THE MEANINGS GHANAIAN JUNIOR SECONDARY SCHOOL STUDENTS GIVE TO SCIENCE CONCEPT-RELATED WORDS

A THESIS PRESENTED TO THE DEPARTMENT OF SCIENCE EDUCATION UNIVERSITY OF CAPE COAST IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER OF EDUCATION (M. Ed.) DEGREE

BY

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NOVEMBER, 1995

CANDIDATE'S DECLARATION

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this University or elsewhere.

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DEDICATION

This work is dedicated to my wife, Florence Datuma, and my children, Gandapaala, Mbamba and Suntuuro for sacrificing their comfort to enable me pursue the MASTER S programme in Science Education.

ACKNOWLEDGEMENT

I am most grateful to my supervisors, Professors Jophus Anamuah-Mensah and J. O. E. Otuka for their invaluable assistance I enjoyed throughout the research period. I am also grateful to them for reading through the scripts at the various stages of the work and for offering useful suggestions.

I am grateful to the Headmistresses/Headmasters, students and teachers of the Junior Secondary Schools in the Navrongo District of the Upper East Region selected for the study, for their invaluable assistance in the administration of the instrument without which the work would have been impossible.

The analysis of the data collected would not have been possible if not for Mr. Isaac Galyuon and Mr. Ghartey Ampiah who made available their time and expertise in data analysis. I am also specially grateful to Mr. Galyuon for drawing the graphs and his encouragement I enjoyed throughout the work.

I am also grateful to *CompuOffer* for typing and printing the manuscript.

There are others behind the scene who helped in diverse ways to enablı me successfully pursue the Master's programme. I am thankful to all these people. I take the responsibility for any errors in this work.

All to the glory of God.

TABLE OF CONTENTS

CONTENT	PAGE
Table of Content	iii
List of Tables	ix
List of Figures	xi
Abstract	xii
Chapter One	1
1.0 INTRODUCTION	1
1.1 Background of the Study	1
1.2 Statement of The Problem	2
1.3 Purpose of The Study	5
1.4 Hypotheses	6
1.5 Significance of The Study	7
1.6 Definition of Terms	9
Chapter Two	11
2.0 REVIEW OF LITERATURE	11
2.1 Introduction	11
2.2 The Effect of the Native Language of the Learner in Science Concept Formation	11
2.3 Problems Associated with Learning Science Through a Second Language	16

2.4 Context and Meaning of Everyday Words in Science Context 17
2.5 Summary and Conclusions 21
Chapter Three 23
3.0 METHODOLOGY 23
3.1 Population and Sample 23
3.2 Sample 24
3.3 Design of The Study 25
3.4 Instrumentation 25
3.5 Procedure 27
3.6 Pilot Study 28
3.7 Data Analysis 28
Chapter Four 30
4.0 INTRODUCTION 30
4.1 Preliminary Analysis of Data in Tests A and B 30
4.2.0 Testing of Hypotheses 40
4.2.1 Hypothesis I 41
4.2.2 Hypothesis II 44
4.2.3 Hypothesis III 45
4.2.4 Hypothesis IV 52
4.2.5 Hypothesis V 53
4.2.6 Hypothesis VI 55

4.2.7 Hypothesis VII 56

4.3 The Influence of Native Language on Students' Interpretation of Science Concept-Related Words In and Out of Science Context 57

Chapter Five 62

5.0 DISCUSSION OF RESULTS 62

5.1 Discussion and Implications for Science Concept Formation 62

Chapter Six 72

6.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS 72

6.1 Introduction 72

6.2 Sample, Instrument, Procedure 72

6.3 Data Analysis 73

6.4.0 Findings of the Study 76

6.4.1 Preliminary Analysis of Data of Test Scores of The Overall Sample In Tests A and B 76

6.4.2 The Students' Interpretation of Science Concept-Related Words in Science Language Context 77

6.4.3 The Influence of Native Language on Students' Interpretation of Science Concept-Related Words In and Out of Science Context 77

6.4.4 Statistical Analysis of Test Scores 78

6.5 Conclusions 81

6.6 Recommendations for Improvement of Students' Understanding of Science Concept-Related Words 83

6.7 Suggestions for Further Research 85

REFERENCES 87

APPENDICES 92

APPENDIX		PAGE
1	Test A	92
2	Test B	100
3.	List of Words Used in the Study	108
4.	Letter of Introduction	109
5.	Letter of Introduction	110
6.	Frequency Distribution of Students' Scores for Tests A and B	111
7.	Students' Percentage Interpretation of the Words used in the Study	112
8.	Interpretation of Science Concept-Related Words by JSS Students	113
9.	Frequency Distribution of Students' Scores in Tests A and B	114
10.	Frequency Distribution of Rural Junior Secondary School Students' Scores in Tests A and B	115
11.	Students' Correct Interpretation of Science Concept-Related Words (Rural JSS)	116
12.	Interpretation of Science Concept-Related Words by JSS Students	117
13.	Interpretation of Science Concept-Related Words by Rural JSS Students	118
14.	Frequency Distribution of Urban Junior Secondary School Students' Scores in Tests A and B	119

15. **Students' Correct Interpretation of Science Concept-Related Words (Urban JSS)** 120

16. **Students' Correct Interpretation of Science Concept-Related Words (Urban JSS)** 121

17. **Students' Correct Interpretation of Science Concept-Related Words (Urban JSS)** 122

LIST OF TABLES

TABLE		PAGE
1.	The Sample and its Characteristics	25
2.	Percentage Frequency of Students' Scores on Some of the Words Tested	33
3.	Frequency Distribution of Students' Correct Responses to Test Items of Tests A and B (Urban JSS)	35
4.	Frequency Distribution of Students' Correct Responses to Test Items of Tests A and B (Rural JSS)	36
5.	Interpretation by Students to Some of the Words Used in Science Context (Test B)	34
6.	Summary of the 2 x 2 x 3 ANOVA on the Scores of the Overall Samples on the Interpretation of Science Concept-Related Words Out of and In Science Context (Tests A and B respectively)	42
7.	Means, Standard Deviations of Test Scores of Categories of Students on Interpretation of Science Concept-Related Words Out of and In Science Context	44
8.	Differences Among The Means Of The Forms Of The Overall Samples For Tests A and B	46
9.	Differences Among The Means Of The Test Scores Of The Forms For The Urban Sub-Sample for the Tests A and B	48

10. Means, Standard Deviations of the Forms for the Rural and Urban Sub-Samples on Interpretations of Science Concept-Related Words In and Out of Science Context 49

11. Differences among the means of the gender groups of the Rural and Urban Sub-Samples for Tests A and B 53

12. Means, Standard Deviations of Test Scores of Gender Groups Of Rural and Urban Sub-Samples On Interpretation of Science Concept-Related Words In and Out of Science Context 55

13. Native Language Equivalent Words With/Without Similar English Meanings to the Words Tested and Words Tested Without Equivalent Words in Native Language of Students 58

LIST OF FIGURES

FIGURE		PAGE
1	Students' Correct Interpretation of Science Concept-Related Words	31
2.	Percentage Correct Interpretation of Science Concept-Related Words (Urban JSS Students)	37
3.	Percentage Correct Interpretation of Science Concept-Related Words (Rural JSS Students)	38
4.	The Educational Levels of the Students and the Interpretation of Science Concept-Related Words In and Out of Science Context	47
5.	Relationship Between Location of School and Educational Level of Student	50
6.	Relationship Between Gender and Location of School	54

ABSTRACT

This study investigated the meanings Ghanaian Junior Secondary School Students give to science concept-related words they encounter in science textbooks for Junior Secondary Schools. The study also tried to determine whether the location of the school, gender differences and the native language of the students, have any influence on their understanding of science concept-related words.

The study involved 1028 students (455 females and 573 males) from 12 (6 urban and 6 rural) out of 33 Junior Secondary Schools in Navrongo District in the Upper East Region of Ghana.

Two multiple choice tests (A and B), each containing 25 science concept-related words, were used for the study.

The data were analysed using descriptive and inferential statistical methods.

The findings of the study included the following:

1. The urban sample performed better on the interpretation of science concept-related words than the rural sample.

2. Gender differences in the interpretation of science concept-related words existed between the male and female students of the rural sample.

3. The absence or presence of concept words in the native language of the student, similar to science concept words influence the understanding of, and the meaning they give to science concept-related words.

The implications for science concept formation have been discussed and summarized.

Among the recommendations made to improve the students' understanding of science concept-related words were that, a study should be carried out to relate science words to words in the native language and the language environment of the rural Junior Secondary Schools should be enriched with additional reading materials and other instructional materials. These would enhance students' vocabulary, word association and comprehension of science text.

CHAPTER 1

1.0 INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Language is one of the various media through which every culture expresses its ideas or concepts about the natural environment. These concepts or ideas are expressions concerning natural phenomenon experienced or observed by the people of that culture. Also language is a vehicle for the expression of thoughts from which the concepts or ideas concerning the environment are formed by the individual. This is aptly put by Sutton (1992), that language in science is for 'creating and communicating ideas', while in teaching it is for 'recreating ideas'. However these functions of language can only be effective if common meanings are given to the words which describe the science concepts or are concept labels, encountered in the classroom during the teaching and learning process or read from science textbooks. This situation can be facilitated if the language of instruction is the first language or native language of the learner (Mori *et al*, 1974).

However, this is not the situation in Ghana. The native language (or vernacular) of the child is used as a medium of instruction only in the first three years of basic education after which English language becomes the only medium of instruction for the rest of the child's academic career. The student is expected to think and speak in English in order to find meaning to the concepts and to communicate this to others.

Since the English language has different cultural roots, with its different classificatory system, from that of the native language of the Ghanaian child, the latter is confronted with a situation where he/she has to give meaning to the science concepts or concept-related words from his or her own language perspective, that is, he/she will have to interpret them in relation to his or her language system. This situation is further compounded by the fact that most of the science concept words may not have one meaning. According to Sutton (1992) most science concept words have both peripheral and core meanings with a few of them having one precise meaning.

If equivalent words are not in the vocabulary of the native language of the child, then the child will learn the new concepts by rote (Yakubu, 1976).

There has been a dramatic growth of interest in aspect of language related to the teaching and learning of science and a number of studies have been conducted in the 70s and 80s (e.g. Evans, 1973; Collison, 1974; Bell, 1981; Ross and Sutton, 1982) on various topics in the Sciences, mostly at the secondary and tertiary levels. However, no research works (known to the researcher) have been carried out in Ghana to assess the role of language in science concept formation at the Junior Secondary School level.

The present research investigated the meanings given to science concept-related words by Junior Secondary School students.

1.2 STATEMENT OF THE PROBLEM

Science teaching in Ghana is done in a multilingual language environment which forms part of the tri-contextual milieu characteristic of the science classroom (Anamuah-Mensah and Akpan, 1992). The language in the classroom is characterized by the language of instruction, the language of the science textbooks and the language of the learner (Ogbu, 1992). The understanding of science concepts will, in most part, depend on whether the language of instruction is the native language of the learner and on the proficiency and standard of the learner in the foreign language (Ogbu, 1992; Barba, 1993) if the latter is the language of instruction. The words in the second language used during instruction and in the science texts may have different cultural roots from those of the native language. The learner will have to translate the words into his/her native language before he/she can discern the meaning of the words (Anamuah-Mensah and Akpan, 1992).

This situation is further compounded by the fact that some of the words in the second language are encountered in both everyday use of the language and in scientific language. The understanding of the word will depend on the learner's ability to detect the context in which the word is used (Sutton, 1992).

The ability of the learner to get the meaning from the context in which the word is used may be possible if the science text is based on the environment of the learner. However, content analysis of the textbooks for basic education in Ghana revealed that texts are abstract and not based on the Ghanaian environment (Kraft, 1994).

A comparative study involving two Ghanaian languages (Twi and Ga) and English language as media of instruction for concept formation revealed consistently that where English language was the language of instruction, the experimental groups were not able to exercise their full conceptual potential (Collison, 1974). This was attributed to poor development of the native languages in the pupils which led to poor English language development. The native language is used in Ghana only for the first three years of the child's basic school period.

The situation described above may further be deepened by the general environment in which the learner spends most of his/her time. Studies have shown, for instance, that students who live in an environment where chores, everyday household work, farm and school work are carried out manually achieve less well on high-order cognitive skills in science when compared with those students who live in predominantly automated environment (Okebukola and Jegede, 1990).

Okebukola and Jegede (1990) also cited literature which showed that rural dwellers held on more to magical and superstitious beliefs than to empirical reasoning which in turn hindered learning of science text.

Thus the urban and rural areas of Ghana may have an influence on the respective students in these areas in their interpretation of science concept-related words.

Studies reported on language ability and gender differences are inconclusive. However, some (e.g. Gleason, 1989) held the view that girls appear more fluent and automatic in performing various linguistic tasks while boys seem to be better in recognitive and expressive vocabulary.

Gage and Berliner (1984) reported that on measures of verbal fluency, girls usually did better than boys, but in verbal reasoning, verbal comprehension and vocabulary, consistent feminine superiority does not usually hold. In another study Dwyer (1973) concluded that the kid of impact society has on reading ability, a crucial scholastic behavior, may have an influence on gender differences. It was found out that among fourth and sixth grade pupils, while American girls were superior to American boys the reverse was true in Germany.

The use of second language as a medium of instruction and the native language of the learner may influence the students' understanding of science concept-related words. This may hinder or promote science concept acquisition. Other factors such as the location of the school (urban or rural environment), gender and level of education of the learner may also influence the learner's understanding of science concept-related words which may affect science concept formation or acquisition among Ghanaian Junior Secondary School students.

1.3 PURPOSE OF THE STUDY

The study investigated the meanings Junior Secondary School students give to science concept-related words found in their science textbooks and are in everyday use of the English language. The study was also to find out the effect of factors such as gender, native language of the student, and location of the school and the educational level of the student on the meanings the students give to the science concept-related words.

Specific Research Questions

Specifically, the study addressed the following research questions:

1. What are the meanings Junior Secondary School students give to science concept-related words they encounter in and out of science context?

2. Are there any significant differences in the meanings given to science concept-related words in and out of science context by Junior Secondary School students from rural and urban areas?

3. Do male students differ significantly from female students in their interpretations of science concept-related words in and out of science context?

4. Are there any significant differences in the meanings given to science concept-related words in and out of science context by male and female Junior Secondary School students from rural and urban areas respectively?

5. Do students in higher forms have a better interpretation of science concept-related words in and out of science context than students in lower forms of Junior Secondary Schools?

6. Does the local or native language of the student have any influence on the interpretation he/she gives to the words in and out of science context?

1.4 HYPOTHESES

The study addressed the following hypothesis:

1. The interpretations given to science concept-related words in and out of science context by students from rural Junior Secondary Schools are not significantly different from the interpretations given by students from urban Junior Secondary Schools.

2 The interpretations given to science concept-related words in and out of science context by female Junior Secondary School students are not significantly different from the interpretations given by male students in Junior Secondary Schools.

3. The interpretations given to science concept-related words in and out of science context by students in a higher form of a Junior Secondary School are not significantly different from the interpretations given by students in a lower form of a Junior Secondary School.

4. The interpretations given to science concept-related words in and out of science context by male students from urban Junior Secondary Schools are not significantly different from the interpretations given by male students from rural Junior Secondary Schools.

5. The interpretations given to science concept-related words in and out of science context by female students from urban Junior Secondary Schools are not significantly different from the interpretations given by females from rural Junior Secondary Schools.

6. The interpretations given to science concept-related words in and out of science context by female students from rural Junior Secondary Schools are not significantly different from the interpretations given by male students from the rural Junior Secondary Schools.

7. The interpretations given to science concept-related words in and out of science context by female students from urban Junior Secondary Schools are not significantly different from the interpretations given by male students from urban Junior Secondary Schools.

1.5 SIGNIFICANCE OF THE STUDY

Studies have shown that proficiency in English language (Barba, 1993) and the use of standard English (Ogbu, 1992) enhance the acquisition of science concepts. The same studies also revealed that multilingual/bilingual students lag behind their monolingual peers in science concepts acquisition when the language of instruction is not the native language of the learner.

It has also been found out that Ghanaian children do not exercise their full conceptual potential when English is used as the medium of instruction (Collison, 1994). Also the poor performance of Ghanaian students in subjects other than science is sometimes blamed on the poor standard of English language among students (WAEC Chief Examiner's Reports, 1993, 1994). However the formation of proper science concepts will depend on the understanding of science concept-related words when they are used in and out of science language context.

The study is likely to provide valuable information on Ghanaian Junior Secondary School Students' understanding of science concept-related words which they encounter in their science textbooks and during instruction. The study would also provide information on language problems students face in learning science concepts through a second language and the influence of the native language of the child on his/her comprehension of science concept-related words.

The findings would be of tremendous help to curriculum experts when they review or write science textbooks for Junior Secondary Schools. They would be mindful of the language problems the students face in understanding science concept-related words, so that the books produced will be appropriate for the language level of the students. This would facilitate the students' understanding of science concept-related words which would lead to proper science concept formation.

Science inspectors would find the results of the study valuable. They would be guided by the findings when they visit schools. They would be in the position to assist science teachers to ensure that the language used by the science teacher is understood by the students. The evaluation of the inputs and the instructional strategies of the science teacher by inspectors based on the findings would enable them to appropriately assist the science teachers in their teaching of science concepts. They would be able to advise on the language level to be used by the teacher that would promote proper concept formation.

The findings would provide information on the extent to which the absence or presence of equivalent words in the native language of the learner to science concepts affects his/her understanding of the latter. The science teacher would be guided to identify such equivalent words from the native language to explain the equivalent science concepts to be studied. This would promote proper science concept formation.

The tutors or science teacher educators of training colleges, diploma awarding institutions and other tertiary science teacher education institutions would find the results of the study useful in preparing preservice science teachers. During methodology classes, the students would be exposed to the language problems f their future students.

1.5 DEFINITION OF TERMS

Rural School: A school located in an area where majority of the adult population are predominantly farmers, often television sets, library or newspapers are hardly available.

Urban School: A school located in an area where majority of the adult population have received formal education, have library facilities, television sets and newspapers.

Cultural/action knowledge: Everyday knowledge of or experience the child uses to interpret the world around him/her.

Science Concepts: Ordered information about properties of one or more things - objects, events or processes - that enables any particular thing or classes of things to be differentiated from and also related to, other things or classes of things, e.g. conservation, absorption, animal, etc.

Science Concept-related words: Words used in Junior Secondary School science textbooks to describe or interpret scientific phenomena e.g. disperse, absorb, etc

CHAPTER 2

2.0 REVIEW OF LITERATURE

2.1 INTRODUCTION

The studies reviewed included research works carried out in the early 1970s to 1993. Works based on the general role of language in science teaching were reviewed first followed by studies on technical words in science and the studies on science words in everyday use and their influence on students' understanding of science concept words. Some of the science words in everyday use are either science concepts or concept-related words.

2.2 THE EFFECT OF THE NATIVE LANGUAGE OF THE LEARNER ON SCIENCE CONCEPT FORMATION

Various definitions are given to language by various authorities or authors. Wilkinson (1975) defined language as a system of symbols representing thought; while Alexander (1967) defined it as formalized and traditionalized set of spoken, written or gesticulated symbols and signs which serve to express and communicate feelings and thoughts. Kozulin (1990) stated that 'language serves a role of mental representation and communication of virtual situation'.

Thus, language is seen as a double system - a system of content or meaning and a system of expression or signs. Every culture has its unique language through which the individual's perceptions of the world are expressed in relation to the organizing patterns of the cultural language as stated by Alexander (1967).

Language determines out thinking and speakers of different languages may perceive the world differently based on the different patterns of the languages in organizing the world. Solomon

(1992) reported that in the 1940s, the linguists, Benjamin Whorf and Edward Sapir put forward a hypothesis which asserted that what we believe about the world around us - even what we perceive and experience - is actually dictated by the language that we have available to express it. Observers are not led by the same evidence to the same picture of the universe unless their linguistic backgrounds are the same.

The hypothesis was subjected to vigorous testing by socio-linguists and psychologists. They found evidence of the statement in their works except that some perceptions held by the individual could not be represented by words. Based on these pieces of evidence, Whorf (1956) formulated that it was not so much that we could not perceive states for which we did not have a word but that the words we have and use serve to direct us towards a particular point of view and way of thinking.

Language differences can therefore lead to learning problems in specialized areas such as science education. This is because the concepts used by one language to explain the environment or the world may differ from those in another language. Therefore in science education certain words needed to explain certain natural phenomena or to understand some science concepts may or may not be available when a native language is used as a medium of instruction. For example, a study was conducted by Yakubu (1976) to identify equivalent science concept words within the Kusaal language that are needed to understand such concepts as energy, temperature, time, speed and cell. The native language equivalent words for these words were absent.

Among the Kpelle of Liberia, Gay and Cole (1967) found that the Kpelle (culture) language had few geometrical concepts and that though they measure time and volume, their culture lacked measurements of weight, area, speed and temperature; hence the learning of these concepts may be hampered.

Mori and Kitagawa (1974) carried out a research to verify the fact that a child's judgement of duration remains undifferentiated from that of distance and is closely related to the linguistic factor. The study involved children from Thailand and Japan. In Japanese, temporal length and spatial length are both expressed by the same word.

In Thai, each word is expressed by a different word. Kindergarten children (105) between the ages of three and six years and elementary school children (106) between the ages of eight and twelve years were involved in the case of Thailand, while 60 kindergarten children of ages between five and six years and elementary school children (111) of ages between ten and eleven years were involved in the case of Japan.

Three experiments based on the method of Piaget and Cohen (1976) were provided for the study. The experiments involved two moving bodies - two model electric locomotives.

In the first experiment the locomotives started at the same time but at different velocities from the same starting line. They moved in the same direction on parallel lines. The faster locomotive stopped after 7 seconds and it covered a distance of 3.85 m. The slower one stopped after 9 seconds and it covered a distance of 1.7 m. The children were to determine which locomotive moved a longer time.

In the second experiment, the locomotives moved at different velocities from the same starting line and were stopped simultaneously. The children were to determine which locomotive travelled the longer distance.

In the third experiment, one locomotive moved on a straight track speeding up after a ring of a bell. It was then stopped after moving for the same duration as the first instance. The locomotive moved different distances for the same duration before and after the ring of the bell. The children were asked if the locomotive required more time before or after the ringing of the bell for the distance covered.

The Thai kindergarten children showed less tendency to judge the length of time by the length of distance than the Japanese kindergarten children.

The results showed that the effect of language cannot be disregarded in the development of spatio-temporal recognition and that a child's spatio-temporal recognition does not always depend on the development of logical thinking. The culture in which he lives also conditions the way he looks at the world.

In another study, Mori *et al* (1976) were to find out more on the role of language on children's framing of concepts, especially speed, by comparing Japanese and Thai children. Two experiments were used involving 63 Japanese children between the ages of four and five years and 29 Thai children between the ages of three and six years.

In the first experiment, two cars were moved by hands, concealed from the subjects, at different velocities. The first set out before the second car which was at a higher velocity. The first car reached the end shortly before the second car. Immediately after the visual display, the subjects were asked whether the two cars had run with equal speed or not.

In the second experiment, two iron balls were rolled down two slant slopes hidden from the subjects except the grooves in which the balls moved. The slants were adjusted so that one ball might move faster than the other along a longer groove when the balls were released simultaneously. The slower ball rolled with the same speed.

The results showed that Thai children were able to discriminate between the words *temporal precedence* and the word *speed*, which conceivably led them to obtain a more advanced concept of speed than the Japanese children at the same age. The Thai language accelerates the Thai children's acquisition of the concept speed, while the Japanese language affects the Japanese children's development of the concept. Therefore the native language can facilitate or limit the child's understanding of science concept words or concept-related words.

Collison (1974) carried out a comparative study to explore bilingual problems with Ghanaian children from a conceptual perspective. The study was to find out whether the native language of the Ghanaian child or English language (a second language) was a better medium of instruction for concept acquisition.

Two groups of Grade Six Twi and Ga speaking Ghanaian children were used in the study. The children carried out two experiments on floatation to find out why some objects sink and others do not sink. In one experiment the group were to use the native language as the medium of communication in explaining their findings. In the other experiment, they were to use English language as the medium of communication.

The study revealed consistently that where English was the language of communication, majority of the experimental subjects were not able to exercise their conceptual potential. The native languages were more fruitful media for enhancing the language-thought interaction than English. He concluded that the native language of the child is a factor and cannot be ignored in science concept formation. He recommended a long period of instruction of pupils in their native language at the basic education level for better conceptual development and development of thought processes for a better second language development. This is because a high linguistic and cognitive development in the child can lead to transfer of linguistic skills to a second language.

2.3 PROBLEMS ASSOCIATED WITH LEARNING SCIENCE THROUGH A SECOND LANGUAGE

A number of studies have been carried out to investigate the problems related to the learning of science in a second language.

Sanders and Nhlapo (1993) carried out a study to develop a diagnostic test which could be used to provide both pupils and teachers with feedback on problems the pupils might have with understanding the precise meanings of selected terms used in local ecology textbooks and to determine the extent or problems experienced by 10 year English first language and English second language speakers in understanding those terms after instruction.

Three categories of words which seem to pose difficulty were used, namely, technical terms, non-technical terms and paradoxical terms. *Technical terms* refer to the specialized term of a subject and *non-technical words* refer to words in everyday use of English language which are not specific to a subject. *Paradoxical words* are words with more than one meaning, one often being non-technical and the other technical.

The results of the study suggested that many pupils do not understand the precise meaning of various terms used in the Ecology section of their textbooks and that all the English second language pupils have more severe problems. It was also alarming to note that even some English first language scholars did not understand the precise meanings of many everyday English words used in their ecology lessons.

Solomon (1992) reported a number of cross-cultural education studies to test the effect of language on children's understanding of science. One such research was conducted by Ross and Sutton (1982). The research was undertaken with secondary school students in England and in the

Tiv-speaking region of Nigeria. The research examined the effect of mother-tongue and school language on the development of science concepts such as growth, heat, energy and electricity. The second method used was to collect the word associations of Tiv-pupils and English pupils educated in English and Tiv-pupils educated in Tiv. The results showed that most of the same associations were present for all the three groups of children but in different proportions. Both groups with Tiv as their mother-tongue gave similar numbers of the different associations.

2.4 CONTEXT AND MEANING OF EVERYDAY WORDS IN SCIENCE CONTEXT

Many of the difficulties experienced by youngsters in the science classes arise from both the technical terms or words and the non-technical terms or words used. The specialized vocabulary or technical language characteristic of some science subjects may cause an interference with learning.

The demands on students to communicate in the specialized language of the scientist may hinder their participation in the teaching and learning process as they may be unable to express their ideas in such a language (Bently and Watts, 1992). Everyday words or non-technical words or familiar phrases in ordinary language are given different meanings in science. Although the words are the same, their context changes and thus their meaning. If a listener or reader is not aware of this change in context, then it is to be expected that the words will be interpreted within the context of ordinary language rather than within that of science language (Munby, 1976). Also some technical words may be used in both technical and non-technical senses. The sense in which a term is understood is therefore determined by the context in which it is used (Evans, 1973).

A study was carried out by Veign *et al* (1989) to investigate the potential effect of the inevitable use of 'science' and 'everyday' language by both pupils and teachers in instruction. A sample of 30 Portuguese students from Grades 5 to 9 (10 - 15 years old) was used for the study. The focus of the experiment was to investigate how teachers' own perceptions may influence the development of pupils' ideas. The common factors in teachers' and pupils' conceptualization of heat, temperature and energy were identified. The results of the study re-emphasized the idea that it is impossible to keep external everyday informal culture out of the classroom.

A number of studies have been carried out on the effects of concept words in everyday use in science concept formation. Lynch (1978) carried out a study to examine the ability of high school pupils to recognize simple definitions of concept words associated with the theme, "nature of matter". Sixteen concept words were selected after examining general science textbooks of the last decade. A multiple-choice test was administered to students using the concept words (described as simple definitions). Pupils had difficulty with some of such words e.g. description of volume was associated with a set of other usages, for example, turning up the volume of radio. This is a reflection of the interference of everyday usage on the understanding of concept words in scientific sense.

A study conducted from 1974 to 1976 by the Science Education Center, Philippines, identified students' difficulties with non-technical vocabulary used in teaching of science and mathematics at high school level in the Philippines. Sixteen final tests, each of 50 items, were administered to over 40,000 first and fourth year students. The findings showed an enormous gap between the desired level and the actual level of comprehension.

Bell (1981) investigated the meaning children give to the term 'Animal'. The study involved 39 students of ages between 10 and 25 years. She used names of animals and objects and interviewed the students to find out the classification the children used. Thirty-five (35) of the students could not classify all the animal instances correctly. The conclusion drawn was that there appeared to be a common and a scientific meaning of the word 'animal' and the common meaning appeared to refer to the restricted 4-legged terrestrial animals. The difficulty of the science students may not necessarily lie with the complexity of the science meaning of the word 'animal' but with the confusion between its common and scientific meaning.

The non-equivalence between concept words used in textbooks and native language of the student can further hinder proper science concept formation in students. An ethnographic study was conducted by Tull (1991) with the goal of examining the botanical knowledge of sixth grade students.

The language, meaning, classification and interpretation of botanical concepts presented to students were compared with those found in elementary textbooks series.

The results showed that many of the science terms in the elementary science textbooks were either not used or were poorly understood by the students. The students did use folk botanical terms and categories that adult laymen would use. The students' explanation for abstract botanical phenomena were poor and somewhat idiosyncratic, based partly on folk cultural knowledge.

The understanding of concept-related words which would otherwise help students to understand or form the equivalent concept often times eludes them. They are not able to discern the contextual meaning of the word and they often get confused between the science meaning and its meaning in everyday use.

Boyes and Stanistreet (1990) carried out a study to find out how the understanding of the words *law* and *conservation* help students to understand the law of conservation of energy. A questionnaire was used to collect data, to investigate possible confusion due to the use of vocabulary and to investigate changes in understanding of the pupils in terms of age. 1130 pupils were involved in the study. A relatively low percentage of the pupils in the 11 or 12 year old group identified an acceptable meaning of the law of conservation of energy and one-third of 15 or 16 year olds were certain of the response; the highest percentage of all age groups related the idea that the law of conservation of energy is a statutory requirement to preserve the natural environment. This highlights the likely source of misconception which lies in the interchangeability of vocabulary between scientific and everyday domains which pupils experience. The erroneous interchageability of terminology by the pupils is probably caused by the inability to distinguish between the life world outside the school, and the 'symbolics' of science teaching. The multiple meanings of science words in everyday use have prompted Pella (1976), with obvious frustration, to write that '... the vocabulary in Science Education has been prostituted to the point where any one word regardless of context, represents as many concepts as people who use it'. In the same vein Jackson (1983) called for an urgent national need to improve upon instruction in science and mathematics at all levels of education in America by basing it on cultural literacy. Very little work has been done in Ghana to evolve cultural literacy as basis for instruction and there is a need for it. This cultural literacy should possess the basic information needed to thrive in the modern world and must be commonly shared throughout the society.

2.5 SUMMARY AND CONCLUSION

The literature reviewed emphasized the important role of language in science concept formation. Language, through communication, not only embodies the information that is transmitted to the student but furnishes him with the organizing patterns that permit him to remember the experiences, and the conceptual substance from which he can build new creations of thought, and the signals with which he can then direct himself. However, language can only facilitate the process of concept formation if only the language of instruction is the same as the native language of the learner. But where the native language is different from the language of instruction, a number of difficulties may be encountered during the learning process. Where equivalent words to the science concepts to be learnt exist in the language of the learner, the understanding of such concepts will be possible but where there are non-equivalent words to the concepts, the understanding of such concepts is likely to be hindered.

The role of everyday words and technical words found in everyday usage was evaluated. They seem to have dual meanings and their specific meanings can only be ascertained within the context in which they are used. Therefore failure to notice the context in which the word is used will lead to misinterpretation of the word. The literature indicated that students' understanding of the everyday words was not congruent with the scientific meaning when the words were used in science context (Munby, 1976; Lynch, 1978).

None of the research works which investigated the effect of second language on the understanding of science concept words by students considered the effects of factors such as the urban or rural setting of the schools from which the samples were taken, gender differences, etc., on the interpretations of the science concept words by the students.

The present study, apart from investigating the meanings Ghanaian Junior Secondary School students give to some concept-related words, also investigated whether significant difference exists in the meanings of concept-related words between students from urban Junior Secondary Schools and students from rural Junior Secondary Schools from within the same cultural background. The study also investigated whether the meanings students give to science concept words are gender-related.

The implications of the interpretation by students of the concept-related words for science teaching in Junior Secondary Schools were considered in the study.

CHAPTER 3

3.0 METHODOLOGY

3.1 POPULATION AND SAMPLE

The population was all the Junior Secondary School students in the Upper East Region. Time constraints and logistic problems, influenced the limitation of the study to Junior Secondary School students in Navrongo District.

There are thirty-three Junior Secondary Schools (JSS) in the Navrongo District and all are mixed schools with a higher population of males than females. The students were between the ages of eleven to nineteen years. The JSS One students were between the ages of 11 years and 13 years with a mean age of 12 years (standard deviation = 1.9).

The JSS Two students were between the ages of 12 years and 16 years with a mean age of 14 years (standard deviation = 1.6). The JSS Three students were between the ages of 13 years and 19 years with a mean age of 15.5 years (standard deviation = 1.6).

The population is heterogeneous in terms of the native language spoken in the District. Three principal native languages are spoken namely: Nankani, Kassem and Buli. However, Kassem is the predominant native language and it is the official native language used in the schools.

Majority of the students come from the rural areas where agricultural activities are the predominant occupation of the people. Most parents of the students from the urban centre are in government employment while the rest are engaged in small scale businesses. The urban population has a higher literacy rate than the rural population since 39% of 53.2% of the Ghanaian adult literate population live in the urban areas (World Bank Report, 1993). Literacy rate here refers to the number of people who have formal education and who have attained a level of literacy in the English language.

3.2 SAMPLE

The thirty-three Junior Secondary Schools were classified as either rural or urban based on the following criteria:

i) Nearness of the school to a library;

ii) Availability of television sets within the locality in which the school is situated;

iii) The predominant occupation of the adult population of the area in which the school is located (e.g. predominantly farming community was classified as rural and schools near to a library, and located in areas where there was easy access to television sets were classified as urban).

Stratified random sampling was used to select the schools for the study. Six Junior Secondary Schools, from each cluster of schools (rural and urban), were randomly selected by lottery method with replacement. Aa total of twelve Junior Secondary Schools were used for the study. Whole classes were used for the study. Though this might have introduced threats to internal validity of the study it was to ensure that classes were not unduly disturbed it sampling of students was to be random. Where there was more than one class in the form, one of the classes was randomly selected for the study by simple balloting. This was to eliminate researcher's bias in selecting the sample class.

The sample size was 1028 students; 409 students samples from six rural schools and 619 students from six urban schools. Further break down of the sample is shown in the table on the next page.

TABLE 1

The Sample And Its Characteristics

Characteristics	Urban Schools	Rural Schools	Total
Total No. of Students	619	409	1,028
No. of Males	326	247	573
No. of Females	293	162	455
No. of Students in Form 1	222	181	403
No. of Students in Form 2	215	117	332
No. of Students in Form 3	182	111	293

3.3 DESIGN OF THE STUDY

Ex post facto design was used in the study. Though Ex post facto design has certain weaknesses as a research tool, which include lack of control of the variables and lack of randomization, it was found appropriate for the study. This was because the researcher had no control over the independent variables of the study, which included gender, the background of the students, including their native language and the locations of the schools being attended. The dependent variable was the interpretation the students give to science concept-related words found in the Junior Secondary School science textbooks.

3.4 INSTRUMENTATION

Two multiple-choice tests (A and B), (see Appendix 1 and 2), involving twenty-five science concept-related words were administered in the study. The words used in the study are found across the science textbooks for the three forms of the Junior Secondary School. The words were also encountered by the students in primary five and six; they also occur in daily usage of English language, and in newspapers, radio and television broadcasts.

In both tests, the student was to select the word underlined in the test item and to indicate the correct option by means of a tick in the box against the corresponding letter to the option selected. For example;

Conserve can mean

- ❑ A Save
- ❑ B Use quickly
- ❑ C Purify
- ❑ D Destroy

In test A, the students were expected to give the meaning of the words as they have come to understand them without putting them in any context while in test B they were expected to give the meaning of the words in the scientific context in which they have been used.

The instrument (words in science) obtained by the kind permission of Mr. Peter Towse of the Centre for Studies in Science and Mathematics Education, University of Leeds, was adapted for the study. Very few changes were made on the original instrument. Such changes included replacing names unfamiliar to the Ghanaian child and names of months to suit the rainfall pattern of Ghana.

The content validity of the instrument was determined by three senior science educators in the University of Cape Coast and they found the instrument appropriate for application in Ghana. They individually confirmed that words used are among the words in common usage in the science textbooks used at the three levels of Junior Secondary School.

3.5 PROCEDURE

The tests were administered by the researcher six weeks after the schools had re-opened for the first term of the 1994/95 academic year by which time the school programme was in progress. This was favourable for the administration of the tests as the students, especially those in Junior Secondary School Form One, had covered most of the words in the classroom.

Written permission was sought from the District office. Copies of the letters are enclosed as appendices 3 and 4.

Two visits were made to the selected schools. The first visit was used to familiarize with the school. The second visit made to the schools was used by the researcher to establish rapport with the subjects of the study to facilitate the administration of the tests. The tests were also administered on the second visit.

The modalities involved in the tests were explained to the students and questions raised by the students appropriately answered. They were informed that the results of the tests would have no effect on their class mark. This was to create a relaxed atmosphere and to forestall any malpractices that could have invalidated the results.

The tests were administered by the researcher and the scripts collected immediately the students completed the tests. Each student was given sufficient time to complete the instrument and the scripts were collected only when the student indicated he/she had completed the test.

Test A was administered first followed immediately by test B after the former was collected. This was to prevent any extraneous factors from influencing the responses to the second text if time was allowed between the tests.

Also the tests were administered to the forms during class hours to eliminate possible contacts between the students of different forms. Since contacts could lead to discussions on the test items among students which could invalidate the results of consequent administration of the tests in the same school. The equivalent words in the native language of the students to some of the words used in the tests were obtained from the Ghanaian language teachers in the schools visited.

3.6 PILOT STUDY

A pilot study was carried out with a group of students not involved in the actual study but of similar characteristics to the sample used in the study. This was to determine the reliability of the instrument. It was also to find out whether the instrument was suitable for the sample used for the study.

The Kuder-Richardson formula 21 (Gronlund, 1971; Slavin, 1984) was used to establish the internal consistency of the instrument. The reliability coefficient was found to be 0.75.

The respondents did not encounter any problems in responding to the items in the tests. No other changes were made on the instrument apart from those mentioned under section 3.4.

3.7 DATA ANALYSIS

Both descriptive and inferential statistical analysis were used on the data collected in the study.

A point was awarded to a correct response. An individual's total scores in both tests were recorded separately. The mean scores of each form, and the gender groups were calculated. Also the means of the total scores of the sets of schools (urban and rural schools) were calculated. The means were used for further statistical analysis.

The percentage score on each test item was determined and this was used to find out which word(s) posed difficulties to students when used in and out of science language context.

The frequency distribution of the scores for each test was presented as tables and histograms. These were used to compare the general performance of the students on the basis of gender, and the location of the school (urban and rural).

ANOVA and/or t-test were used to test for any significant differences between the mean scores of the sets of schools, and the mean scores of female and male students, in order to test the respective hypotheses stated in section 1.4. The level of significance used in testing the significant differences between the means was 0.05.

CHAPTER 4

RESULTS

4.0 INTRODUCTION

In this chapter the results and interpretation of the analysis conducted to answer the research questions and to test the hypotheses are presented.

4.1 Preliminary Analysis of Data in Tests A and B

The reliability coefficient calculated using Kuder-Richardson formula 21was found to be 0.75.

The frequency distribution of students' scores on tests A and B are presented in Appendices 6, 8, 9 and Figure 1.

The performance of the students in both tests was very poor. Only 10.8% and 14.7% of the total number of students (1028) obtained scores of 12 plus, out of 25 in tests A and B respectively. The range of scores for each test was: Test A: 0 - 20; Test B: 1 - 23. The poor performance could be due to poor standard of English language among students. The multilingual learning environment of the Ghanaian child (Anamuah-Mensah and Akpan, 1992) and the unfamiliar content of the textbooks used in Ghana (Kraft, 1994) may affect the expected level of proficiency in English needed by the students to understand the words.

The male students seemed to have performed better in the tests than their female counterparts. 12.7% and 16.1% of the males (573) obtained scores 12 plus in tests A and B respectively, while 8.4% and 12.9% of the females (455) obtained similar scores in tests A and B

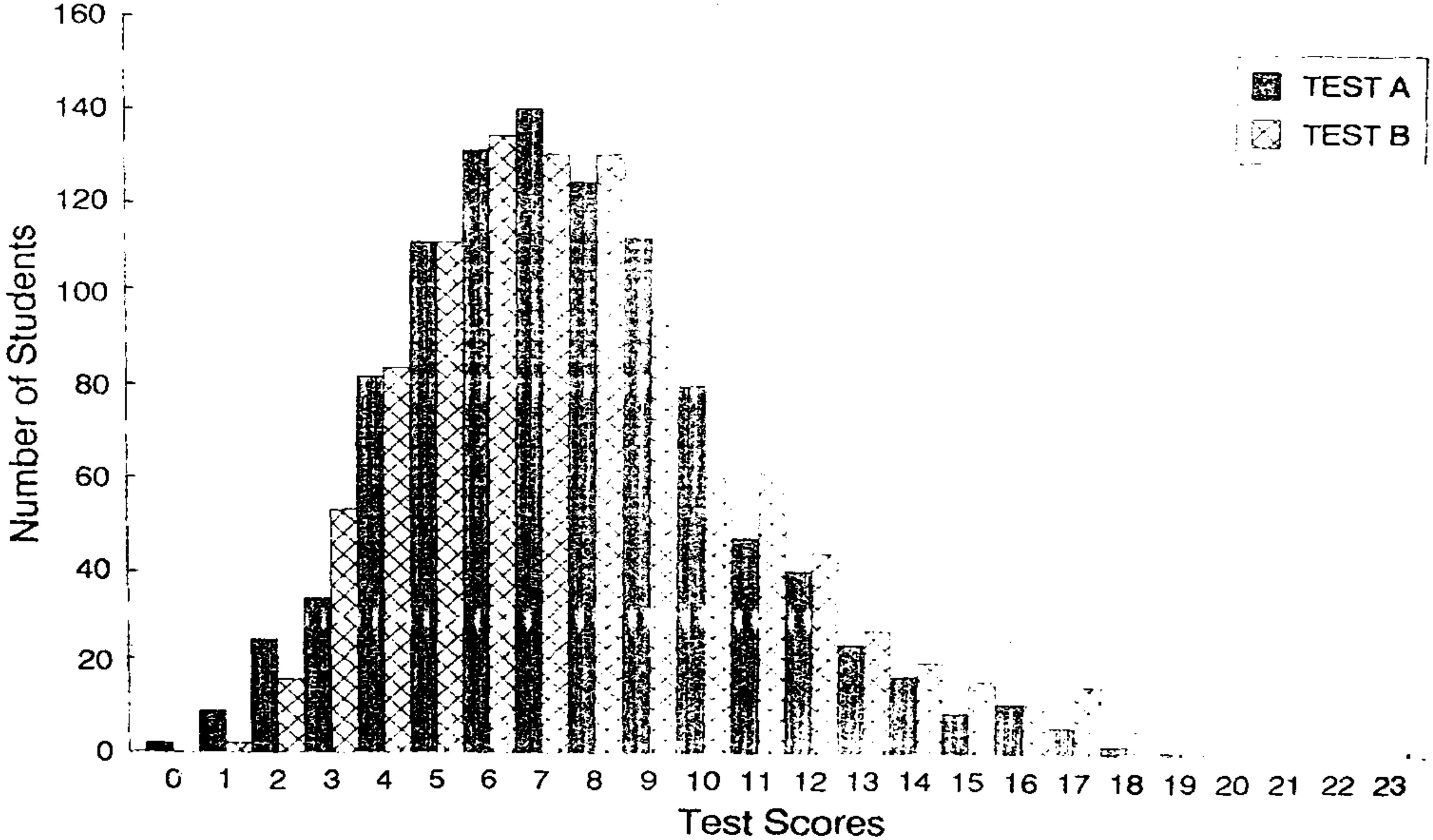

Figure 1. Students Correct Interpretations of Science Concept-related Words

respectively. However both gender groups seemed to have performed better in test B than in test A (see Appendix 8).

The improvement of the test scores in test B over those of test A may be due to the context based nature of test B which made the meanings of the words clearer. This agrees with the findings of Sutton (1992) that the context in which a word is used enriches the word meaning. This is because the context restricts the meaning of the word since a word may have several meanings (Vygotsky, 1986).

The performance of the overall sample on the word items was generally poor. The percentage scores for fourteen word items were below an overall average percentage frequency score of 29.9% in test A. In test B, the percentage scores of thirteen word items were below an overall average percentage frequency score of 31.6% (see Appendix 7). The result indicates that students have poor understanding of science concept-related words and hence poor interpretation of the science concept-related words when used in and out of science context.

Some of the words were found difficult by the students. The percentage scores on items involving these words were below the average percentage frequency of students' scores (29.9% and 31.6% for tests A and B respectively). The words and their corresponding percentage frequencies of students' scores are given in Table 2.

The possible causes may be poor vocabulary or poor word association among the students with regard to test A and coupled with the inability of the students to get the contextual meaning of the words when used in science language context as in test B.

Other words with percentage frequencies above the overall average percentage frequency of students' scores (29.9%) in test A registered lower values in test B in which the students recorded an overall percentage frequency of 31.6% (see Appendix 7).

TABLE 2

Percentage Frequency Of Students' Scores On Some Of The Words Tested.

Word Tested	% Frequency	
	Test A	Test B
Estimate	20.8	26.3
Convert	24.9	28.5
Rate	20.3	28.1
Surround	26.5	24
Dehydrate	19.4	24.2
Proportion	19.2	26.8
Effect	16.6	25.8

These words include:

Prepare : 51.9% in test A and 29.9% in test B;

Device : 34.8% in test A and 22.3% in test B;

Independent : 58.0% in test A and 27.7% in test B.

This inconsistency may be due to the inability of the students to get t' e meaning of the words in science language context. This supports the findings that the inability to detect the context in which the word is used may lead to poor understanding of the word (Evans, 1973; Munby, 1976; Lynch, 1978; Boyes and Stanistreet, 1990). Thus the students might have interpreted the words based on their everyday usage.

There were few words in which the students obtained scores above the average percentage frequency scores in both tests (see Appendix 7). these words include conserve, system, source, displace, separate and average. These words may be frequently encountered by the student in both everyday use of English language and in scientific texts.

The sub-sample from the urban area seemed to have performed better than their rural counterparts (see Appendix 10). More than 30% of the urban sub-sample (619) responded correctly to 11 and 4 items in tests A and B respectively, whereas a similar proportion of the rural sub-sample (409) responded correctly to 9 and 12 items in tests A and B respectively (see Tables 3 and 4; Figures 2 and 3). However both groups seemed to perform better in test B than in test A (see Figures 2 and 3, and Appendix 10). The general trend (for the overall sample and the sub-samples) was an increase in the number of correct responses to corresponding items in test B. However this trend was inconsistent as some students obtained high scores on some items in test A and registered low scores on corresponding items in test B (e.g. items 3, 11, 12, 20 and 24; see Appendix 3 for words).

Below are some examples of the interpretations students gave to some of the words in test B.

TABLE 5

Interpretations By Students To Some Of The Words Used In Science Context. (Test B)

Word Tested	Non-Science Meaning of the Word
Disperse	Burst
Displace	... the stone gets bigger as it is lowered into the water in the beaker; ... the stone reacts with the water.
Conserve	... to make the water pure for drinking; ... to keep it and not to use it.
Dehydrate	... the child has a right amount of water in the body.
Absorb	... the soil mixes with the water; ... the soil does not mix with the water.

TABLE 3

Frequency Distribution Of Students' Correct Responses To Test Items Of Tests A and B

(Urban JSS)

TEST A			TEST B		
TEST ITEM	NO. OF STUDENTS	% FREQUENCY	TEST ITEM	NO. OF STUDENTS	% FREQUENCY
1	207	33.4	1	213	34.4
2	169	27.3	2	277	44.7
3	251	40.5	3	215	84.7
4	241	38.9	4	232	37.5
5	198	32	5	207	33.4
6	103	16.6	6	167	27
7	251	40.5	7	258	41.7
8	130	21	8	163	26.3
9	153	24.7	9	173	27.9
10	119	19.2	10	184	29.7
11	216	34.9	11	203	32.8
12	347	56.1	12	197	31.8
13	305	49.3	13	220	35.5
14	180	29.1	14	135	21.8
15	125	20.2	15	154	24.9
16	160	25	16	248	40.1
17	128	20.7	17	178	28.8
18	221	35.7	18	250	40.4
19	137	22.1	19	251	40.5
20	229	37	20	143	23.1
21	136	22	21	236	38.1
22	108	17.4	22	230	37.2
23	380	61.4	23	171	27.6
24	18	19.2	24	177	28.6
25	124	20	25	119	19.2

TABLE 4

Frequency Distribution Of Students' Responses To Test Items Of Tests A And B (Rural JSS)

TEST A			TEST B		
TEST ITEM	NO. OF STUDENTS	% FREQUENCY	TEST ITEM	NO. OF STUDENTS	% FREQUENCY
1	98	24	1	108	26.4
2	97	23.7	2	155	37.9
3	171	41.8	3	124	30.3
4	131	32	4	136	33.3
5	112	27.4	5	131	32
6	68	16.6	6	98	24
7	160	39.1	7	161	39.4
8	84	20.5	8	107	26.2
9	103	25.2	9	120	29.3
10	90	22	10	105	25.7
11	156	38.1	11	132	32.3
12	187	45.3	12	110	26.9
13	180	44	13	146	35.7
14	92	22.5	14	112	27.4
15	74	18.1	15	95	23.2
16	96	23.5	16	134	32.8
17	69	16.9	17	98	24
18	132	32.3	18	149	36.4
19	85	20.8	19	183	44.7
20	129	31.5	20	86	21
21	94	23	21	166	40.6
22	78	19.1	22	150	36.7
23	216	52.8	23	114	27.9
24	106	25.9	34	101	24.7
25	81	19.8	25	100	24.4

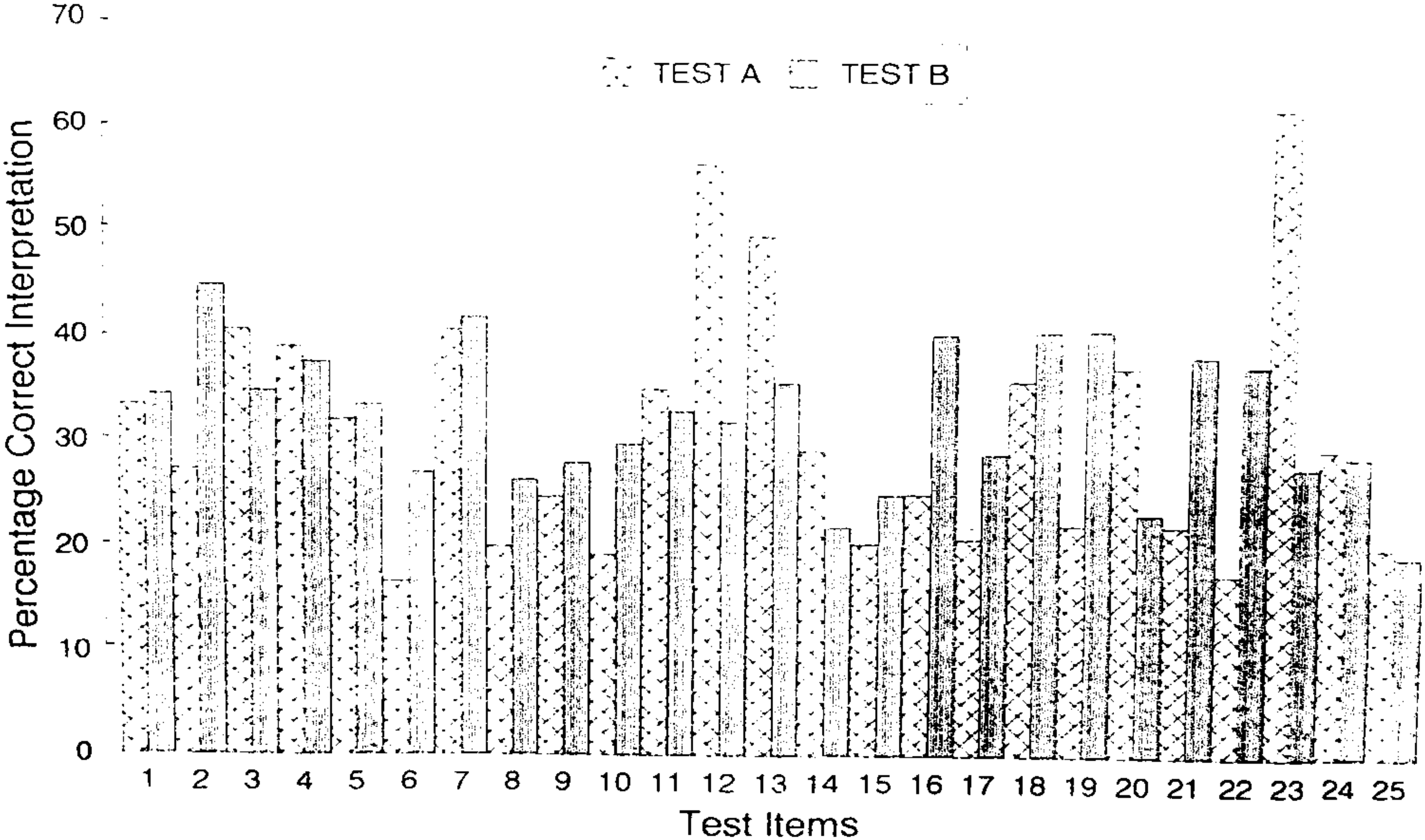

Figure 2. Percentage Correct Interpretation of Science Concept-related Words (Urban JSS Students)

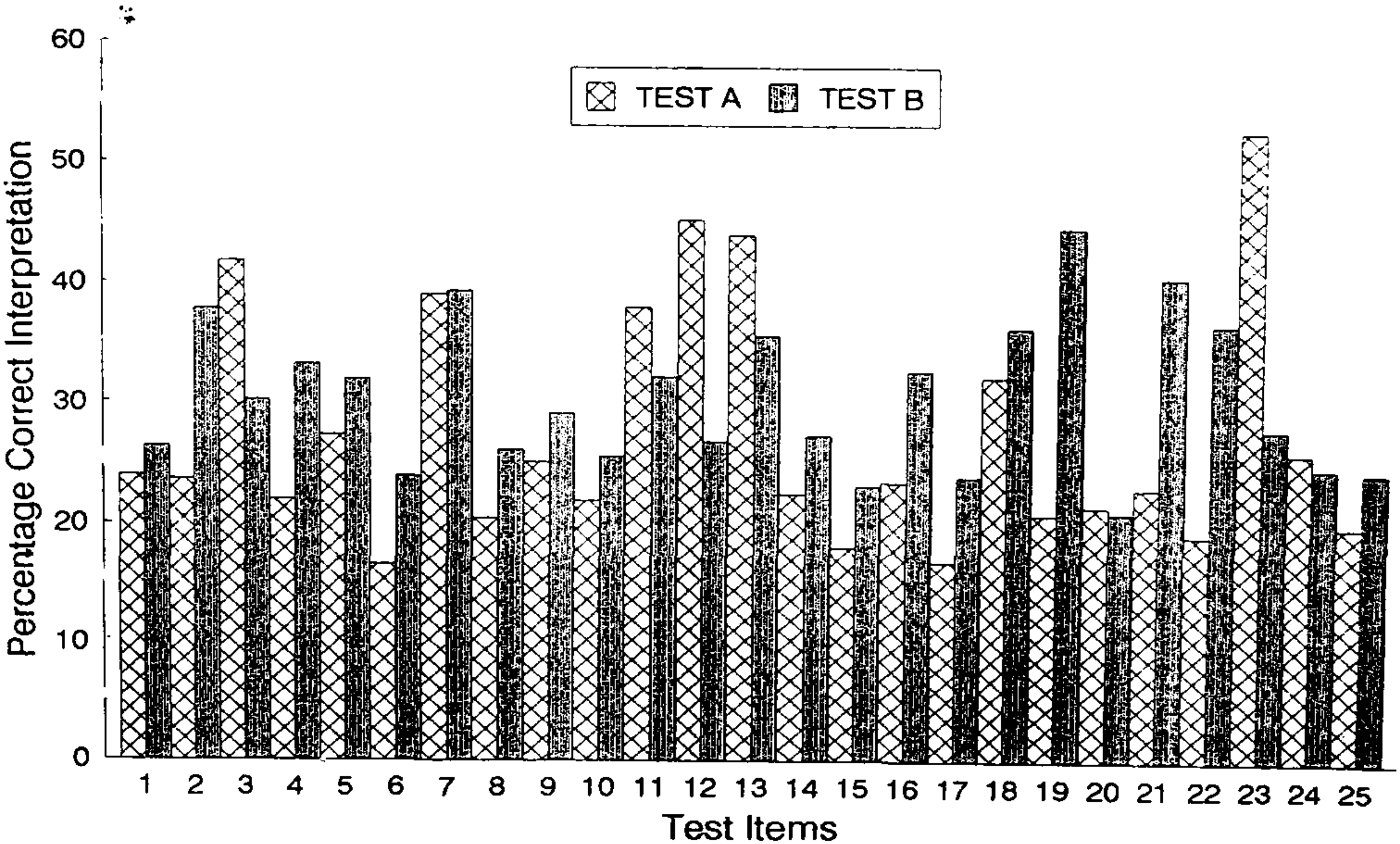

Figure 3. Percentage Correct Interpretation of Science Concept-related Words (Rural JSS Students)

The generally poor vocabulary and comprehension of the students may account for some of these interpretations given to some of the words, e.g. dehydrate.

The results of the rural sub-sample (247 male and 162 female students) are represented in Appendices 10, 11 and 12. Generally the students seemed to perform better in test B than in test A. 9.3% of the students obtained scores between 12 and 20 out of 25 in test A while 10.02% of the students obtained scores between the same range in test B.

The results of the female and male students in tests A and B are presented as histograms (Appendix 13), 18.0% of the male students (247) obtained scores between 10 and 18 out of 25 in test A while 29.6% of the females obtained similar scores out of 25.

The mean scores for the male students were 7.69 and 8.07 in tests A and B respectively while the mean scores for the female students were 6.05 and 6.90 for tests A and B respectively. However, the standard deviations for the female scores were less than those of their male counterparts. The standard deviations for the test scores of the females were 2.48 and 2.64 for test A and B respectively; that for the males, were 3.36 and 3.78 for tests A and B respectively. Therefore the dispersion of the scores from the mean scores was less for the females than for the males.

The results of the urban sub-sample are represented in Appendices 12, 14 and 15. About 23% of the sub-sample (619) obtained scores greater than 10 out of 25 in test B while 17.3% obtained similar scores out of 25 in test A. Thus the urban sub-sample seemed to have performed better in test B than in test A.

The results of the male (326) and female (293) students are presented as histograms (Appendices 16 and 17). The male students seemed to have performed better than the female students in test A (Appendix 16). 27.7% of the males (326) obtained scores between 10 and 19 out of 25 while 22.4% of the female students (293) obtained scores between 10 and 18 out of 25 (see Appendix 14). The mean scores for the gender groups were 8.02 for the males and 7.55 for the females.

The female students seemed to have performed better in test B than the male students. The former obtained a mean score of 8.29 while the latter obtained a mean score of 7.99. Also 28.8% of the females obtained scores between 10 and 21 while 26.3% of the males obtained scores between 10 and 23.

The standard deviations for the females were 3.60 and 3.37 for tests A and B respectively, and those for the males were 3.69 and 3.70 for tests A and B respectively. Therefore the dispersion of the scores from the mean scores was less for the females than the males.

4.2.0 Testing of Hypotheses

The factors involved in this study are gender, location of school (urban or rural) and the forms or educational levels of the students. A 2 x 2 x 3 ANOVA was used to carry out analysis on the data collected in the study for tests A and B to test the hypotheses stated in section 1.4.

The analysis yielded significant main effects on all independent variables (Gender, school/location and form) with test A and on two independent variables (school location and form) with test B (see Table 6). Also there were significant effects from all two-way interactions between the variables in tests A and B except in test A where there was no significant effect from the interaction between gender and form. The results of the interaction among the independent variables and the results of the pairwise comparison analysis using least significant difference, were used to test hypotheses IV, V, VI and VII on the various categories of the overall sample.

4.2.1 Hypothesis I

The interpretations given to science concept-related words in and out of science context by students from rural Junior Secondary Schools are not significantly different from the interpretations given by students from urban Junior Secondary Schools.

The results of 2 x 2 x 3 ANOVA (Table 6) showed significant differences (test A:[$F(1,1027) = 15.09$, $p<0.05$; test B:[$F(1,1027) = 4.8$, $p<0.05$) between the total mean scores of students from Junior Secondary Schools in rural and urban areas. The students from Junior Secondary Schools in urban areas did better in both tests (A: mean = 7.80, B: mean = 8.14) than their counterparts in rural areas (A: mean = 7.04, B: mean = 7.61) (see Table 7). Therefore students from Junior Secondary Schools in urban areas have better understanding of science concept-related words when used out of and in science context than those from rural areas. The urban areas may have a better or richer language environment than the rural areas. The factors such as exposure to mass media, e.g. newsprint, television and radio broadcasts, library facility, literate parents and educated homes, avenues for social interaction with peers and adults (Lizdzey *et al*, 1975; Allen *et al*, 1986) more prevalent in the urban areas, may contribute to the understanding of the words. These factors are limited or absent in the rural areas.

TABLE 6

Summary of the 2 x 2 x 3 ANOVA on the scores of the overall sample's interpretation of science concept-related words in and out of science context (tests A and B respectively)

Test A

Source	SS	df	ms	f
Main Effects				
Gender	199.28	1	199.28	21.51*
School/location	139.82	1	139.82	15.09*
Form	367.25	2	187.63	19.82*
2-way Interaction				
Gender x School	80.91	1	80.91	8.73*
Gender x Form	20.68	2	10.34	1.116 (ns)
Form x School	84.51	2	42.25	4.56*
3-way Interaction				
Gender x School x Form	3.77	2	1.88	0.2 (ns)
Error	9,412.66	1,016	9.26	-
Total	10,334.98	1,027	10.06	-

$p<0.05$

Table 6 (continued)

Test B

Source	SS	df	ms	f
Main Effects				
Gender	12.14	1	12.14	1.050 (ns)
School/location	55.48	1	55.48	4.8*
Form	782.37	2	391.19	33.82*
2-way Interaction				
Gender x School	130.37	1	130.37	11.27*
Gender x Form	84.96	2	42.48	3.67*
School x Form	108.41	2	54.28	4.69*
3-way Interaction				
Gender x School x Form	24.48	2	12.24	1.058 (ns)
Error	11,750.22	1,016	11.57	-
Total	12,964.38	1,027	12.62	-

$p<0.05$

TABLE 7

Means, Standard Deviations of Test Scores of Categories of Students on Interpretations of Science Concept-related Words Out of and In Science Context

		TEST A		TEST B	
Categories	**N**	**Mean**	**SD**	**Mean**	**SD**
1. Overall Sample					
Urban Sub-sample	619	7.8	3.16	8.14	3.36
Rural Sub-sample	409	7.08	3.14	7.61	3.41
2. Gender					
Male Students	573	7.84	3.21	8.03	3.71
Female Students	455	7.01	3.03	7.78	3.22
Form 1	403	6.85	2.95	7.21	2.76
Form 2	332	7.48	2.94	7.58	3.38
Form 3	293	8.4	3.49	9.31	4.26

4.2.2 Hypothesis II

The interpretations given to science concept-related words in and out of science context by female Junior Secondary School students are not significantly different from the interpretations given by male students in Junior Secondary Schools.

There was significant difference (test A: $F[1,1027) = 21.51$, $p < 0.05$) between the total mean scores of the female students and the male students in test A but there was no significant difference (test B: $F[1,1027) = 1.05$, $p > 0.05$) between the total mean scores of the gender groups on test B (see table 6). The male students did better in test A (mean = 7.84) than the female students (mean = 7.01) (see Table 7). This suggests that the male students seem to have a better understanding of science concept-related words out of science context than female students. Thus the understanding of science concept-related words out of science context, may be gender related. The findings are in conformity with the research findings reported by Gleason (1989) that boys seem to be better in recognitive and expressive vocabulary than girls. The students need to have a good word association or good vocabulary to be able to respond correctly to the items in test A.

The gender groups have comparable comprehension of science concept-related words when used in science context since there was no significant difference between their mean scores in test B in which the words were used in science context. Though the total mean score of the male students (mean = 8.03) was slightly higher than that of the female students (mean = 7.78), the statistical test indicates that any difference between the means was by chance. Males and females may have comparative competence in other linguistic tasks rather than on recognitive and expressive vocabulary.

4.2.3 Hypothesis III

The interpretations given to science concept-related words in and out of science context by students in a higher form of a Junior Secondary School are not significantly different from the interpretations given by students in a lower form of a Junior Secondary School.

The analysis of the data obtained for the different forms (educational levels) showed significant differences (test A: $F[1,1027) = 19.82$, $p<0.05$; test B: $F[1,1027) = 33.82$, $p<0.05$) among the mean scores (see Table 6).

Students of the higher forms perform better than those in the lower forms (test A: F1 mean = 6.85, F2: mean = 7.48, F3 mean = 8.40; test B: F1 mean = 7.21, F2 mean = 7.58, F3 mean = 9.31 (see Table 7). There was a progressive increase in the mean scores from the lower forms to the higher forms. This trend may be due to the fact that students in the higher forms have been exposed to more instruction in English language than students in lower forms. This may lead to an increase in their word vocabulary and word association. Exposure to more scientific texts as the students advance through the educational levels of Junior Secondary School might have improved their understanding of science concept-related words when used in science context. Also the forms two and three students may have encountered the words more often than the form one students in everyday use of English language and in science texts.

A pairwise comparison analysis between the means was carried out using Least Significant Difference formula. The results indicated that forms two and three students performed significantly better than the form one students in both tests since the differences between the respective means were more than the calculated value from the pairwise comparison analysis. The Form three students performed better than the form two students in both tests (see Table 8 and Figure 4).

TABLE 8

Differences Among the Means of the Forms of the Overall Sample for tests A and B

	Test A			Test B		
Form	**1**	**2**	**3**	**1**	**2**	**3**
1	0	0.386*	0.396*	0	0.503*	0.515*
2	-	0	0.417*	-	0	0.543*
3	-	-	0	-	-	0

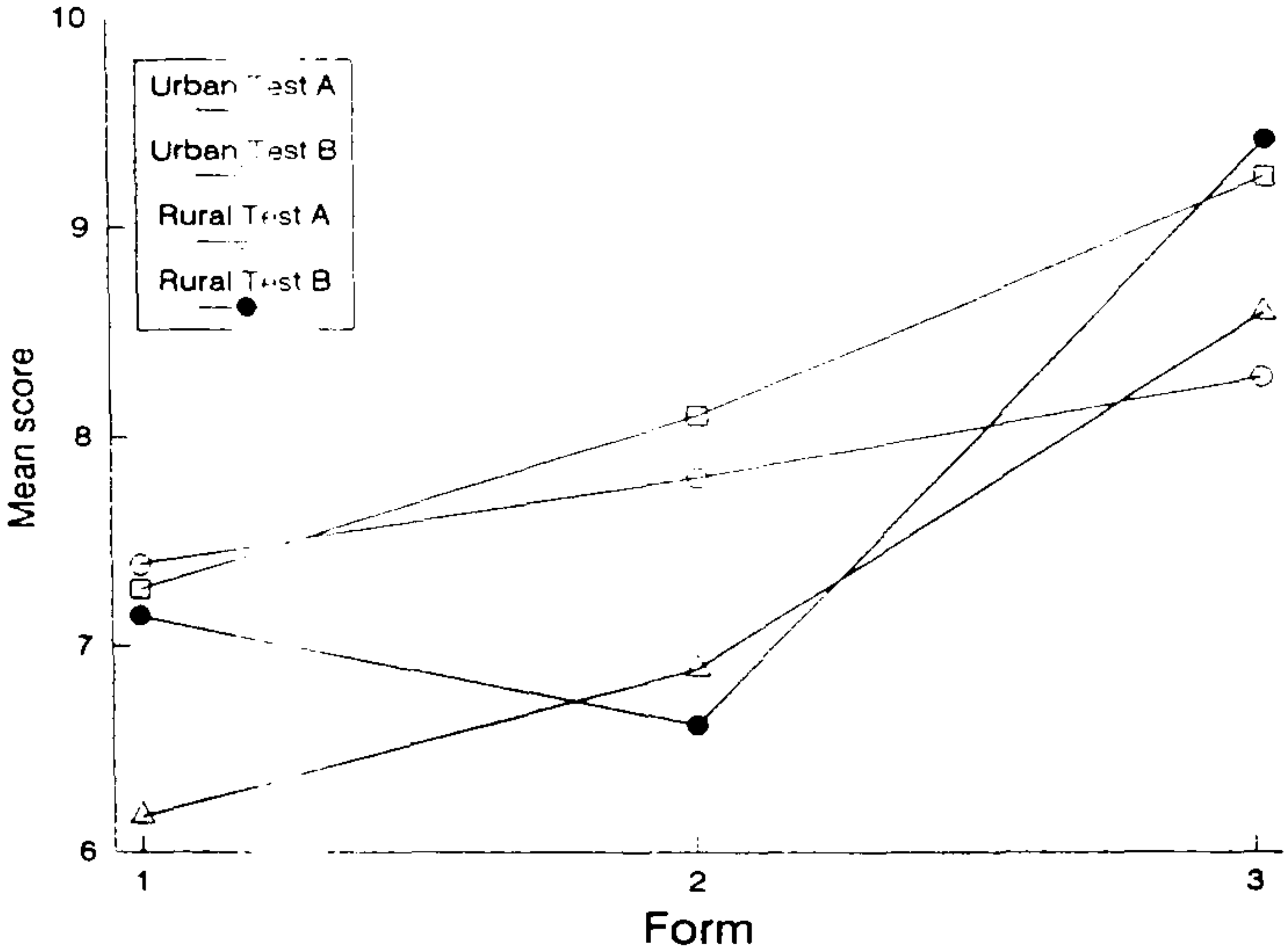

Figure 4 The educational level of the students and interpretation of science concept-related words in and out of science context

A further pairwise comparison analysis was carried out to find out the pair(s) of means of the different forms within the sub-samples (rural/urban) and between the sub-samples in which differences occurred since the interaction between form and school was significant ($p < 0.05$) (see Table 6). The Forms Two and Three students of the urban sub-sample did better than their counterparts in Form One in both tests while the Form Three students did better than the Form Two students (see Table 9).

TABLE 9

Differences Among the Means of the Test Scores of the Forms for the Rural and Urban sub-samples for Tests A and B

	TEST A						TEST B					
Form	UF1	UF2	UF3	RF1	RF2	RF3	UF1	UF2	UF3	RF1	RF2	RF3
Urban F1(UF1)	0	0.291*	0.304*	0.305*	0.348*	0.354*	0	0.34*	0.34*	0.34a	0.389*	0.395*
Urban F2(UF2)	-	0	0.308*	0.307*	0.350*	0.358*		0	0.342*	0.343*	0.391*	0.397*
Urban F3(UF3)	-	-	0	0.319*	0.361*	0.366a	-	-	0	0.357*	0.393*	0.409a
Rural F1(RF1)	-	-	-	0	0.361*	0.368*			-	0	0.403*	0.410*
Rural F2(RF2)	-	-	-	-	0	0.403*		-	-	-	0	0.451*
Rural F3(RF3)	-	-	-	-	-	0	-	-	-	-	-	0

a = not significant at $p > 0.05$

* = significant at $p < 0.05$

The trends described above was similar to that of the forms from rural Junior Secondary Schools except in test B where the Form One students did better than the Form Two students (see Tables 9, 10, and Figure 5). Therefore the Form One students have better understanding of science concept-related words when used in science context than the Form Two students. There seems to be no obvious reason for this anomaly. However, they may have been exposed to more improved instruction in English language and in science as a result of the in-service courses organized for upper primary English and Science teachers which started in 1992 when they would have been in primary four.

TABLE 10

Means, Standard Deviations of Test Scores of the Forms for the Rural and Urban Sub-samples on Interpretations of Science Concept-related Words: In and Out of Science Context

		TEST A		TEST B	
Sub-sample	**N**	**Mean**	**SD**	**Mean**	**SD**
Urban sub-sample					
Form 1	222	7.39	3.15	7.27	2.84
Form 2	215	7.8	2.82	8.1	3.59
Form 3	182	8.29	3.48	9.24	4.23
Rural sub-sample					
Form 1	181	6.18	2.55	7.17	2.67
Form 2	117	6.89	3.07	6.62	2.73
Form 3	111	8.6	3.52	9.42	4.33

The pairwise comparison analysis also indicate significant differences among the means of the urban and rural sub-samples since the differences between the means are greater than the calculated mean differences from the least significant difference analysis (Table 9). All the forms of the urban sub-sample did better than the Forms One and Two students of the rural sub-sample in test A while the Form Three students of the latter did better than the Forms One and Two students of the urban sub-sample in the same test (see Figure 5). However the Form Three students from urban and rural Junior Secondary Schools have comparable understanding of science concept-related words when used out of science context.

The Forms Two and Three students from urban Junior Secondary Schools did better than the Form One and Two students from rural Junior Secondary Schools in test B. The Form One students

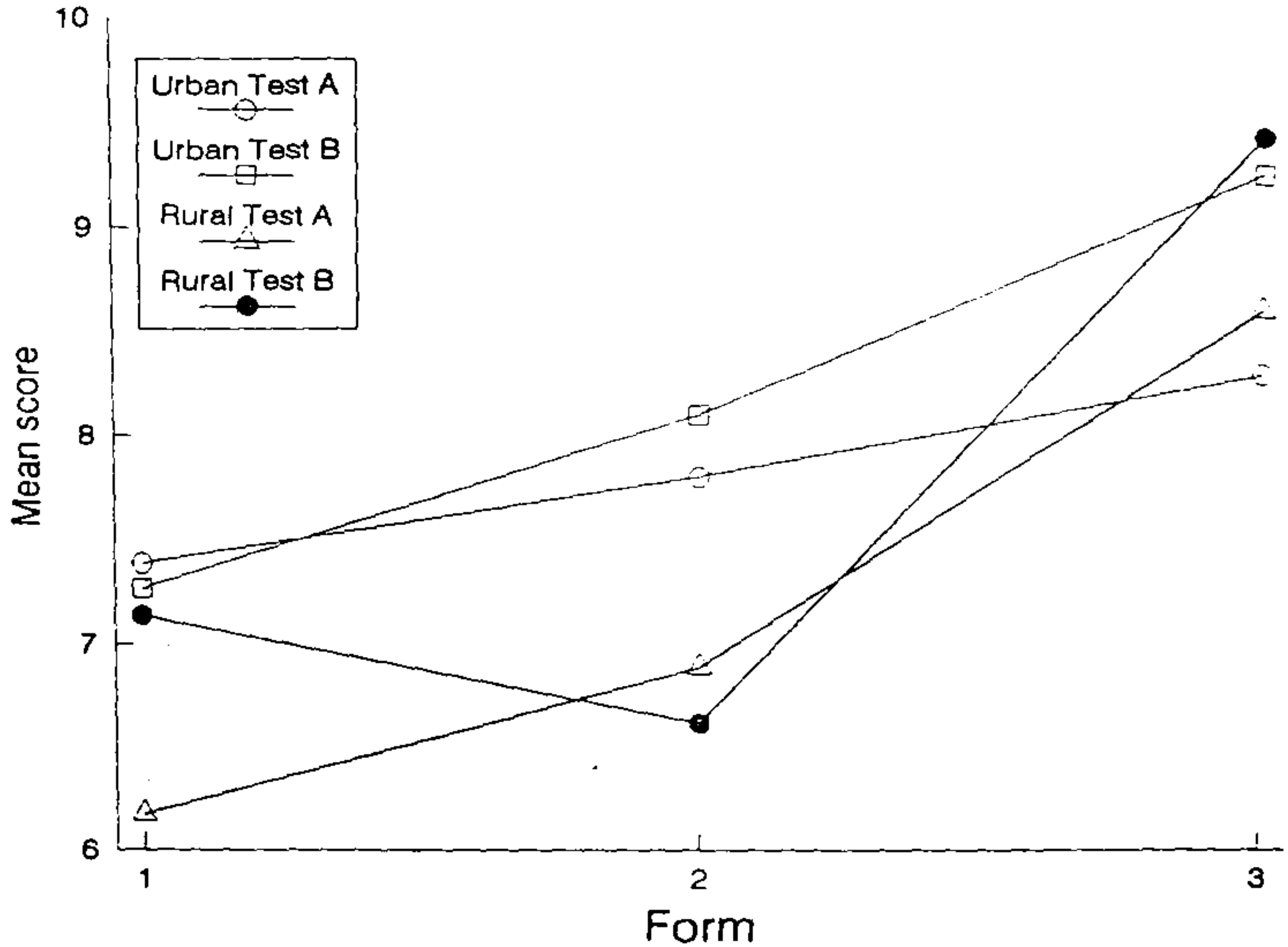

Figure 5 Relationship between location of school and educational level of students

from the former did better than the Form Two students of the latter but are comparable to the Form One students from the rural Junior Secondary Schools in understanding science concept-related words when used in science context (see Table 9 and Figure 5). The Form Three students from rural Junior Secondary Schools did better than the Form One and Two students of the urban sub-sample in test B but have comparable comprehension of the words in science context as the Form three students from urban Junior Secondary Schools.

There was a progressive increase in the mean scores of the forms from the rural to urban Junior Secondary Schools in both tests except among the terminal forms where higher mean scores were rather obtained by students from rural Junior Secondary Schools. However there was no significant difference between the mean scores of the Form Three students from the two sub-samples (Table 9). The exposure to more instruction coupled with preparation for the Basic Education Certificate Examinations may account for the comparable performance of the Form Three students from the urban and rural Junior Secondary Schools.

The urban areas may present a better environment than the rural areas for language acquisition by students of lower forms of Junior Secondary Schools which may explain the better understanding of science concept-related words in and out of science context by the students from urban areas than their rural counterparts. The students from urban areas may encounter the words more often than those in the rural areas. However, as the students progress through the levels to the exit point of basic education, they seem to have comparable understanding of the words as indicated by the non-significant differences between the mean scores of the Form Three students from urban and rural areas. This may be due to more exposure to the words through instructions in English language and frequent encounter with the words in science textbooks and other reading materials as they progress through the levels. There may also be an increase of informal and formal learning experiences as they prepare for the Basic Education Certificate Examinations.

4.2.4 Hypothesis IV

The interpretations given to science concept-related words in and out of science context by male students from urban Junior Secondary Schools are not significantly different from the interpretations given by male students from rural Junior Secondary Schools.

The differences between the mean scores of the male students from Junior Secondary Schools in urban and rural areas in the tests were less than the calculated differences between their means from the pairwise comparison analysis (see Table 11). Therefore there were no significant differences between the mean scores of the male students from Junior Secondary Schools in urban and rural areas (Figure 6). They have comparable understanding of science concept-related words when used in and out of science context. This is inconsistent with the better performance of students from urban area in the tests than those from the rural area. No obvious reasons can be given for this. Other factors may account for the better performance of the students from the urban area other than the fact than the urban area is a better language environment. Further research is recommended to clarify the inconsistency.

TABLE 11

Differences among the Means of the Gender Groups of the Rural and Urban Samples for Test A and B

	TEST A				TEST B			
Gender groups	UM	UF	RM	RF	UM	UF	RM	RF
Urban Males(UM)	0	0.6(ns)	0.620(ns)	0.678*	0	0.067(ns)	0.693(ns)	0.758*
Urban Females(UF)	-	0	0.515(ns)	0.584*	-	0	0.576(ns)	0.652*
Rural Males(RM)	-	-	0	0.603*	-	-	0	0.674*
Rural Females(RF)	-	-	-	0	-	-	-	0

$p<0.05$

4.2.5 Hypothesis V

The interpretations given to science concept-related words in and out of science context by females students from urban Junior Secondary Schools are not significantly different from the interpretations given by female students from rural Junior Secondary Schools.

The calculated mean differences from the pairwise comparison analysis between the mean scores of the female students from Junior Secondary Schools in urban and rural areas respectively, are greater than the differences between the mean scores they obtained from tests A and B respectively (see Table 11). Therefore there were significant differences between their mean scores in both tests ($p<0.05$). The female students from the urban Junior Secondary Schools did better in the tests (mean: A = 7.55; B = 8.29) than their counterparts from the rural Junior Secondary Schools (mean: A = 6.05; B = 6.90) (see Table 12 and Figure 6). Therefore the female students from urban Junior Secondary Schools have better understanding of science concept-related words when used in and out of science context than female students from rural Junior Secondary Schools.

The urban area may have a better or richer language environment which enhances the language acquisition of the female students from urban Junior Secondary Schools.

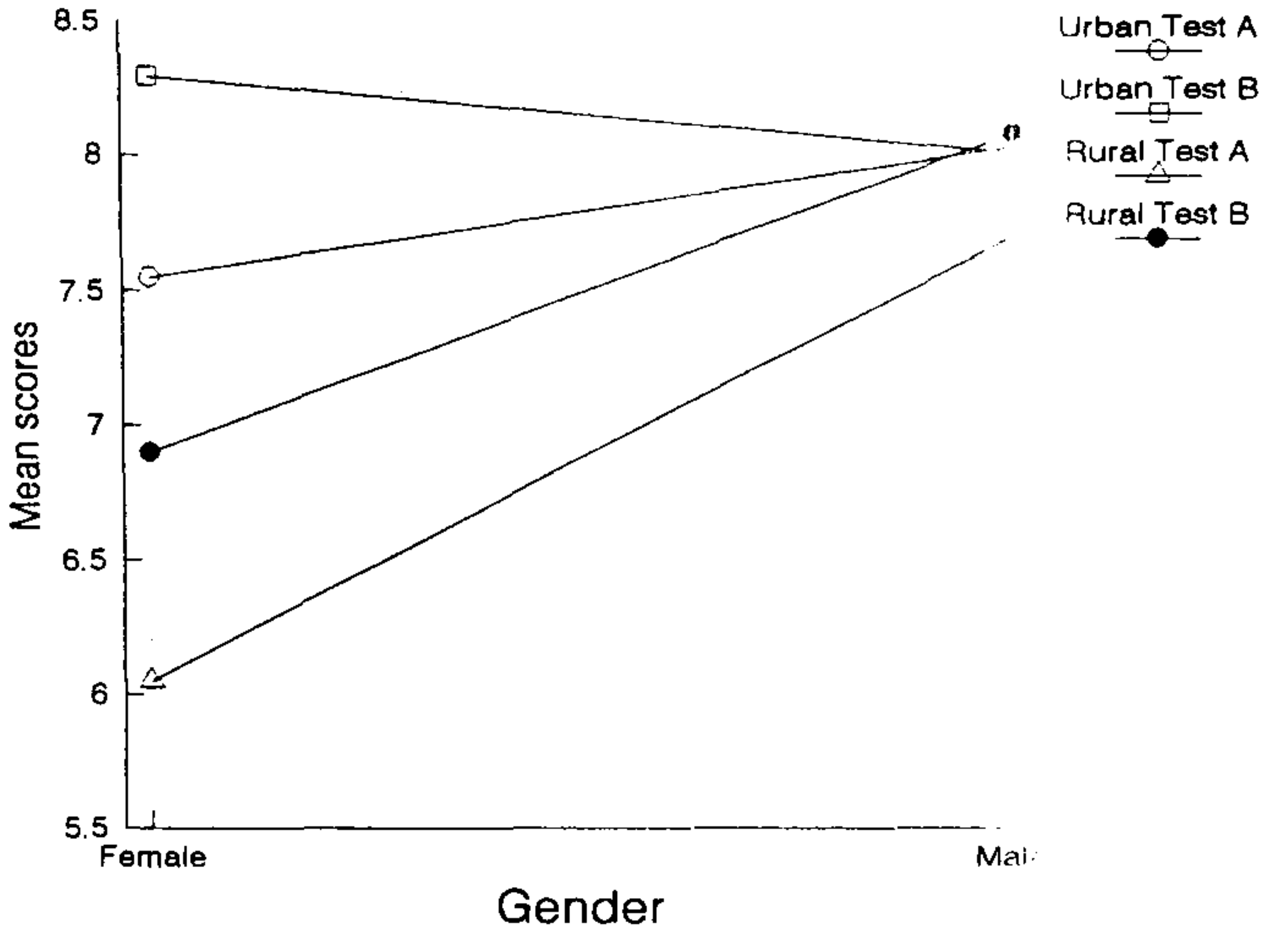

Figure 6 Relationship between gender and location of school

TABLE 12

Means, Standard Deviations of Test Scores of Gender Groups of Rural and Urban Sub-samples on Interpretations of Science Concept-related Words In and Out of Science Context

		TEST A		TEST B	
Gender Group	N	Mean	SD	Mean	SD
Urban Males	356	8.02	3.13	8	3.69
Urban Females	293	7.55	3.18	8.29	3.57
Rural Males	247	7.69	3.36	8.07	3.76
Rural Females	162	6.05	2.48	6.9	2.64

4.2.6 Hypothesis VI

The interpretations given to science concept-related words in and out of science context by female students from rural Junior Secondary Schools are not significantly different from the interpretations given by male students from rural Junior Secondary Schools.

The results of the pairwise comparison analysis on the differences between the mean scores of the female students and the male students obtained in both tests showed significant differences ($p<0.05$) between the mean scores obtained in the respective tests (see Table 11). The calculated mean difference in both tests are greater than the differences between the mean scores the female and male students obtained in tests A and B respectively. Therefore the male students did better in the tests (mean: A = 7.69, B = 8.07) than their female counterparts (mean: A: = 6.05; B = 6.90) (Table 12 and Figure 6). Therefore, the male students from the rural Junior Secondary Schools can be said to have better understanding of science concept-related words when used in and out of science context than their female counterparts. The interpretations of the words seem to be gender related.

This agrees with research findings reported by Gleason (1989) that boys seem to be better in recognitive and expressive vocabulary. Inequalities in both formal and informal learning experiences of boys and girls have been identified as major factors that explain the gender gap in science achievement tests (Catsambis, 1995). This may explain the better performance of the male students than their female counterparts from the rural Junior Secondary Schools.

4.2.7 Hypothesis VII

The interpretations given to science concept-related words in and out of science context by female students from urban Junior Secondary Schools are not significantly different from the interpretations given by male students from urban Junior Secondary Schools.

The results of the pairwise comparison analysis showed no significant differences ($p > 0.05$) between the mean scores of the female and male students from urban Junior Secondary Schools in both tests {A: Females: mean = 7.55, Males: mean = 8.02; B: Females: mean = 8.29, Males: mean = 8.00} (Table 12 and Figure 6). The differences between the means in the respective tests were less than the calculated mean differences (see Table 11). Any differences between the means of the male and female students in the tests were therefore due to chance. Both gender groups may have comparable understanding or comprehension of science concept-related words when used both in and out of science context. Therefore the interpretation of science concept-related words in and out of science context is not gender related among students from Junior Secondary Schools in urban areas. The findings disagree with some of the research findings reported by Gleason (1989) on gender differences in language acquisition and that boys seem to be better than girls in recognitive and expressive vocabulary.

Though the conditions under which the research reported by Gleason (1989) was conducted may be different from those of this research, there is not much difference between the linguistic skills of boys and girls in the urban environment. The rural environment may vary. Thus explaining the similarity in performance of boys and girls in the urban area.

4.3 The Influence of Native Language on Students' Interpretations of Science Concept-related Words In and Out of Science Context

Some of the words tested have equivalent words in Kassem which is the official native language used as a medium of instruction in the first three years of basic education and taught as a subject in the Junior Secondary Schools in Navrongo District in the Upper East Region. The native equivalent words were obtained by the researcher from the language teachers in each school visited. Other words tested do not have equivalent words in the native language. The table below shows the words with equivalent words in the native language with/without similar English meaning and words without native language equivalence (Table 13).

One would have expected the students to perform better on words which have equivalent words in the native language of the students and which have similar English meaning to their corresponding words tested. However except *prepare*, and *conserve* (test A) and *disperse, conserve* and *function* (test B) in which the percentage correct interpretations exceeded the average percentage frequency of students' scores of 31.7% and 32.9% in tests A and B respectively (Table 13) students performed poorly on the words. This disagrees with findings in the literature that where equivalent words occur in the native language, the learner understands the science concept word (Gay and Cole, 1967; Mori and Kitagawa, 1974; Mori *et al*, 1976; Tull, 1991). The poor performance of the students in test A, where the words were used out of science context, may be due to poor vocabulary or poor word association. The poor interpretation of the words when used in science context (test B) may be due to the failure of the students to get the contextual meaning of the words tested. Perhaps because the science contextual meaning of the words differed from the cultural meaning of the words. The better performance of the students on some of the words in test A (conserve, prepare) and in test B (disperse, conserve, function) may be due to the fact that these words are encountered more often in everyday use of English language and in science texts respectively.

The students' performance on the words with dissimilar English meaning to the native language equivalent words did not differ much from their performance in the words with similar English meaning (see Table 13). The average percentage correct interpretations are 33.3% and 30.65% in tests A and B respectively (see Table 13). The words in which the students registered scores above the average score in test A and B (displace, separate) may be encountered more often in instructions in English and the everyday use of English language. However the dissimilar English meanings of the native equivalent words to words such as *estimate, absorb* and *average* may have influenced the low scores of the students in test A (Table 13). Also the context did not improve the meanings of the words, except average, in test B where the words were u..ed in science context.

The average percentage scores obtained by the students in test items involving words without native language equivalent words are lower than those of words tested which have native language equivalent words (e.g. test A: contaminate, essential, source, system, device, independent; test B: contaminate, essential, source, generate, crude, efficient) may be compared favorably with their performance on some of the words with native language equivalent words in corresponding tests

(e.g. test A: prepare, conserve, displace, separate; test B: disperse, conserve, function, displace, average, separate)

This is because the percentage correct interpretations of these words are above the respective average percentage correct interpretations of the word categories (i.e. words with native language equivalence and without native word equivalence).

This seems to differ from the findings stated in the literature (Gay and Cole, 1967; Mori *et al*, 1974; Yakubu, 1976; Tull, 1991) that the absence of native language equivalent words to science concepts or words will hamper the students' understanding of these concepts or words.

The high scores obtained by the students on test items involving some of the words without native language equivalent words may be due to the fact that these words may be encountered more often during instruction in English language and in science lessons. Also since they do not have native equivalent words, their meanings may not be contaminated by or clouded with cultural meanings of the word. The poor scores registered on some of the words in test A may be due to the fact that they may be unfamiliar to the students but their meaning seemed to have been improved when used in science context. This is reflected in the general increase in percentage scores on corresponding word items in test B (Table 13). However the progressi e increase in scores was inconsistent with words such as independent, device and system, which registered percentage scores above the average score in test A but with values below the average score in test B.

The rather low scores in items involving device and system in test B may be attributed to unfamiliarity associated with these words in the context in which they were used. It may be possible that majority of the students did not understand the word *digestive* associated with system, and the words *thermos flask* associated with device (see Appendix 2 items 18 and 20).

Over 50% of the students interpreted correctly the word independent when used out of science context but the number dropped drastically to 27.7% when the word was used in science language context (see Table 13). This word may be encountered in everyday use of English language; pupils are made to celebrate Ghana's independence day,; etc. This may account for the high percentage scores in test A. However majority of the students failed to get the contextual meaning of the word when used in science context. The commonest response among the students was '... as the baby grows it needs more attention from the mother' (see Appendix 2 item 23). The students' option seems to reflect their cultural experience with growing babies. A toddler needs more attention as it gains mobility to prevent it from getting into trouble such as falling over an edge, etc. The students' experience as baby sitters to other siblings in the family might have influenced their interpretation of the word. This seems to confirm the findings of (Mori *et al*, 1976, Tull, 1990) that where the learner fails to get the context of a word in science text he or she tends to interpret it from the perspective of his or her cultural experience.

CHAPTER 5

5.0 DISCUSSION OF RESULTS

5.1 Discussion and Implications for Science Concept Formation

The study was to investigate the meanings Ghanaian Junior Secondary School students give to science concept-related words when they are used both in and out of science language context and their implications for science concept formation. A number of hypotheses were formulated from the research questions of the study and tested using ANOVA and/or t-test on the mean scores of the overall sample and of the urban and rural sub-samples.

The findings of the study include the following

1. Students have poor interpretations of science concept-related words when used both in and out of science language context. However the students seem to have a better understanding of words encountered frequently during instructions in English language, in everyday use of English language and in scientific text.

2. Students from Junior Secondary Schools in urban areas have better understanding of science concept-related words than those from rural areas.

3. Interpretation of science concept-related words is gender-related among the students of the rural sub-sample.

4. The gender groups from Junior Secondary Schools in urban areas have comparable understanding of science concept-related words when used both in and out of science context. The

urban (language) environment may offer equal opportunities to both gender groups.

5. The male students from Junior Secondary Schools have better understanding of science concept-related words when used out of science context than their female counterparts.

6. The interpretation of science concept-related words improves progressively from lower forms to higher forms in all the Junior Secondary Schools selected for the study. However, students in lower forms in Junior Secondary Schools in urban areas have better understanding of the words than their colleagues from rural areas. It was however evident that students in terminal forms from both urban and rural Junior Secondary Schools have comparable understanding of science concept-related words when used in and out of science context.

7. The presence or absence of equivalent concept or science concept-related word in the native language of the learner may not necessarily promote or hinder proper science concept formation if the medium of instruction is a foreign language.

The following broad areas will be discussed in this section: The generally poor performance of the sample population on the interpretation of science concept-related words, the disparity between the performance of the students from urban Junior Secondary Schools, the influence of the native language of the student on word meaning and the gender differences in the interpretation of science concept-related words among students from Junior Secondary Schools in rural areas.

The performance of the entire sample population on the test items was very poor. About 27.2% of the overall sample population of 1028 students were able to interpret the science concept-related words correctly in test A and 32.5% of the sample gave correct interpretation of the words in test B. A number of factors could be associated with such dismal performance of the students.

The unfamiliar nature of some of the science concept-related words to the students resulted in low scores on items in which such words were used. This is evidenced by rather higher scores students registered on test items in which familiar words in everyday use of English language were used. For example, 40% of the students correctly interpreted *essential* (in test A) which is in common use in English language (e.g. essential commodities is a household term) while 19.4% of the students could interpret the word *dehydrate* in the same test (see Appendix 7).

Another cause was the inability of the students to detect a change in context of the familiar words from out of science to science language context, e.g. the percentage frequency of the students' correct responses to test items involving *displace* dropped from 41.1% in test A to 33.0% in test B, for *independent* it dropped from 58.0% in test A to 27.7% in test B, and for *prepare* the percentage frequency dropped from 51.9% to 29.9% in test A (Appendix 7). According to Munby (1976), when the learner fails to detect the change of context of the science concept-related word from its ordinary language context to science context, he or she turns to interpret the word within its ordinary language rather than within its science language context. Also Lynch (1978) maintains that the everyday usage of the word interferes with the understanding of the science concept word(s) in scientific sense. Hence the inability of the students to interpret the words, such as prepare, displace and independent correctly, when used in science context as in test B (Appendix 2), might have been influenced by the ordinary language meaning of the words. However other factors, such as the students' poor vocabulary and word association, might have increased their difficulty in getting the contextual meaning of the words. Other words connected with some of the words tested did not improve students' interpretation of such words. They needed to understand such words before they could get the contextual meaning of the science concept-related word, e.g. the students needed to understand the words 'thermos flask' before they could interpret 'device' correctly (see Appendix 3 item 20 and Appendix 7). Most students in the study asked the researcher for the meaning of thermos flask. The commonest response of the students to the test item involving 'independent' (needs more attention from the mother) (Appendix 2 item \23) suggested an interference of the students' cultural knowledge as regards child care. This has been discussed later in the chapter.

The interpretations of the word 'displace' as indicated (see Table 5), suggested an interference of students' informal experience or action knowledge in displacement experiments with stones and water. However further investigation is needed to substantiate the observation.

Students' inability to detect change in the context of science concept-related words from out of science to science language context or inability to get the contextual meaning of the word(s), poor vocabulary and word association, will hinder proper science concept formation.

The language environment of the urban areas has an immense contribution to the overall better performance of the students from the urban Junior Secondary Schools than the students from the rural Junior Secondary Schools. The urban areas are endowed with factors such as the print media, e.g. newspapers, magazines, etc., library facilities where books can be borrowed, and access to radio and television broadcasts, especially of educational programmes for children. These factors, among others, have been identified as essential factors for proper language development in children (Lizdzey *et al*, 1975; Allen *et al*, 1986). These factors, therefore, enrich the language environment of the urban Junior Secondary School. Proper interaction of the student with such a rich language environment will lead to better language development and cognitive skills in the student. The rural areas are mostly deprived of such amenities. The student in the rural Junior Secondary School has little or no access to these facilities and he/she is therefore expected to lag behind his/her urban counterpart in the comprehension of science concept-related words in everyday use of English language and in science language context.

Another added advantage is literate parents. As indicated in the introduction, most of the adult population in the urban centre have formal education while the rural areas have a higher number of illiterate parents. Out of 53.2% adult literate population, 39.0% is in the urban areas (World Bank Report, 1993). The literate parent(s) may serve as a motivational factor to the child's language development. If in the family, the parents commonly interact with the child in English, the child will be motivated to learn the language to be able to interact well with the parents and other siblings. A literate parent is more likely to emphasize correct usage of words than an illiterate parent. The literate parent may also seek to promote correct usage of words and language acquisition by providing additional magazines for children, etc. He/she may also make provision for extra classes which are a common phenomenon in urban centres in Ghana.

The educated parents may also create avenues such as taking children to recreational centres, parties, etc., for social interaction between the child and his/her peers and or with adult literates who may be present. These informal experiences will promote the language development of the child from the urban areas.

Apart from the general English language problems identified which affect students from both urban and rural Junior Secondary Schools, students from the latter have an improvised language environment to grapple with. These inadequacies will hamper proper science concept formation since word vocabulary and comprehension of the science texts are necessary for science concept formation.

The findings of Sandman (1993) and Kraft (1994) confirmed the poor language environment of the student especially in the rural schools, and based on their recommendations, United States Agency for International Development (USAID), through the Ministry of Education, has provided 'box' libraries, preset radios and other instructional materials to schools, including Junior Secondary Schools, to improve the language environment of the student.

The findings on gender differences in the interpretation of science concept-related words did not show a clear case of gender difference with the overall sample. However, there was an indication of gender differences within the rural sub-sample in the interpretation of science concept-related words in and out of science context. The male students were better in word association which was needed to correctly interpret the words used in test A (Appendix 1). It has been found out that boys are better in recognitive and expressive vocabulary than girls (Gleason, 1989). The male students also have better comprehension of science concept-related words when used in science context (Appendix 2) than their female counterparts.

A number of other reasons may account for these gender differences among the students of rural Junior Secondary Schools in understanding science concept-related words in and out of science context.

Societal impact on gender education (Dywer, 1973) and differences in informal and formal learning experiences of boys and girls (Catsambiis, 1995) have been identified as some of the factors which account for the gap between the performance of boys and girls in science achievement tests.

The societal impact on female education could be a factor responsible for the gender differences noticed between the gender groups of the rural sub-sample. There is a social bias towards female education since she is not likely to contribute directly to the family livelihood in future as she marries out of the family. This situation is more pronounced in the rural than urban areas. Also the mode of inheritance among the people in the study area - Navrongo District - is patrilineal. Therefore families do not seem to have a hope of direct benefit from educating a female child. Therefore illiterate parents may not monitor the learning habits of their daughter. Also equal learning opportunities may not be made available to the male and female children.

It has been found that boys engage more in informal (extra-curricular activities) and formal learning experiences in science and mathematics (Catsambiis, 1995) which accounts for differences in performances in science achievement tests with the boys performing better than the girls. The engagement of the boys in these activities increases their social interaction with others and this may, through communication, improve their proficiency in and their standard of English language. This will promote their understanding of science concept-related words when used in and out of science context. This may be true for the gender groups from the rural areas since it was only within the rural sub-sample that the male students performed better in the tests than their female counterparts.

Though the above factors may account for the gender differences in the performance of the students from the rural Junior Secondary Schools in the tests, the level of formal education of the adult population appears to be the determinant factor. The comparative performance of the urban female students to their male counterparts lends support to this. If equal opportunities are given to both gender groups among the students from the rural Junior Secondary Schools, the female students will perform equally well as their male counterparts in the interpretation of science concept-related words when used in and out of science context. It seems therefore that the high illiteracy rate among the adult population in the rural areas (World Bank Report, 1993) may account more for the differences among the students from the rural Junior Secondary Schools than any other factor. A literate parent is likely to support female education. Therefore he/she is more likely to provide equal opportunities to both sexes for informal and formal learning experiences. The illiterate parent(s) may hold a different view.

The findings on the influence of the native language of the learner in the interpretation of science concept-related words indicated that it is not just the presence or absence of equivalent concept words in the native language to science concepts or science words that may hinder or promote proper science concept formation. Other factors were indicated and they include:

1. limited vocabulary of the students,
2. unfamiliar words in the context in which the science concept word with a native equivalent word is used,
3. interference of the cultural contextual meaning of the word with its science context meaning, and
4. the conflict between the English language meaning of the science concept word/science word and the native language meaning of its native equivalent word.

The native equivalent word for convert is 'le' which has an English equivalent word as change. The latter is the correct option for test item 9 in test A and it forms part of the correct option for test item 9 in test B (see Appendices 1 and 2) yet the students registered scores lower than the average percentage frequencies, 29.9% and 36.1% for tests A and B respectively (see Appendix 7). The students might not have been aware that 'le' stands for convert. Limited word association or poor vocabulary of the students might have also accounted for the low scores registered by the students on the test item involving 'change' in test A where it was used out of science context. Also limited vocabulary and unfamiliar word association with the word in test B may account for the low scores on the item in test B. The students needed to understand the terms such as kinetic energy and potential energy before they could get the contextual meaning of the word *convert*. It appeared the terms were unfamiliar to the students. This was indicated by the number of times the students involved in the study asked the researcher for explanation of these terms.

Also, the native equivalent word 'le' for convert may have a different cultural meaning or native language meaning from its English equivalent word, *change*, which is synonymous to convert. This may account for the low percentage frequency scores registered on the test items involving the word in both its use in and out of science context.

Other conflicts between the English meaning of some of the native language equivalent words and their corresponding science concept-related words may account for the students poor performance on test items involving the latter. For example, the native equivalent word, 'mange' for estimate literally means measure, so the students interpreted the word estimate as used in tests A and B (see Appendices 1 and 2, item #9) as 'a careful measure' instead of 'a careful guess'.

The native equivalent word for absorb is 'nyu' which has two literal meanings namely drink and soak. The low scores registered by the students in test B might have been influenced by the native language meaning of the word (see Appendix 7). The students were unsure which meaning to apply.

Therefore lack of congruence in meaning between the science concept-related words and their native equivalent words will hinder the students' understanding of the science concept-related words when a foreign language is used as the medium of instruction. This may lead to improper science concepts formation as the student may maintain the cultural meaning of the concept or may learn such concepts by rote. Also, even where there is congruence between the English meanings of the science concept-related words and its native equivalent word, the latter may have a different cultural meaning when the word is used in science language context. This may lead to wrong concept acquisition. Further research is necessary to clarify the issues raised.

The findings and discussion on the influence of the native language of the students on their understanding of science concept-related words point to the fact that there may be poor transfer of thought processes or cognitive language skills from the native language to the second language (English) which is the language of instruction (Collison, 1974). The native language of the Ghanaian child is used as a medium of instruction for the first three years of primary education. Thereafter, it is studied as a subject. The three years may not be enough for proper native language development, thereby leading to poor transfer of linguistic skills to the second language (Collison, 1974; Ogbu, 1992). The primary school years of the child are crucial for language and cognitive skills development. Kraft (1994) reported that a number of research works indicate that if a child goes through a fairly lengthy period with first language, the child will be able to transfer over to the foreign language with comparable ease. This will enhance learning of science concepts in a second language.

CHAPTER 6

6.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

In the first five chapters, the background of the study, statement of the problem, a brief review of literature, methodology, analysis and discussion of the findings were presented. A brief summary of the study, followed by conclusions and recommendations will be presented in this chapter.

The understanding of science concept-related words is very vital for proper science concept formation. But understanding of these words may depend on a number of factors which include, the proficiency of the learner in the use of standard English language, the ability to get the contextual meaning of the word in their ordinary or out of science language and in science language context. However, the Ghanaian child may be hindered by the multilingual classroom environment, where English language - a second language of the child, - is used as medium of instruction, in developing the above linguistic skills. Also the environment (the home, the urban/rural setting of the school) in which the child spends most of his/her time and gender differences may hinder or promote the learner's understanding of science concept-related words in and out of science context.

The study investigated the meanings Ghanaian Junior Secondary School students give to science concept-related words found in their science textbooks. It was also to find out the relationship between factors such as gender, native language, location of the school (rural or urban setting), educational level of the student and the meaning the student gives to these words.

The study specifically addressed the following research questions:

1. What are the meanings Junior Secondary School students give to science concept-related words they encounter in and out of science context?

2. Are there any significant differences in meanings given to science concept-related words in and out of science context by Junior Secondary School students from rural and urban areas?

3. Do male students differ significantly from female students in their interpretation of science concept-related words in and out of science context?

4. Are there any significant differences in the meanings given to science concept-related words in and out of science context by male and female Junior Secondary School students from rural and urban areas respectively?

5. Do students in higher forms have a better interpretation of science concept-related words in and out of science context than students in lower forms of Junior Secondary School?

6. Does the local or native language of the student have any influence on the interpretations he/she gives to the words in and out of science context.

6.2 SAMPLE, INSTRUMENT, PROCEDURE

A sample of 1028 (455 females and 573 males) Forms One to Three students from 12 (6 rural and 6 urban) out of 33 Junior Secondary Schools in Navrongo District, in the Upper East Region of Ghana, was used in the study. The students were between the ages of eleven and nineteen years with an average age of 14 years (S.D. = 2.7). The predominantly spoken native languages are Buli, Kassem and Nankani. Kassem is the official native language used as medium of instruction in the first three years of basic education and taught as a subject in the Junior Secondary Schools.

The rural sub-sample consisted of 409 students (162 females and 247 males) and the urban sub-sample consisted of 619 students (293 females and 326 males).

Whole classes were used in the study to ensure that enough females were included in the study since the female to male student ratio is 1:2. Where there was more than one class to a form, one of the classes was randomly selected by simple balloting.

The instrument used to collect the data for the study was adopted from an original instrument developed by Center For studies In Science And Mathematics Education, University of Leeds.

The content validity of the instrument was determined by three senior science educators in the Department of Science Education, University of Cape Coast. They found the instrument appropriate for application in Ghana. They individually confirmed that the words used are among the words in common usage in the science textbooks used at the Junior Secondary School Forms One to Three levels. The instrument consisted of two multiple-choice tests (A and B) involving 25 science concept-related words. Test A was to investigate the meaning the students give to the words when used out of science context and test B was to investigate the meanings they give to the words when used in science language context.

A pilot study was carried out to establish the reliability of the instrument and to find out its suitability for use in the selected schools.

The instrument was administered by the researcher 6 weeks after the schools had re-opened for the first term of the 1994/95 academic year. Permission was sought from the District Office.

Two visits were made to each selected school. The first was to familiarize with the school. The tests were administered during the second visit. Test A was administered first followed immediately by test B after the scripts for test A were collected. Enough time was given to the students to complete the tests. The scripts were collected only when the student indicated that he/she had completed the tests.

Measures were taken to prevent any interaction among the students during and between the administration of the tests to prevent any extraneous factors that would have invalidated the results.

6.3 DATA ANALYSIS

Both descriptive and inferential statistical analysis were used on the data collected in the study.

The reliability coefficient of the instrument was calculated using Kuder-Richardson formula 21 and it was found to be 0.75.

A point was awarded to a correct response to a test item and each test was apportioned 25 marks.

The percentage score on each test item was determined and used to find out how the students performed on the words in and out of science language context.

The frequency distribution of the students' scores for each sub-sample and for each gender group within the sub-samples were determined and presented in tables, histograms and line graphs. These were used to compare the performance of the students on the basis of location of the school (urban/rural) and gender.

Some of the responses of the students were analysed to find out whether they were influenced by the native language of the student. The performance of the students on words with native language equivalent words were compared with their performance on words without native language equivalent words.

The mean scores and the standard deviations of the overall sample, the sub-samples, the gender groups and of the individual forms were computed. These were used in ANOVA and/or t-test analysis on the test scores to answer the research questions and to test the hypotheses stated in sections 1.3 and 1.4 respectively. The level of significance for testing for any significant differences between the mean scores was 0.05.

A pairwise comparison analysis was carried out on the relevant mean scores to establish between which means there was a significant difference, where the interaction between any two independent variables was significant.

6.4.0 FINDINGS OF THE STUDY

6.4.1 Preliminary Analysis of Data of Test Scores of the Overall Sample in Tests A and B

Generally, the performance of the pupils was very low. Only 14.7% and 10.8% gave correct meaning of the words in and out of science context respectively.

The preliminary analysis of the data showed a significant difference between the means of the test scores in tests A and B. The students performed generally better in test B than in test A. Therefore they have better understanding of science concept-related words in science context than when used out of science context. The context within which the words were used might have made the meanings of the words clearer.

6.4.2 The Students' Interpretation of Science Concept-related Words in Science Language Context

The results indicated poor interpretation of some of the words in science context. The possible causes might have been due to the inability of the students to detect the change in context of such words from out of science context to science context; some of the answers indicated the retention of the meanings of the words in ordinary language use of English language; in some cases the unfamiliar words associated with the words tested might have affected the students' interpretations of such words.

6.4.3 The influence of Native Language on Students' Interpretation of Science Concept-Related Words In and Out of Science Context

The students performed poorly on some of the words without native language equivalent words and did better even on some of the words without native language equivalent words than those with equivalent words. These may be words frequently encountered by students during instruction in English language, in everyday use of English language and in science textbooks.

The students performed poorly on some of the words with native language equivalent words where the latter have dissimilar meanings to their corresponding science concept-related words in both out and in science language context.

The students performed poorly in some words used in science language context even though they obtained high scores on word items in test A where they were used out of science context.

The students' responses suggested that the native language meanings of the native language equivalent words to some of the words used in texts might have contaminated or clouded the contextual meaning of such words when used in and out of science context. The responses also suggested an interference of the cultural contextual meaning of the words in the interpretations of the science concept-related words when used in science language context.

6.4.4 Statistical Analysis of Test Scores

1. There were significant differences between the interpretations students from rural Junior Secondary Schools give to science concept-related words in and out of science context and the interpretations given to the words by students from urban Junior Secondary Schools. The students from the Junior Secondary Schools in the urban areas performed better than their rural counterparts. They therefore have better understanding of science concept-related words in and out of science context.

2. There was a significant difference between the interpretations given to science concept-related words out of science context by male and female students of the overall sample. That is the male students performed better than the female students. They therefore have better understanding of the words when used in everyday or out of science context. However there was no significant gender differences in the interpretations of the words when used in science context. They have comparable comprehension of the words in science language context.

3. There were significant differences between the interpretations of science concept-related words in and out of science context by students in higher forms of Junior Secondary Schools and by students in a lower form of the overall sample. The students in higher forms did better than those

in lower forms of Junior Secondary Schools. Therefore the students in the higher form have better understanding of the science concept-related words in and out of science context. There was a progressive increase in the mean scores from lower forms to the higher forms.

A pairwise comparison analysis between the means revealed the following:

i. The understanding of science concept-related words in and out of science context progresses from the lower forms to the higher forms among students from urban Junior Secondary Schools.

ii. The understanding of science concept-related words out of science context progresses from the lower forms to the higher forms among the rural Junior Secondary Schools. However the Forms One and Three students have a better understanding of the words when used in science context than the Form Two students while the Form Three students are better than the Form One students.

iii. The Forms One to Three students of the urban Junior Secondary Schools have better understanding of science concept-related words in and out of science context than their counterparts from rural Junior Secondary Schools except the Form Three students of the latter who have better understanding of the words than the Forms One and Two students from urban Junior Secondary Schools, and have comparable understanding of the words with the Form Three students of the urban Junior Secondary Schools.

iv. As the students progress through the different levels of the Junior Secondary Schools, the differences in understanding of science concept-related words in and out of science context seem to disappear. This is evidenced by the comparable comprehension of the words in and out of science context among the Form Three students from the urban and rural Junior Secondary Schools respectively and between the Form Three students from urban and rural Junior Secondary Schools.

4. There was no significant differences between the interpretations of science concept-related words in and out of science context by the male students from urban and rural Junior Secondary Schools respectively. This is inconsistent with the finding that students from urban areas have better understanding of the words. Further research is recommended to clarify the inconsistency.

5. There were significant differences between the interpretations of science concept-related words in and out of science context by female students from urban and rural Junior Secondary Schools respectively. The female students from urban Junior Secondary Schools have better interpretations of the words than their rural counterparts. Thus the female students from the urban Junior Secondary Schools seem to have a better understanding of the words when used in and out of science context.

6. There were significant differences between the interpretations of science concept-related words in and out of science context by female and male students of rural Junior Secondary Schools. The latter have better interpretations of the words than the former. Therefore the male students have a better understanding of the words when used in and out of science context than their female counterparts.

7. There were no significant differences between the interpretations of science concept-related words in and out of science context by male and female students from urban Junior Secondary Schools respectively. Therefore the gender groups have comparable understanding of the words when used in and out of science context.

6.5 CONCLUSIONS

Based on the findings from the study, the following conclusions are drawn:

1. Ghanaian Junior Secondary School students have generally poor understanding of science concept-related words when used in and out of science context. Poor vocabulary and poor word association, the inability to detect change of context of some of the words, among other factors, may account for the dismal performance of the students.

2. Some of the interpretations given to some of the science concept-related words, especially when used in science context, suggested an interference of the cultural experiences of the students with such words. Also where students failed to get the contextual meaning of words in science context, the everyday language meaning of the word was used.

3. The presence of equivalent native words with congruent English language meaning to some of the science concept-related words did not, in most cases, improve the interpretation of such words. Also where the English meaning of some of the native language equivalent words differed from those of their corresponding science concept-related word, the students' interpretation of the word was hindered.

The cultural experiences related to some of the native equivalent words clouded the meaning of their corresponding science concept-related words when used in and out of science context.

4. The urban areas are better language environments than the rural areas. The urban areas may have a richer language environment than the rural areas. Such an environment leads to a high language development in the students which may enhance the understanding of science concept-related words.

5. Homes of educated parents (formal education) are better language environments for language acquisition than illiterate homes. The literate parent(s) are more likely to promote language development in children than illiterate parents by providing a rich and stimulating language environment.

However the nearly comparable performance of the gender groups of the students from urban Junior Secondary Schools indicates that given equal opportunities for informal and formal learning, the females may have a comparable language acquisition, hence comparable understanding of science concept-related words with their male counterparts in rural Junior Secondary Schools.

6.6 Recommendations for Improvement of Students' Understanding of Science Concept-Related Words

A number of recommendations have been made to improve students' understanding of science concept-related words which would eventually lead to proper science concept formation.

1. The provision of a variety of reading materials, additional instructional materials by the school management boards, will enrich the language environment of the students, especially those in the rural schools. Effective interaction with the rich language environment will improve the students' vocabulary, word association and comprehension of texts by the students. These are vital for understanding science concept-related words.

2. The school authorities should monitor the effective use of the 'box' libraries supplied to the schools and the participation of the students in the radio broadcasts of educational programmes during school hours. These will help improve students' English language which is necessary for understanding science texts.

3. The science and language teachers should engage students in word association exercises. The pool of words that will be formed by the class will enhance the students' vocabulary. The word connections that will be built will improve the contextual meaning of the words when encountered in science textbooks.

4. The context of new concept words or everyday words in science text to be studied should be identified by the teacher and discussed with the students before the topic is treated to enhance understanding of the contextual meaning of the words. This will promote proper science concepts formation.

5. The science teacher should identify and discuss with the students, concepts or concept-related words in the native language which are equivalent to science concepts in the science text to be studied. This will enhance the students' understanding of the science concepts or concept words when the science text is treated.

6. Concept words or equivalent words in native language of the students which may lack congruence in word meaning to their English language equivalent should be identified and discussed with the class to get the correct meaning before the students are introduced to new concepts to be learned in the science text.

7. The Ministry of Education and experts in Ghanaian languages and linguistics should review the current policy on the use of Ghanaian languages in the primary schools and assist the Government of Ghana to reformulate the policy to enhance proper language and cognitive skills development in the child. In addition to the use of native language in the first three years in the primary school, Government should recommend the use of the native language alongside English language in instruction for the next three years since it has been discussed that proper native language development will enable the child to transfer over to the second language, thought and

conceptual process skills. This will ease the problems associated with learning science concepts through a second language.

6.7 Suggestions for Further Research

1. Some interpretations given by the students to some of the words used in the study, e.g. displace, independent, conserve, absorb, etc., were not based on the science language context in which the words were used. Further research, through interviews and other probes, is needed to get the reasons for students' interpretations of such words.

2. The societal impact on female education and the attitude of the family towards female education were other factors which could be associated with the gender differences among the rural sub-sample in understanding science concept-related words. Therefore further research is recommended to determine the effects of these factors on children's science concept formation.

3. An in-depth study into the effect of parental background, socio-cultural aspects of the native language on rural Junior Secondary School students' understanding of science concept-related words is recommended. This is to further explain the disparity between the urban and rural samples' interpretation of science concept-related words.

In summary, the presence or absence of congruent concepts in the native language of the student can facilitate or hinder proper science concept formation, also a rich language environment promotes language development and hence better understanding of science concept-related words.

Therefore there is an urgent need for Science Educators to develop a common functional scientific literacy as a medium of instruction for science concept formation if the future leaders of the nation are to interact favorably with the ever-changing global science and technology.

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APPENDIX 1

TEST A

DEPARTMENT OF SCIENCE EDUCATION

UNIVERSITY OF CAPE COAST

THE MEANINGS GHANAIAN JUNIOR SECONDARY SCHOOL STUDENTS GIVE TO SCIENCE CONCEPT-RELATED WORDS AND THEIR IMPLICATIONS FOR SCIENCE FORMATION

Name of School: ....

Sex: ❑ Male ❑ Female Age: ....

Form: ❑ 1 ❑ 2 ❑ 3

Father's Occupation: ....

The questions in this booklet are to find out your ideas about some words used in science. It is not a test so do not worry about your answers being right or wrong.

INSTRUCTIONS

Please read each question carefully and think about the word that is underlined. Put a tick in the box next to what you think is the best meaning of the word.

Put up you hand if you need help in understanding a question. Make sure you try every question. Do not spend too long on any one question.

Thank You.

1. *Average* can mean

- ❑ a. highest
- ❑ b. lowest
- ❑ c. normal
- ❑ d. best

2. *Disperse* can mean

- ❑ a. prepare
- ❑ b. collect
- ❑ c. change
- ❑ d. scatter

3. *Displace* can mean

- ❑ a. put into place
- ❑ b. take the place of
- ❑ c. spread
- ❑ d. break up

4. *Conserve* can mean

- ❑ a. save
- ❑ b. use quickly
- ❑ c. purify
- ❑ d. destroy

5. *Contaminate* can mean

- ☐ a. collect
- ☐ b. purity
- ☐ c. poison
- ☐ d. clean

6. *Effect* can mean

- ☐ a. result
- ☐ b. attack
- ☐ c. change
- ☐ d. frequent

7. *Essential* can mean

- ☐ a. usual
- ☐ b. permanent
- ☐ c. particular
- ☐ d. necessary

8. *Estimate* can mean

- ☐ a. careful measurement
- ☐ b. careful guess
- ☐ c. pour out carefully
- ☐ d. fill up carefully

9. *Convert* can mean

- ☐ a. leave
- ☐ b. change
- ☐ c. identical
- ☐ d. opposite

10. *Rate* can mean

- ☐ a. shape
- ☐ b. size
- ☐ c. speed
- ☐ d. distance

11. *Source* can mean

- ☐ a. what result you get
- ☐ b. what conclusion you make
- ☑ c. where it comes from
- ☐ d. what you make

12. *Prepare* can mean

- ☐ a. destroy
- ☐ b. break up
- ☐ c. react
- ☐ d. make

13. ***Separate*** **can mean**

- ❑ a. take apart
- ❑ b. join up
- ❑ c. make
- ❑ d. destroy

14. ***Surround*** **can mean**

- ❑ a. keep apart
- ❑ b. cover up
- ❑ c. mix
- ❑ d. encircle

15. ***Dehydrate*** **can mean**

- ❑ a. change to a gas
- ❑ b. dried out
- ❑ c. wet
- ❑ d. too much water

16. ***Function*** **can mean**

- ❑ a. what job it does
- ❑ b. how important it is
- ❑ c. how it is made
- ❑ d. what is wrong

17. *Proportion* can mean

- ❑ a. the correct amount
- ❑ b. similar amount
- ❑ c. an unfavorable portion
- ❑ d. a certain amount

18. *System* can mean

- ❑ a. group of vague ideas
- ❑ b. total
- ❑ c. set of connected things
- ❑ d. pattern

19. *Generate* can mean

- ❑ a. destroy
- ❑ b. make
- ❑ c. examine
- ❑ d. reduce

20. *Device* can mean

- ❑ a. an appliance
- ❑ b. a luxury
- ❑ c. a list
- ❑ d. a method

21. *Crude* can mean

- ❑ a. refined
- ❑ b. exceptional
- ❑ c. finished
- ❑ d. natural

22. *Efficient* can mean

- ❑ a. difficult
- ❑ b. wasteful
- ❑ c. capable
- ❑ d. worthwhile

23. *Independent* can mean

- ❑ a. free
- ❑ b. relies on
- ❑ c. relative
- ❑ d. hanging down

24. *Absorb* can mean

- ❑ a. give out
- ❑ b. take in
- ❑ c. mix with
- ❑ d. take apart

25. *Constant* can mean

- ❑ a. increase
- ❑ b. decrease
- ❑ c. same
- ❑ d. first one thing, then the other

APPENDIX 2

TEST B

DEPARTMENT OF SCIENCE EDUCATION

UNIVERSITY OF CAPE COAST

THE MEANING GHANAIAN JUNIOR SECONDARY SCHOOL STUDENTS GIVE TO SCIENCE CONCEPT-RELATED WORDS AND THEIR IMPLICATIONS FOR SCIENCE CONCEPT FORMATION

Name of School: ....

Sex: ❑ Male ❑ Female Age: ....

Form: ❑ 1 ❑ 2 ❑ 3

Father's Occupation: ....

The questions in this booklet are to find out your ideas about some words used in science. It is not a test so do not worry about your answers being right or wrong.

INSTRUCTIONS

Please read each question carefully and think about the word that is underlined. Put a tick in the box next to what you think is the best meaning of this word.

Put up your hand if you need help in understanding a question. Make sure you try every question. Do not spend too long on any one question.

Thank You.

1. *The rainfall in Navrongo was average for June.*

This means it was:

- ❑ a. the highest ever for June
- ❑ b. about normal for June
- ❑ c. the lowest ever for June
- ❑ d. higher than for any other month

2. *The wind disperses the seeds.* This means it makes them:

- ❑ a. smaller
- ❑ b. burst
- ❑ c. scatter
- ❑ d. stay where they were

3. *When the stone is lowered into a beaker of water, it displaces some of the water.*

This means it:

- ❑ a. reacts with some of the water
- ❑ b. simply falls through the water to the bottom of the beaker
- ❑ c. gets bigger
- ❑ d. pushes away some of the water

4. *The people of the village were asked to conserve water.* This means they were asked to:

- ❑ a. use it carefully and make it last
- ❑ b. make it pure for drinking
- ❑ c. use it straight away before it could evaporate
- ❑ d. keep it and not use it

5. *The village water supply is <u>contaminated</u>.* This means;

- ☐ a. it must be cooled before it can be drunk
- ☐ b. chemicals have been added to make it safe to drink
- ☐ c. it contains micro-organisms and is not safe to drink
- ☐ d. it is enough to let it settle before it can be drunk

6. *Mensah was asked to explain the <u>effect</u> of evaporation.* This means he was asked to explain;

- ☐ a. what can change the way evaporation takes place
- ☐ b.. what happens as a result of evaporation
- ☐ c. what happens during evaporation
- ☐ d. how hard it is for evaporation to take place

7. *A person who does not eat each of the <u>essential</u> types of food will become ill.* This means these types of food are;

- ☐ a. advisable
- ☐ b. usual
- ☐ c. customary
- ☐ d. necessary

8. *Mensah was asked to <u>estimate</u> the volume of water in the beaker.* This means he was asked to;

- ☐ a. make a careful guess of the volume
- ☐ b. measure the volume carefully
- ☐ c. pour the water into the sink
- ☐ d. fill the beaker from the tap

9. *Potential energy is <u>converted</u> into kinetic energy.* This means;

- ❑ a. potential energy and kinetic energy are identical
- ❑ b. potential energy cannot be changed into kinetic energy
- ❑ c. potential energy can be changed into kinetic energy
- ❑ d. potential energy is obtained from kinetic energy

10. *The experiment is designed to study the <u>rate</u> of evaporation.* This means it is designed to study;

- ❑ a. what happened during evaporation
- ❑ b. how quickly evaporation takes place
- ❑ c. what is left after evaporation is complete
- ❑ d. why evaporation takes place

11. *The doctor knows the <u>source</u> of the infection.* This means she knows;

- ❑ a. what the result of the infection will be
- ❑ b. where the infection has come from
- ❑ c. how to cure the infection
- ❑ d. how much it will cost to cure the infection

12. *Jane is asked to describe the <u>preparation</u> of oxygen.* This means she has to say;

- ❑ a. how it is made
- ❑ b. what it is used for
- ❑ c. how it behaves
- ❑ d. what substances are needed to make it

13. *Martin is given some soil in water and asked to* *__separate__* *the two substances.* **This means he is asked to;**

- ❑ a. **get rid of them both**
- ❑ b. **shake the two substances together**
- ❑ c. **get them to react together**
- ❑ d. **obtain a sample of dry soil and a sample of pure water**

14. *The earth is* *__surrounded__* *by air.* This means;

- ❑ a. **the earth and the air cannot mix**
- ❑ b. **the earth's surface is changed by the air**
- ❑ c. **the air forms a layer above the earth**
- ❑ d. **the earth and the air are mixed together**

15. *The child is* *__dehydrated__*. *This means it:*

- ❑ a. **has just drunk a lot of water**
- ❑ b. **has too much water in its body**
- ❑ c. **has the right amount of water in its body**
- ❑ d. **has not enough water in its body**

16. *Beatrice knows the* *__functions__* *of the heart.* This means she knows;

- ❑ a. **what the heart does**
- ❑ b. **what is wrong with the heart**
- ❑ c. **what influence the heart**
- ❑ d. **how the heart is made up**

17. *Ama was worried about the proportion of fat in her diet.* **This means she was worried by;**

- ❑ a. the presence of fat in her diet
- ❑ b. the absence of fat in her diet
- ❑ c. the amount of fat in her diet
- ❑ d. what the fat in her diet might do

18. *The teacher described the human digestive system. This means she described;*

- ❑ a. what humans eat
- ❑ b. what forms a balanced diet
- ❑ c. what the different foods we eat will do
- ❑ d. how the organs involved in breaking down food are linked together

19. *Animals generate heat through respiration.* This means they;

- ❑ a. produce heat
- ❑ b. gain heat
- ❑ c. lost heat
- ❑ d. do not need heat

20. *The thermos flask is a useful device for keeping liquids cold.* This means it is;

- ❑ a. a luxury
- ❑ b. an appliance
- ❑ c. a method
- ❑ d. an opportunity

21. *Oil that is found in the earth is called <u>crude</u> oil.* **This means it is;**

- ❑ **a. refined**
- ❑ **b. exceptional**
- ❑ **c. finished**
- ❑ **d. natural**

22. *The electrician fits the water heater in the most <u>efficient</u> position.* **This means he fits it;**

- ❑ **a. in the easiest position**
- ❑ **b. in the most common position**
- ❑ **c. in the best position**
- ❑ **d. in the least likely position**

23. *As the baby grows, it becomes more <u>independent</u>.* This means it:

- ❑ a. needs less attention from the mother
- ❑ b. needs more attention from the mother
- ❑ c. is growing faster than you might expect
- ❑ d. is growing slower than you might expect

24. *The soil <u>absorbs</u> water.* This means it:

- ❑ a. gets rid of water
- ❑ b. takes in water
- ❑ c. mixes with water
- ❑ d. does not mix with water

25. *The loss of heat was a* constant. This means it;

- ☐ a. was increased
- ☐ b. was decreasing
- ☐ c. was not increasing or decreasing
- ☐ d. was increasing and decreasing at different times.

APPENDIX 3
LIST OF WORDS USED IN THE STUDY

1. Average
2. Disperse
3. Displace
4. Conserve
5. Contaminate
6. Effect
7. Essential
8. Estimate
9. Convert
10. Rate
11. Source
12. Prepare
13. Separate
14. Surround
15. Dehydrate
16. Function
17. Proportion
18. System
19. Generate
20. Device
21. Crude
22. Efficient
23. Independent
24. Absorb
25. Constant

APPENDIX 4

DEPARTMENT OF SCIENCE EDUCATION

FACULTY OF EDUCATION

UNIVERSITY OF CAPE COAST

Our Ref. SED/49.1/VOL.2/33 Date: 31st Oct., 1994

The District Director
Navrongo District
G. E. S.
P. O. Box 56
Navrongo, U. E. R.

RESEARCH VISIT

We are introducing the bearer Ngman-Wara Ernest I. D. N. who is a student of th Department. He is embarking on a research which will require the participation of staff in yo department.

We would be very grateful if you could give him your usual co-operation.

Thank you.

Yours faithfully

(Sgd. Head)

APPENDIX 5

GHANA EDUCATION SERVICE
District Education Office
P. O. Box 56
Navrongo
7th November, 1994

NED/201/20

LETTER OF INTRODUCTION - RESEARCH VISIT

I am introducing to you the bearer Mr. Ngman-Wara Ernest T. D. N. a student of the Cape Coast University undertaking a research in your school.

I will be pleased if you can give him your fullest co-operation.

(sgd) C. A. Atirimbey

Assistant Director (Manpower)
for Ag. District Director/Navrongo

THE HEAD OF:

1. St. Mary's JSS
2. Balobia JSS
3. Dokomolo JSS
4. Adda JSS
5. Eng/Arabic JSS
6. Msgr. Abatey JSS
7. Manyoro JSS
8. Katiu JSS
9. Tedam JSS
10. Kologa JSS
11. Kayoro JSS
12. Natugnia JSS

cc: The Regional Manager
C E U
P. O. Box 46
Navrongo

APPENDIX 6

Frequency Distribution of Students' Scores for Tests A and B

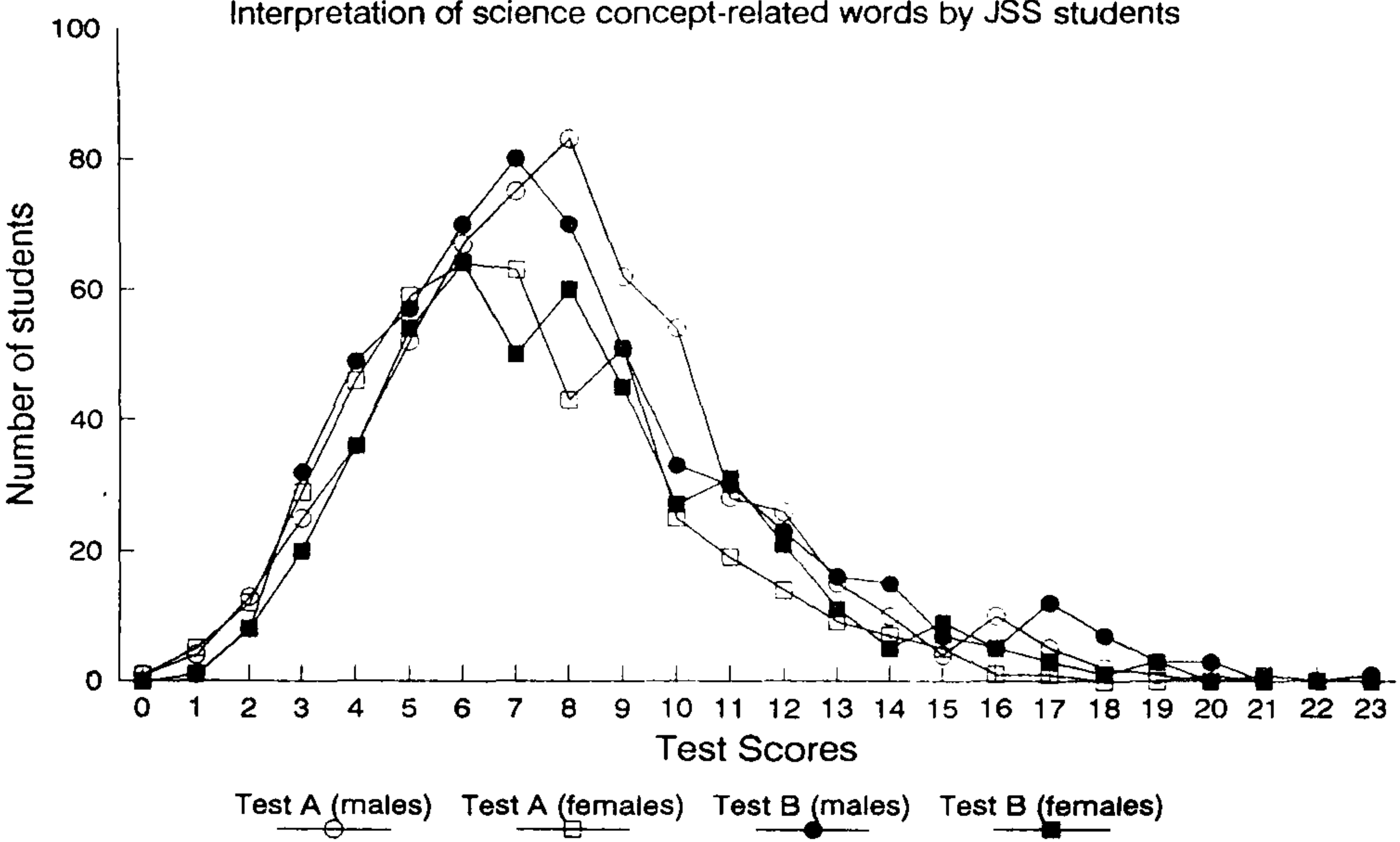
	Test A		Test B	
Test Score	No. of Students	% Frequency	No. of Students	% Frequency
0	2	0.19	0	0
1	9	0.88	2	0.19
2	25	2.43	16	1.56
3	54	5.25	53	5.16
4	82	7.98	84	8.17
5	111	10.8	111	10.8
6	131	12.74	134	13.03
7	140	13.62	130	12.64
8	124	12.06	130	12.64
9	112	10.9	96	9.34
10	80	7.78	60	5.84
11	47	4.57	61	5.93
12	40	3.89	44	4.28
13	24	2.34	27	2.63
14	17	1.65	20	1.95
15	9	0.88	16	1.56
16	11	1.07	11	1.07
17	6	0.58	15	1.46
18	2	0.19	7	0.68
19	1	0.1	5	0.48
20	1	0.1	4	0.39
21	0	0	1	0.1
22	0	0	0	0
23	0	0	1	0.1
Total	1,028	100	1,028	100

APPENDIX 7

STUDENTS' PERCENTAGE INTERPRETATIONS OF THE WORDS USED IN THE STUDY

	% CORRECT	
Word Tested	**Test A**	**Test B**
Average	29.7	31.2
Displace	41.1	33
Disperse	25.9	42
Conserve	36.2	35.8
Contaminate	30.2	32.9
Effect	16.6	25.8
Essential	40	40.8
Estimate	20.8	26.3
Convert	24.9	28.5
Rate	20.3	28.1
Source	36.2	32.6
Prepare	51.9	29.9
Separate	47.2	35.6
Surround	26.5	24
Dehydrate	19.4	24.2
Function	24.9	37.2
Proportion	19.2	26.8
System	34.3	38.8
Generate	21.6	42.2
Device	34.8	22.3
Crude	22.4	39.1
Efficient	18.1	37
Independent	58	27.7
Absorb	27.9	27
Constant	19.9	21.3
Average % of Frequency	29.9	31.6

Appendix 8



Interpretation of science concept-related words by JSS students
100
80
60
40
20
0
Number of students
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Test Scores
Test A (males)
Test A (females)
Test B (males)
Test B (females)

APPENDIX 9
FREQUENCY DISTRIBUTION OF STUDENTS' SCORES IN TESTS A AND B

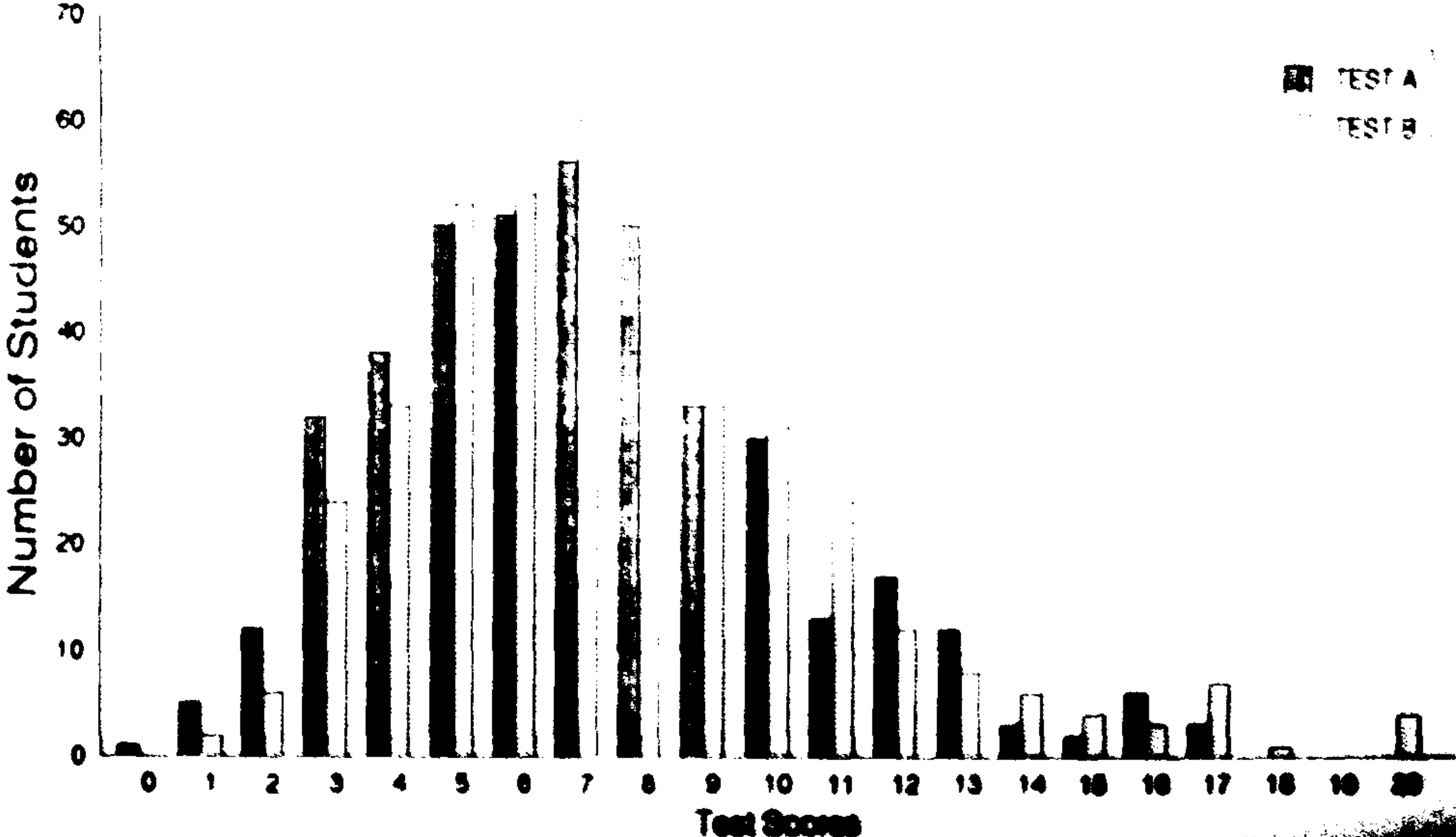
Scores	Frequency							
	Test A				Test B			
	Males	% Frequency	Females	% Frequency	Males	% Frequency	Females	% Freque
0	1	0.17	1	0.22	0	0	0	0
1	4	0.7	5	1.1	1	0.17	1	0.22
2	13	2.27	12	2.64	8	1.4	8	1.76
3	25	4.36	29	6.37	32	5.58	20	4.4
4	36	6.28	46	10.11	49	8.55	36	7.91
5	52	9.08	59	12.97	57	9.95	54	11.87
6	67	11.69	64	14.07	70	12.22	64	14.07
7	75	13.09	63	13.85	80	13.96	50	10.99
8	83	14.49	43	9.45	70	12.22	60	13.19
9	62	10.82	51	11.21	51	8.9	45	9.89
10	54	9.42	25	5.49	33	5.76	27	5.93
11	28	4.89	19	4.18	30	5.24	31	6.81
12	26	4.54	14	3.08	23	4.01	21	4.62
13	15	2.62	9	1.98	16	2.79	11	2.42
14	10	1.75	7	1.54	15	2.62	5	1.1
15	4	0.7	5	1.1	7	1.22	9	1.98
16	10	1.75	1	0.22	5	0.87	5	1.1
17	5	0.87	1	0.22	12	2.09	3	0.66
18	2	0.35	0	0	7	1.22	1	0.22
19	1	0.17	0	0	3	0.52	3	0.66
20	0	0	1	0.22	3	0.52	0	0
21	0	0	0	0	0	0	1	0.22
22	0	0	0	0	0	0	0	0
23	0	0	0	0	1	0.17	0	0
Total	573	100	455	100	573	100	455	100

APPENDIX 10
FREQUENCY OF RURAL JUNIOR SECONDARY SCHOOL STUDENTS' SCORES IN TESTS A AND B

Scores	Frequency							
	Test A				Test B			
	Males	% Frequency	Females	% Frequency	Males	% Frequency	Females	% Frequency
0	1	0.4	0	0	0	0	0	0
1	4	1.62	1	0.62	1	0.4	1	0.62
2	5	2.02	7	4.32	3	1.21	3	0.19
3	12	4.86	20	12.35	14	5.67	9	5.56
4	19	7.69	19	11.73	18	7.29	16	9.88
5	26	10.53	24	14.81	24	9.72	28	17.28
6	24	9.72	27	16.67	29	11.74	24	14.81
7	34	13.77	20	12.35	41	16.6	19	11.73
8	36	14.57	16	9.88	32	12.96	14	8.649
9	22	8.91	12	7.41	17	6.88	16	9.88
10	20	8.1	9	5.56	18	7.29	13	8.02
11	11	4.45	2	1.23	12	4.86	12	7.41
12	13	5.26	4	2.47	7	2.83	5	3.09
13	6	2.43	1	0.62	6	2.43	2	1.23
14	3	1.21	0	0	6	2.43	0	0
15	2	0.81	0	0	4	1.62	0	0
16	6	2.43	0	0	2	0.81	0	0
17	3	1.21	0	0	7	2.83	0	0
18	0	0	0	0	2	0.81	0	0
19	0	0	0	0	1	0.4	0	0
20	0	0	1	0	3	1.21	0	0
Total	247	100	162	100	274	100	162	100

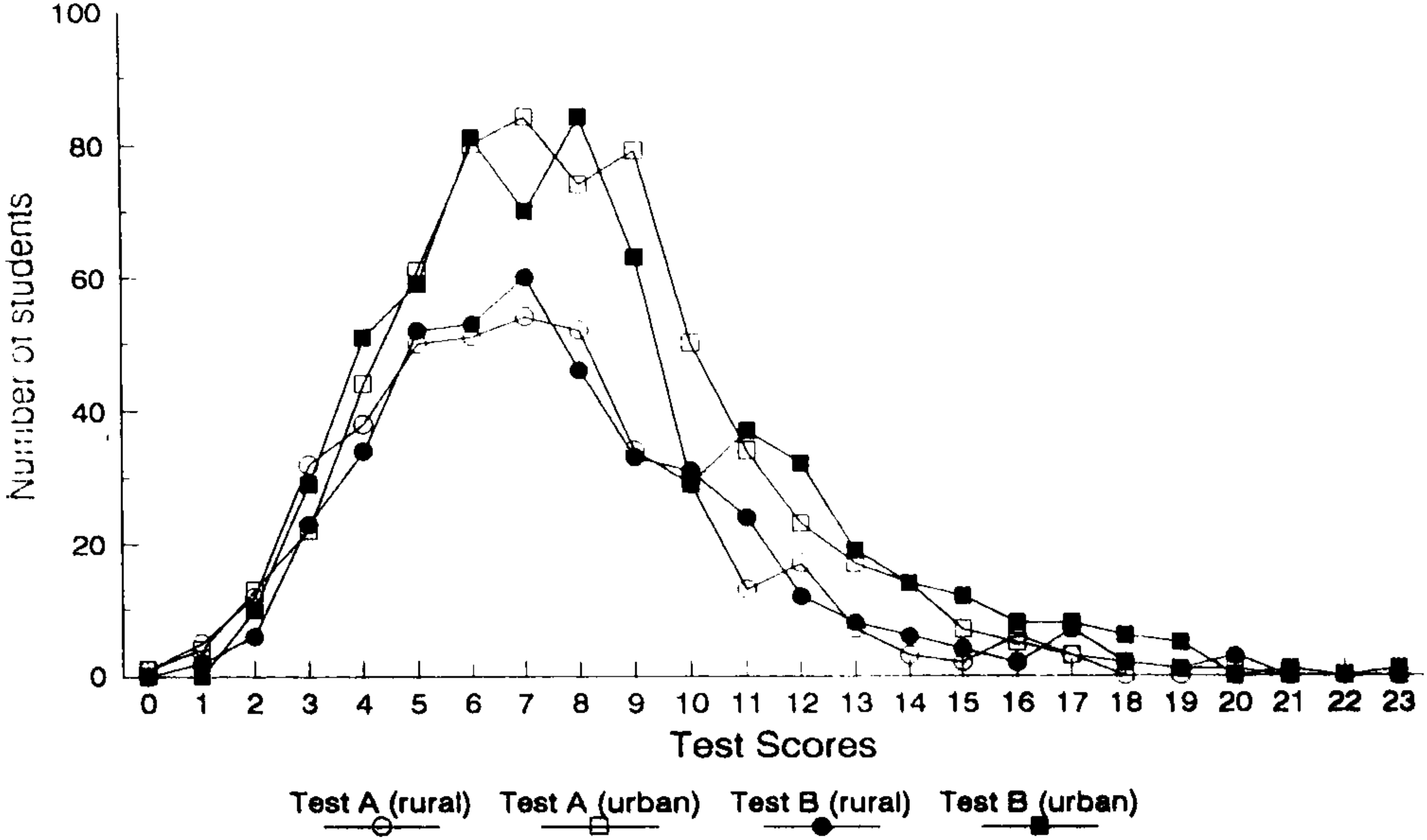
Appendix 11

Students' Correct Interpretation of Science Concept-related Words (Rural JSS)



Appendix 12

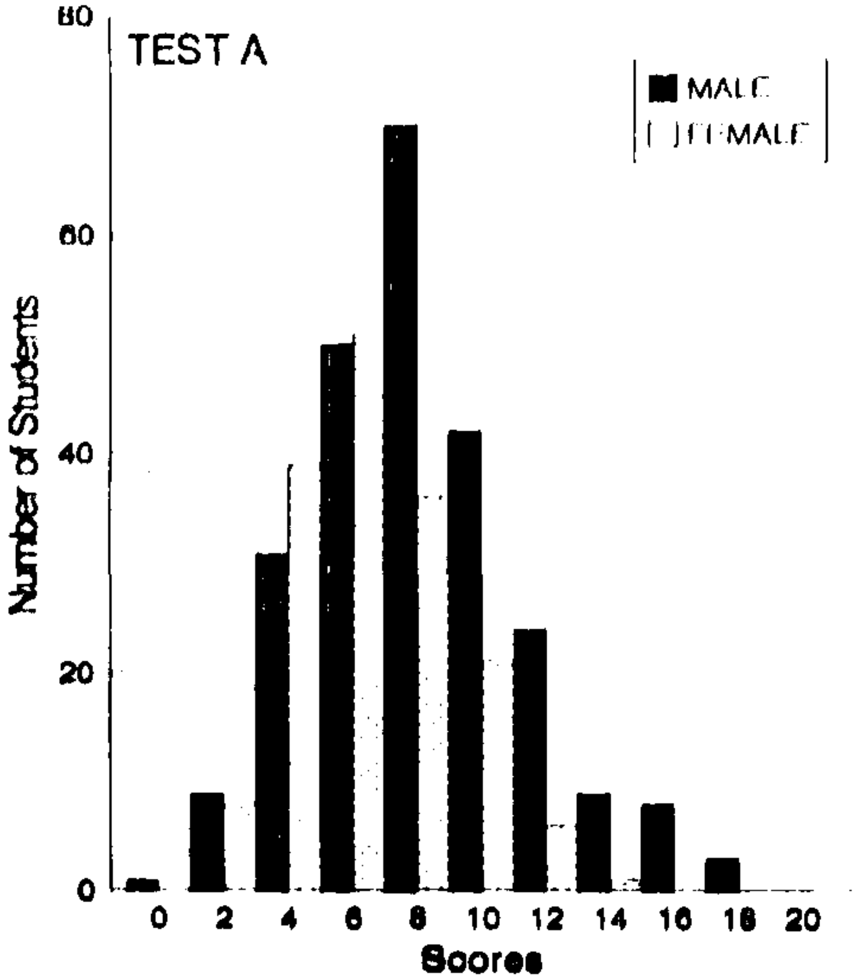
Interpretation of science concept-related words by JSS students

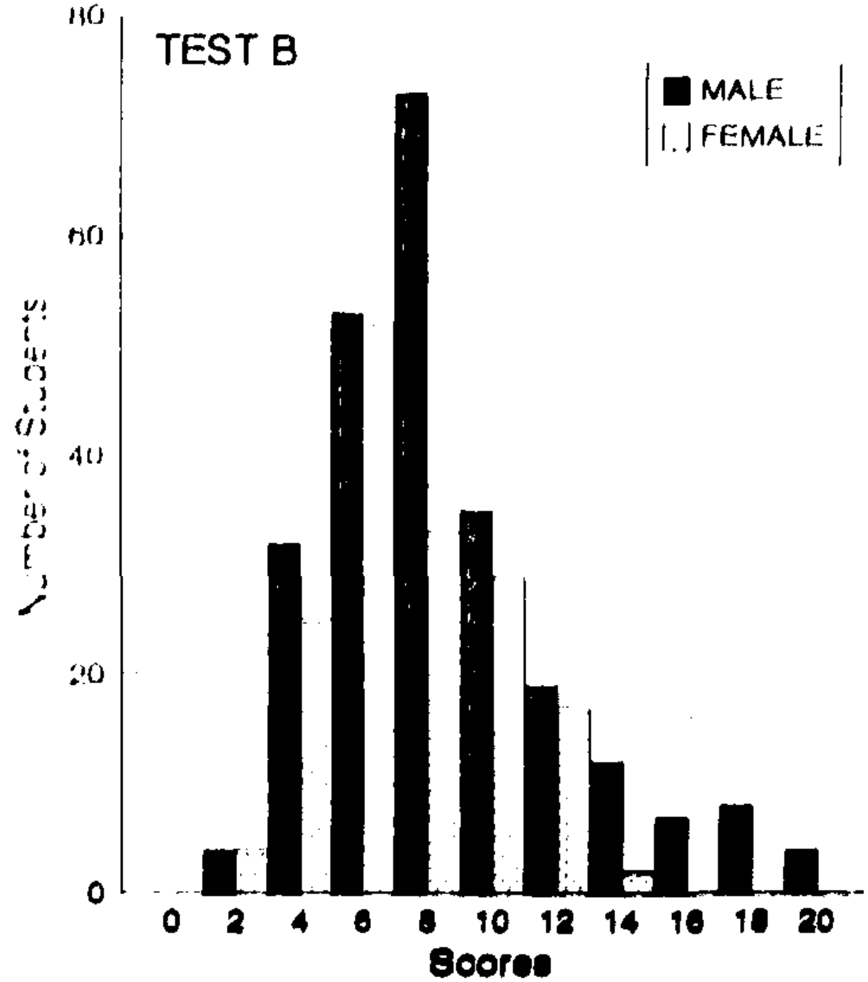


Appendix 13

Interpretation of Science Concept-related Words

by Rural JSS Students

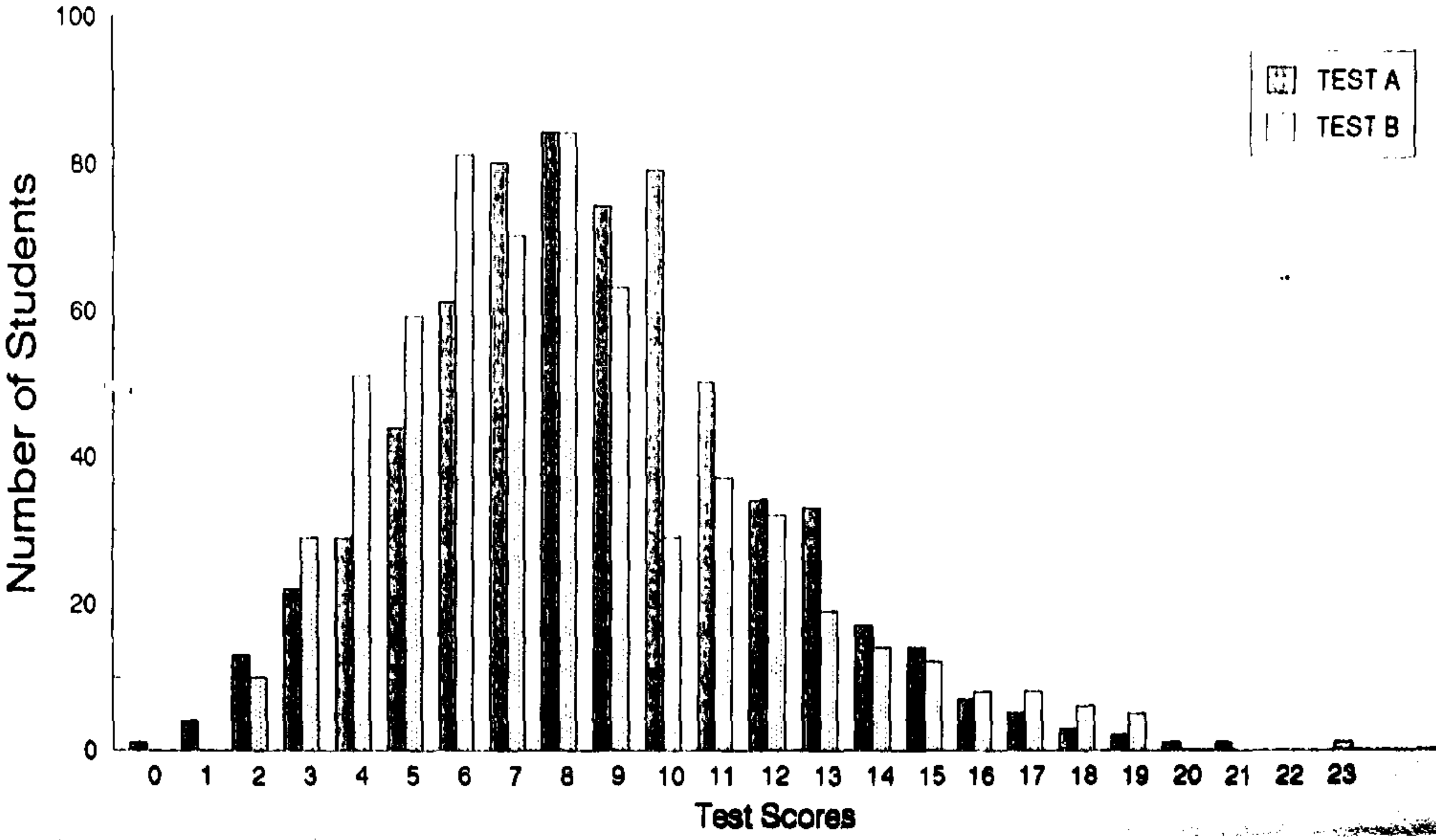




APPENDIX 14
FREQUENCY DISTRIBUTION OF URBAN JUNIOR SECONDARY SCHOOL STUDENT: SCORES IN TEST A AND B

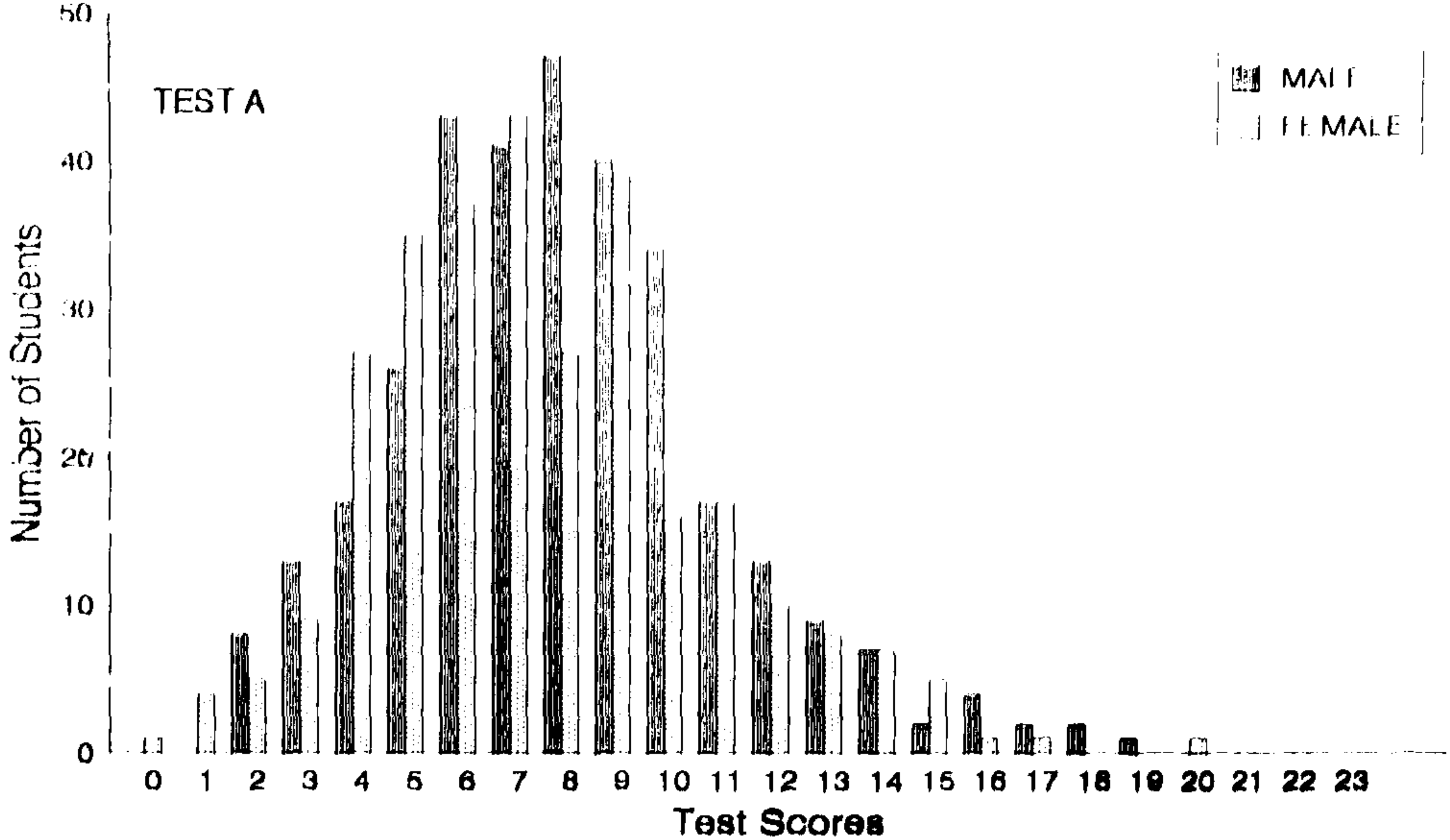
Scores	Frequency							
	Test A				Test B			
	Males	% Frequency	Females	% Frequency	Males	% Frequency	Females	% Freque
0	0	0	1	0.34	0	0	0	0
1	0	0	4	1.37	0	0	0	0
2	8	2.45	5	1.71	5	1.53	5	1.71
3	13	3.99	9	3.07	18	5.52	11	3.75
4	17	5.21	27	9.22	31	9.5	20	6.83
5	26	7.98	35	11.95	33	10.12	26	8.87
6	43	13.19	37	12.63	41	12.58	40	13.65
7	41	12.58	43	14.68	39	11.96	31	10.58
8	47	14.42	27	9.22	38	11.66	46	15.7
9	40	12.27	39	13.31	34	10.43	29	9.9
10	34	10.43	16	5.48	15	4.6	14	4.78
11	17	5.21	17	5.8	18	5.52	19	6.48
12	13	3.99	10	3.41	16	4.91	16	5.46
13	9	2.76	8	2.73	10	3.07	9	3.07
14	7	2.15	7	2.39	9	2.76	5	1.71
15	2	0.61	5	1.71	3	0.92	9	3.07
16	4	1.23	1	0.34	3	0.92	5	1.71
17	2	0.61	1	0.34	52	1.53	3	1.02
18	2	0.61	0	0	5	1.53	1	0.34
19	1	0.31	0	0	2	0.61	3	1.02
20	0	0	1	0.34	0	0	0	0
21	0	0	0	0	0	0	1	0.34
22	0	0	0	0	0	0	0	0
23	0	0	0	0	1	0.31	0	0
Total	326	100	293	100	326	100	293	100

Appendix 15
Students' Correct Interpretation of Science Concept-related Words (Urban JSS)



Appendix 16

Students' Correct Interpretation of Science Concept related Words (Urban JSS)



Appendix 17

Students' Correct Interpretation of Science Concept-related Words (Urban JSS)