	4	4	7	6
B						
C	1		7	6	3	3
D	1	3				
E	2		3	5	3	2
F	2	1	1	2		
G	2	1	1	1		
H	3	1	1			
I	3	6	4	1	3	5
J						
K	1	4	5	1	5	2
L	1					
M		4	4	1	5	4
N	1	1				
O	2	1				
P		1				
Q						
R	7	4	1	6	2	1
S	2					
T						
U	3	1	3	1		
V		1				
W	2	2				
Z		1				

TABLE 4.3 FREQUENCY OF RESPONSES FOR STANDARDS 5, 8 AND 10(RURAL AND URBAN) FOR INSTANCE 3(Person)

Responses	5R n=8	5u n=8	8R n=8	8U n=8	10R n=8	10U n=8
A	4	7	3	5	6	5
B						
C	6	5	7	3	3	4
D						
E						
F	4	2	1	3		
G						
H	2					
I	5	7	4	3	4	2
J						1
K		3	5	2	6	2
L						
M	7	4	6	6	7	6
N						
O	1	2	1	1		1
P				1		
Q						
R				1		
S						
T						
U	3	1	3	3	1	1
V						
W	2	1	4	1	1	4

TABLE 4.4 FREQUENCY OF RESPONSES FOR STANDARDS 5, 8 AND 10(URBAN AND RURAL)FOR INSTANCE 4(Fish)

Responses	5R n=8	5U n=8	8R n=8	8U n=8	10R n=8	10U n=8
A	3	5	5	5	7	5
B						
C	1		4	1	2	2
D						
E	3			1	2	2
F		1	1			
G						
H	4			1		
I	1	6	7	3	3	3
J						
K	3	5	2	2	5	1
1				1		
L		1				
M		4	5	2	5	4
N						
O						
P	8	5	4	5	2	
Q						
R	1					
T						
U	4	3	5	3	2	3
V						
W	7	5	2	6	1	5

TABLE 4.5 FREQUENCY OF RESPONSES FOR STANDARDS 5,8,AND AND 10(URBAN AND RURAL) FOR INSTANCE 5(Worm)

Responses	5R n=8	5U n=8	8R n=8	8U n=8	10R n=8	10U n=8
A	4	6	6	8	6	6
B	1					
C	4		5	2	2	3
D	2	3		1	1	1
E			2	2	3	1
F		1				
G						
H	4	1	1	3		
I	3	8	6	2	5	3
J						
K	1	4	6		6	2
L						
M	2	3	3	2	5	5
N		1				
O	1	3	1	3		1
P						
Q						
R						
S	1	1				
T						
U	1	3	1	4		2
V	5	1	1			
W	1	4	2	2		4
Z						

TABLE 4.6 FREQUENCY OF THE FOUR MOST COMMON RESPONSES FOR ALL INSTANCES(All Pupils- rural and urban)

Responses	5R n=40	5U n=40	8R n=40	8U n=40	10R n=40	10U n=40	n=240
A	17	34	15	22	34	22	144
C						14	14
I	8	34	16		13		84
K		19	15		26		60
M	7	14	19	11	26	16	93
R				9			9
U				7			7
W	7					15	22

TABLE 4.7 FREQUENCY OF RESPONSES PER STAGE FOR ALL INSTANCES (All Pupils)

Responses	2A n=25	2A/2B n=115	2B n=105	3A n=15
A	14	59	75	15
B	1	1		
C	5	42	40	2
D		13	3	1
E	2	14	21	5
F	2	15	7	1
G	1	8	5	
H	2	9	7	
I	1	69	50	8
J	1	2		
K	8	60	47	6
L	2	5	2	
M	12	61	54	7
N	1	5		
O	5	23	7	
P	2	1	7	1
Q	2	3	6	
R	2	16	7	2
S	1	7	2	
T	2	3	1	5
U	6	29	25	2
V	3	7	1	
W	10	36	26	5
Z	2	3	1	

TABLE 4.8 PERCENTAGE FREQUENCY OF RESPONSES PER STAGE FOR ALL INSTANCES (All Pupils)

Responses	2A n=25	2A/2B n=115	2B n=105	3A n=15
A	56	51	71	100
B	4	0,8		
C	20	37	38	13
D		11	3	7
E	8	12	20	33
F	8	13	7	7
G	4	7	5	
H	8	8	7	
I	4	60	48	53
J	4	2		
K	32	52	45	40
L	8	4	2	
M	48	53	51	46
N	4	4		
O	20	20	7	
P	8	0,8	7	7
Q	8	3	6	
R	8	14	7	13
S	4	6	2	
T	8	2	1	33
U	24	25	24	13
V	12	6	1	
W	40	31	25	33
Z				

CHAPTER 5

DISCUSSION

In this chapter an attempt is made to account for the possible origin of anthropocentric thinking, for the similarity of the conceptions held by rural and urban pupils and to analyse the nature of the pupils alternative conceptions and frameworks in relation to underachievement by black pupils in biology.

Gilbert and Watts(1983:69) distinguish between conceptions that pupils hold and frameworks from which they operate. They present Engel and Driver's(1982) definition of framework, viz: that frameworks are

> "transcontextual in small domains,that is,are demonstrated in the context provided by more than one interview session."

Engels and Driver argue that

> " a framework ought to be a description of a perspective from which prediction of events can be made."(Gilbert and Watts p69)

Gilbert and Watts(1983:69) further propose that

> "Conception be used to focus on the personalised theorising and hypothesising of individuals."

Taking these definitions and distinctions made by Gilbert and Watts as a frame of reference for this section of the

study, the results of this investigation can be categorised as follows:

1. Alternative Framework : Anthropocentrism.

The incidence of anthropocentric thinking as illustrated in chapter 4 under Qualitative analysis can be regarded as a definite alternative framework for classification. It differs from the biologist's framework in that it takes the human being as a point of reference for classification whereas, whilst the biologist creates a hierarchy of organisms according to their structural and functional complexity, he does not use man as the starting point.

In the interviews, anthropocentric thinking was observed mainly among rural standard 5's and a few rural and urban standard 8's and 10's. Osborne and Gilbert(1980:377) also found anthropocentric views mainly among younger children and some older ones. They found, for example, that pupils evaluated oxygen on its capacity to support human breathing.

Among the rural standard 5's, the reason most frequently given for classifying an animal was its ability to talk, hence this reason appears in the list of reasons from which standard 5's could choose in the survey phase. Among older pupils anthropocentrism was expressed mainly in terms of what an animal could not do and a human being could

do. These reasons varied from pupil to pupil, thus anthropocentric ideas could not be represented in the answers provided for the survey phase.

The origin of anthropocentric thinking in this particular study is not clear but it appears to be a common feature of both the traditional African way of thinking and the Christian religion. According to the Christian religion, man is God's most important creation and everything else is subordinate to him. The Bible teaches that God created man in his image thus making him superior to all creatures.

Writing about African religion, Mbiti(1969:48)states that

> "man in some ways considers himself the centre of the universe, and this egocentrism makes him interpret that universe both anthropocentrically and anthropomorphically...African ontology is firmly anthropocentric and this makes man look at God and nature from the point of his relationship with them."

It is not clear, however, whether the pupils who use anthropocentric thinking derive it from their traditional African background or from the Christian religion. This is especially difficult to determine because the Batswana have been exposed to the Christian religion and intense proselytization for nearly two hundred years.

Excerpts from the interviews, however, seem to indicate that pupils move from a mainly anthropocentric way of thinking to an animal-centred one as they advance in school. This progression from anthropocentric thinking to animal-centred thinking is indicated by the fact that in the interviews some pupils were found to be vacillating between the two forms of thinking. This stage of vacillation seems thus to be intermediate to the two forms of thinking. It seems therefore reasonable to conclude that anthropocentrism is a culture-based way of thinking which is gradually replaced by scientific thinking during the course of science study.

2. Alternative Conceptions

As suggested above,"conceptions" are used to focus on the personalised theorising and hypothesising of individuals.

Thus the following reasons for classifying instances of 'animal' given by the populations in the study, and which differ from those of biologists, can be regarded as alternative conceptions. These reasons were presented by most pupils with varying degrees of frequency:

i. It can breathe

ii. It can reproduce

iii. It can protect itself from danger

iv. It lives in water

v. It has four legs

vi. It can/cannot talk

vii. It has a mouth.

The first three reasons were more frequently used by the pupils in higher classes (std 8's and 10's) whilst the latter four were given by those in the lower class. (Std 5's) (It should be pointed out, though, that the average age of the rural standard 5's was the same as that of the urban standard 8's).

The use of reasons (i) and (ii), i.e. breathing and reproduction, indicates an incomplete appreciation of the concepts, namely that these processes are not unique to animals only. Pupils seem to perceive superficial similarities and differences such as the gases taken in and given off and the organs used in gaseous exchange. Their conception of the processes seems to stop at this point - it does not go as far as an appreciation of the real function of respiration viz, energy production in all forms of life. In the case of reproduction, pupils seem also to appreciate superficial similarities and differences and not the true purpose of reproduction - the perpetuation of species. Bell's study among New

Zealand pupils also reveals this same type of confusion. She identified the following alternative criteria for classifying animals, which are also similar to those used by pupils in the present study:

i. Habitat

ii. Noise production

iii. Breathing and reproduction

iv. Number of legs.

Perhaps one should pause at this point to clarify the apparent contradiction to the terms of the constructivist view which comes as a result of stating that 'the pupils views are a result of an incomplete appreciation of the concepts - breathing and reproduction.' <u>According to the constructivist view (to which this study subscribes), pupils' alternative conceptions have their own validity and should be appreciated in their own right.</u> However, the purpose of research into uncovering pupils' alternative conceptions is to make teachers aware of their existence so that they and the pupils may challenge them in the face of scientifically accepted ones. It is hoped that by so doing, the pupils will not only resolve the conflict between their own conceptions and the scientifically sanctioned ones, but will ultimately come to accept the latter. Thus stating that "pupils' conceptions result from an incomplete appreciation of concepts" does not deny

the validity of the pupils' conceptions, but juxtaposes them with scientific concepts - an exercise that would probably be done in the process of encouraging conceptual change.

The reasons (iv) - (vii) on page 73, which were given by the younger pupils, seem to be based on features that are immediately discernible. The use of reason(iii) - it can protect itself from danger, also indicates failure to see this reason as a function of reasonM - it has a brain and can feel - which appears on the list of answers.It appears therefore, that the alternative conceptions that older pupils have result from an incomplete appreciation or understanding of the concepts about living things, whilst those given by younger pupils are much less sophisticated and bear much less resemblance to the biologically accepted reasons. It appears reasonable, therefore, to conclude that pupils' formation of the concept "animal" develops and improves as they advance in the study of the subject, and they acquire more insight into the principles and explanatory ideals of the subject. This idea is also reflected in the analysis of responses according to Piagetian stages. The pupils in the highest stages(3A) use the most sophisticated scientific reason - it has no cells with cell wall more frequently whilst pupils in stages 2A and 2A/2B use reason - it lives on land more frequently. Chandler(1984:29)states this with

regard to Piaget's theory of cognitive development:

> "Piaget sees cognitive structure in terms of the adaptation or adjustment of an organism to its environment.This adaptation involves intellectual development which reflects evolution through qualitatively different stages of thought."

This study notes, however, the controversy surrounding the claim that pupils found to be at one stage of cognitive development will consistently perform according to the characteristics of that stage. As Driver(1983:55)states,

> "currently there is some controversy as to the validity and utility of the so-called stage theory. It is recognised that the ability of a pupil to use a certain logical operation,for example proportional thinking,depends on the familiarity with the context within which a task is set. Pupils may control variables competently in one task but not in another."

This points to the fact that extrapolating pupils' performance from Piagetian tests is not necessarily valid. However, the Piagetian tests were carried out in this study on the basis that Piaget subscribes to the constructivist view of knowledge and also recognises a qualitative development of pupils' concepts over time and in keeping with the demands of the environment.

The idea that pupils' concepts develop as they they advance in school and as their intellects grow, is also buttressed by Vygotsky's(1962:83) statement that:

> "at any stage a concept embodied in a word

> represents an act of generalisation. But word meanings evolve. When a new word has been learnt by the child, its development is barely starting; the word at first is a generalisation of the most primitive type; as the child's intellect develops, it is replaced by generalisations of a higher and higher type - a process which leads in the end to the formation of true concepts."

However, while this study suggest that broader generalisations about concepts develop with advancement in schooling, it also notes that the structure and format of the prescribed school syllabus may also discourage generalisation about concepts. For example, this study maintains that because the prescribed school syllabus for secondary schools in South Africa and Bophuthatswana presents biology in a fragmented manner, pupils are inclined to compartmentalise ideas about organisms and processes. This syllabus recommends that zoology be studied in standard nine and botany in Standard 10. This division may lead to the impression that processes that take place in animals are essentially different from those that occur in plants. A more holistic approach could, perhaps, yield better results in as far as broader conceptualisation of biological ideas is concerned. Such an approach would, for example, treat nutrition or respiration as a concept and deal with it as it occurs in plants and in animals. The similarities and differences between these processess as they occur in various forms of

life would then be discernible to the pupils.

3. Similarity between concepts held by rural and urban pupils.

Figures in Tables 4.1 - 4.5 show a marked similarity in the frequency of responses held by urban and rural pupils, although the rural standard 5's have a much more diffuse idea of the concept "animal". These findings contradict the hypothesis that there would be an appreciable cognitive difference between urban and rural pupils with regard to their understanding of the concept. This expected difference was based on Toulmin's(1972:49) idea that

> "what concepts a man employs,what standards of rational judgement he acknowledges,how he organises his life and interprets his experiences;all these things depend - it seems- not on the characteristics of universal human nature or the intuitive self-evidence of his basic ideas alone,but also on when he happened to be born and where he happened to live."

In other words, the concepts that a person holds reflect among other things, the socio-cultural environment in which he lives .

Given this idea by Toulmin (conceptual ecology), which also formed the basis of this investigation, it seems that the similarity which was observed between the conceptions held by the pupils from rural and urban areas can be explained as follows:

a. As pointed out in the definition of concepts, rurality and urbanity proceed along a continuum - there is no abrupt line of demarcation between the two types of settlement. Whilst Dinokana is an old traditional village, it is near the urban area used in this study (Mmabatho is 120km from Dinokana). The social flux between the two areas in the form of migrant labour, commuter labour and the resettlement of communities also makes the restriction of ideas impossible. (There have been many people moving either to or away from Dinokana and Mmabatho). Thus the conceptual milieu in either area has not been kept "pure".

b. Pupils in both groups of the study are mainly Batswana, thus they draw their concepts from the same linguistic pool. Vygotsky(1962) emphasises the role of language in concept formation, and Ryman(1974:141) states that

> "the common mis-use(in the biological sense)of terms such as "flower","fish",and "amphibian",and "birds",illustrate how linguistic problems may affect the formation of precise biological concepts."

c. Formal education, in the form of schooling, is in itself an equalising factor. Pupils are bound to have many similar ideas if only because the common examination expects this of them. It is thus not surprising to find that rural and urban pupils have more or less the same understanding of biological concepts. As Cole et al(1971:57)point out about the Kpelle child

> "The Kpelle school child is a mixture of the traditional and modern ...We can offer some tentative ways in which the school affects the Kpelle child which may be relevant to our study of cognitive processes. First, the child is systematically exposed to an entirely new set of ideas and institutions which are presented as the correct way to live,the way of the future. As our interviews have indicated,the propaganda of progress has had an effect on the child...Both literacy and learning detached from the immediate situation are likely to have significant effects on cognition."

Finally, the effect of the "propaganda of progress" on the Motswana child should also be emphasised. All of Africa sees modernisation as the way of the future. Thus the school child acquires aspirations that are directed away from his/her indigenous culture and he/she is attuned to taking up concepts that derive from outside. As a result, the conceptual differences that could have occurred because of living in different environments, are offset by the motivation to hold modern(technological) concepts.

4. Links with Bell's findings.

The pupils that Bell(1981) interviewed classified the instances and non-instances of "animal" presented to them into the following main groups:-

i. animals

ii. Insects

iii. Unspecified groups which includes birds, fish, reptiles and humans.

iv. non-animals.

Bell states that,

> "few pupils categorised a spider, a worm or a butterfly as insects because of their size. This is perhaps expected as no alternative names e.g. arachnida were known to them."

She states further that,

> "Only about half of the pupils categorised a fish, frog, snail, snake or whale as an animal. Birds, fish, reptiles and humans were not seen as a subset of of animals but as comparable sets to the set of animals... In contrast the cow, cat, and lion wwere classified by all pupils as animals and the elephant by all except one. It appears that many of the pupils used the word "animal" in a way that is synonymous with the word "mammal", as the terrestrial four-legged mammals were more readily categorised as animals than non-mammals."

Bell does not indicate the incidence of anthropocentrism in her study. That half her pupils did not classify the human being as an animal, nor as a subset of of animals does not necessarily imply anthropocentrism. In other words, it seems that

Bell's pupils did not use the human as a point of reference in their classification . In the present study, anthropocentrism was reflected in the fact that the pupils seemed to regard any organism (except plants) that was not human as an animal. Still, one cannot say conclusively that Bell's pupils did not use anthropocentric thinking at all, since her study was more concerned with the identification of the criteria that pupils use for classification rather than the broad frameworks which guided the formulation of these criteria. According to Gilbert and Watts(1983), Bell's study can be said to have focused on identifying pupils' conceptions only. As stated already, Gilbert and Watts(83:69) define conceptions as "personalised theorising and hypothesising of individuals."

As indicated earlier, there were some similarities between the conceptions that some pupils in the present study held and those in Bell's study.

The present study, however, went further than Bell in the analysis of the interviews. It identified not only the pupils' conceptions, but their conceptual frameworks as well. The three frameworks that were identified can be said to represent, in Kuhn's(1962)terms, the pupils' paradigms in that they reflect pupils' theoretical perspectives which govern their conceptions.

5. Implications for current theories.

The cultural deficiency model is a broad theory that tends to generalise about the causes of weak performance in some areas of science. As shown in the literature review, some educators use it to explain why black pupils do badly in the science subject. In their view, black pupils come from a culture that does not provide the necessary intellectual stimulation for good performance in the sciences. However, the present study revealed a number of similar conceptions that were held by urban and rural pupils. Such similar conceptions were also found between pupils in this study and those from Bell's(1981) study. The effect of schooling in determining the nature of concepts that school-going pupils have, has already been referred to. However, it seems reasonable to state that there are certain concepts that are not culture-bound. This notion is perhaps endorsed by Horton's(1982) idea of continuities between traditional African culture and western culture.

Some pupils in this study have been found to use an anthropocentric way of thinking when classifying animals.As has been pointed out already it is not easy to state categorically that these pupils derive this form of thinking from their traditional African culture since anthropocentrism is a feature of the Christian western culture as well. The pupils in the

study had been exposed to both cultures. No other concepts that could have been said to be a result of the African world-view as is described in the literature review were encountered in the present study. Perhaps it was in the nature of this study that no such concepts would be elicited. However, that no concepts that were based on the so- called African-world view were encountered, seems to invalidate broad generalizations about the effect of the African world-view on science concept formation. Whatever its original form, it seems to bear some resemblences to the western culture and as such, it cannot be impede the learning of science completely. It seems that the true effect of the African culture on the learning of science will only be revealed when more contemporary and positive studies have been carried out.

CHAPTER 6

SUMMARY, RECOMMENDATIONS AND CONCLUSIONS.

SUMMARY

1. This study focuses on the problem of underachievement of black pupils in the sciences and attempts to analyse some of its possible causes.

2. The validity of the commonly advanced reasons for underachievement, viz: cultural deficiency and African world-view are examined in the literature review.

3. It is suggested that an alternative explanation might be sought in the pupils' prior experiences and preconceptions and the conflict of these with school science. Indications of such conflict should influence science teaching.

4. The notion of "alternative conceptions" is examined in the light of the constructivist view of knowledge and the work of Driver(1983), Hewson P(1980), Posner et al(1982), Gilbert and Osborne(1980).The empirical work of Bell(1981) is adapted to investigate black pupils' alternative conceptions with regard to the concept "animal".

5. Definitions of "rural" and "urban" are examined for relevance to the outcomes of the study.

6. Definition of the term concept is attempted at some length, as it is another issue central to the validity of this study.

7. The experimental design, sampling and data collection are described. The experimental design is based largely on the work of Bell(1981) - When is an animal not an animal? The study uses the method of interview-about-instances developed by Osborne (1979). This method is based on Piaget's method of clinical interviews. The subjects are presented with 19 cards depicting some familiar instances and non-instances of the concept "animal". They are then asked to classify each picture and state the reasons for their classification.

   The subjects were asked later to choose four reasons from a list of 26, which they considered best for classifying an animal.

   A Science Reasoning Task designed by Shayer and Adey(1981) was administered to the pupils to measure their levels of cognitive development.

8. Results of the interview phase indicate the following forms of pupil thinking:

   a. Anthropocentrism, i.e. making judgements and giving reasons using the human being as a point of

reference.

b. Animal-centredness, i.e. classifying instances and non-instances of animal on the basis of the of animals in general and not just human beings.

c. Vacillating between anthropocentrism and zoo-centrism, i.e. some pupils were uncertain about the framework they should use for classification.

A number of alternative reasons for classification were found among pupils who used zoo-centric ways of thinking; for example, some pupils used reasons such as the ability to breathe and reproduce as distinguishing characteristics of animals. Most of these alternative reasons were used similarly by rural and urban pupils.

The pupils' conceptions when analysed according to their different Piagetian stages, seem to indicate an improvement in the quality of the concepts held by pupils in the higher stages.

9. In the discussion an attempt is made to account for the possible origin of anthropocentric thinking, for the similarity of the conceptions held by rural and urban pupils, and to analyse the nature of the pupils' alternative conceptions and frameworks.

10. The study concludes with a discussion of:-

a. Alternative conceptions and frameworks as possible causes of underachievement by black pupils in biology.

b. The importance of cultural background as a determinant of teaching strategies and school performance.

c. Limitations of the present study.

CONCLUSIONS AND RECOMMENDATIONS.

Owing to the small size of the populations in this study, the following will serve more as pointer for future research rather than definite recommendations.

1. Alternative frameworks and conceptions are probable causes of underachievement in biology among black pupils in Bophuthatswana.

The study has shown quite clearly that alternative frameworks and conceptions are held by both rural and urban black pupils in Bophuthatswana. The framework and conceptions identified were based on :-

- anthropocentrism
- an incomplete appreciation of the biological concepts related to plants and animals, e.g. the use of respiration and reproduction as criteria for classifying animals.
- features that were immediately discernible e.g. number of legs.

A clear understanding of the concept "animal" is central to the study of biology. However, this concept

has both an everyday meaning which is derived from experience and culture, and a school/scientific meaning; hence the alternative conceptions listed above which differ from the scientific ones. It is possible that these alternative conceptions hamper effective communication between teachers and pupils in Bophuthatswana. As pointed out by Bell(1981), most teachers proceed on the assumption that the pupils have a similar understanding of the concepts as they.

Gilbert, Osborne and Fensham(1982) suggest that three forms of science may exist in a teaching situation,viz:

a. The scientist's science, as represented in the textbook.
b. The teacher's science, which results from the interaction between the teacher's own science and the scientist's science.
c. The pupil's science, which comes from the pupil's experiential background.

These authors point out that very often these three forms of science are not identical, with the result that if teaching goes on without taking cognisance of this divergence, the following may be the outcome of teaching:

i. Undisturbed pupil's viewpoints despite teaching. This could possibly account for the occurrence of similar alternative conceptions among standard 5s and 10s.

among standard 5s and 10s.

ii. Two-perspective outcome i.e. pupils basically reject the teacher's science but consider it something to be learned for examination purposes. The pupil in the present study who said that he knows that biologists say that man is an animal but he disagrees(excerpt on page 52) can probably be seen as having had a two-perspective outcome from his biology lessons.

iii. Reinforced outcome i.e. pupils' prior concepts are reinforced unintentionally by the teacher. Alternative conceptions are generally held to be resistent to traditional methods of teaching (Hewson 1983); could it be that because teachers usually do not set out to challenge the pupils' prior knowledge, they give them the impression that it is acceptable and therefore needs no changing with the result that pupils carry alternative conceptions with them through their schooling period?

iv. Mixed-outcome i.e. scientific outcomes are learned and understood by the pupils, but the inter-relationships between these concepts are not understood with the result that the pupils have contradictory concepts.

As already indicated, all the above outcomes are possible in schools in Bophuthatswana if teaching does not challenge the pupils' alternative conceptions. It

would also be useful to investigate the existence of similar alternative conceptions among school teachers for it is possible that most of them went through schooling without ever having had their preconceptions examined. An awareness of the existence of alternative conceptions thus seems to make it possible that the teacher would try to bring together the divergent viewpoints referred to above.

2. The importance of cultural background as a determinant of teaching strategies and school performance.

The present study hypothesised that there would be marked differences between conceptions held by rural and urban pupils with regard to the concept "animal". It was assumed that urban pupils would hold more sophisticated conceptions due to their greater exposure to modern amenities and media. However, this study discovered similar conceptions among the two groups of pupils. These conceptions were also similar to those held by New Zealand pupils in Bell's(1981) study. An attempt has already been made to account for the similarity between the concepts held by the urban and rural pupils. The following inferences may, however, be made with regard to the similarity between the two main populations in this study and those in Bell's:

a. There are many similarities between the apparently different cultures. Future research should thus focus on identifying those concepts

that are significantly different as a result of their cultural source. Or as Goodman(1982) states, one of the challenges facing research on culture and thought is the "need to to obtain, by combining results from several studies, some picture of the skills common to people from different backgrounds as well as skills that differentiate among them." She states further that "we need to find features of the milieu that account for the similarities and differences in skills."

Most writers, especially those who use the cultural deficiency model with regard to the African, are often ready to make generalisations about weak performance in one area to include most, if not all abilities.

b. No culture is static.:- As pointed out in the literature review under Cultural deficiency, some writers consider the African cultural background as a possible cause of underachievement. This study has already argued that while the African culture may have hampered the development of certain concepts, it has existed side by side with other cultures - in fact it can be said that the African culture has been under siege since the advent of

colonialism. This study has, for example demonstrated that it is impossible to say categorically that anthropocentrism, as displayed by the pupils in the study, is typically African since anthropocentrism is also a feature of Christianity. Thus much caution is needed when attempts are made at typifying pupils for there has been much exchange between cultures in Africa. Traditional African culture has, like all cultures, undergone changes with time.

It should also be pointed out that whilst some African communities may as yet have no direct contact with some aspects of modern technology, such as electricity, most communities in Southern Africa live within reach of areas where such technology exists. Pupils from such communities may develop concepts about such technology indirectly, for instance, from just trying to make sense of how it is possible to have street lights in the city. The concepts that they develop in this manner will admittedly be different from the scientific ones. Nevertheless, it can still be said that living in a rural area in Southern Africa does not preclude the development of some scientific concepts altogether. Thus research into

alternative conceptions seems to offer an opportunity for a dialogue with the pupils and a chance to know what their culture has to offer now so that both the pupils' and their teachers' preconceptions and sometimes prejudices may be changed.

3. Limitations of the Study.

a. Problems with the method of Interview-about-instances.

This study owes much of its success to the cooperation it received from the Department of Education in Bophuthatswana and the Principals and staff of the schools involved. Most of the interviews were carried out in the Principals' offices. However, the main problem of the study occurred as a result of the lengthiness of the interview sessions. The pupils were exhausted by the 45 - 50 minutes interviews. The younger ones enjoyed it more that the older ones who seemed bored by the repeated identical questions.

Osborne(1981) recommends the use of 20 cards depicting instances and non-instances for an in-depth study of the pupils' conceptions, 19 cards were used in this study. It was felt at the end of the interview sessions that fewer cards, perhaps 10, could have still provided an in-depth study and been enjoyable to the pupils.

b. Problem with the Survey Phase

The survey phase of the study involved a pencil and

paper session in which the pupils were required to choose four answers which they considered the best, from a list of 26 answers. There seemed to be a shift of framework among some pupils in this phase. For example, some pupils who used anthropocentric thinking in the interviews, abandoned it in the survey phase. It thus appeared that pupils assumed a school/scientific paradigm when writing.

In conclusion, it is suggested that alternative conceptions are such a significant issue in children's learning that there are important implications for teacher education, school syllabuses, text-books and examinations. Further research and controlled experimentation are required to explore these issues further.

Assumptions about cultural barriers to science learning need to be viewed sceptically. More research should be aimed at clarifying the impact of culture on children's thinking, especially as cultures are becoming more and more homogeneous, particularly in Southern Africa.

Further research would also be worthwhile in refining the methods used in the present study. Although the length of the interview needs attention, care should be taken to ensure that the thoroughness of the interview sessions is not be reduced.

Most significant of all is the challenge that research

like this provides for the researcher and, it is hoped, for the reader as well. Our approaches to science teaching can never be quite the same. Malcolm Skilbeck(1980), writing of recent Australian curriculum development says:

> "Modern society requires more of its citizens by way of common, universal understanding and skills than reading, writing and arithmetic.To be effective participants in contemporary life demands complex and inter-related sets of learning experiences." (quoted in the Times Education. 24. 10.1980.)

APPENDIX 1

Characteristics of the Thinking and Learning Styles in the Different Stages.

(Reprinted from Adey,P and Delgety, J.1976. The development of concepts in science: A survey of Junior Secondary pupils in Guyana)

Stage 1A : Preoperational

The child interprets phenomena egocentrically in terms of his or her own self. Things are believed to be as they appear to immediate perception and they cease to exist when they can no longer be perceived ,e.g. when salt dissolves in water it disappears altogether. The child does not conserve quantities; length, volume and weight of objects are seen varying with their position in space and time. When faced with a mature person's idea of "evidence" of conservation, he will deny it, explaining it anthropologically, or be silent with incomprehension.

Stage 1B : Transition

The child occasionally shows some notion of conservation of substances but is not consistent in this. He is beginning to see the need for some explanations for observed phenomena such as floating and sinking and to classify objects, but his attempts fail because he is unable to consider the whole phenomena as distinct from a series of individual observations.

Stage 2A : Early Concrete Operations

He will investigate what happens in a situation, but his interest is exhaus ted when everything that happens has been experienced. Operates in terms of "this goes with that" (associative reasoning). He can put things together to form a series, as with number scale, but is unlikely to see that as an obvious way of summing up details of what has been seen to happen. Accepts that the amount of substance does not change when it changes position or shape, but still believes that volume and weight do change.

Stage 2B : Late Concrete Operations.

He will investigate what happens using tools of perception, of seriation, and of classification as the obvious way of summing up what has happened. Tends to operate in terms of cause and effect, provided that they are directly observable in a situation, e.g. "as this goes up, that goes down", or "if you double this, you must double that." Can use classification procedures, provided that examples of the application are shown. Can work in terms of rules of a model e.g. simple algebraic manipulations of a simple kinetic theory picture of molecules) but is not able to apply it by translation to reality; conserves mass, weight and volume.

Stage 3A : Early Formal Operations.

He has begun to expect some causative necessity behind a relation that has been established associatively. Thus,

although he will use the same tools of perception as in the previous stage, he will also allow for a possibility of a cause that is not seen to operate in the situation. This means he will see the point of making hypotheses, and can make simple deductions about how a system should behave in terms of the hypothesis or model, and he can use a model as a classifying or ordering tool under guidance. Can operate with proportionality, e.g. sees density as a mass volume ratio.

NAME:.....

CLASS:.....

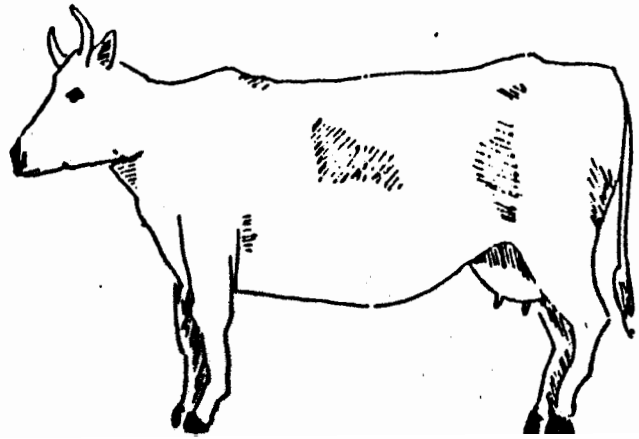
a) Is a cow an animal? Yes ☐ No ☐ (Put a tick in one box)

b) Look at the List Of Reasons on the separate sheet and choose FOUR of them.

These reasons should be the ones you think are the BEST.

Put a tick in the box beside the letters

A ☐	H ☐	O ☐	V ☐
B ☐	I ☐	P ☐	W ☐
C ☐	J ☐	Q ☐	X ☐
D ☐	K ☐	R ☐	Y ☐
E ☐	L ☐	S ☐	Z ☐
F ☐	M ☐	T ☐	
G ☐	N ☐	U ☐	



NAME:.....

CLASS:.....

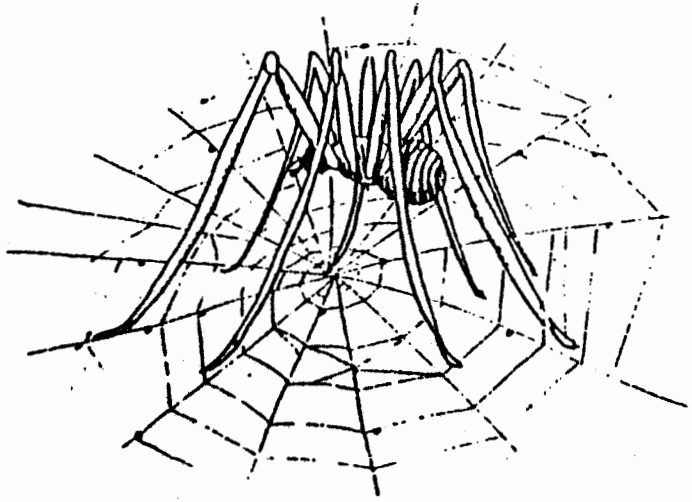
a) Is a spider an animal? Yes ☐ No ☐ (Put a tick in one box)

b) Look at the List of Reasons on the separate sheet and choose FOUR of them.

These reasons should be the ones you think are the BEST.

Put a tick in the box beside the letters.

A ☐	H ☐	O ☐	V ☐
B ☐	U ☐	P ☐	W ☐
C ☐	J ☐	Q ☐	X ☐
D ☐	K ☐	R ☐	Y ☐
E ☐	L ☐	S ☐	Z ☐
F ☐	M ☐	T ☐	
G ☐	N ☐	U ☐	



NAME:.....

CLASS.....

a) Is grass an animal? Yes ☐ No ☐

(put a tick in one box)

b) Look at the List Of Reasons on the separate sheet and choose FOUR of them.

These reasons should be the ones you think are the BEST.

Put a tick in the box beside the letters.

A ☐	H ☐	O ☐	V ☐
B ☐	I ☐	P ☐	W ☐
C ☐	J ☐	Q ☐	X ☐
D ☐	K ☐	R ☐	Y ☐
E ☐	L ☐	S ☐	Z ☐
F ☐	M ☐	T ☐	
G ☐	N ☐	U ☐	

NAME:.....

CLASS.....

a) Is a person an animal? Yes ☐ No ☐ (Put a tick in one box)

b) Look at the List of Reasons on the separate sheet and choose FOUR of them

These reasons should be the ones you think are the BEST.

Put a tick in the box beside the letters.

A ☐	H ☐	O ☐	V ☐
B ☐	I ☐	P ☐	W ☐
C ☐	J ☐	Q ☐	X ☐
D ☐	K ☐	R ☐	Y ☐
E ☐	L ☐	S ☐	Z ☐
F ☐	M ☐	T ☐	
G ☐	N ☐	U ☐	

NAME:.....

CLASS:.....

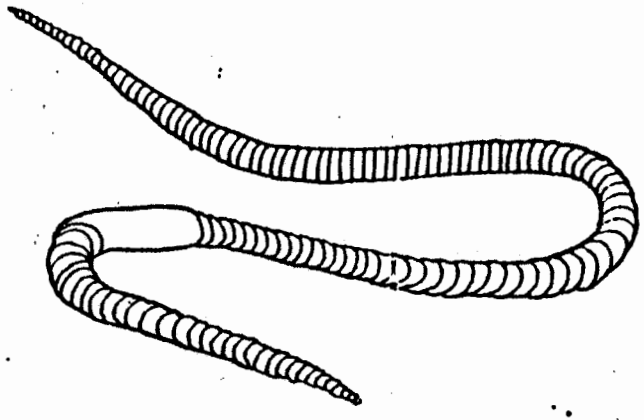
a) Is a worm an animal? Yes ☐ No ☐ (Put a tick in one box)

b) Look at the List Of Reasons on the separate sheet and choose FOUR of them.

These reasons should be the ones you think are the BEST.

Put a tick in the box beside the letters.

A ☐	H ☐	O ☐	V ☐
B ☐	I ☐	P ☐	W ☐
C ☐	J ☐	Q ☐	X ☐
D ☐	K ☐	R ☐	Y ☐
E ☐	L ☐	S ☐	Z ☐
F ☐	M ☐	T ☐	
G ☐	N ☐	U ☐	



NAME:.....

CLASS:.....

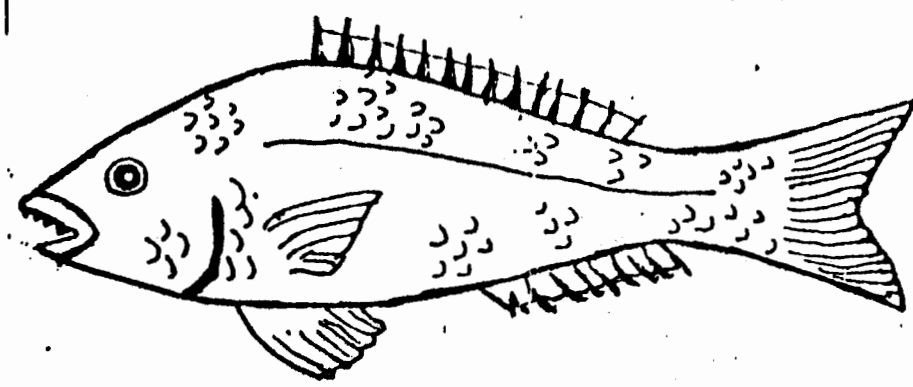
a) Is a fish an animal? Yes No (Put a tick in one box)

b) Look at the List of Reasons on the separate sheet and choose FOUR of them.

These reasons should be the ones you think are the BEST.

Put a tick in the box beside the letters.

A ☐	H ☐	O ☐	V ☐
B ☐	I ☐	P ☐	W ☐
C ☐	J ☐	Q ☐	X ☐
D ☐	K ☐	R ☐	Y ☐
E ☐	L ☐	S ☐	Z ☐
F ☐	M ☐	T ☐	
G ☐	N ☐	U ☐	



APPENDIX 3

TASK II

SCIENCE REASONING TASKS

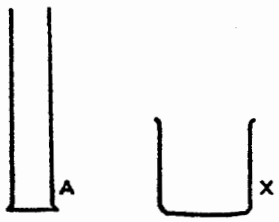
NAME ..... TODAY'S DATE ....

BOY OR GIRL ..... CLASS ....

SCHOOL ..... DATE OF BIRTH ....
day month year

VOLUME AND HEAVINESS

1.



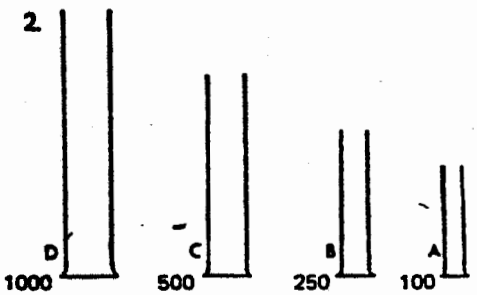
(tick the best answer)

A has more .....

less .....

the same ..... amount of water compared with X.

2.



Do these cylinders all have the same amount of water? YES ....

NO .....

If you answered "NO" write down which has most .....
(A/B/C/D)

3.a) The pop-corns have less .....

more .....

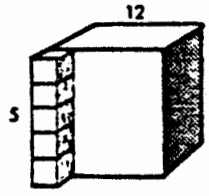
the same ..... amount of maize, compared with the grains.

b) The pop-corns weigh more .....

less .....

the same ..... compared with the grains.

4. (show your working here)



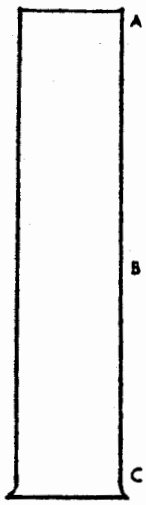
What is the volume of this plasticine block, in cubic centimetres?

Your answer .....

Correct answer .....

5. How much water will spill over when the plasticine is all under water? .....

6.



You see that water spills over when the block is lowered to A.

If it is lowered to B instead, will more .....

less .....

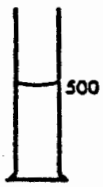
the same ..... amount of water spill over ?

If it is lowered to C instead, will less .....

more .....

the same ..... amount of water spill over ?

7.



What will the new volume-reading be?

.....

---

8. If the plasticine is made into a ball, will the level be the same .....

higher .....

lower ..... ?

---

9. If the plasticine is made into a cylinder, will the level be the same .....

higher .....

lower ..... ?

---

10. If the metal block is lowered in, will more .....

less .....

the same ..... amount of water spill over ?

Why?

.....

.....

---

11. a) Will this flat piece float .....

sink ..... ?

b) Will this small flat piece float? YES .....

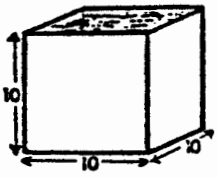
NO .....

c) Will this tiny piece float? YES .....

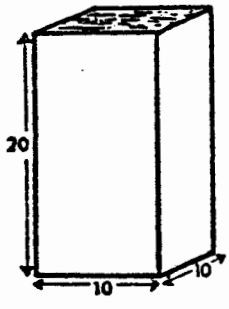
NO .....

---

12. a) This box, full of dry-cleaning fluid weighs 1500 grams.



Another box (twice as tall) filled with water weighs 2000 grams.



Would the box with the dry-cleaning fluid

float .....

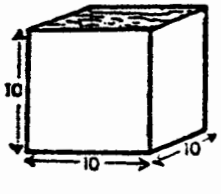
sink ..... in water?

How did you work out your answer?

.....

.....

b) When this box is emptied, and filled with alcohol it weighs 850 grams.



Will it float .....

sink ..... in water?

How did you work out your answer?

.....

.....

---

13. a)

How do you think Archimedes measured the old and the new crowns' volumes to compare them, using a measuring cylinder ?

.....

.....

b) Archimedes then weighed the two crowns and found that the new, bigger crown weighed more than the old one. Nevertheless he said that the new crown had some lighter metal in it.

How do you think he worked it out?

.....

.....

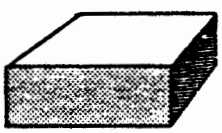
.....

14.

A

Both blocks are made of the same brass.

A weighs 60 grams, and its volume is $15cm^3$.



B

B weighs 160 grams.

What is its volume? .....cm^3.

How did you work out your answer?

.....

.....

.....

.....

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