THE COGNITIVE LEVEL OF CLASSROOM INSTRUCTIONAL QUESTIONS AND THEIR IMPLICATIONS ON STUDENT ACHIEVEMENT IN BIOLOGY: A CASE OF TWO SCHOOLS

BY

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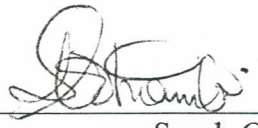
DECLARATION

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



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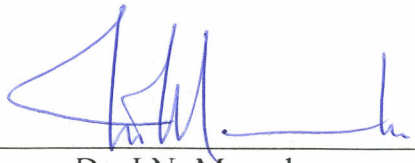

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To my husband Allan, my children Lilian, Roselyne, Susan, Dorcas and Gideon and to my late father E.A. Otieno whose encouraging words were:-

"Education has no limit"

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ABSTRACT

Students' achievement in the Kenya Certificate of Secondary Education (KCSE) Biology examination has been poor over the years. Factors such as lack of textbooks, facilities and equipment, and teacher qualification have been identified as those affecting performance The low attainment in the examination show that the students do not answer the Biology questions set well. Using Bloom's 1956 theoretical framework which covers different cognitive levels namely knowledge, comprehension, application, analysis, synthesis and evaluation; an analysis of the KCSE Papers 1 and 2 Biology examination questions for 1993-1998 was done by the researcher. The results revealed that majority of questions set were comprehension followed by knowledge questions. There were only a few application, analysis and synthesis questions. For students to answer examination questions well they must get adequate preparation during classroom instruction.

The purpose of the study was therefore to investigate the cognitive level of classroom instruction questions Biology teachers ask in secondary schools in Kasipul Division Nyanza Province, Kenya. The research design used was survey since the researcher was to move from one class to another. Two schools were purposively selected – one high performing (HP) and one low performing (LP) in Biology. Form 1-4 Biology teachers in each school were observed teaching four times per class and the lessons were audio taped. The researcher thus observed a total of 32 lessons. All the questions asked by the Biology teaches in both schools were recorded on the question classification form then analyzed using Blooms' theoretical framework. The data on questioning was presented in tables in the form of frequencies and percentages.

The results revealed the following:

- The number of questions asked by Biology teachers was an average of 6 questions per lesson in the HP school and 5 questions in the LP school.
- In both the HP and the LP school, the teachers emphasized knowledge questions during instruction.
- In both the HP and the LP school, the teachers emphasized comprehension type of questions in the end-of-term tests.

The researcher concluded that since the teachers observed in the HP and LP schools displayed similar characteristics in the type of questions asked in class and in the end-of-term tests, questions asked could not be taken as a major factor

affecting students' achievement in Biology in the two schools observed. Other factors outside the scope of this study should be investigated to explain the poor performance. However from the results of the study the researcher recommends that teachers should ask questions which test other mental abilities and not only knowledge type questions.

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ACRONYMS AND ABBREVIATIONS USED

ACRONYMS

UNESCO	-	United Nations Educational Scientific and Cultural Organization
KCSE	-	Kenya Certificate of Secondary Education.
KNEC	-	Kenya National Examination Council.
PGDE	-	Post Graduate Diploma of Education
PH.D	-	Doctor of Philosophy

ABBREVIATIONS

Kn	-	Knowledge
Co	-	Comprehension
Ap	-	Application
An	-	Analysis
Sy	-	Synthesis
Ev	-	Evaluation

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Science education has a significant role to play in developing among pupils the competencies and attitudes that will help them solve real life problems, process the ever increasing information that will come their way and make sound decisions on issues and problems that may result from interactions of science and technology and society (UNESCO 1987). The successful teacher provides students with an understanding of the thought processes which are necessary throughout life, namely: comprehension, analysis, synthesis, organization and self evaluation skills (UNESCO 1990).

Biology is one of the science subjects offered at secondary level in the Kenyan 8-4-4- system of education. For the majority of students, a course in biology is primarily an opportunity to become acquainted with a discipline that affects daily life (UNESCO 1987). Biology enables students to understand scientific methods as well as the environment.

Shortcomings in teaching of science in general and Biology in particular have been noted in many countries. For example more emphasis is placed on accumulation of knowledge than development of creativity and acquisition of know-how (UNESCO 1988).

Biology which is being taught in our secondary schools as a scientific discipline has varied objectives which are stipulated by the Kenya National Examinations Council in the 8-4-4 syllabus (KNEC 1995). In summary they include abilities to communicate, acquire knowledge and practical skills, apply knowledge gained, be creative, evaluate and develop positive attitudes towards Biological sciences. These abilities are expected to be developed in the classroom by the Biology teacher and students during instruction.

In the classroom many factors impact on the effective learning of Biology and hence student attainment of the above objectives. A recent report on the examination results for 1997 noted that there is poor performance in Biology, a trend that has continued for sometime now (Daily Nation February 1998).

Table 1.1 shows the national results of students achievement in Biology for the years 1993-1997.

TABLE 1.1: NATIONAL KCSE BIOLOGY EXAMINATION RESULTS FOR THE YEARS 1993-1997

YEAR	CANDIDATURE	MAXIMUM SCORE	MEAN SCORE	STANDARD DEVIATION
1993	48623	160	44.35	18.39
1994	55543	160	50.97	16.79
1995	55838	160	47.93	18.69
1996	66578	160	51.71	21.79
1997	73953	160	49.35	19.49

Source: Kenya National Examinations Council (KNEC 1998)

The results indicate that the mean score in relation to the total marks is low. The standard deviation also ranged between 18-22 over the years.

A number of studies have been carried out to investigate the factors that contribute to low achievement in Biology. Factors such as lack of adequate textbooks, lack of facilities and equipment and teacher qualification have been identified (Mangela 1983; Otemwa 1985; Misango 1985; Maundu 1986; Kamunge

1988; and Achola 1990). Another factor identified is quality of instruction (Orodho 1996 and Kaiguri 1996).

From the foregoing it is evident that many factors, some known, some not yet known affect students' achievement in biology in K.C.S.E national examinations.

The low attainment in biology in the KCSE examinations suggests that students do not answer the questions set in the examination as expected. Different types of questions are set by Kenya National Examinations Council (KNEC) in KCSE examination, which can be analyzed and placed in various categories. Before analyzing the questions, the researcher presents the theoretical framework of the study since the information will be used when analyzing the questions.

1.2 THEORETICAL AND CONCEPTUAL FRAMEWORKS

1.2.1. Theoretical Framework

The study is based on Blooms' Taxonomy of Educational objectives (Bloom 1956). Bloom and other college examiners developed a classification system for desirable educational objectives. The purpose was to facilitate exchange of ideas and testing materials among examiners or groups concerned with educational research and curriculum development. The taxonomy is divided into three main domains:- cognitive, affective and psychomotor. The cognitive domain emphasizes the development of intellectual abilities. The affective

domain emphasizes feelings, emotions, values and attitudes, while the psychomotor domain emphasizes motor skills such as typing and swimming.

For the purpose of this study, the researcher has dealt with only the cognitive domain. This is because the majority of instructional objectives at the secondary school level fall within this domain. Also most of our examinations for evaluating and grading purposes emphasize the objectives in this domain. The following are the levels of the cognitive domain in ascending order of complexity as put forward by Bloom and his colleagues in 1956.

(a) **Knowledge:-** Emphasizes recall of previously learned facts, concepts and principles.

(b) **Comprehension:** Ability to translate or interpret information.

(c) **Application:** Ability to use previously learned information to solve a problem.

(d) **Analysis:** Ability to break down material into their constituent parts.

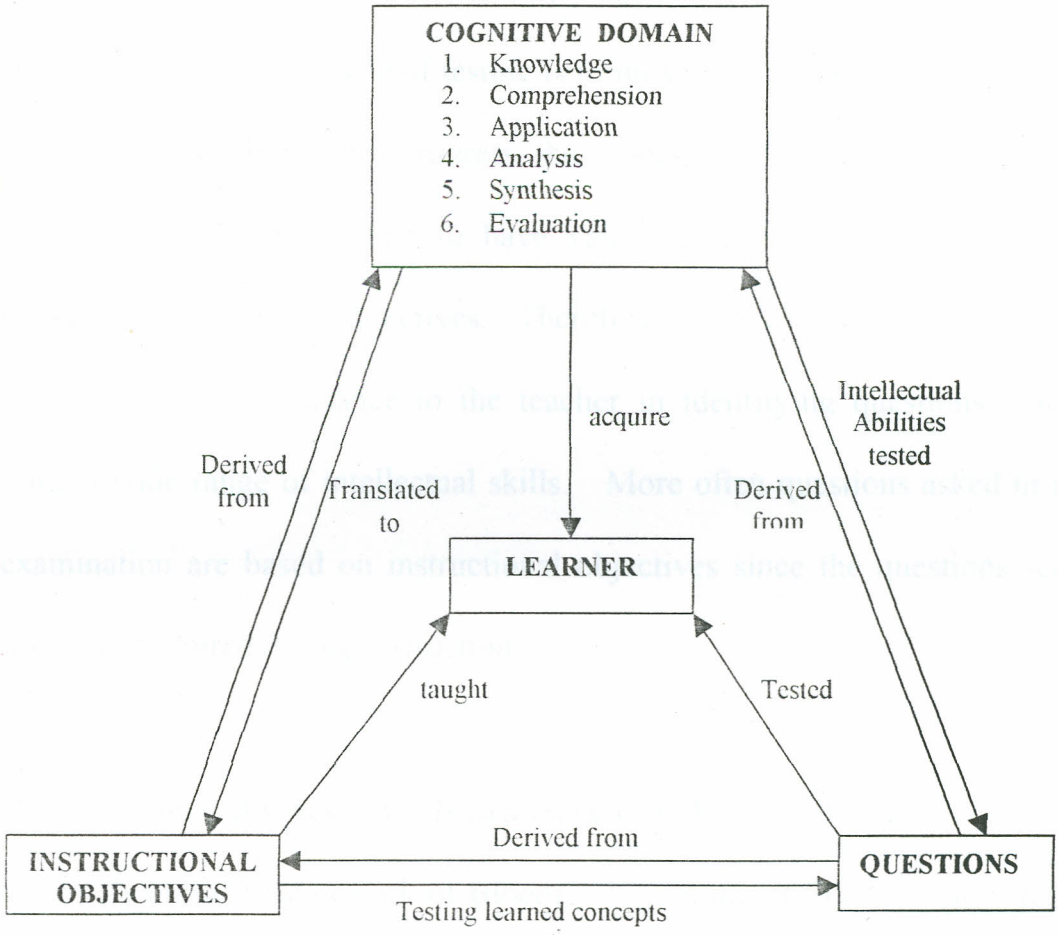
(e) **Synthesis:** Ability to put together elements or facts to form a new whole.

(f) **Evaluation:** Ability to make judgements in terms of logic, accuracy and consistency.

Bloom's taxonomy has served as a model for the construction of instructional objectives and test items. The classification can also be used to analyse questions. The relationship between the cognitive domain, instructional objectives and questions can be diagrammatically represented as shown in Figure 1.1.

1.2.2 Conceptual Framework

FIGURE 1.1: Conceptual Relationships Between the Cognitive Domain, Instructional Objectives, Questions and the Learner



Source: Adapted from Falk (1971)

The conceptual framework in figure 1.1 shows that the instructional objectives are derived from the cognitive domain. The cognitive domain, as indicated above aims

at developing the various intellectual abilities. For example the instructional objective of a lesson may require that pupils name the parts of a plant. It follows that the cognitive domain being emphasized here is at the level of knowledge. At the end of the programme, learners are finally tested. From the figure 1.1 above, the questions are derived from the instructional objectives and these questions test different intellectual abilities such as knowledge or comprehension. Falk (1971) states that the primary purpose of testing is to provide information for both teacher and students concerning the progress the students are making towards stated objectives. Ideally, for a test to have validity, there must be representative questions for each of the objectives. Therefore the cognitive domain taxonomy can be of practical assistance to the teacher in identifying questions that will measure a wide range of intellectual skills. More often questions asked in a test or examination are based on instructional objectives since the questions seek to test abilities acquired during instruction.

1.2.3. Examples of Questions drawn from 1996 Biology Papers

Using the theoretical framework of Bloom's Taxonomy of Educational objectives the researcher analysed the KCSE biology examination question for the years 1993 to 1998 (see Appendix C for a sample analysis for the 1996 Papers 1 and 2, Theory and practical respectively).

Below are examples of questions drawn from the 1996 papers and categorized in the various cognitive levels by the researcher.

Example1: State the functions of the cell sap.

Level: Knowledge; the learner has to recall previously learned facts.

Example2:

To estimate the population size of crabs in a certain lagoon, traps were laid at random. 400 crabs were caught marked and released back into the lagoon. Four days later traps were laid again and 374 crabs were caught. Out of 374 crabs, 80 were found to have been marked.

(a) Calculate the population size of the crabs in the lagoon using the formula

$N = \frac{nxM}{m}$ Where

N = Total population in the lagoon

n= Total number of crabs in the 2^{nd} catch

m= number of marked crabs during 1^{st} catch

M = number of marked crabs in the 2^{nd} catch.

Level: Comprehension; the candidate should have ability to translate or change communication given in words to numbers through calculation.

Example 3: You are provided with specimen labelled H, which is a piece of mammalian intestine. Squeeze the contents of the lumen into a test-tube. Add 3mls of water and shake the contents.

Use the reagents provided to test for the presence of starch, proteins and reducing sugar in the contents.

Level: Application; the candidate has to apply previous knowledge and procedures for testing each food substance.

Example 4: You are provided with a specimen labelled **D** which is part of a plant.

(i) Using external feature only, identify the part of the plant.

Level: Analysis, the candidate has to recognize the appropriate features of the specimen that may lead to identifying the specimen.

Example 5: Explain how the mammalian skin is adapted to perform its function.

Level: Synthesis; The candidate create his own style and form of organizing the essay by putting pieces of information together and organizing them systematically.

There was no question asked in the 1996 Biology paper which could be categorized as an evaluation level question.

As stated earlier, the researcher analysed KCSE Biology examination questions for the years 1993 to 1998 in order to get the cognitive levels of questions asked. A summary of this analysis is shown in Tables 1.2 and 1.3. The tables show the percentage of questions in each cognitive level in the theory and practical papers, respectively.

TABLE 1.2: PERCENTAGE QUESTIONS IN EACH COGNITIVE DOMAIN KCSE BIOLOGY PAPER 1 (1993 – 1998)

YR.	NO. OF QUESTIONS IN THE PAPER	PERCENTAGE OF QUESTIONS IN EACH LEVEL					
		Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
1993	42	23.8	45.2	11.9	16.6	4.8	-
1994	45	17.7	51.1	13.3	15.5	-	-
1995	42	21.4	42.8	14.2	14.2	11.9	-
1996	42	30.9	40.3	23.8	7.1	9.5	-
1997	52	21.1	40.3	19.2	13.4	7.7	-
1998	50	36.0	48.0	12.0	6.0	4.0	-
Mean %		**24.15**	**44.62**	**15.73**	**12.13**	**6.32**	-

The percentage of questions in each level was obtained by dividing the total number of questions of each level by the total number of questions in each paper then multiplying by 100. The mean percentage was obtained by adding all the percentages of each level (for example knowledge) and then dividing by 6, that is the number of years.

A similar procedure was used in arriving at the information in Table 1.3.

TABLE 1.3: PERCENTAGE OF QUESTIONS IN EACH COGNITIVE DOMAIN IN KCSE BIOLOGY PAPER 2 (1993-1998)

YEAR	NO. OF QUESTIONS INTHE PAPER	PERCENTAGE OF QUESTIONS IN EACH LEVEL					
		Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
1993	20	20.0	35.0	15.0	20.0	5.0	-
1994	15	26.0	33.3	20.6	20.0	-	-
1995	14	28.5	35.7	14.2	21.4	-	-
1996	18	27.7	33.3	33.3	22.2	-	-
1997	14	14.2	35.7	21.4	20.7	-	-
1998	20	25.0	45.0	15.0	10.0	5.0	-
Mean %		**23.51**	**36.33**	**19.91**	**19.05**	**1.67**	-

Tables 1.2 and 1.3 indicate that the variety of questions set range from knowledge to synthesis. However comprehension followed by knowledge questions form the bulk of the questions set in all the papers analysed. For students to get good grades in both papers, they have to answer these questions well and therefore teachers need to expose the students to such questions during instruction. What

really happens in the actual classrooms in Kenya? We may not be able to answer this question until we go to the classrooms. The researcher was thus prompted to go into the biology classrooms to find out.

1.3 STATEMENT OF THE PROBLEM

Although questions are useful for all classroom interactions, this does not however signify effective use of the same (Dillon 1988). Teachers' questions exert a crucial influence on students as far as development of intellectual abilities is concerned. Questions asked in class by the teacher are expected to elicit and develop a variety of skills. From the analysis done on KCSE Biology examination papers a sample of which is presented in Appendix C, it is clear that the KCSE Biology examinations tests for knowledge, comprehension, application, analysis and synthesis, the bulk of questions being the comprehension and knowledge type. However there has been low achievement in Biology.

Low achievement in Biology suggests that the students answer the examination questions poorly. This in turn suggests that students are probably not being prepared to answer the variety of questions found in the KCSE Biology examination papers. The researcher therefore set out to investigate the cognitive level of questions students are asked in Biology during instruction in secondary schools.

1.4 PURPOSE OF THE STUDY

The purpose of the study was to investigate the cognitive level of oral and written questions secondary school Biology teachers ask during instruction.

1.5. SPECIFIC OBJECTIVES

1. To find out the frequency of questions asked by Biology teachers during instruction.
2. To find out the cognitive level of questions asked by Biology teachers during instruction.
3. To find out the level of questions asked in end of term tests.
4. To compare the level of questions asked during instruction and those asked in the KCSE Biology national examination.
5. To make recommendations to teachers regarding questioning in class.

1.6. RESEARCH QUESTIONS

The following were the research questions, which guided the study.

1. What is the frequency of the oral questions asked by Biology teachers during instruction?
2. What is the frequency of written questions asked by Biology teachers during instruction?
3. What level of questions do teachers of Biology ask during instruction?
4. What level of questions do Biology teachers ask in the end of term tests?

5. How do the levels of questions asked during instruction compare to the levels of questions in the KCSE Biology examination?

1.7 SIGNIFICANCE OF THE STUDY

It was hoped that a description of the level of questions teachers ask would provide information on which questions the teachers stress in the Biology classroom during instruction. The results of the study will be useful to KNEC as they would advice teachers through reports regarding the range of cognitive abilities the students need to be exposed to during classroom instruction. It is also hoped that the results of the study will influence the training and in-service programmes of Biology teachers. Teachers also need feedback just as students do especially in developing their pedagogical skills (Astin 1985). Therefore it is hoped that the findings of this study will be useful to the teachers in guiding them to balance the kind of questions they ask pupils for effective teaching and learning.

1.8 BASIC ASSUMPTIONS OF THE STUDY

The researcher made the following basic assumptions.

- Teachers ask questions in class during instruction.
- The questions asked test different intellectual abilities.
- The practice given to students in class through questions asked by Biology teachers during instruction has an effect on students' achievement in Biology in national examination.

- The questions teachers ask during instruction are in line with the objectives of teaching Biology in secondary schools in Kenya.

1.9 SCOPE AND LIMITATION OF THE STUDY

The study covered the following areas:

- Questions falling in the cognitive domain were analysed
- Oral and written questions asked during instructions were considered

The limitations faced by the current researcher were financial constraint, being self sponsored, and also time. For these reasons the study involved Form 1-4 of two schools in Kasipul Division of Rachunyo District, Kenya.

1.10 DEFINITION OF TERMS USED

Intellectual abilities - This refers to skills such as knowledge, analysis, comprehension, synthesis and evaluation.

Question - A question is considered to be a sentence worded or expressed in such a way as to elicit a response (Procter 1995)

Student achievement - Refers to the grade obtained by the student in the KCSE Biology examination.

Category - Level of question e.g. knowledge level

Low level questions - Questions that require pupils to recall and/ or interpret a given information

High level questions - Questions that require pupils to manipulate information for some purpose.

Open questions - Questions that require answers running to a sentence or more and for which a variety of responses could be acceptable.

Closed questions - Questions that require very brief responses for which there is a single correct answer.

Chapter Summary

The chapter pointed out the significance of science education and identified Biology as one of the scientific disciplines in the secondary curriculum in Kenya. It gave a summary of the objectives of teaching Biology and raised concern over the low student achievement in the subject. Previous research findings concerning the factors contributing to poor performance in Biology were cited. The theoretical framework guiding the study was discussed and findings of an analysis of KCSE Biology examination questions for the years 1993-1998 on the cognitive level of questions was reported. The chapter also outlined the statement of the problem, purpose of the study, objectives of the study, research questions,

significance of the study and definitions of various terms as used in the text. Chapter two focuses on the literature review.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews literature related to questioning. The literature reviewed includes literature on purpose of questioning, types of questions and effect of teacher training on type of questions asked.

2.2 PURPOSE OF QUESTIONING

Questions are important to teachers both as a means of finding out what students have learned and as part of a teaching technique (Rowntree, 1981). Similarly Kerry observes that questioning is an important aspect of a teachers' teaching skill and pupils' learning environment (Kerry 1982). In support of the above statements Wragg and Brown (1993) state that teachers ask questions to stimulate recall, deepen understanding, encourage problem solving and develop imagination. These four functions spelt out by Wragg and Brown correspond to the levels of questions described by Bloom (1956) namely knowledge, comprehension, application and synthesis respectively.

Most educators are aware that questions are used for formative evaluation. However Ogunniyis (1981) points out that most teachers lack the basic skill of using this tool to improve instruction. A similar sentiment is expressed by

Kissock and Lyortsuun (1982) who observe that teachers pay more attention to recall of learning which requires pupils to repeat facts memorized earlier and neglect the higher levels of thinking that direct pupils to find relationships between ideas, draw inferences, apply skill and understanding to new situations, analyse and create new ideas.

According to Deighton (1971) no method of teaching is more widely used than questioning. Taba, Levine and Elzey (1964) have shown that different types of questions stimulate different kinds of thinking. The teacher should therefore be conscious of the purpose of his/her questions. When a teacher varies his/her questions, a wide range of responses can be elicited thereby developing in pupils a broad set of cognitive skills (Hyman 1970).

Teacher's oral questions have been found to consume 6-16% of classroom time (Doneau 1985). A study carried out by Pate and Bremer (1967) required 190 teachers in American elementary schools to provide reasons for asking questions. They found out that 86% of the teachers asked questions to check the effectiveness of teaching by checking on what students have learned, 54% used questions to diagnose pupils' difficulties, 47% used questions to assist pupils recall learned facts and 10% to encourage pupils to think.

Brown and Edumundson (1984) also studied why teachers ask specific questions. The researchers used a sample of 40 secondary school teachers. Teachers of different subjects gave different reasons for asking questions. English teachers used questions for gaining the pupils' attention in class and also for general management of the class. Maths and science teachers asked questions specifically to check understanding of the learned concepts as well as to encourage thinking in pupils. History and Geography teachers asked questions to encourage students to participate, to check understanding of material taught and to gain students' attention in class. Practical art teachers used questions for revision and to check on the understanding of learned material. The foregoing indicates that teachers' reasons for asking questions are varied. One reason that almost all the teachers had in common was checking on the understanding of learned material or concepts. In Bloom's view a question asked by the teacher to check on understanding would require the pupils to translate or interpret information or summarize the communication given in his/her own words.

Studies by Galton and Simon (1980) distinguished six styles of teaching based on aspects of verbal interaction and classroom management. The most successful style was that labelled "classroom enquires". This style placed emphasis on questioning particularly relating to the task set. Galton and Simon's study adds to the above information, that questioning as a teaching technique improves classroom instruction. A study carried out by Schilling aimed at testing the

perception of Ohio middle school principals towards six elements of effective teaching (Schilling 1997). These included set induction, classroom climate, stimulus variation, reinforcement, questioning and closure. An ex post facto study was employed and 210 middle school principals of Ohio participated in the study. The results of the study showed that the middle school principals rated all of the elements of effective teaching highly.

Galton and Simon and Schilling's studies described above have mentioned questioning among other techniques as a technique that leads to effective learning. The present researcher has attempted to establish the cognitive level of instructional questions asked by biology teachers in secondary schools in Kenya.

2.3 TYPES OF QUESTIONS

Educators agree that teachers should emphasize the development of students' intellectual skills rather than encouraging recall of facts (Dodd 1970). However, various studies have indicated that teachers' questions have by and large emphasized facts. A number of studies have been carried out on types of questions teachers ask in class. Sirotnik (1983) observed lessons in more than 1000 United States classrooms (Kindergarten through high school) and found that teachers' questions were almost invariably at the recall level.

Another study by Brown and Edmundson (1984) also recorded and analysed more than 1000 questions asked by teachers in different primary schools in the United Kingdom. The results obtained were as follows: 35% of the questions were recall questions; 57% managerial and 8% higher order questions. The results revealed that more weight was given to recall questions compared to higher level questions.

Okere (1984) conducted a study on the cognitive level of questions asked in social studies classes in two primary schools in Kakamega in Kenya. Standard 1 – 6 classes were involved in the study and a total of 22 teachers were observed. The total number of questions asked by the teachers was 205. An analysis of the 205 questions revealed the following percentages for each cognitive level of questions: knowledge 39.5%, comprehension 34.2%, application 13.2%, analysis 10.2% and synthesis 2.9.% Okere concluded that knowledge and comprehension level questions were popular with the primary social studies teachers. The study done by Okere investigated the cognitive level of questions asked by primary teachers of social studies. The present researcher has attempted to investigate the cognitive level of questions asked by secondary school teachers of biology.

In a survey study, Otieno (1996) investigated teachers' oral questions in English language in five secondary schools in Molo Division of Kenya.. Teachers in five Form 4 classes were observed for a period of one week each. The following were the results obtained; 578 teacher-formulated questions were recorded from the forty lessons. 30.3% of questions were open type and 65% were closed type. The study revealed that the English teachers observed tended to ask more closed type questions than open type questions. One of the observations this researcher made was that teachers' questions were closed and did not encourage free expression of oral language practice. While Otieno investigated the type of questions English teachers ask, the present researcher has investigated the cognitive level of questions asked by biology teachers.

Arnott (1996) investigated questioning behaviour and level of reflective process as seen through verbal and written responses. The subjects of this study included teachers who were recommended as having demonstrated excellence in the classroom. All the teachers were language arts teachers with varying levels of experience. The study found out that the teachers asked low level questions. Arnott's study investigated questioning behaviour in language arts teachers with varying experience. The present researcher did not consider experience as a variable in investigating the cognitive level of questions asked by the biology teachers.

2.4 EFFECT OF TEACHER TRAINING ON TYPES OF QUESTIONS ASKED

Studies done by Gall (1970), Rowe (1974) and Ogunniyis (1981) revealed that effective teacher training on questions resulted in teachers asking more thought provoking questions and reduction of emphasis on recall questions. These findings suggested that teachers should be trained to ask 'good' questions. According to Weigand (1971) a "good" question can be judged by its clarity, its provision for reflective thinking and facilitating the accomplishment of goals set by the teacher.

White (1997) also examined teacher change as exhibited by four third grade teachers who were participants in an in-service teacher enhancement project. The project included a summer in-service program as well as a mathematics specialist assigned to each school during the school year. The teachers attended a 22-day summer in-service program that included information on recent research on children's mathematical thinking, classroom questioning and equity. The study investigated how teachers used the information to transform their classroom practices, and how the students' mathematical content knowledge changed during the school year. Qualitative data was collected from audio-taped classroom observations. Each classroom was observed during twelve mathematics lessons. Observations revealed that all the 4 teachers changed their questioning patterns

and included more higher-level questions as they taught mathematics. As measured by the project assessments each teacher's classroom showed a significant increase in mathematics knowledge during the school year.

Chapter Summary

Chapter two looked at literature and research on questioning, specifically literature on purpose of questioning, types of questions and effect of training on questioning. Major findings cited in this chapter are as follows:

- Questions asked by teachers in the classes observed were mainly to check on understanding of learned concepts.
- Types of questions asked by teachers in the classes observed in some subjects such as English and social studies were mainly knowledge type.
- Training/in-servicing teachers on questioning changed their questioning patterns so that the teacher asked higher order questions.

The methodology of the study is discussed in chapter three.

CHAPTER THREE

METHODOLOGY

3.1 INTRODUCTION

The study was descriptive and this chapter explains how the study was conducted. The areas discussed in the chapter are description of the study area, sampling, the pilot study and data collection.

3.2 STUDY AREA AND POPULATION

According to Wamahiu and Mwiria (1995), aspects of research that render themselves to delimitation include the size of the population and the geographical location where the study is to be conducted to make the research manageable. The study took place in Kasipul Division of Rachuonyo District, which was purposively selected. The division was purposively selected because of its accessibility to the researcher and to reduce financial constraints. The division was also selected because the researcher works there as a teacher and therefore has professional interest in the Division.

Kasipul Division has a total of 18 public secondary schools distributed in 10 educational zones. Out of these only nine schools have presented candidates for KCSE examinations. The nine schools formed the population from which a sample was obtained.

3.3 SAMPLING

Purposive sampling was used to select two schools since the researcher was not able to observe all the nine schools due to time factor. Since only two schools were involved in the study, the findings of the study are not generalizable to schools in the whole Republic of Kenya. KCSE biology examination results for the years between 1994-1998 were used as a basis to sample the schools from the population described in Section 3.2 above because KCSE is the examination used to rank schools. The following two schools were selected:

(a) A high performing school in biology (hereafter referred to as HP school) The school was considered high performing because it had a mean score of over seven points out of ten in biology for five consecutive years.

(b) A low performing school in biology (hereafter referred to as LP school) The school was considered low performing because it had a mean score of below five points in biology for five consecutive years.

A high performing and a low performing school were selected because students in these schools exhibited differential performance and the researcher wanted to find out the levels of instructional questions asked by biology teachers in these schools and whether the questions had a bearing on students' achievement. Two schools were purposively selected to make the research manageable. Hyman (1970) states that questions constitute one third of classroom discourse and teachers ask about

86% of the questions. It seemed therefore that if many schools were chosen, the data to be analysed would be overwhelming.

The study targeted Forms 1 to 4 Biology teachers because these teachers begin preparing students for the KCSE national Biology examination in Form 1 and end in Form 4. By observing Form 1 to 4 Biology teachers, a cross-section of the type of questions asked by these teachers was obtained. The teacher to be observed was the one handling Biology in a given class at a given time. This was because the schools sampled had more than one stream and subsequently more than one Biology teacher per form. Thus in each school a Biology lesson was observed four times per class. Since there were four classes it means that in one school a total of 16 lessons were observed. Therefore total number of lessons observed in the two schools was 32.

3.4 FIELD WORK PREPARATION

The main fieldwork preparation involved conducting a pilot study. A pilot study was carried out in one of the schools in the study area. The pilot study school was excluded from the main study. Four lessons were observed during piloting. The purpose of the pilot study was to ascertain the effectiveness of the tape recorder in recording teachers' questions and for the researcher to generally get a 'feel' of classroom observation in readiness for the main study. The researcher also wanted to learn how to establish rapport with classroom teachers. The pilot study revealed

that the tape recorder alone was inadequate for recording all the questions since the teacher kept on changing positions within the classroom. In this case some of the questions asked would not be audibly taped and therefore writing the questions on paper was found to be necessary. The researcher therefore decided to tape the teachers' questions as well as write those questions which the teacher asked when far away from the tape recorder.

3.4 DATA COLLECTION

The researcher visited the two schools and obtained the head teachers' consent. The researcher then sought consent from the biology teachers to be observed. The information revealed to the teachers was that the researcher was interested in observing teacher-pupil interaction in class and to have a tape record of the lessons as well. The teachers were very willing and did not inquire about the details of the study and willingly availed their timetables to help the researcher schedule observation time. The data was collected in the schools' second term and the researcher observed four lessons in each class. Since teachers' questions were the focus the researcher sat at the front near the teacher in order to tape the teachers' questions clearly. However, the teachers kept on moving and therefore most of the teachers' questions were written down by the researcher in a question classification form (Appendix D).

Written questions in form of class assignments were also written down by the researcher in a similar but separate form.

Chapter Summary

The researcher selected Kasipul Division as the study area where sampling was done. Observation procedure was the main method of data collection and the researcher observed four lessons per class in the two schools selected. The questions asked by the Biology teachers were tape-recorded as well as hand written. The study data is presented, analysed and discussed in chapter 4.

CHAPTER FOUR

PRESENTATION, ANALYSIS AND DISCUSSION OF FINDINGS

4.1 INTRODUCTION

In this chapter the data collected from the lessons observed are presented. The researcher observed four lessons per class thus making a total of 16 lessons per school. Since the research was conducted in two schools, a total of 32 lessons were observed, during which the researcher recorded the questions asked by the Biology teachers. Each research question has been addressed in the following sections.

Tables are used to present the data in terms of frequencies and percentages.

4.2 FREQUENCY OF ORAL QUESTIONS ASKED IN THE CLASSROOMS

The first research question was:

What is the frequency of oral questions asked by teachers during instruction?

In all the lessons observed teachers asked oral questions but the frequency differed from class to class. All the questions recorded on tape were transferred onto the question classification form. Thus the researcher obtained the number of questions asked per lesson and hence per class from the question classification form. The results obtained from the HP school and LP schools are shown in Tables 4.1 and 4.2 respectively.

TABLE 4.1: NUMBER OF ORAL QUESTIONS PER LESSON OBSERVED IN THE HP SCHOOL

CLASS	LESSONS OBSERVED	DURATION (MINUTES)	NUMBER OF ORAL QUESTIONS PER OBSERVATION	TOTAL NO. OF ORAL QUESTIONS PER CLASS
FORM 1	1	40	06	-
	1	40	08	-
	1	40	11	-
	1	40	09	-
TOTAL	**4**	**160**	**34**	**34**
FORM 2	1	40	06	-
	1	40	07	-
	1	40	08	-
	1	40	04	-
TOTALS	**4**	**160**	**25**	**25**
FORM 3	1	40	06	-
	1	40	05	-
	1	40	07	-
	1	40	06	-
TOTALS	**4**	**160**	**24**	**24**
FORM 4	1	40	07	-
	1	40	01	-
	1	40	04	-
	1	40	05	-
TOTALS	4	160	17	**17**
			Grand Total	**100**

In the HP school, the number of oral questions asked in all the four lessons observed in each class were recorded and totalled. The results were as follows:- 34 in Form 1, 25 in Form 2, 24 in Form 3 and 17 in Form 4. The total number of oral questions asked in all the four classes was a 100 questions.

Likewise the results from LP school were obtained and recorded in Table 4.2

TABLE 4.2: NUMBER OF ORAL QUESTIONS PER LESSON OBSERVED IN THE LP SCHOOL

CLASS	LESSONS OBSERVED	DURATION (MINUTES)	NUMBER OF ORAL QUESTIONS PER OBSERVATION	TOTAL NO OF ORAL QUESTIONS PER CLASS
FORM 1	1	40	05	-
	1	40	03	-
	1	40	06	-
	1	40	08	-
TOTAL	**4**	**160**	**22**	**22**
FORM 2	1	40	07	-
	1	40	10	
	1	40	09	
	1	40	10	-
TOTAL	**4**	**160**	**36**	**36**
FORM 3	1	40	01	-
	1	40	02	
	1	40	03	-
	1	40	03	-
TOTAL	**4**	**160**	**09**	**9**
FORM 4	1	40	07	-
	1	40	05	-
	1	40	04	
	1	40	06	-
TOTAL	4	160	22	22
			Grand Total	89

In the LP school, the number of oral questions asked per class were 22 in Form 1, 36 in Form 2, 9 in Form 3 and 22 in Form 4. The total number of oral questions asked in all the four classes were 89. Tables 4.1 and 4.2 show the number of questions asked per lesson. On average the number of questions asked in HP school per lesson was six, that is, the total number of questions asked (100) divided by the number of lessons observed (16). While in LP school the average number of questions asked was five, that is; the total number of questions asked (89) divided by the number of lessons observed (16). Six questions (in HP school) and five questions (in LP school) for a forty minutes lesson gives a low frequency of questions in class. This low frequency can be explained by the features observed by the researcher in the classrooms. Apart from questioning, the teachers were involved in the following activities.

4.2.1 Explanation of Concepts.

Teachers had to spend a considerable amount of time giving explanations of new concepts. For example a lesson on 'Hydrophytes' in Form 3 had the following biological terms to be explained - '*Aerenchyma, submerged, emergent, physiological drought* and *pneumatophores*'. Students had to listen to these explanations.

4.2.2 Notes.

Notes were either dictated to students or written on the blackboard for the students to copy as the lesson progressed.

4.2.3 Drawing Diagrams.

Biology being a subject with many diagrams to draw, there was a tendency for the teachers to draw these diagrams on the blackboard while the lesson progressed. Teaching time and questioning in class would be increased if these diagrams were drawn in advance on a manila paper. For example in a Form 2 class, the teacher who was teaching "mammalian circulatory system" drew a diagram showing circulation of blood within the heart. Likewise, in a Form 4 class, the teacher drew the structure of the 'inner ear.' The students on the other hand were given time to draw the diagrams in their note books during the lesson.

The features discussed above were common in all the lessons observed. It was evident from the observations made that questioning in the classroom could not be considered in isolation from other classroom activities and availability of teaching-learning aids.

4.3 FREQUENCY OF WRITTEN QUESTIONS

The second research question was : What is the frequency of written questions asked by teachers during instruction?

Written questions were even fewer than oral questions. In fact in most of the classes observed students were not given written questions. Out of the 32 lessons observed in HP and LP schools, 12 lessons in HP school and 8 lessons in LP school did not have written questions. The total number of written questions in HP school was only four while that of LP school was 19. This information is presented in Table 4.3 below.

Table 4.3 FREQUENCY OF WRITTEN QUESTIONS IN HP AND LP SCHOOLS

CLASS	WRITTEN QUESTIONS			
	HP school		LP school	
	Frequency	Percentage	Frequency	Percentage
Form 1	-	-	12	63.16
Form 2	1	25.00	5	26.32
Form 3	1	25.00	1	5.26
Form 4	2	50.00	1	5.26
TOTAL	4	100	19	100

The percentage of written questions in Forms 1 and 2 in the LP school was quite high compared to those in the HP school. This is because one of the teachers observed was very keen on giving assignments after the lesson. The questions were related to what had been covered during the lesson. For example after a lesson on "Classification", in the Form 1 class, the following questions among others were given:

a) The scientific name for housefly is *Musca domestica.* Which taxonomic group does the name *domestica* refer to?

b) Classify *Panthera Leo* to its taxonomic unit.

The other common assignments given by the teachers observed were in the form of instructions to students on what to do. For example students were instructed to do any of the following:-

a) Make notes on a given topic.

b) Draw a diagram from a book.

c) Read ahead on the subtopics that follow.

Most of the teachers observed explained that assignments to be marked were not common features after every lesson because of time factor and also there were many topics to be covered within the term. The number of students in the classes observed ranged between 45 and 55. Indeed these were large classes which would hinder administering and marking assignments after every lesson hence the limited number of written assignments.

4.4 COGNITIVE LEVEL OF QUESTIONS ASKED DURING INSTRUCTION

The third research question was:-

What cognitive level of questions do teachers ask during instruction?

Analysis of the type of questions asked by the Biology teachers was done by using the definitions explained in appendices A and B. For example, a teacher in a Form 2 class asked the question – "Name the enzyme that digests fats". This question was categorized as knowledge because it required the pupil to recall what had been taught previously. The action verb 'name' is also used for knowledge questions. These definitions in Appendices A and B assisted in placing the questions in the various cognitive levels namely: knowledge, comprehension, application, analysis, synthesis and evaluation. A sample of questions asked by teachers in the lessons observed are presented in Appendix E .

Tables 4.4 and 4.5 show the cognitive levels of questions asked by biology teachers in HP and LP schools respectively.

TABLE 4.4: COGNITIVE LEVELS OF QUESTIONS ASKED BY BIOLOGY TEACHERS DURING INSTRUCTION IN HP SCHOOL.

		COGNITIVE LEVEL OF ORAL QUESTIONS					
CLASS	**LESSONS OBSERVED**	**Kn.**	**Co.**	**Ap.**	**An.**	**Sy.**	**TOTAL OF LEVELS**
FORM1	1	6	-	-	-	-	6
	1	5	3	-	-	-	8
	1	6	3	1	-	1	11
	1	5	3	1	-	-	9
TOTAL	**4**	**22**	**9**	**2**	-	**1**	**34**
FORM2	1	3	2	1	-	-	6
	1	3	4	-	-	-	7
	1	6	2	-	-	-	8
	1	3	1	-	-	-	4
TOTAL	**4**	**15**	**9**	**1**	-	-	**25**
FORM3	1	3	2	1	-	-	6
	1	3	1	1	-	-	5
	1	4	3	-	-	-	7
	1	3	2	1	-	-	6
TOTAL	**4**	**13**	**8**	**3**	-	-	**24**
FORM4	1	5	2	-	-	-	7
	1	1	-	-	-	-	1
	1	3	1	-	-	-	4
	1	4	1	-	-	-	5
TOTAL	4	13	4	-	-	-	17

From Table 4.4 it can be seen that a total of 34 questions were asked in Form 1 of which 22 were knowledge level questions, 9 comprehension, 2 application and 1 synthesis. In Form 2, a total of 25 questions were asked of which 15 were knowledge, 9 comprehension, and 1 application. In Form 3, a total of 24 questions were asked, of which 13 were knowledge questions, 8 were comprehension and 3 application. In Form 4, a total of 17 questions were asked of which 13 were knowledge and 4 comprehension. There were no evaluation questions. Table 4.5 shows the above information in percentage form. To get the percentage, the number of questions in each level was divided by the total number of questions asked. For example the 64.71% in Form 1 was obtained by dividing 22 (number of knowledge questions) by 34 (total number of questions) and multiplying by 100. This procedure was done for all levels to obtain the percentages shown in Table 4.5 below.

TABLE 4.5: PERCENTAGE OF QUESTIONS IN EACH COGNITIVE LEVEL ASKED PER CLASS IN HP SCHOOL.

	PERCENTAGE OF QUESTIONS PER CLASS					
CLASS	Kn.	Co.	Ap.	An.	Sy.	Ev.
Form 1	64.71	26.47	5.88	-	2.94	-
Form 2	60.00	36.00	4.00	-	-	-
Form 3	54.17	33.33	12.50	-	-	-
Form 4	76.47	23.53	-	-	-	-

Table 4.5 reveals that knowledge questions formed the bulk of the oral questions asked in class followed by comprehension, application and synthesis questions. Another observation made from Table 4.5 was that more low-level questions were asked in Form 4. This was because the lessons being covered at the time of observation required students to recall what they had learnt previously in the lower classes.

Similarly, results obtained from LP school are recorded in Table 4.6 as shown below.

TABLE 4.6 COGNITIVE LEVELS OF QUESTIONS ASKED BY BIOLOGY TEACHERS DURING INSTRUCTION IN LP SCHOOL

		COGNITIVE LEVELS OF ORAL QUESTIONS					
CLASS	**LESSONS OBSERVED**	**Kn.**	**Co.**	**Ap..**	**An**	**Sy.**	**TOTAL OF LEVELS**
FORM1	1	2	2	-	-	1	5
	1	2	1	-	-	-	3
	1	4	2	-	-	-	6
	1	5	3	-	-	-	8
TOTAL	**4**	**13**	**8**	**-**	**-**	**1**	**22**
FORM2	1	6	1	-	-	-	7
	1	6	3	-	-	1	10
	1	7	2	-	-	-	9
	1	6	4	-	-	-	10
TOTAL	**4**	**25**	**10**	**-**	**-**	**1**	**36**
FORM3	1	1	-	-	-	-	1
	1	1	1	-	-	-	2
	1	3	-	-	-	-	3
	1	2	1	-	-	-	3
TOTAL	**4**	**7**	**2**	**-**	**-**	**-**	**9**
FORM4	1	6	1	-	-	-	7
	1	4	1	-	-	-	5
	1	2	2	-	-	-	4
	1	3	2	1	-	-	6
TOTAL	4	15	6	1	-	-	22

From Table 4.6 it can be observed that a total of 22 questions were asked in Form 1, of which 13 were knowledge, 8 comprehension and 1 synthesis. In Form 2 a total of 36 questions were asked of which 25 were knowledge, 10 comprehension and 1 synthesis. In Form 3 a total of 9 questions were asked of which 7 were knowledge and 2 were comprehension. In Form 4 a total of 22 questions were asked of which 15 were knowledge, 6 comprehension and 1 application. There were no evaluation questions. Table 4.7 below shows percentages of the above information. (See page 42 for explanation on how the percentages have been arrived at).

TABLE 4.7: PERCENTAGES OF QUESTIONS IN EACH COGNITIVE LEVEL ASKED PER CLASS IN LP SCHOOL.

	PERCENTAGE OF LEVELS OF QUESTIONS PER CLASS					
CLASS	Kn.	Co.	Ap.	An.	Sy.	Ev.
Form 1	59.09	36.36	-	-	4.55	-
Form 2	69.44	27.78	-	-	2.78	-
Form 3	77.78	22.22	-	-	-	-
Form 4	68.18	27.27	4.55	-	-	-

Table 4.7 reveals that knowledge questions formed the bulk of the oral questions asked in class followed by comprehension questions.

In both HP and LP schools, results revealed that during instruction, knowledge questions formed the bulk of questions asked by the biology teachers (Table 4.5 and Table 4.7 respectively). From classroom observations, the researcher noticed that knowledge questions were asked particularly at the beginning of the lesson to find out whether the students could recall what had been covered in the previous lesson, before embarking on the present lesson. For example in a Form 2 lesson on the topic "Digestive System," the following knowledge questions were asked .

- Name the process of taking in food.
- What does the gall bladder secrete?
- Name the enzyme that digests fats.

The researcher also observed that teacher questions which required elaborate answers did not elicit the kind of explanation expected. Most students restricted or preferred to give their answers in one or two word answers. Questions that required elaborate explanations were met with long periods of silence from the students forcing the teacher to revert to knowledge type questions. When teachers asked knowledge type questions, students raised their hands for nomination to answer. The students' enthusiasm to answer knowledge type questions might explain the teachers' tendency to ask more of this type of questions. An example was found in a Form 2 class observed. The question asked was:-

- What happens to food consisting of rice and meat in the alimentary canal?

The students kept quiet and the teacher tried to get the required answer by asking 3 leading questions:

- In which classes do (a) rice (b) meat belong ?
- State the enzymes that digest (a) rice (b) meat?
- Where are these enzymes found in the alimentary canal?

These questions enabled the students to give short answers for each.

Of the 32 lessons observed in HP and LP schools only two lessons were practical oriented. For example a double lesson on "cell physiology in Form 1 was split into two phases. Part of the lesson was used for theory while the rest of the time was utilized in performing a simple experiment on "diffusion". This experiment was performed in eight groups of six students each. Examples of questions asked in this lesson are listed below:-

- Learners were asked to name the apparatus they were using (such as droppers, beakers, measuring cylinder)

This was knowledge question since the learner had to recall the names of the apparatus as was presented to them in the previous lesson.

- What is the approximate volume of water in the beaker?

This was a comprehension question as the learner had to measure and translate the information required into numbers.

- After the experiment on diffusion the students were asked to say what they had observed.

This was a synthesis question as the learner had to put together facts from his/her observation.

4.5 COGNITIVE LEVEL OF QUESTIONS IN THE END OF TERM TESTS.

The fourth research question was:-

What level of questions do classroom teachers ask in end of term tests?

End of term test papers were analysed by the researcher to find out the type of questions set by Biology teachers for Forms 1 to 4 classes. The researcher obtained the 1998 Form 1 to 4 end of terms' test papers for term 1,2 & 3 from both the HP school and LP school. Table 4.8 shows the number of questions in the end of term 1, 2 and 3 tests in HP School. The percentage of each level of question has also been shown. The percentages were obtained by dividing the total number of questions in each class by the number of questions in each level, and then multiplying by 100.

TABLE 4.8: COGNITIVE LEVELS OF QUESTIONS ASKED IN END OF TERM TESTS IN HP SCHOOL FOR THE YEAR 1998

CLASS	Type of Question	Term 1	Term 2	Term 3	Total	%
Form 1	Knowledge	10	14	13	37	43.53
	Comprehension	15	13	12	40	47.06
	Application	-	2	2	4	4.71
	Analysis	2	-	1	3	3.53
	Synthesis	-	-	1	1	1.18
TOTAL		**27**	**29**	**29**	**85**	
Form 2	Knowledge	13	9	8	30	34.48
	Comprehension	19	14	14	47	54.02
	Application	2	1	2	5	5.75
	Analysis	1	1	-	2	2.30
	Synthesis	1	1	1	3	3.45
TOTAL		**36**	**26**	**25**	**87**	
Form 3	Knowledge	5	7	9	21	20.39
	Comprehension	24	24	15	63	61.17
	Application	3	3	2	8	7.77
	Analysis	-	2	3	5	4.85
	Synthesis	2	2	2	6	5.83
TOTAL		**34**	**38**	**31**	**103**	
Form 4	Knowledge	12	14	18	44	32.59
	Comprehension	25	28	24	77	57.04
	Application	1	2	2	5	3.70
	Analysis	2	-	2	4	2.96
	Synthesis	2	2	1	5	3.70
TOTAL		42	46	47	135	-

Table 4.8 reveals that in each class, the bulk of questions in the end of term tests are comprehension type, followed by knowledge questions. Thus 47.06% of questions in Form 1 were comprehension while 43.53% were knowledge. Secondly, 54.02% of questions in Form 2 were comprehension while 34.48% were knowledge. Thirdly, 61.17% of questions in Form 3 were comprehension while 20.39% were knowledge. Lastly, 57.04% of question in Form 4 were comprehension while 32.59% were knowledge. These results show that in the end of term tests, teachers emphasized comprehension questions just as they were emphasized in the national examination. It is likely that this was an attempt made by the teachers to give students more practice in answering written comprehension questions followed by knowledge and application.

Table 4.9 shows the results of the analysis of end of term test papers for the LP school.

TABLE 4.9: COGNITIVE LEVELS OF QUESTIONS ASKED IN END OF TERM TESTS IN LP SCHOOL FOR THE YEAR 1998

CLASS	Type of Question	Term 1	Term 2	Term 3	Total	%
Form 1	Knowledge	9	6	8	23	27.71
	Comprehension	16	18	20	54	65.06
	Application	1	4	1	6	7.23
	Analysis	-	-	-	-	-
	Synthesis	-	-	-	-	-
TOTAL		**26**	**28**	**29**	**83**	
Form 2	Knowledge	10	10	5	25	25.00
	Comprehension	22	21	23	66	66.00
	Application	-	-	3	3	3.00
	Analysis	-	-	1	1	1.00
	Synthesis	2	1	2	5	5.00
TOTAL		**34**	**32**	**34**	**100**	
Form 3	Knowledge	7	3	12	22	22.45
	Comprehension	18	22	22	62	63.26
	Application	3	2	1	6	6.12
	Analysis	1	-	1	2	2.04
	Synthesis	3	-	3	6	6.12
TOTAL		**32**	**27**	**39**	98	
Form 4	Knowledge	16	19	9	44	34.11
	Comprehension	21	19	27	67	51.94
	Application	2	2	2	6	4.65
	Analysis	-	2	3	5	3.88
	Synthesis	2	2	3	7	5.43
TOTAL		41	44	44	129	

Table 4.9 reveals that the bulk of questions asked in the end of term tests in LP school was comprehension followed by knowledge. Thus 65.06% of the questions in Form 1 were comprehension while 27.71% were knowledge. Secondly, 66.00% of questions in Form 2 were comprehension while 25.00% were knowledge. Thirdly, 62.26% of questions in Form 3 were comprehension while 22.45% were knowledge. Lastly 51.94% of questions in Form 4 were comprehension while 34.11% were knowledge. It was evident from these results that the teachers in this school were emphasizing comprehension questions in the end of term tests.

Table 4.8 and 4.9 of HP and LP schools respectively show a similar trend in the type of questions set by biology teachers. In both cases questions in the end of term tests were mainly comprehension questions followed by knowledge and a few application, analysis and synthesis questions. The style of setting questions in the end of term test was quite similar to the style used in KCSE biology examination. There was also a tendency by the teachers to get questions from the KCSE biology examination past papers set by KNEC for all classes. This was evident as the researcher went through the questions during analysis.

The following are examples of such questions.

Form 2: Explain what would happen to red blood cells if they are placed in a concentrated salt solution? (From KCSE 1995)

Form 4: State two structural difference between ribonucleic acid (RNA) and deoxyribonucleic acid (DNA)? (From KCSE1994)

Form 3: Explain the flow of energy from the sun through different trophic levels (From KCSE 1993).

4.6 CLASSROOM INSTRUCTION QUESTIONS AND BIOLOGY NATIONAL EXAMINATION QUESTIONS.

The fifth research question was:-

How do the level of questions asked during instruction compare to the level of questions in the KCSE Biology examination?

Tables 4.5 and 4.7 show percentages for the different levels of oral questions asked in HP and LP schools respectively. From the Tables it can be seen that the Biology teachers emphasized knowledge type questions followed by comprehension type questions in each class. Analysis of the KCSE biology Examination papers (1993-1998) on the other hand revealed that each year the bulk of questions asked were comprehension type followed by knowledge type (Chapter 1, Table 1.2). From the foregoing, it is evident that during classroom instruction, the emphasis was on knowledge questions while in biology national examination the emphasis was on comprehension. This tells us that most likely the students do not get enough practice in answering comprehension questions during instruction.

4.7 STUDENTS' ACHIEVEMENT AND QUESTIONING

Analysis of data collected from both the HP and LP schools revealed that trends shown in the frequency and levels of questions asked by the biology teachers during instruction were similar. Tables 4.5 and 4.7 show that the percentage of knowledge questions was high in both schools, followed by comprehension questions. Similarly the end of term test questions asked by the teachers in both schools had more comprehension questions followed by knowledge and a few application, analysis and synthesis questions (Tables 4.8 and 4.9). Although the students in the two schools differed in their achievement in biology, the teachers observed displayed similar characteristics in the level of questions they asked during instruction and in the end of term tests.

The results of this study also largely conforms to some of the results of the previous researches, whereby knowledge type of questions dominate during instruction. However the previous researchers did not attempt to match instructional questions with questions that face the students in examinations.

The argument, therefore, that the level of questions teachers ask during instruction can affect students' achievement does not stand. In this case questioning cannot be pin-pointed as a factor that affects students' achievement in biology in the schools

studied. Other factors outside the scope of this study should be investigated to explain the poor performance.

Chapter Summary

In this chapter, the data collected, has been analysed and discussed. The data was summarized in tables using frequencies and percentages. Results revealed that the number of questions asked by Biology teachers was on average six questions in HP school and five questions in LP school during a 40 minutes lesson. In HP and LP schools, teachers emphasized knowledge type questions during instruction and comprehension type questions in the end of term tests. Therefore in both HP and LP schools, the teachers observed displayed similar characteristics in the level of questions asked in class and in end of term tests and thus questioning cannot be taken as a significant factor affecting students' achievement in Biology in the two types of schools. However the research has revealed the type of questions which dominate our classrooms during instruction.

CHAPTER FIVE

SUMMARY, CONCLUSION, RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER STUDY

5.1 INTRODUCTION

This chapter summarizes the findings of the study from which conclusions are then drawn. Recommendations to teachers and suggestions for further study are given.

5.2 SUMMARY OF FINDINGS

The main purpose of this study was to investigate the cognitive level of questions secondary school Biology teachers ask in class during instruction and their implication on student achievement. The following sections summarize the findings as per the research questions of the study.

5.2.1 Research question 1: What is the Frequency of Oral Questions asked by Biology Teachers During Instruction?

The results revealed that the number of questions asked during a single lesson (40 minutes) was an average of 6 questions in HP school and 5 questions in LP school. These averages show that the number of questions asked in class were low. It was

also evident from the observations made that questioning in the classroom could not be considered in isolation from other factors such as other teaching learning activities and availability of learning aids. Although the factors stated were not investigated, they were observed by the researcher.

5.2.2 Research question 2: What is the Frequency of Written Questions asked by Biology Teachers during Instructions?

Out of the 32 lessons observed in HP and LP schools, 12 lessons in HP School and 8 lessons in LP school did not have written questions. In the HP school 4 written questions were given while in LP school 19 questions were given. The implication here was that written questions given to students would give them a chance to answer such questions in writing.

5.2.3 Research question 3:- What level of Questions do Biology Teachers ask During Instruction.

From the findings, knowledge questions formed the bulk of the oral questions asked in class in both HP and LP schools. This was followed by comprehension type questions; very few application, analysis and synthesis questions were asked.

5.2.4 Research question 4:- What is the level of Questions asked by the Teachers in the End of Term Tests.

Results revealed that comprehension questions formed the bulk of the questions followed by knowledge type in the end of term papers obtained from HP and LP schools.

5.2.5 Research question 5:- How do the level of questions asked by Teachers during instruction compare with the Biology National Examination Questions.

Knowledge questions formed the bulk of classroom instructional questions while Comprehension questions formed the bulk of questions in KCSE Biology National Examination.

5.3 CONCLUSION

The researcher having collected, presented and analyzed the data on the level of questions asked in HP and LP schools, made the following conclusions:

Questioning in class could not be considered in isolation to other activities going on in class. The teachers observed were involved in activities such as explaining biological concepts, drawing diagrams on the board and giving or dictating notes to the students thus reducing the interaction of teacher and students through

questioning. This explained the low frequency of questions per lesson in all the classes observed.

During instruction, knowledge questions were predominant in all the classes observed. On the other hand, end of term tests from both schools had comprehension questions dominating followed by knowledge. The latter was in line with the KCSE Biology Examination, as analysis of the KCSE Biology Examination (Chapter 1) revealed that comprehension questions were dominating followed by knowledge questions. Finally trends in the frequency and the cognitive level of questions asked by the Biology teachers in the two schools studied were similar, therefore the question levels asked in class could not be the factor responsible for the high or low achievement in Biology in the two schools.

5.4 ISSUES RAISED BUT NOT DISCUSSED

From the study, it was evident that knowledge and comprehension level questions were emphasized in schools and examination. Students need to be exposed to higher levels of thought processes by asking them more questions, which require them to apply, analyse, synthesize and evaluate information. This would be in line with Kenyas' goal of being industrialized by the year 2020. Giving the students more practice in application, analysis and synthesis level questions in the classroom/examination would contribute greatly towards this goal of industrialization by producing more practical oriented students.

5.5 RECOMMENDATIONS TO TEACHERS

Although there was no correlation between the questions asked in HP and LP schools and students performance, what was observed in the classroom still served as a basis to make recommendations. The following are some recommendations made by the researcher to teachers. Since the researcher observed that teachers asked mainly knowledge questions, the teachers should formulate questions to be asked during instruction in advance. This will ensure that different cognitive levels are covered and not only the knowledge level questions dominating as was the case in the study. Secondly, teachers should engage students in more practical work in order to encourage questioning at all cognitive levels. Thirdly more written assignments should be given to students in order to give them practise in answering such questions.

5.6 SUGGESTIONS FOR FURTHER RESEARCH

The researcher made the following suggestions for further study.

- A study to find out the amount of practical work students are exposed to between Form 1-4.
- A study similar to this one should be carried out using a much larger sample of schools.
- A study to find out students' explanation of their poor achievement in Biology.

REFEERENCES

Achola, P.P.W. (1990). "The influence of selected Teacher factors and school practices in school achievement. A case of the semi-arid Kajiado Maasai land. BER Seminar paper No. 20206. Bureau of Educational Research, Kenyatta University, Nairobi."

Arnott, T R.F. (1996). "Teaching effectiveness. demonstration of action reflection, relevance, questioning and learning style consideration by elementary teachers at different experiential levels," Doctoral dissertation of the University of South Mississippi.

Astin, A.W. (1985). **Achieving educational excellence**. San Fransisco: Jossey-Boss Inc.

Bloom, B.S. ed. (1956). **A taxonomy of educational objectives, Handbook 1. Cognitive domain.** New York: David Mickay Company Inc.

Brown, G.A. & R. Edmundson (1984). 'Asking questions' in E C. Wragg (ed) **Classroom teaching skills.** London: Croom Helm.

Daily Nation (1998). **Worrying trends in national examinations**, Daily Nation, February 25. Nairobi: Nation Centre.

Deighton, L. C. (ed) (1971). **The Encyclopedia of Education**. New Jessey: Macmillan and Tree Press.

Dillon, J.T. (1988). **Questioning and teaching; A manual of Practice**. London: Croom Helm.

Dodd, W.A. (1970). **The Teacher at work.** London: Oxford University Press.

Doneau, S.J. (1985). "Soliciting in the classroom"; in Husten and Postlethwaite T. n. (ed) 1985, **The International Encyclopedia of Education Research and Studies**, Oxford Pergamon Press.

Falk, D. (1971). **Biology teaching methods**. New York: John Wiley and Sons Inc.

Gall, M.D. (1970). "The use of questions in teaching." **Review of Educational Research Volume** *40 No. 51.*

Galton, M. and B. Simon (Eds) (1980). **Progress and performance in the primary classrooms**. London: Routledge and Kegan Paul.

Hyman, R.T. (1970), **Ways of teaching.** New York: Lippincott Company.

Kamunge, J.M. (1988). **Report on the Presidential working party on education and manpower training for the next decade and beyond.** Nairobi: Government Printers.

Kaiguri, D.M. (1996). "Survey of some factors affecting the academic achievements of Biology at secondary level in different schools." P.G.D.E. thesis of Kenyatta University, Nairobi.

Kenya National Examinations Council (1995). **Kenya Certificate of Secondary Education regulations and syllabus (1996-1997)**Nairobi: KNEC

Kenya National Examinations Council(1998). **Analysis of K.C.S.E biology Examination.** Nairobi: KNEC

Kerry, T. (1982). **Effective questioning, a teaching skills workbook** London: Macmillan Education.

Kissock, C. and P. Lyortsuun. (1982): **A guide to questioning; classroom procedure for teachers**. London: Macmillan Publishers Ltd.

Mangela, V. (1983). "A survey of some factors affecting the academic achievement in Biology at ordinary level." PGDE thesis of Kenyatta University, Nairobi.

Maundu, J.N. (1986). "Student achievement in science and mathematics; a case study of extra provincial, provincial and harambee secondary schools in Kenya." Ph.D. dissertation Mcgill University, Montreal.

Misango, J.S. (1985). "Survey of some factors affecting the academic achievement in biology at ordinary level in secondary schools within Bungoma District." P.G.D.E thesis of Kenyatta University, Nairobi.

Ogunniyis, M.B. (1981). **Educational measurement and evaluation.** U.K.: Longman Group Ltd.

Okere, J. (1984). "A study of the cognitive level of classroom questions in social studies in primary schools in Kakamega Municipality. M.ED (PTE) University of Nairobi, Nairobi

Otemwa, J. (1985). "Factors affecting the teaching of Biology in both Government and harambee secondary schools in Kenya." M.ED. thesis of University of Nairobi, Nairobi

Otieno, A.O. (1996). "A study of teachers oral questions in English Language classes in selected schools in Nakuru district." M.ED. thesis of Kenyatta University, Nairobi.

Orodho, J.A. (1996). "Factors determining achievement in science subjects at secondary school in Kenya." Bureau of Educational Research, Kenyatta University, Nairobi.

Pate, R.T. and N.H. Bremer (1967) **Guiding learning through skillful Questioning**. The elementary school Journal 67.

Procter, P. ed.(1995). **International Dictionary of English**. Australia: Cambridge University Press.

Rowe, M.B. (1974) "Wait time and rewards as instructional variables, their influence on logic and fate control," Journal for research in science teaching. volume 2 no. 2.

Rowntree, D. (1981). **A dictionary of education**. London: Harper and Row.

Schilling, J.M. (1997). "Elements of effective teaching: testing their values with Ohio middle school principles in the 1990s (direct instruction, teachers)." EDD Thesis of the University of Akron.

Sirotnik, K.A. (1983). "What you see is what you get – consistency, persistence and mediocrity in classroom." Harvard Educational review, 53.

Taba, H. Levine, S. and F.Elzey`. (1964). "Thinking in elementary school children," Co-operative research project No. 1574, San Francisco State College, San Francisco California.

UNESCO, (1987). **New trends in Biology teaching Volume V.** Paris, UNESCO.

UNESCO, (1988). Science and technology and endogenium development in Africa – CATASFRICA II UNESCO.

UNESCO, (1990). **New trends in Biology teaching Volume VI.** Paris, UNESCO.

Wamahiu, S.P. and A.K. Mwiria. (1995). "Qualitative research in Education" in S. Wamahiu and K. Mwiria (eds) **Issues in educational research in Africa.** Nairobi: East African Educational Publishers.

Wragg, E.C. and G. Brown (1993).**Questioning.** London: Routledge.

Weigand, J. (1971). **Developing Teacher Competencies**. New Jersey: Prentice Hall Inc. Englewood Cliffs.

White, D.Y. (1997). "The mathematics classroom question and response patterns of third grade teachers in high-minority population schools." Doctoral Dissertation of University of Maryland College Park.

APPENDIX A

ELABORATIONS ABOUT THE COGNITIVE DOMAIN CLASSES

Source Bloom (1956:201-207)

Knowledge

Test situation which emphasizes recall of previously learned facts, concepts, procedures, categories, principles, theories and generalizations.

Comprehension

When confronted with communication, the student should be able to translate it, that is the student should be able to use a concept when it appears in different symbols or order from the one originally presented. The student should also be able to interpret information, see and use relationships between ideas and make estimates and predictions.

Application

When a student is confronted with a new problem he/she will decide on what information to use and then use it to solve the problem.

Analysis

Emphasizes the breakdown of materials into their constituent parts and the detection of relationships of parts and of the way they are organized.

Synthesis

Requires students to put together pieces, elements, facts so as to form a new whole.

Evaluation

Students are called upon to make judgments in terms of logic, accuracy and consistency.

APPENDIX B

ACTION VERBS APPROPRIATE FOR USE WITH EACH COGNITIVE LEVEL

(Kissock and Lyortsuun (1982) Gronlund (1985:37).

Knowledge
Define, recall, remember, name, list, tell count.

Comprehension
Compare, contrast, differentiate, explain rephrase, distinguish, describe, relate, interpret, rearrange, put in your own words, calculate, and predict.

Application
Apply, solve, design, use, demonstrate, choose, and build.

Analysis
Analyze, recognize, draw, identify, infer, support, distinguish, and determine evidence.

Synthesis
Create, plan construct, formulate put together, design draw up, illustrate, write, suggest, compose.

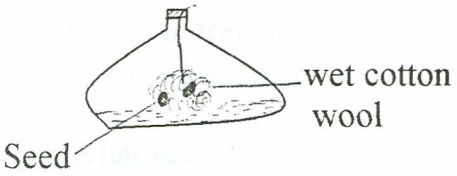
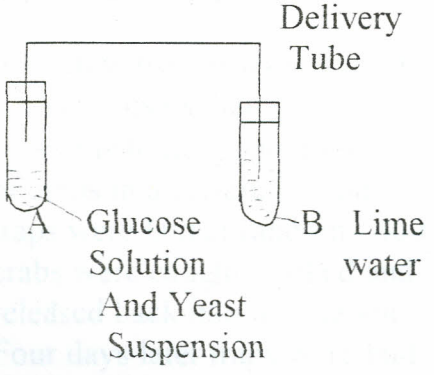
Evaluation
Judge, assess, decide, appraise evaluate, select, conclude.

APPENDIX C

ANALYSIS OF THE 1996 KCSE EXAMINATION QUESTION PAPER FOR BIOLOGY PAPER 1 (THEORY) AND PAPER 2 (PRACTICAL).

PAPER 1 – Theory

No.	QUESTION	TYPE
1.	State the function of deoxyribo nucleic acid (DNA molecule)	Knowledge Requires recall of specific concept learned
2.	State two ways by which immune deficiency syndrome (AIDS) virus is transmitted..	Knowledge Recall of facts taught.
3.	When is glycogen which is stored in the liver converted into glucose and released into the blood?	Comprehension Student has to understand the relationship between glycogen and glucose and what glucose does in the body.
4.	Name the disease in human diet that is caused by lack of vitamin C.	Knowledge Requires recall of facts taught.
5.	An organism with an exoskeleton, segmented body, two pairs of legs per segment, a pair of eyes and a pair of short antennae belongs to phylum.	Comprehension. Requires knowledge and understanding of classification.
6.	When are two organisms considered to belong to the same species.	Comprehension Has to understand what term 'species' is, before giving correct answer.
7.	State the role of light in the process of (a) photosynthesis. (b) Name one end product of dark reaction.	Knowledge Requires recall of a specific fact. Knowledge Requires recall.
8.	State two functions of the cell sap.	Knowledge Recall of facts learned.
9.	State three characteristics that ensure cross pollination takes place in flowering plants.	Comprehension. Has to understand what cross-pollination entails and relate structure to function.
10.	A student set up an experiment	

	as shown in the diagram below  Pyrogallic acid The set up was left at room temperature for a week A. What was the aim of the Experiment? B. What would be the expected results at the end of the experiment.	Application: should apply knowledge learned earlier. Comprehension Has to know the relationship between wet cotton, seeds and pyrogallic acid.
11.	Give a reason why it is only mutations in genes that influence evolution	Comprehension Requires to know what mutations are and what gametes are for to answer why.
12.	Give a reason why it is necessary for frogs to lay many eggs. **SECTION B** The diagram below shows a set up that was used to demonstrate fermentation  Glucose solution was boiled and oil added on top of it. The glucose solution was allowed to cool before adding the yeast suspension.	Comprehension Has to understand the mode of reproduction of on frogs and give a reason for why many eggs.

	(a) Why was glucose solution boiled before adding the yeast suspension?	Comprehension Has to understand the principle being investigated.
	(b) What was the importance of cooling the glucose solution before adding the yeast suspension.	Application Has to apply knowledge on temperature and enzymes.
	(c) What was the use of oil in the experiment?	Comprehension. Has to understand the relationship between the oil and glucose solution
	(d) What observation would be made in test-tube 3 at the end of the experiment	Application Has to apply knowledge on anaerobic respiration.
	(e) Suggest a control for this Experiment.	Synthesis Has to come up with the requirements to be used to serve as a control..
14.	(a) Describe the path taken by carbon dioxide released from the tissues of an insect to the atmosphere.	Comprehension Requires knowledge on respiratory tissues in insects and how they are related to one another.
	(b) Name two structures used in gaseous exchange.	Knowledge Recall of specific facts.
15.	To estimate the population size of crabs in a certain lagoon traps were laid at random. 400 crabs were caught marked and released back into the lagoon. Four days later traps were laid again and 374 crabs were caught. Out of 374 crabs, 80 were found to have been marked. (a) Calculate the population size of the crabs in the	Comprehension Should have ability to translate, change communication given in words to number.

	lagoon using the formula below $N=\frac{nxM}{m}$ N= Total population in the Lagoon. n= total number of crabs in the 2nd catch. M= No. of marked crabs during 1st. catch m= No. of marked crabs in the 2nd. Catch. (b) State two assumption that Were made during Investigation (c) What is the name given to This method of estimating The population size.	Application Has to use his knowledge in ecological methods of obtaining population sizes. Knowledge Recall of specific fact.
16.	A shoot of seedling exposed to light on one side bends towards the source of light as it grows. (a) Name the response Exhibited by the shoot of the seedling. (b) Explain how the bending towards the source of light occurs.	Knowledge Recall of specific concept. Application. Has to use knowledge on tropisms and auxins.
17.	(a) How may excessive bleeding result in death. (b) Name the process by which the human body naturally Stops bleeding. (c) How can low blood volume be brought back to normal.	Application Has to use knowledge on red blood cells and the role of haemoglobin in the body Knowledge Recall of specific facts Application Use knowledge on balanced diet and transfusion
18.	In an experiment black mice were crossed with brown mice	

	and the off springs were black. Black colour is dominant over that for brown colour. Using letter B to represent the gene for black colour and b to represent the gene for brown colour.	
	(a) Work out the genotypes of F1 generation.	Comprehension Has to translate and interpret the information
	(b) What is the phenotype ratio Of the offspring.	Comprehension Has to interpret the information. Has to recognize the various genotype, in order to give ratio.
19.	The diagram below represents the pathway of water from the soil in the plant.	
	(a) Name the structures labeled K and L.	Comprehension Has to interpret the diagram as showing structure concerned with absorption of water.
	(b) Explain how water from the Soil reaches the structure Labeled L.	Application Has to apply knowledge on osmosis to get the correct explanation.
	(c) Name the process by which Mineral salts enter into the Plant.	Knowledge Recall of a specific fact.
	SECTION C	
20.	A culture of bacteria was incubated in nutrient agar at 35°C. Samples were taken at intervals in order to estimate the number of bacteria in the population. The data obtained	

	is shown in the graph. (a) When was the population of Bacteria at 750 million? (b) Account for the shape of The graph between A & B, and C and D. (c) Give three reasons for the Shape of the curve between D and E. (d) Suggest what would happen to the population of bacteria if the temperature was lowered to 0°C after incubating for 12 hours. (i) Give a reason for your answer. (e) Give 3 reasons why it is Important to control human Population growth in Kenya.	 Comprehension Ability for translate information. Comprehension Has to translate and interpret what is in the graph. Application Has to apply his knowledge on factors affecting population growth. Synthesis Has to think of division of bacteria in relation to temperature. Comprehension Has to understand to effect of temperatures on division Application Has to use his knowledge on effect of high population.
21.	Explain how the mammalian skin is adapted to perform its function.	Knowledge Recall of specific concepts Comprehension Relate structure of function Synthesis Put up pieces of information together.
22.	Describe how new plants arise by asexual reproduction.	Knowledge Recall of specific facts Comprehension An understanding of what asexual reproduction entails. Synthesis Put piece of information together.

PAPER 2 – PRACTICAL

No.	QUESTION	TYPE
1.	You are provided with a specimen labelled D which is part of a plant. (D Was a freshly picked sukuma wiki).	
	(i) Using external features only identify the part of the plant.	Analysis Involve in analysing the external features of the specimen.
	(ii) Give three reasons for your answer.	Application Has to apply his knowledge of leaf structure.
	(b) Peel off the epidermis from The lower surface of the Specimen. Mount a portion Of the epidermis in a drop of Water on a microscope slide. Stain with me thylene blue. Cover with cover slip. Observe the specimen under High power objective lens and Count the number of stomata in the field of view. Record the number of stomata for each field of view in the table.	Knowledge: Has to follow instruction. Comprehension has to follow procedure and record.
	(c) Repeat the procedure in (b) Above using peeling of Upper epidermis and record the number of stomata in the Table.	Knowledge Has to count directly and record.
	(d) Record the following from the microscope you used to count the stomata. (i) Magnification of eye piece lens (ii) Magnification of objective lens	Knowledge Has to get the information by looking at the eye piece lens and objective lens for magnification indicated.

	(iii) From the data in d(i) and d(ii) calculate the total Magnification. Show your working.	Comprehension Has to translate the information given in words to give answers in numbers.
	(e) Account for the average number of stomata on each side of the specimen.	Application Knowledge on Transpiration and gaseous exchange required.
2.	You are provided with a specimen labelled H which is a piece of a mammalian intestine. Squeeze the contents of the lumen into a test tube. Add 3 ml of water and shake the contents. Reserve the piece of intestine for questions (b).	
	(a) Use the reagents provided To test for the presence of Starch problems and Reducing sugar in the Contents.	Application Has to apply previous knowledge on what each reagent is used for before choosing the appropriate one for testing for each food substance. Comprehension Has to interpreted colours obtained and make conclusions as to whether the food-substance is present or not.
	(ii) Account for the results obtained in a (I) above.	Application Knowledge of the digestive process in the intestine is required.
	Cut the specimen H along its length and expose the inner surface.	
	b(i) Feel the inner and outer surfaces of the specimen. Record your observation.	Knowledge Record what is exactly felt.
	(iii) Account for your Observation of the inner surface.	Application Has to apply knowledge on digestion.
3.	You are provided with specimen labelled J.	
	(a) Using observable features	Analysis

	Only, identify the class to Which the specimen belong.	Has to recognize the features which place the organism in a particular class.
	(ii) List the observable features used to identify the class which the specimen belongs.	Knowledge Has to list down the features identified.
	(b) Stroke the specimen on the Lateral side from the head End to tail end. Repeat the Stroking from the tail end to Head end.	
	(i) Record your observation.	Knowledge Record what is felt.
	(ii) Observe the arrangement of scales, record your observation.	Knowledge What is directly observed.
	(iii) State the arrangement of scales, record your observation.	Application Requires knowledge on adaptation to habitat.
	(c) Cut and remove the operculum to expose gills. Remove one complete gill from the specimen and place it in a petri dish containing enough water to cover it.	
	(i) Examine the gill using a hand lens Draw and label.	Analysis Shall diagram the gill by indicating each part of it.
	(ii) How is the gill adapted to its function.	Comprehension Has to relate structure of each part of the gill to function.

APPENDIX D

QUESTION CLASSIFICATION FORM

Source: Kissock and Lyortsuun (1982: 133)

TOPIC _____

DURATION _____

CLASS _____

	L E V E L S					
QUESTIONS RECORDED	K	C	AP	AN	S	E
TOTAL						
PERCENTAGE						

KEY:
K - Knowledge
C - Comprehension
AP - Application
AN - Analysis
S - Synthesis
E - Evaluation.

APPENDIX E

A SAMPLE OF ORAL QUESTIONS ASKED

CLASS: **FORM 1**

TOPIC: **CELL SPECIALIZATION**

QUESTIONS RECORDED	COGNITIVE LEVELS: KNOWLEDGE	COMPREHENSION	APPLICATION	ANALYSIS	SYNTHESIS	EVALUATION
What are the requirements of photosynthesis?	✓					
When absorbs sunlight energy?	✓					
When plants have a lot of water, what happens to the stomata and why?		✓				
When plants have little water, what happens to the stomata and why?		✓				
What is cell specialization?		✓				
What is the function of mitochondria?	✓					
What is the function of gamete cells?	✓					

CLASS: FORM 2

TOPIC: DIGESTIVE SYSTEM

COGNITIVE LEVELS						
QUESTIONS RECORDED	**K**	**C**	**AP**	**AN**	**S**	**E**
What is the name given to the process of taking in food?	✓					
What is the shape of the stomach as seen in the diagram?	✓					
What does the gall bladder secrete?	✓					
What is the function of the bile salts?	✓					
What is emulsification?		✓				
What is the significance of emulsification?		✓				
What is the difference between ingestion, digestion and digestion?		✓				
Why isn't protein digested in the mouth?		✓				

CLASS: FORM 3

TOPIC: DIGESTIVE SYSTEM

COGNITIVE LEVELS						
QUESTIONS RECORDED	**K**	**C**	**AP**	**AN**	**S**	**E**
Which is higher – density of water or of salt?	✓					
Is Lake Victoria a fresh water lake?	✓					
When a plant tissue is placed in salty water, what happens?		✓				
Why is there more stomata on the upper side of the leaf?			✓			
What are the conditions of the habitat?	✓					
When the surrounding water has a lower concentration than the plant tissue, what happens?			✓			
What is endosmosis?	✓					

CLASS: FORM 4

TOPIC: DIGESTIVE SYSTEM

COGNITIVE LEVELS						
QUESTIONS RECORDED	**K**	**C**	**AP**	**AN**	**S**	**E**
What is the locomotory structure of cuglena?	✓					
How does paramecuim more?	✓					
Which kind of skeleton is found in vertebrates?	✓					
How is fish adapted to living in water?		✓				
Why is th body of fish referred to as streamlined?	✓					
Name the different types of fins?	✓					
Which are paired fins?	✓					
Which are unpaired fins?	✓					

APPENDIX F

A LETTER OF INTRODUCTION TO THE HEADTEACHER

Sarah A.O. Onduru
Kenyatta University,
P.O. Box 43844,
NAIROBI.

Date---------10·4·1999·

Dear Sir/Madam,

RE: RESEARCH INFORMATION

I am a master's student pursuing a course in Curriculum Development at Kenyatta University. I am conducting a research on the 'Cognitive Level of Classroom Instruction Questions in Biology'. I would be very grateful if you could allow me to carry out lesson observation in form 1-4 classrooms. The information gathered will be used for the purposes of this research only and will be treated with utmost confidentiality.

Thank you for your anticipated co-operation.

Yours faithfully,

SARAH ONDURU.