

AN INVESTIGATION INTO THE RELATIONSHIP BETWEEN CONCEPT  
MAPPING STRATEGY AND PERFORMANCE OF STUDENTS ON AN OBJECTIVE  
TEST

BY

Oliver Mubita Kalabo

**216371**

A dissertation submitted to the University of Zambia in  
partial fulfilment of the requirements of the degree of  
Master of Education

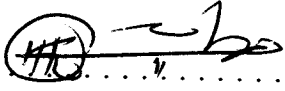
THE UNIVERSITY OF ZAMBIA

LUSAKA

1994

DECLARATION

I, Oliver Mubita Kalabo, declare that this dissertation has been composed by me and that the work recorded is my own. All quotations have been distinguished by quotation marks. The sources of all materials used have been specifically acknowledged and the dissertation has not been previously submitted for a degree at this or another university.

Signature:..........

Date:.....25. 8. 94.....

**APPROVAL**

This dissertation of Kalabo, Mubita Oliver is approved as fulfilling part of requirements for the award of the degree of Master of Education by the University Zambia.

Examiners

Signature: *[Handwritten Signature]* ..... Date: 30/9/94 .....

Signature: *[Handwritten Signature]* ..... Date: 03/10/94 .....

Signature: *[Handwritten Signature]* ..... Date: 05/10/94 .....

Signature: ..... Date: .....

Date of Approval

.....

## DEDICATION

This dissertation is dedicated to my wife, Mosty,  
daughters, Matakala and Akoyawa, and to my parents.

## ABSTRACT

This study set out to assess the effectiveness of concept mapping as a learning strategy in a secondary school environment under conditions that had extremely high external validity without significantly sacrificing experimental control. The study also investigated the extent to which knowledge acquired through concept mapping was retained.

The subjects consisted of two Grade 10 girls' classes of 15 students. The quasi-experimental nonequivalent control group design was used. Both groups were given a pretest, posttest and after about a month another posttest. Besides the two objective posttests, the experimental group was also subjected to concept mapping evaluation. Research instruments were administered as proposed by Novak and Gowin (1984) with modifications to suit the local situation. The t-test pairwise comparisons of group means, gain score means and test item comparison means were used as the statistical procedure for analysing the data of the study.

The result of this study showed that exposure to concept mapping learning strategy did not make students perform

better on an objective test. However, students using concept mapping learning strategy reflected a better performance when evaluated by a concept mapping evaluational technique. The implications of these results are discussed and some suggestions for further research are advanced.

## ACKNOWLEDGEMENTS

The study reported in this dissertation would not have been carried out without the support of various people and institutions.

I would like to thank Dr. R.F. Zimba for supervising my work and Dr. R.C.M. Siachiwena for supervising my corrections. My parents, O. Kalabo Kalabo and M. Matakala Noanga, deserve special thanks for teaching me to find pleasure in excellence. Without the participation of teachers and students from Caritas Secondary School, this study would not have been done. I sincerely appreciate these people's help.

Institutions that need to be acknowledge for their help are the Ministry of Education, Directorate of Human Resources Development and the University of Zambia. I thank my employers, the Ministry of Education, for financing my study leave. I am also grateful to the Directorate of Human Resources Development for offering me a scholarship. The School of Education-University of Zambia should be thanked for giving me a graduate teaching assistantship.

Lastly, to all those individuals who contributed to this work, thank you.

## TABLE OF CONTENTS

DEDICATION	iv
ABSTRACT	v
ACKNOWLEDGEMENTS	vii
LIST OF TABLES	xi
LIST OF FIGURES	xi
CHAPTER ONE: INTRODUCTION	1
Background to the Problem	1
Definition of terms	4
Statement of the Problem	5
Hypotheses	7
Rationale of the Study	7
Assumptions of the Study	10
Limitation of the Study	10
CHAPTER TWO: LITERATURE REVIEW	12
Literature Related to the Learning Theory	12
Literature Related to Concept Mapping	24
Literature Related to Concept Mapping Evaluation	29

Scoring Concepts Maps as Related to Learning Theory	31
<b>CHAPTER THREE: METHODOLOGY</b>	34
The Population	34
The Sample	34
Research Design	35
Research Measures	36
Procedure	41
<b>CHAPTER FOUR: RESULTS</b>	42
A Descriptive Summary of the Data	42
Test of the Statistical Hypotheses	45
Test of Comparisons on Test Items	48
<b>CHAPTER FIVE: DISCUSSION, AND CONCLUSIONS</b>	51
Discussion	51
Conclusions	54
Suggestions for further Research	55

## BIBLIOGRAPHY

57

## APPENDICES

A	Concept Mapping Questions	67
B	Objective Test	68
C	Strategies for Introducing Concept Mapping	84
D	Content Instruction of Landforms of Glaciation	90
E	Hierarchy of Concepts and Points Awarded	92
F	Scoring Algorithm for Interlinkages between Concepts	93
G	Students Concept Maps	94
H	Students Raw Scores and Percentages	
I	T-Test Results	99
J	T-Test Results on Test Items Comparison	101

## LIST OF TABLES

1.	Arithmetic means of the two groups on the measures made in the study	43
2.	Gain Score means of the two groups on the measures made in the study	44
3.	Test item comparison means	46
4.	Summary results of t-test	50

## LIST OF FIGURES

1.	A Concept Map Representing Ausubels's Theory of Assimilation	13
2.	Novak's Theory of Conceptual Education	25
3.	Test by Group mean Scores	43

## CHAPTER ONE

### INTRODUCTION

#### BACKGROUND TO THE PROBLEM

A major scientific revolution occurred in psychology over two decades ago. The behaviouristic, mechanistic model of humans, with its reduction of learning to simple, reflexible, and quantifiable activity was replaced by an active organism model. This is a constructivist model that conceives learners as organised entities who actively participate in the construction of their reality (Reese and Overton, 1970). This cognitive model assumes that learning entails knowing. Knowing is a process of constructing systems of transformation that model reality (Piaget, 1970).

One major implication of this cognitive revolution for education is the emergence of learning strategies, which are rooted firmly in cognitive information-processing theory. Learning strategies promote the practising of specialised skills for integrating information into and rearranging a learner's cognitive structure.

Learning strategies represent complex mental operations that assist learners to perceive, store, retain, and recall

different forms of knowledge and performance. Unlike traditional instructional techniques, learning strategies are not intended to teach learners specific course content. Rather, they are generalizable, transferable mental skills designed to teach learners how to learn. They may include information-processing strategies such as integrative or organisational skills; support strategies such as test-taking or time structuring; metacognitive strategies such as monitoring comprehension of reading; and active study strategies such as note-taking, outlining, or mapping as in concept mapping. These specific information-processing competencies represent preferred or at least effective methods for acquiring and applying knowledge that may be taught to and practised by learners. They are not specific to a content area, medium of delivery, or type of learner (Johassen 1985).

Many educational psychologists have researched and written a lot on learning strategies (for example, Ausubel, 1963; Brunner, 1973; Ausubel, Novak and Hanesian, 1978; and Novak and Gowin, 1984). Research has been directed towards understanding these learning strategies and how they contribute to meaningful learning. One such strategy is concept mapping (Bogden 1977, Cardemone 1975 quoted by Novak and Gowin 1984, Gurley 1982, Loncaric 1986, and Musonda 1986).

Claims have been made that concept mapping has come to be

viewed as an appropriate learning strategy for assessing the effectiveness of meaningful learning (Novak and Gowin 1984). It can increase awareness of and capacity for meaningful learning (Loncaric 1986, and Novak and Gowin 1984). The lack of specificity, however, with regard to measurement of the learning outcome has led to some confusion among investigators. This confusion arises because concept mapping performance is not the same performance measured by other assignments. For example Gurley (1982) in his research on the use of Gowin Vee and concept mapping strategies to teach students responsibility for learning in high school biological sciences, found no significant difference on objective test performance between the control and the experimental group.

In their Taxonomy of Educational Objectives Bloom, et al. (1956), outlined six levels of objectives in education, namely, Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. Most objective tests used in these research studies test Bloom's Level I objective (rote recall of specific information), but rarely test to determine whether new knowledge has been analysed, synthesised, and evaluated by students (Novak and Gowin 1984).

The validity of the six levels of Bloom's taxonomy has been widely and justifiably criticised. This work is referred to only because it is widely cited in educational literature and

because it is well recognised that evaluation of "higher" objectives is at best difficult.

## DEFINITION OF TERMS

For the purpose of this study, and in line with the theoretical framework outlined in chapter Two, the following definitions will be used:

1. Concept Maps refer to meaningful relationships between concepts in the form of propositions. In its simplest form, a concept map would be just two concepts connected by a link word to form a proposition. For example, "Sky is Blue" would represent a simple concept map forming a valid proposition about two concepts "sky" and "blue" (Novak and Gowin 1984). In short a concept map is a schematic device for representing meanings embedded in a framework of propositions.
2. Concept Mapping is a technique for externalising concepts and propositions (Novak and Gowin 1984).
3. Meaningful Learning refers to the process of relating new knowledge to relevant concepts and propositions which persons already know (Novak and Gowin 1984).

4. Retention of knowledge refers to the process of maintaining the availability of the new meanings or some part of them(Novak and Gowin 1984).
5. Concept Mapping Evaluation refers to the process whereby learning is evaluated using concept mapping scoring criteria when applied with an understanding of meaningful learning principles(Novak and Gowin 1984).
6. Cognitive Structure is the knowledge which consists of facts, propositions, theories, and raw perceptual data that the learner has available to him at any point in time. Concept maps are a way to represent this knowledge structure(Novak and Gowin 1984).

#### **STATEMENT OF THE PROBLEM**

It is known from experience that the teaching of geography poses a challenge to many teachers in Zambia today. A topic such as glaciation from the physical geography component is one such example in which the teacher has to use his/her ingenuity to effectively enable pupils conceptualise what is alien to their immediate environment. Teachers are always faced with a problem of finding methods (strategies) which can help learners master geographical concepts with easy. One such strategy is concept mapping. The purpose of this study

was therefore to assess the effectiveness of concept mapping in a secondary school environment under conditions that had extremely high external validity without significantly sacrificing experimental control.

The study also investigated the extent to which knowledge acquired through concept mapping is retained. Because it requires students to perform at all six levels of Bloom's taxonomy of educational objectives, concept mapping makes meaningful learning and evaluation of this learning possible. It is crucial for investigators to pin point specific learning outcomes of concept mapping and to begin to measure these outcomes with instruments which are reliable and valid.

Specifically, this study seeks to answer the following questions:

1. Does exposure to concept mapping learning strategy make students perform better on an objective test?
2. Can concept mapping learning strategy lead to meaningful learning?

## **HYPOTHESES**

The above question led to the following research hypotheses:

- H1. Students using concept mapping learning strategy perform better, on an objective test, than those that are not

using this strategy, soon after the geography unit instructions.

H2. Students who have used concept mapping learning strategy perform better, on an objective test, than those that have not used this strategy, one month after the Geography unit instructions.

H3. There will be no significant difference in performance, on the experimental group, between scores from an objective test and those from concept mapping evaluation soon after the Geography unit instructions.

#### **RATIONALE OF THE STUDY**

When educators such as Good and Brophy (1987) and Landa (1976) discuss the increasing discrepancy between what students are able to learn in school and what they should be learning, geography is a primary target. The importance and practical applicability of geography concepts in everyday life of adults becomes increasingly apparent, yet the failure rate on national examinations is high, about 40 percent for both grades 9 and 12 (G.R.Z./E.C.Z. 1991). Thus far, efforts to rectify the situation have been aimed at creating a better geography curriculum (like the forthcoming senior syllabus and already produced junior one), whereas little has been done

regarding the learning processes that underlie geography instruction (G.R.Z./E.C.Z. 1990). The large number of individuals in Zambian schools who fail to do well in their work may be attributed to lack of proper strategies for learning. In the epigraph to Educational Psychology: A Cognitive View, Ausubel (1978) says,

"If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly" (p.vi).

What Ausubel has done is to provide functional tools to help ascertain 'what the learner already knows'. Concept mapping is such an educational tool. It has been developed to help the learner and the teacher to see what they already know (Novak and Gowin 1984).

Some teaching methods emphasise compensating for or supplanting learning skills not present in learners. However, by attempting to compensate for mental skills deficient in learners in the design of instruction or presenting information the learners preferred modality, we reduce the amount of mental effort learners invest in learning, thereby reducing performance (Johassen 1985). If we perform the

mental work for the learner, then learning as such may not occur. Therefore, rather than reducing mental effort, teachers should attempt to increase the learner's repertoire of mental skills (through the use of learning strategies) with which he can construct knowledge.

It can be deduced from the preceding sections that the issues to be pursued in this study have relevance to educational policies beyond a particular teaching subject. Infact, according to Johassen (1985), learning strategies may be detached from the content such as explicit instructions to generate a question or form an image about material. Learning strategies may also be embedded in the content in the medium, so that learners must perform the mental operations in order to acquire the subject matter, such as a question that forces learners to relate new material to prior learning in order to proceed or solve a problem.

It is hoped that the results of the study would contribute to the development of knowledge in the field of educational psychology in a number of ways. It may, for example, help explain the extent to which students using concept mapping learn more meaningfully and the degree to which concept mapping can be employed as an evaluation tool. In practical terms the results of the study would be useful to those individuals in schools who find work difficult especially in

physical geography topics.

### **ASSUMPTIONS OF THE STUDY**

This study assumed that concept mapping learning strategy was:

- (a) learnable by students from instructions deliberately tailored for this purpose, and
- (b) testable through a paper-and-pencil testing instrument.

In addition, this research exercise was grounded in the following theoretical framework:

- (a) Ausubel's (1963, 1968, 1978) assimilation or subsumption theory of meaningful learning.
- (b) Novak's (1977) theory of conceptual education.

These theories are presented in the next chapter.

### **LIMITATIONS OF THE STUDY**

The findings of this study are limited by the following factors:

- (a) Since it was not feasible to assign students randomly to the experimental and control groups, results should be used with caution.

(b) Only a single-sex secondary school was selected by the researcher to participate in this study. Consequently, application of the findings of the study to other types of schools should be done cautiously.

(c) Only one physical geography topic was explored. Accordingly, the findings of the study may apply only to those related topics, and not to others.

## **CHAPTER TWO**

### **LITERATURE REVIEW**

This chapter reviews literature related to various aspects of the study. It first presents the main facets of Ausubel's (1968) theory of learning (also see figure 1). The work of Ausubel is very important as it gives the necessary theoretical framework. Other works relating to concept mapping and concept mapping evaluation as well as scoring concept maps are also reviewed.

#### **LITERATURE RELATED TO THE LEARNING THEORY**

Although there are many definitions of learning, most include the idea that learning is a change in behaviour of an organism that comes about as a result of experience (Gagne, 1967, Novak, 1977; Woolfolk and McCane-Nicolith, 1980). For Ausubel, however, learning refers to the process of acquiring particular meanings from the potential meanings presented in the learning material and making them more available. It represents an increment in the availability of new meanings (Ausubel, 1968). And this, according to Ausubel occurs more frequently by reception, not through discovery.

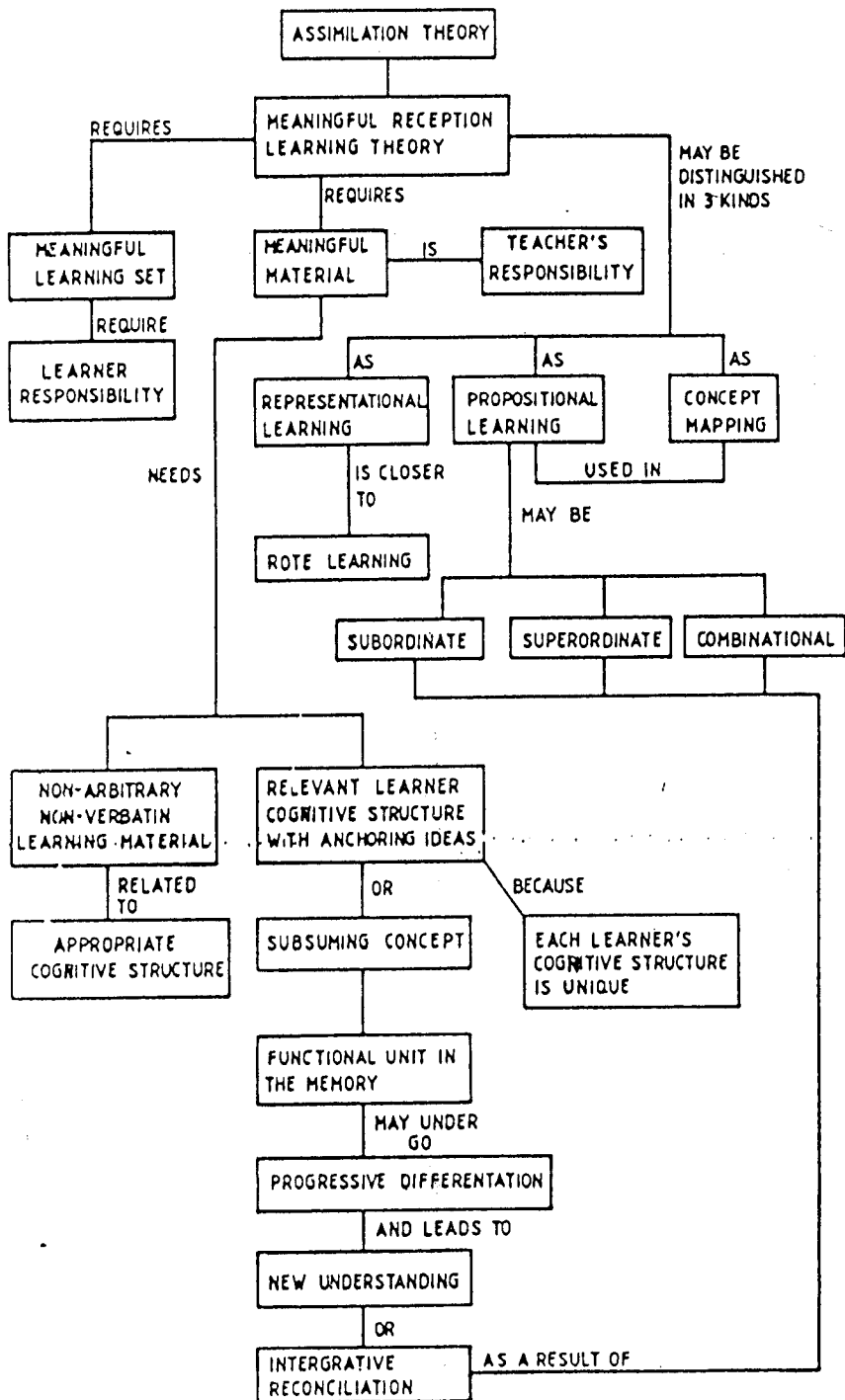


Fig.1. Ausubel's: Theory of Assimilation (Composed by Ausubel, 1968)

The key idea in Ausubel's theory is the nature of 'meaningful learning' as contrasted with 'rote learning' (Gagne, 1970; Novak, 1985). He makes a very important distinction between 'reception' and 'discovery' learning, on one hand and 'rote' and 'meaningful' learning on the other (Ausubel, 1962; 1967; 1968; Novak, 1977a; 1978). These fall on two different continua, with reception and discovery learning on one continuum and rote and meaningful learning on the other. The former represents the mode of instruction whereas the later represent the form in which information is acquired in cognitive structure (Novak, 1977a; 1978).

Ausubel (1967; 1968) argued that just like we may have rote or meaningful reception learning we can equally have rote and meaningful discovery learning depending on the conditions under which learning takes place, and suggested that a learner, therefore, does not have to discover something for it to be meaningful. According to Ausubel (1962; 1967; 1968) during 'reception learning' the learning content is presented to the learner in its final form. The learner only has to internalise the material so that it is reproducible at some later date, while 'discovery learning' involves the learner in discovering something previously unknown before incorporating it into cognitive structure. During 'meaningful reception learning' the potentially meaningful material is comprehended during the process of internalisation while during 'rote learning' the

task is either not 'potentially meaningful' or is not made meaningful during internalisation.

For some of the reasons cited elsewhere Ausubel advocates 'meaningful reception learning' for schools. His theory of learning, however, is restricted and applicable only to reception learning (Novak et al. 1972). It describes how prior knowledge influences subsequent learning (West and Fensham, 1972) and is limited to the nature and conditions of meaningful verbal reception learning and forgetting; 'it deals only with the problem of cognitive organisations and interaction' (Ausubel, 1962; p.213).

Ausubel's theory is based on the assumption that an individual's cognitive structure is hierarchically organised in terms of highly inclusive conceptual structures under which less inclusive subconcepts and informational data are incorporated (Ausubel, 1960, 1962, 1967, 1968). Before information and ideas are incorporated into cognitive structure, however, they have to be perceived (Ausubel, 1967, 1968). The initial process of perception, however, does not give rise to meaning. It simply results in the awareness that follows the interpretation of sensory input (Ausubel, 1967, 1968).

Following the perception of potential meanings is the process of 'cognition' in which the perceived meaning is incorporated under a relevant, more general and inclusive

idea already present in the cognitive structure. This process of incorporating new ideas under more general and inclusive idea in cognitive structure is called 'subsumption' and the ideas under which new information is subsumed, a 'subsumer' (Ausubel, 1962, 1968, Novak, 1977a, 1978). This process of subsumption is presumed to give rise to new meanings. If an individual's cognitive structure cannot support the incorporation of the new material meaningful learning cannot occur. What results is rote learning. When subsumed by a more inclusive concept a 'potentially meaningful unit' leads to a change in the unit as well as the entire 'ideational complex' giving rise to new meaning (Ausubel, 1962, 1967, 1968).

The newly learned material is initially dissociable from the linked relationship of a subsuming idea and may be reproducible as an individual identifiable entity. However, as subsumption progresses the new material tends to be incorporated into the generalised meaning of the subsuming concept and the specific items become less dissociable as individual entities until they are no longer available as distinct entities in their own right and are said to be forgotten (Ausubel, 1962, 1967, 1968; Novak 1977a, 1978). When this stage is reached 'obliterative subsumption' is said to have occurred. Although the details of the concepts may not be remembered, the residual elements will still serve to facilitate new relevant meaningful learning and the forgetting that follows

obliterative subsumption is referred to as 'meaningful forgetting'. Thus, subsumption facilitates both meaningful learning and retention of potentially meaningful material and provides a basis for forgetting (Ausubel, 1967,1968).

For Ausubel, therefore, meaningfully learned materials have been related to existing concepts in the cognitive structure of an individual in ways that make it possible to understand various relations by a process of subsumption. Rotely learned materials, on the other hand, are discrete and isolated entities that have not been related to established concepts in the cognitive structure. Because of this rotely learned materials are much more vulnerable to forgetting unless they are greatly overlearned. Rotely learned materials are isolated from cognitive structure and are therefore, primarily influenced by the interfering effects of similar rote materials learned previously or concurrently. The learning and retention of meaningful materials, on the other hand, is primarily influenced by the attributes of available relevant subsuming concept in the cognitive structure with which they interact.

The rote-meaningful learning distinction is not a simple dichotomy (Novak et.al. 1972; Novak, 1977a, 1978). Strictly speaking 'rote learning' occurs only when there are no relevant concepts in the learner's cognitive structure to which new ideas can be linked. Frequently,

however, some kind of relevant concept is present and depending on the extent to which the concept is stable, the resulting new learning can be at varying degrees of 'meaningfulness'. Thus, depending on the nature of the learner's existing knowledge in cognitive structure and how it interacts with the new knowledge there will be varying levels of 'meaningful learning' (Novak, et. al. 1972; West and Fensham, 1974; Novak, 1977a, 1978). As new knowledge is acquired during meaningful learning, development and elaboration of the subsuming concepts and propositions occurs as new linkages form between concepts, modifying the whole matrix of interconnected concepts in cognitive structure (Novak, 1977a, 1978). This process is presumed to start early in childhood and continues throughout adult life. Any given concept may never be 'acquired' as such, but is in the process of being differentiated (Novak, 1977a, 1978). In Ausubel's view, concept development proceeds best when the most inclusive elements of a concept are introduced first and then the concept is 'progressively differentiated' in terms of detail and specificity (Ausubel, 1967, 1968). This principle is based on the assumption that:

- (a) It is easy to grasp the differentiated aspect of a previously learned, more inclusive whole than to formulate the inclusive whole from previously learned differentiated parts;
- (b) Subject-matter organisation in an individual's mind is

hierarchically organised with the most inclusive ideas at the apex (Ausubel, 1967, 1968). The specific sequence of experiences provided to achieve concept differentiation, however, is one of an almost infinite variety of learning sequences (Novak, 1977a).

As new information is received and associated with a concept in cognitive structure the concept grows or differentiates (Ausubel, 1962, 1967, 1968; Novak, 1977a). This subsumption process may continue until the concept is differentiated to the point that new concept labels are applied to subordinate elements. When this is reached 'superordinate learning' is said to have occurred: when previously learned concepts are recognised as elements of a larger more inclusive concept (Ausubel, 1962, 1967, 1968; Novak, 1977a). Superordinate learning also results in 'progressive differentiation' in cognitive structure as superordinate concepts acquire new meaning (Novak, 1977a).

Whenever 'superordinate learning' occurs concepts that were recognised as distinct or in conflict are integrated into new higher order concept meanings. The process of establishing such meanings involves establishing in what ways previously learned ideas are similar or different and is referred to as 'integrative reconciliation' (Ausubel, 1967, 1968; Novak, 1977a). Ausubel suggests that instruction must be sequenced to provide for progressive differentiation and integrative reconciliation of concepts.

The availability of relevant subsuming concepts at an appropriate level of inclusiveness affects the incorporability of new meaningful material. The presence of relevant subsumers, however, does not guarantee that they will be called into play to produce meaningful learning. If an appropriate, relevant subsumer is not available or not recognised as such a 'tangentially' relevant subsumer may be pressed into action giving rise to unclear, unstable, and ambiguous meanings of short term (Ausubel, 1962, 1967, 1968). To avoid this chanciness in subsumption the use of 'advance organisers' is proposed.

An 'advance organiser' is an introductory statement of high-level concepts, broad enough to encompass the information that follows. Its principal function is to bridge the gaps between what the learner already knows and what he needs to know before he can successfully learn the task at hand (Ausubel, 1968). It provides the learner the information they will need to make sense of the lesson or to help them remember and apply knowledge they already have but may not realise is relevant to the lesson (Woolfolk and McCune-Nicolith, 1980). An effective organiser is one that presents relevant ideas that are of a higher level of abstraction, generality, and inclusiveness than the material that follows. Greater use of appropriate substantive advance organisers in teaching of meaningful verbal materials is presumed to lead to more effective retention (Ausubel, 1960, 1967, 1968). An organiser may

take form of broad concepts, rules, theories, or principles which subsume the detailed knowledge to follow or an analogy comparing new material with some well-known example (Woolfolk and McCune-Nicolith, 1980, Imenda, 1982).

Organisers may be of two types:

(a) Expository organisers.

Expository organisers are used when the learning task is completely unfamiliar to provide some framework or scaffold for new material while comparative organisers are used for material that is not completely unfamiliar to distinguish between what is known and what is unknown (Davies, 1976). The facilitating effect of expository organisers, however, seems to be limited to learners who have low verbal and analytic ability (Ausubel, 1968).

(b) Comparative organisers.

Comparative organisers, on the other hand, delineate similarities and differences between sets of ideas and can therefore significantly increase discriminability, thus aiding assimilation and retention of new concepts (Ausubel and Fitzgerald, 1961).

The teachers should, of necessity, have good command of subject matter to be able to give a good advance organiser. The advance organisers should also be at an appropriate level of inclusiveness and stated in terms of what the learner already knows, so that teachers must also know what their pupils already know before presenting new material to them as the knowledge that they already have will influence the subsequent learning (Ausubel, 1968; Imenda, 1968).

The above are some of the main facets of Ausubel's theory of meaningful verbal reception learning. His theory is based on the assumption that the human cognitive structure is hierarchically organised with the more general, abstract concept at the apex. He explains the acquisition of meanings by a process of subsumption. He argues that reception learning has been and will continue to be the dominant form of school learning and that meaningful learning of verbally presented material constitutes the principal means of augmenting the learner's store of knowledge, both within and outside the classroom. Ausubel suggests that a deliberate manipulation of cognitive variables should be employed in order to facilitate the acquisition and retention of meaningful material. Ausubel holds that advance organisers can facilitate meaningful learning where prior cognitive structure may not contain relevant subsumers. However, advance organisers should be

more inclusive, clear, stable and suitably abstract. It is further emphasised by Ausubel that the need for appropriate sequencing of learning activities and suggests that teaching should begin where the learner is, intellectually. This has been hailed as the most important idea in Ausubel's theory (Novak, 1978; Driver, 1983).

Ausubel recognises that learning is an idiosyncratic constructive activity (Ausubel, 1968; Mc Clelland, 1982). His learning theory, however, would postulate that although learning is idiosyncratic, the progressive differentiation of concepts in cognitive structures may follow similar pathways in individuals with significantly different backgrounds (Novak et al. 1972). This, however, may not be the case even for two individuals that share the same meanings. It might be that different individuals with different backgrounds may follow differing progressive differentiation and end up with similar meaning or different meaning with cognitive structure that has the potential to accommodate two new shared meaning.

## **Novak's Theory of Conceptual Education.**

The theory of conceptual education, as illustrated in Figure 2, is based on the "application of our growing understanding of the way people learn from curriculum, teaching, and the learning environment including all forms of learning material" (Novak 1972, p.9.). Novak's theory of conceptual education centres on the model of human learning. The models' instructional theory focuses on concept learning and concept mapping. The theory of learning incorporates Ausubel's theory of meaningful learning which stresses teaching of general concepts rather than isolated facts as in rote learning which is arbitrary and verbatim. The major premise of the theory is that learners benefit from an educational program that is based on meaningful learning of concepts.

## **LITERATURE RELATED TO CONCEPT MAPPING**

Geography is very difficult to teach and to learn because it consists of a myriad of unfamiliar concepts involving complex relations. The school's favoured approach to teaching unfamiliar materials is rote learning. Rote learning predictably fails in the face of the multi-level, complex interactions involved in geography. Concept mapping, derived from Ausubel's (1968) theory, stresses ,meaningful learning, and appears to be ideally suited to address geography content.

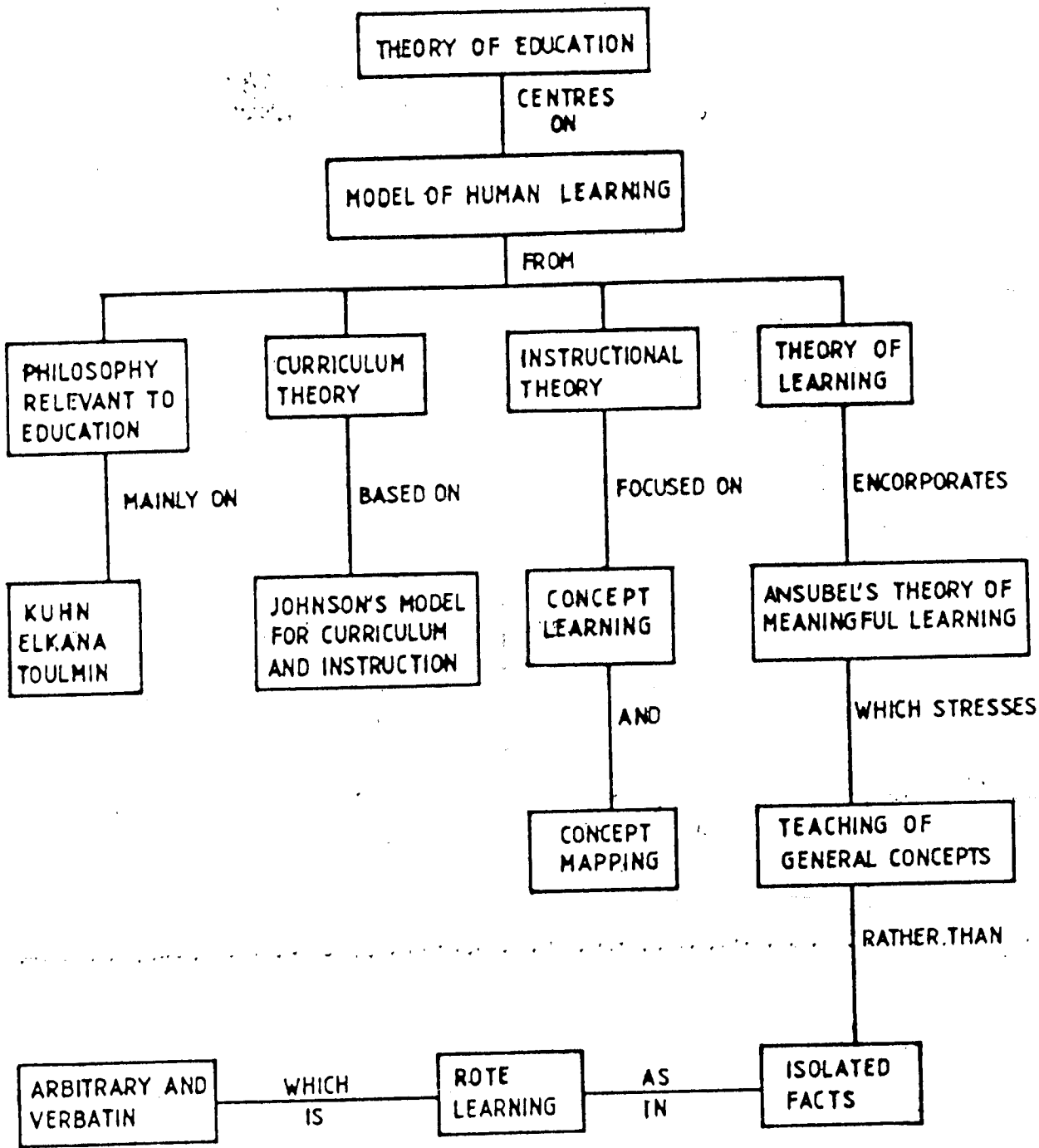


Fig.2 Novak's Theory of Conceptual Education (composed from Novak,197

Concept Maps are diagrams indicative of concepts and their interrelations in both the vertical and horizontal dimensions. The resulting map represents the creator's conceptual organisation of the topic (Gowin, 1979). It has at its top the most general, most inclusive concept and at its bottom the least inclusive concept. The maps can be applied to any subject matter and to any level within the subject. Concept maps are also somewhat subjective because a given topic may be accurately represented in a variety of ways, making the maps ideal for individualised learning (as opposed to individualised teaching). Maps generated by the learner can be used for personal organisation of ideas and as a source for instructor feedback while teacher-made maps can be used as instructional content and guides and as diagnostic and testing vehicles.

Studies examining the instructional effectiveness of concept mapping have been appearing for over 15 years. Most studies have confined their application to the university level (Bogden, 1977; Moreira, 1979), whereas more recent interest has emerged for use in the early grades (Stice and Alvarez, 1987). Novak (1979, 1980a, 1980b, 1981 and Steward, Van Kirk, and Rowell 1979 are among the few to look at the effectiveness of concept mapping with learners in the high school years.

Research into concept mapping can be divided into three groups according to the available literature. Firstly,

there are studies which have not found any effectiveness of concept mapping. Stensvold (1989) assessed concept mapping as a learning tool for the science instructional laboratory. Central to the purposes of this study was the investigation of differences of tests of comprehension and retention. In both comprehension and retention tests, there were no significant differences between the mapping and non mapping means. Allen (1989) examined effects of concepts mapping on meaningful learning and achievement in chemistry and investigated how the student's attitude towards mapping affects his/her ability to master mapping strategies and acquire meaningful learning. He discovered that concept mapping did not enhance meaningful learning or achievement in chemistry. Bodolus (1986) study of the use of concept mapping strategy to facilitate meaningful learning for ninth grade students in science concluded that the mapping process was not a significant factor in effecting academic achievement. He used a pretest/post-test true experimental design. Gurley (1982) examined the use of Gowin's Vee and concept mapping strategies to teach students responsibility for learning in high school biological sciences. The study did not find any significant difference on objective test performance between control and experimental group. Gurley (1982), Bodolus (1986) and Allen (1989) apart from Stensvold (1989) indicated that students using the mapping process either performed slightly better or they did recognise the importance and potential of mapping to enhance learning. The implication

being that concept mapping must have some effect on learning.

Secondly, Loncaric (1986) study of the effect of a concept mapping strategy program upon the acquisition of social studies concepts is one of the few to report a significant difference between the experimental and control group's performance on the test. It also concluded that the concept mapping strategy program benefited both high and low level readers.

Thirdly, there are studies which show some limited effect of concept mapping on learning. In Schmid and Telaro (1990) study, concept mapping was assessed as an instructional strategy for use by high school students in learning biology concepts. As hypothesised, concept mapping facilitated low-ability learners' performance, but only on higher level, relational knowledge. Draheim (1986) examined the effect of four reading approaches on recall of high level ideas in written summaries and on holistic scores assigned to these essays. It was found that conceptual mapping approach had a limited effect on retrieval of high level ideas and on holistic scores. Boyle's (1986) study of the effect of cognitive mapping on reading comprehension and written expression found that trends favoured the mapping group in length essays and identical support details. All these findings suggest that the areas where concept mapping showed limited

effectiveness may correspond to Bloom's higher level educational objectives.

Studies presented so far suggest more research need to be done which will reassess present results in different situations in order to start developing a valid evaluative measure free of the bias and arbitrariness often associated with qualitative reviews. It is possible that most of these studies may not have met conditions stipulated for meaningful learning. However, claims that concept mapping contributes to meaningful learning can not be ignored. Hence, the emphasis on special procedures to determine how concept mapping influences performance.

#### **LITERATURE RELATED TO CONCEPT MAPPING EVALUATION**

According to Novak and Gowin (1984), to most schools and teachers, achievement testing (usually true-false, multiple-choice, or short answer paper-and-pencil exams) is synonymous with evaluation of learning. Although this kind of evaluation will continue to have a role to play in the appraisal of learning, Novak and Gowin believe that a much wider range of practicable evaluation techniques are needed in order to encourage students to use more of their human potential. Evaluation, like other educative events, should help them recognise the great power they have to make sense out of events or objects experienced in their world. Hoffman (1962) cited many of the problems that

derive from the widespread use of objective tests as virtually the only indicators of achievement. Unfortunately, practicable alternatives to objective testing have not been available. Novak and Gowin state that concept maps are workable alternatives. From research by Novak et. al. running from 1974 through 1980 it becomes clear that students and teachers could use and benefit from concept mapping as an evaluation tool.

Wallace (1989) investigated the use of concept maps to examine and evaluate students' conception and structure of knowledge associated with a topic in biology as a result of intervention by computer assisted instruction. The most significant finding in this study was that concepts as evaluative measures were able to reflect differences in the concept and propositional knowledge of learners. Schreiber (1990) presented a method for scoring concept maps generated by students learning introductory college chemistry. His research has demonstrated that the concept map category score for propositional validity reflected students' reasoning ability in chemistry. The ratio of valid connecting lines to total number of connecting lines drawn (per strand) significantly correlated with formal reasoning ability in chemistry. The corresponding map category for hierarchical structure reflected the amount of chemical information possessed by a student.

Although Wallace's (1989) and Schreiber's (1990) studies

show positive results, the techniques used did not compare concept mapping evaluation with existing evaluative measures. In fact studies cited so far, which made this comparison did not reflect any significant difference even though a few had some limited effect. There seems to be more positive results with studies directed towards evaluating concept maps (see Musonda, 1986) than those that compare the concept mapping evaluation to others. Also most of these studies are in the field of physical and biological science. What is lacking in the literature reviewed are:

- (a) Efforts to identify specific learning outcome and measure them with instruments which will be able to reconcile various evaluative measures, and
- (b) More studies in other areas and subjects, other than the physical and biological sciences.

### **Scoring Concept Maps as Related to Learning Theory**

The scoring scheme is based on Ausubel's cognitive learning theory. The following three concepts are instructive (see figure 1)

- (1) The cognitive structure is hierarchically organised with more inclusive, more general concepts and propositions superordinate to less inclusive, more

specific concepts and propositions. This idea incorporates Ausubel's concept of subsumption, namely that new information often is relatable to and subsumable under more general, more inclusive concepts. A good hierarchical structure for a segment of material to be learned begins with broad, inclusive concepts and then leads to more specific, less inclusive concepts.

- (2) Concepts in cognitive structure undergo progressive differentiation. The greater inclusiveness and greater specificity of regularities in objects or events are discerned and more propositional linkages with other related concepts are recognised. Ausubel's principle of progressive differentiation states that meaningful learning is a continuous process wherein new concepts gain greater meaning as new relationships (propositional links) are acquired. Thus concepts are never "finally learned" but are always being learned, modified, and made more explicit and more inclusive as they become progressively more differentiated. Learning is the result of change in the meaning of experience, and concept maps are one method for showing both teacher and learner that real cognitive reorganisation has occurred.
- (3) Integrative reconciliation occurs when two or more concepts are recognised as relatable in new

propositional meanings and/or when conflicting meanings of concepts are resolved. A full discussion of these ideas is beyond the scope of this dissertation but a criterion used for scoring concept maps is presented in the next chapter.

## CHAPTER THREE

### METHODOLOGY

#### THE POPULATION

The target population for this study comprised Grade 10 students in Zambian Secondary Schools.

#### THE SAMPLE

A girls' secondary school in Kabwe district was selected by the researcher for use in this study because it was easily accessible. Because of inadequate time and resources it was not possible to go to other schools. Also accommodation was provided by the school. The sample consisted of the two Grade 10 classes at the school. Classrooms were then randomly assigned to treatment conditions.

This study used intact classrooms. No random assignment of students was possible as the researcher arrived in the school during the last term of the academic year which is an examination time.

The study involved the following subjects:-

- (a) Two classes of 15 students each were used giving a

total of 30;

(b) One secondary school geography teacher. The teacher holds a Bachelor of Arts with Education in Geography and French. At the time of the study he had taught for a year.

## RESEARCH DESIGN

The quasi-experimental nonequivalent control group design was used. Quasi-experimental designs are partly-but not fully-true experimental designs; they control some but not all of the sources of internal invalidity. The general design of this study can be schematized as follows:

A	_____	01	_____	X1	_____	X2	_____	02	_____	03
-----										
B	_____	01	_____			X2	_____	02	_____	03

Where:

A = Experimental group

B = Control group

01 = Pretest

02 = First posttest

O3 = Second posttest

X1 = Introduction to concept mapping

X2 = Instruction in landforms of glaciation

-- = Connotes non-random assignment of subjects  
to groups.

The experimental group received a treatment while the control group did not. Both groups were given a pretest, posttest and after a month another posttest. In this regard, comparisons were made between pre-and posttests scores to determine the effect(s) of the treatment, if any, on students' performance after instruction on landforms of glaciation.

Besides the two posttests, the experimental group was also subjected to concept mapping evaluation. This was to determine how performance measured by the objective test correlated with concept mapping evaluation.

## **RESEARCH MEASURES**

This study involved the construction of the following instruments:

(a) Questions which required students in the experimental group map concepts on the topic: Landforms of Glaciation. These questions are presented in Appendix A.

(b) An objective test to assess the students' mastery of

the topic of landforms of glaciation.

The items for the test were derived from the recommended textbooks and past Grade 12 examination papers. The objective test is presented in Appendix B. This test had a split-half reliability coefficient of .41 which gives a reliability on full test of .58. No specific information on the validity was obtained. This places a major constraint of the test's appropriateness for use. Nonetheless, the fact that the items for the test were obtained from recommended books and past examination papers, suggests that the test had some content validity.

This study involved the development of instructional material to cover the various aspects of the study in accordance with the research design described above. Given below are descriptions of the various types of instructional material and how each was used in the study.

#### Strategies for Introducing Concept Mapping

The first step of the implementation phase of this study was to introduce all the students in the experimental group to concept mapping. This was done as proposed by Novak et al. (1985) whose detailed procedure is presented in Appendix C. The examples and exercises used however were taken from the topics previously covered by students in their geography classes.

## Content Instruction of Landforms of Glaciation

The task here was to teach this topic to all the students involved in this study soon after the experimental group had completed learning concept mapping strategies. The topic was based on Senior Secondary School syllabus. The recommended textbooks used were by Leong (1983) and Burnett (1975) and other materials associated with the topic (i.e. maps, charts, diagrams, pictures etc.). The topic was broken down into 6 units, (see Appendix D).

### Scoring Criteria for Concept Mapping

The scoring format was adapted from Novak et al. (1984) and Musonda (1986). Several aspects of each child's concept map were assigned different points depending on the levels of sophistication and propositional interlinkages (see Appendix E). What follows is a description of the format.

1. Major Conceptions Comprised four levels:

(i) A score of 10 was given for every first level conception such as "glaciated highland," "glaciated lowland," "human aspects of glaciated land," "spatial distribution of glaciated landforms," "glacier," "ice," "snow," "glaciation process," etc.,

(ii) a score of 5 was given for every second level conception such as "glacial erosion," "glacial

deposition," "moraine," "plucking and abrasion,"  
etc.,

(iii) a score of 2 was given for every third level conception such as "fertile plains," "natural routeways," "channels routeways," "tourist attraction," "transhumance," "outwash plains," "marshy landscape," "reservoirs," "hydroelectric power," etc., and

(iv) a score of 1 was given for every other example or minor conception not included in the third level conception.

2. Propositional Interlinkages earned points as well. Three levels of propositional interlinkages were scored as follows:

(i) a score of 20 was awarded to any first level propositional interlinkage,

(ii) a score of 10 was given for any second level propositional interlinkage, and

(iii) a score of 5 was given for any third level propositional interlinkage.

The scoring algorithm is given in Appendix F.

3. Misconceptions: Two levels were considered. 10 points were deducted for an occurrence of a major misconception and 3 points were deducted for an occurrence of a minor misconception. Examples of major misconception are: a student indicates that 'deposition is due to the down fall of ice, or human aspect wears away land'. Examples of minor misconception are: 'a student indicates that plucking steepen the valley of a glacier, or abrasion smoothen the sides of a glacier.

Appended are three sample maps from students in the experimental group. The maps represent three different levels of achievement, i.e. high, middle and low. The researcher and the geography teacher worked out the score which could be achieved from the topic. After listing concepts in different levels and then determining the possible propositional interlinkages a score of 335 points was arrived at. Therefore, the student's concept maps were marked out of this score. (See Appendix G).

## PROCEDURE

In accordance with the research design given earlier, the objective test on landforms of glaciation was administered to the two groups. Soon after this, the researcher introduced the concept mapping strategy to the experimental group. This was done in a 'period' separate from their normal geography class. This took 4 weeks. Thereafter the topic 'landforms of glaciation' was taught in 6 units to the two groups by their regular geography teacher. Whereas the experimental group used concept mapping strategy (reinforced by the researcher in a separate period), the control group used the 'traditional' method of learning. A week after the instruction, the first posttest was administered to the groups and a concept mapping test to the experimental group. A month later the second posttest was administered to the groups. Students' raw scores on these measures are presented in Appendix H.

Before testing the statistical hypotheses of this study presented in Chapter 1, a t-test was done on the pretest scores of the two groups to determine the equivalence of the groups, in addition correlational coefficient was used. The results of all the statistical tests are presented in the next chapter.

## CHAPTER FOUR

### RESULTS

This chapter presents the results of this study as follows: A descriptive summary of the data, the results of the three statistical hypotheses of the study and a brief summary of the results.

#### A DESCRIPTIVE SUMMARY OF THE DATA

Table 1 displays the mean scores obtained by the two groups on the measures used in the study. The pretest scores for the groups were not significantly different. This suggests that the groups were equivalent at the beginning of the study. The first posttest mean scores show a gain from the pretest but display little difference between the two groups. However, there was some gain from the pretest. The concept mapping evaluation show a higher mean score than the first posttest mean scores for both groups. The table indicates very little difference between the two groups with regard to the pre and posttests on the objective tests. On the other hand concept mapping evaluation mean scores is substantially different from the mean scores of the objective test. Figure 3 illustrates the same information graphically. The graph points to possible significant difference between the experimental group and

Table 1

Means of the Two Groups on the Measures made in the Study

Group	Test Means			
	Pretest	Posttest1	*CME	posttest2
Experimental	33.90	50.06	64.49	53.91
Control	30.16	49.73	---	50.61

\*CME - Concept Mapping Evaluation

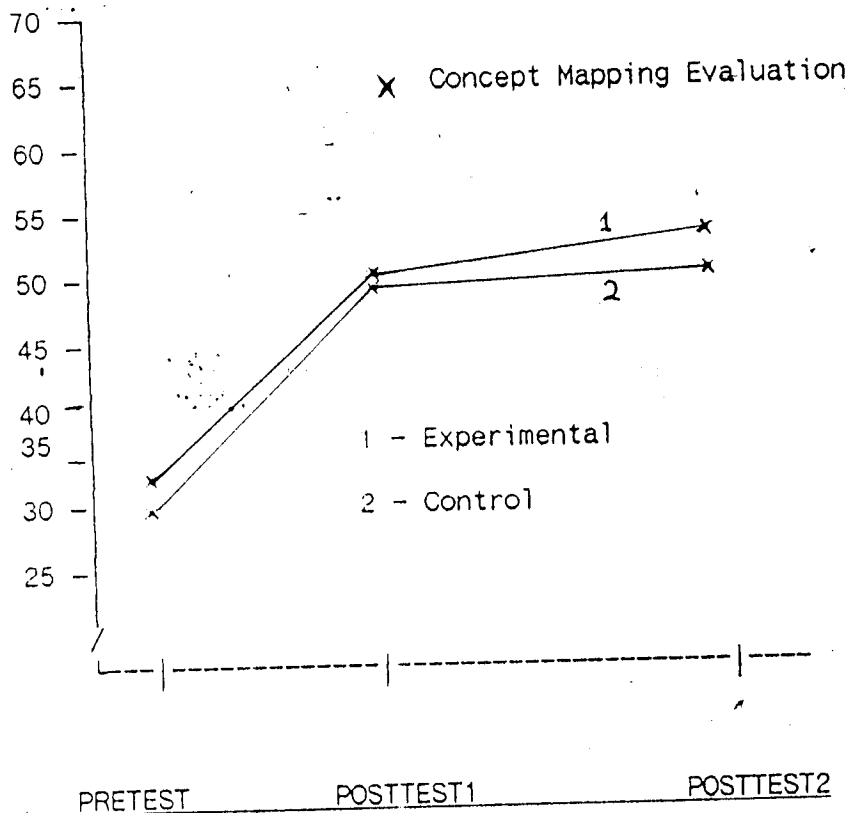


Figure 3 TEST BY GROUP MEAN SCORES

control group with regard to concept mapping evaluation suggesting that this is probably where the treatment effect would be.

Table 2 shows the gain scores of the two groups on the measures made in the study. The control shows a slightly higher gain from the first to the second posttest. There was, however, no significant difference in the gain scores of the two groups with regard to the first and second posttest from the pretest.

Table 2

Gain Score Means of the Two Groups on the Measures made in the Study

Group	<u>Gain Scores (Percentages)</u>		
	Pretest to Posttest1	Posttest1 to Posttest2	Pretest to Posttest2
Experimental	20.22	.45	20.01
Control	19.57	1.33	20.45

A comparison of test items was also done to determine performance between items that required students to use

more than Bloom level 1 objective - rote recall of specific information and those that did not. Appendix B has asterisk sign against questions which required the students to use more than rote recall of specific information. Table 3 displays the mean scores obtained by the two groups on the comparison of test items. For items which required students to use more than rote recall of specific information, the two groups means from pretest to first and second posttest increase steadily. The experimental group has higher means on pre and first posttest while the control has a higher mean on the second posttest. For rote recall items the means for experimental group are higher than control group. While the means for rote recall items are lower than those that require more than rote recall in the pretest for the two groups, the first and second posttest means for rote recall are however higher. The second posttest means for rote recall are slightly lower than the first posttest.

#### **TEST OF THE STATISTICAL HYPOTHESES**

The t-test comparisons show that hypotheses 1 and 2 were insignificant while 3 was significant. The interpretations of these findings are discussed below in relation to each of the research hypotheses of the study.

Table 3

Means of the two groups comparing test items

GROUP	PRETEST		POSTTEST 1		POSTTEST 2	
	More than rote recall items	Rote recall items	More than rote recall items	Rote recall items	More than rote recall items	Rote recall items
Experimental	38.33	30.07	45.83	55.66	46.67	55.35
Control	37.93	27.29	40.83	53.02	48.33	51.47

### **HYPOTHESIS 1.**

The result of the t-test was not significant indicating that concept mapping learning strategy students' performance was not significantly better than those that did not use this strategy soon after geography unit instruction  $t(28)=0.075, p < .05$ . A t-test on the gain scores from the pretest to the first posttest which was conducted to further assess hypothesis 1 was also not significant.

### **HYPOTHESIS 2**

The t-test comparing the students who used concept mapping learning strategy and those who did not use this strategy was not significant  $t(28)=0.095, P < .05$ . Therefore one month after the geography unit instructions, students who used concept mapping learning strategy did not perform better than those who did not use this strategy on an objective test. A t-test on the gain scores from the first to the second posttest which was conducted to further assess hypothesis 2 was not significant.

### **HYPOTHESIS 3**

The t-test comparing differences in performance on the experimental group between scores from an objective test and those from concept mapping evaluation soon after geography unit instructions was significant  $t(14)= 0.015,$

$P < .05$ . This indicates that the experimental group showed a better performance when evaluated by concept mapping evaluation as opposed to objective test evaluation. Table 4 shows the summary results of the t-test according to hypotheses. The complete results are presented in Appendix I.

### **TEST OF COMPARISONS ON TEST ITEMS**

The t-test comparisons on test items did not establish any significant difference in performance between rote recall items and those that required more than rote recall of specific information between the groups. Within the groups performance on rote recall was substantially better than items which required more than rote recall.

In the pretest the performance was substantially better for items that required more than rote recall of specific information for both groups. On rote recall items the experimental group performed slightly better than the control group.

The first posttest performance for the experimental group was not significantly better than the control group on both items,  $t(28) = 0.187, p < .05$  for rote recall items and  $t(28) = 0.138, p < .05$  for items which required more than rote recall of specific information.

The second posttest performance for the experimental group was also not significantly better than the control group on both test items,  $t(28)=0.084, p < .05$  for rote recall items and  $t(28)=0.665, p < .05$  for items which required more than rote recall of specific information. The complete results are presented in Appendix J.

The results of this study showed that when concept mapping learning strategy is evaluated by concept mapping evaluation as opposed to objective test, students perform better. On the other hand objective test alone did not seem to distinguish performance between students instructed in concept mapping learning strategy and those that were using the 'traditional' method. T-test comparisons of test items between the groups was not significant. These results are discussed in the next chapter.

Table 4  
Summary Results of t-test

Hypotheses	Values			Decision
	Critical	Observed	Alpha	
1. Concept Mapping learning strategy versus 'traditional' method soon after instructions	0.075	1.478	.05	not reject Ho
2. Concept mapping learning strategy versus 'traditional' method one month after instructions	0.095	1.343	.05	not reject Ho
3. Experimental groups' scores from objective test versus those from concept mapping evaluation	0.015	2.756	.05	reject Ho

## CHAPTER FIVE

### DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents a discussion of the results in light of the research hypothesis of this study. It also gives a conclusion of the findings of the study as well as some suggestions for further research.

#### DISCUSSION

The study set out to assess the effectiveness of concept mapping in a secondary school environment by a pretest post-test quasi-experimental non-equivalent control group design. It investigated the relationship between concept mapping strategy and performance of students on an objective test.

Statistical tests comparing concept mapping learning strategy students (experimental group) against those that did not use this strategy (control group) on an objective test soon and one month after the geography unit instructions indicated no significant differences (i.e. Hypotheses 1 and 2). This suggested that concept mapping learning strategy did not have any effect on the students. The results are consistent with some findings of earlier investigators (Stensvold, 1989; Allen, 1989; Bodolus, 1986; and Gurley, 1982). In these studies concept mapping

learning strategy students' performance was not significantly better than other strategies especially when determined by an objective test performance. Just as Allen, Bodolus and Gurley reported, in this study concept mapping experimental group means were slightly better than the control group means.

A comparative evaluation of the test items does not suggest any treatment effect especially soon after treatment. On the first posttest students who used concept mapping learning strategy did not perform significantly better on both rote recall and items which required more than rote recall of specific information even though the experimental group means were higher. The isolation of test items failed to establish the effectiveness of concept mapping learning strategy. There was also no significant difference on the second posttest on both test items. Therefore, this test seems to indicate that experimental group students failed to analyse, synthesise and evaluate new knowledge. However, it is important to note that whereas rote recall items means fluctuated, there was a steady increase in the means of items that required more than rote recall of specific information. Students seem to have retained the materials which required more than rote recall and even increase on it in the subsequent test.

The statistical test comparing concept mapping evaluation against an objective test technique showed the existence of

significant difference within the experimental group (Hypothesis 3). This indicates that students using concept mapping strategy performed better than when evaluated by an objective test technique. The correlation coefficient between scores from concept mapping evaluation and objective test for the experimental group was  $-.34$  a moderately negative relationship. This implies that students who had low marks in the objective test had a better performance in the concept mapping evaluation than those who had high marks. The findings of this investigation are generally compatible with previous conclusions by Wallace (1989); Schreiber (1990); Schmid and Telaro (1990); Draheim (1986); and Boyle (1986). Wallace (1989) and Schreiber (1990) showed the effectiveness of concept mapping as an evaluation tool. Schmid and Telaro (1990) showed that concept mapping facilitates low-ability learners' performance. Draheim (1986) and Boyle (1986) concluded that concept mapping learning strategy on its own or in conjunction with other strategies benefited students mostly on evaluation other than the objective test. What this result suggests is that concept mapping evaluation could have been more sensitive to learning outcome than objective testing.

## CONCLUSION

This experiment re-assessed the effectiveness of concept mapping strategy in a secondary school environment under conditions that had extremely high external validity. Concept mapping strategy was compared with the 'traditional' approach. Under these conditions, it was found that exposure to concept mapping learning strategy did not make students perform better on an objective test. The study also failed to establish whether concept mapping strategy lead to meaningful learning. Even though performance on concept mapping evaluation was better than objective test, it needed to have been reinforced by a better objective test showing for it to be meaningful. The implication of a better performance when evaluated by concept mapping evaluation is that experimental group students had learnt meaningful. Therefore, it was expected that performance on more than rote recall items would have been significantly better. Since this did not occur, the validity of concept mapping evaluation is at stake.

There are a number of reasons which could have led to concept mapping learning strategy not being effective especially when determined by an objective test. Since the research did not first establish learning strategies students were using before introducing concept mapping strategy, they may have been in conflict with the existing ones. Also in the face of difficulty especially of not

fully appreciating concept mapping strategy, experimental group students may have reverted to their old strategies seriously affecting the learning and retention process. This would imply that more time should be given to the mastering of learning strategy before its effect could be tested.

Despite the limitations of the results, one can conclude that they provide encouraging support for further research on the use of concept mapping as a learning and evaluation tool. The technique passed perhaps the most critical test, that of viability in an ordinary classroom, and it required no special material, thus making it inexpensive.

#### **SUGGESTIONS FOR FURTHER RESEARCH**

The present study's findings suggest a number of research needs.

1. Studies similar to the present one should be conducted in which different teaching subjects and academic institutions are sampled. Generalizability of the present study's findings could be assessed by such research.
2. Researchers need to investigate what strategies students are presently using before introducing new ones, as they may be in conflict with the existing ones.

3. Studies of this nature should be longitudinal to ensure that strategies introduced are adapted and effectively used before any assessment is done.
4. These studies should go hand in hand with research in other evaluational techniques which will evaluate learning as opposed to achievement testing.

## BIBLIOGRAPHY

- Allen J.D. (1989) Effects of Concept Mapping on Meaningful Learning and Achievement in Chemistry. Ph.D. thesis Dissertation Abstract International. Vol. 50 No. 11 May 1990 p. 3542-A ✓
- Ausubel, P.D. (1960), The Use of Advance Organizers in the Learning and Retention of Meaningful Verbal Material. Journal of Educational Psychology . 51, (5), 267-272. ✓
- Ausubel, P.D. (1962) A Subsumption Theory of Meaningful Verbal Learning and Retention. Journal of General Psychology. 66, 213-224 ✓
- Ausubel, P.D. (1963) The Psychology of Meaning Verbal Learning. New York : Grune and Stratton. ✓
- Ausubel, P.D. (1967) A Cognitive-Structure Theory of School Learning (pp. 207-257), in Siegel, L. Instruction : Some Contemporary View points. New York : Chandler Pub. Co.
- Ausubel, P.D., (1968), Educational Psychology: A Cognitive View. New York : Holt, Rinehart and Winston. ✓

Ausubel, P.D. and Fitzgerald, D. (1962). Organizer, General background, and Antecedent Learning Variables in Sequential Verbal Learning. Journal of Educational Psychology. 53, 243-249.

Ausubel, P.D., Novak, J.D., and Hanesian, H., (1978), Educational Psychology : A Cognitive View. New York : Holt Rinehart and Winston.

Bloom, B.S. et al, (1956), Taxonomy of Educational Objectives : The Classification of Educational Goals, Handbook 1 : Cognitive Domain. New York : Mackey.

Bodolus, J.E., (1986), The Use of A Concept Mapping Strategy to Facilitate Meaningful Learning for Ninth Grade Students in Science. Ed.D. thesis, Dissertation Abstracts International. Vol. 47 No. 09 March 1987.

Boyle, O.F., (1986), The Effect of Cognitive Mapping of Reading Comprehension and Written Expression. Ed.D. thesis. Dissertation Abstracts International. Vol. 47 No. 07 January 1987 p. 2522-A.

Brian, F. and Stan, S., (1970) Physical Geography: Multiple Choice Questions. London : Oxford University Press.

Burnner, J.S., (1973), Beyond the Information Given. Anglia,  
M.J. (Ed) London : George Allen and Unwin Ltd.

Burnett, R.B., (1965), Physical Geography in Diagrams.  
London : Longman.

Campbell, D.T. and Stanley, J.C., (1963), Experimental and  
Quasi-Experimental Designs for Research. Skokie IL :  
Rand McNally.

Copper, H.M., (1984), The Integrative Research Review : A  
Systematic Approach. Applied Social Research Methods  
Series Vol. 2. Beverly Hills : Sage Publications.

Cuff, C. C. (1970), Objective Questions in Physical  
Geography. London : Heinemann Educational Books Ltd.

Davies, K.I., (1976) Objectives in Curriculum Design.  
New York: McGraw-Hill.

Draheim, M.E., (1986) A Study of the Effects of Directed  
Reading Thinking Activity and Conceptual Mapping  
Instruction on Reading and Writing Exposition. Ph.D.  
thesis. Dissertation Abstracts International. Vol. 47  
No. 07 January 1987, p. 2489-A

Driver, R. (1983) The Pupil as Scientist? Milton Keynes :  
Open University Press.

Gagne, R.M., (1970) The Condition of Learning (Second  
Edition) London : Holt, Rinehart and Winston.

Gagne, R.M., (1967) Instruction and the Condition of  
Learning (pp.29-313), In Siegel, L. Instruction : Some  
Contemporary Viewpoints. New York : Chandler Pub. Co.

Good, T.L. and Brophy, J.E. (1987) Looking in Classrooms.  
(4th ed.) New York: Harper and Row.

Government of Republic of Zambia/C.D.C (1990) Interim Social  
Studies syllabus: Geography Component.  
Lusaka: Unpublished.

Government of Republic of Zambia/E.C.Z. (1991) Examination  
Report for Grades 9 and 12-1991. Lusaka:  
Unpublished.

Gowin, D.B., (1979) Educating. New York : Cornell  
University Press.

- Gurley, L.I., (1982), Use of Gowin Vee and Concept Mapping Strategies to Teach Responsibility for Learning in High School Biological Sciences. Ph. D. thesis Dissertation Abstracts International. Vol. 43 No. 04 October 1982. p. 1026-A. ✓
- Hoffman, B., (1952) The Tyranny of Testing. New York : Crowell-Collier. ✓
- Imenda, S.N. (1982) A Textbook of Science Education. Unpublished manuscript. ✓
- Johassen, D.H., (1985), Learning Strategies : A New Educational Technology. Journal of the Association of Education and Training Technology. (PLET) Vol. 22 No. 1 pp. 26-34 ✓
- Landa, L.N. (1976) Instructional Regulation and Control: Cybernetics, Algorithmization and Heuristics in Education. Englewood Cliffs, N.Y.: Educational Technology Pub. ✓
- Leong, G.C., (1983) Certificate Physical and Human Geography. Third Edition. Singapore : Oxford University Press. ✓

- Loncaric, L., (1986) The Effect of a Concept Mapping Strategy Program upon the Acquisition of Social Studies Concepts. Ph.D. thesis. Dissertation Abstracts International. Vol. 47 NO. 6 December 1986. p. 2006-A.
- McClelland, G.A. (1982) Ausubel's Theory of Learning and its Application to Introductory Science : Part 1. Ausubel's Theory of Learning. S.S.R., 64, (226), 157-161
- McMillan, J.H. and Schumacher, S., (1984), Research in Education : A Conceptual Introduction. Boston : Little, Brown and Company.
- Moreira, M.A. (1979) Concept Maps as tools for Teaching. Journal of College Science Teaching. 8, 283-286.
- Musonda, D., (1986) A Twelve-Year Study of Children's Understanding of the Structure of Matter after Audio-Tutorial Instruction in Grades One and Two. Ph.D. thesis. Cornell University. Unpublished.
- Novak, P.J. (1977a) A Theory of Educational. New York : Cornell University Press.

- Novak, J.D. (1977b) An Alternative to Piagetian Psychology for Science and Mathematics Education. Science Education. 61 (4), 453-477.
- Novak, J.D. (1979) Response to Can Ausubel's Theory of Meaningful Learning Become an Alternative to Piagetian Psychology? Science Education, 63, 271-273.
- Novak, J.D. (1980) Progress in Application of Learning Theory. Theory in Practice Vol. 19 No. 1 p. 58-65.
- Novak, J.D. (1985). Metalearning and Metaknowledge Strategies to help Students Learn How to Learn. H.T. Leo West and A Leon Pines (Eds), Cognitive Structure and Conceptual Change. New York : Academic Press.
- Novak, J.D. and Gowin, D.B., (1984) Learning How to Learn Cambridge : Cambridge University Press.
- Novak, J.D. Ring, G.D., and Tamir, P., (1972) Interpretation of Research in terms of Ausubel's Theory and Implications for Science Education. Science Education 55, (4), 483-526.

Ogunyemi, M.A., (1969) Objective Test for School Certificate Geography. London : Heinemann Educational Books Ltd.

Piaget, J. (1970) Genetic Epistemology. New York : Columbia University Press.

Resee, H.W., and Overton, W.F., (1970) Models of Development and Theories of Development. Goulet L.R., and Bates, P.B., (Eds). Life-Span Development Psychology : Theories and Research. New York : Academic Press.

Schimid F.R. and Telaro G., (1990) Concept Mapping as an Instructional Strategy for High School Biology. The Journal of Educational Research. Vol. 84. Nov/Dec. 1990 No. 2 pp. 78-85.

Schreiber, D.A. (1990) Scoring Students-Generated Concept Maps in Introductory College Chemistry Ed.D. thesis. Dissertation Abstracts International. Vol. 51 No. 04 October 1990 p. 1105-A.

Stensvold, M.S., (1989), An Assessment of Concept Mapping as a Learning Tool for the Science Instructional Laboratory. Ph.D. thesis. Dissertation Abstracts International. Vol. 50 No. 10 April 1990 p. 3199-A.

Steward, J.; Van Kirk, J.; and Rowell, R. (1979) Concept Maps: A tool for use in Biology Teaching. The American Teacher. 41, 171-175.

Stice, C.F. , and Alvarez, M.C., (1987) Hierarchical Concept Mapping in early Grades. Childhood Education. 64, 86-96.

Wallace, D.J., (1989), The Use of Concept Maps in Examining Students Conceptions and Structure of knowledge in Science. Ph.D thesis. Dissertation Abstracts International. Vol. 50 No. 11 May 1990. p. 3472-A

West, T.H.L., and Fensham, J.P., (1974) Prior Knowledge and the Learning of Science : A Review of Ausubel's Theory of this Process. Student Science Education. 61-81.

Woolfolk, E.A. and McCune-Nicolith L., (1980) Educational Psychology for Teachers. New Jersey : Prentice-Hall, Inc.

Travers, R.M.W.. (1978) An Introduction to Educational Research. Fourth Edition. London : Collier Macmillian Pub.

Tuckman, B.W., (1978) Conducting Educational Research. Second Edition. New York : Harcourt Brace Javanovich. Pub.

## APPENDIX A

### CONCEPT MAPPING QUESTION

Read the following instructions carefully

1. Answer the question below using the concept mapping technique.
2. Use 'Landforms of glaciation' as the key concept.

**QUESTION:** Using the information above, attempt to explain the various aspects of glaciated landforms. Also show how these features affect human activities.

APPENDIX B  
SCHOOL OF EDUCATION  
DEPARTMENT OF EDUCATIONAL PSYCHOLOGY, SOCIOLOGY  
AND SPECIAL EDUCATION  
OBJECTIVE TEST FOR GRADE 10 ON  
LANDFORMS OF GLACIATION

**INSTRUCTIONS: ANSWER ALL QUESTIONS. CHOOSE THE CORRECT ANSWER OR ENDING. ANSWERS ARE TO BE WRITTEN ON A SEPARATE SHEET OF PAPER.**

**DIAGRAMS ARE SHOWN ON A SEPARATE SHEET OF PAPER.**

1. The main features formed by ice in a highland area are features of:
  - A transportation
  - B deposition
  - C erosion
  - D erosion and deposition equally
  
2. The main features formed by ice near the edge of a lowland ice sheet are features of:
  - A transportation
  - B deposition and erosion equally
  - C erosion
  - D deposition
  
3. The main features formed by ice in an area well back from the edge of a lowland ice sheet are features of:
  - A erosion

- B deposition
  - C deposition and erosion equally
  - D deposition mainly with some erosion
4. During which of the four periods of glaciation did the maximum extent of ice occur?
- A The first
  - B The second
  - C The third
  - D The fourth
5. The ice in a glacier is formed by:
- A The freezing of rain
  - B The freezing of a river
  - C The compacting of snow
  - D The freezing of melt-water
6. The place where a glacier starts is called:
- A A corrie (cirque, cwm)
  - B A nivation hollow
  - C A glaciated depression
  - D A combe
- \*7. Where these features join, (in question 6) a sharp ridge is formed. This is called:
- A A ridge
  - B An arrete
  - C A bergschrund
  - D A knife-edged ridge
8. As ice moves down valley it tends to:

- A Exaggerate any unevennesses in the floor
  - B Smooth out any unevennesses in the floor
  - C Neither exaggerate nor smooth out any unevennesses in the floor
  - D Create a uniform gradient to see level
9. As a river flows down a valley it tends to:
- A Exaggerate any unevennesses in the floor
  - B Create new unevennesses in the floor
  - C Smooth out any unevennesses in the floor
  - D Neither exaggerate nor smooth out unevennesses in the floor
- \*10. In respect to questions 8 and 9 we may say:
- A Rivers and glaciers have almost opposite effects on a valley
  - B Rivers and glaciers have very similar effects on a valley
  - C Rivers and glaciers have no effects on a valley
  - D Rivers and glaciers sometimes have very similar effects and sometimes very different effects on a valley
11. Where a tributary glacier joined a main glacier the feature formed is called:
- A A suspended valley
  - B A waterfall
  - C A hanging valley
  - D A dry valley

12. In creating a typical glaciated valley the ice:
- A Carves a completely new valley
  - B Usually flows down an existing river valley
  - C Fills up an existing river valley from the sea
  - D May do any of these
- \*13. Which of the cross sections in Fig.1 best illustrates a glaciated valley, as we see it today - A,B,C,D?
14. In a glaciated area valleys are usually:
- A Very winding
  - B Slightly winding
  - C Fairly straight
  - D Of any shape
15. Rivers in a wide glaciated valley are usually:
- A Straight
  - B Meandering
  - C Slightly meandering
  - D Of any shape
- \*16. The reason for the fact given by the answer to question 15 is because the gradient of a wide glaciated valley is:
- A Dead flat
  - B Very slight
  - C Steep
  - D Very steep
17. A large glaciated valley usually has a flat floor because:

- A The true shape has been masked with material deposited by the glacier
  - B The glacier cuts the shape
  - C A river flowing over it made it this shape
  - D A river has deposited alluvium
18. Glaciated valleys frequently contain ribbon lakes caused by:
- A Transverse rock barriers
  - B Terminal moraines
  - C Deltas from tributary streams
  - D All of these
19. The material carried and later deposited by a glacier is called:
- A Moraine
  - B Terminal moraine
  - C Ground moraine
  - D Lateral moraine
20. Material deposited at the end of a glacier is called:
- A Ground moraine
  - B Lateral moraine
  - C Terminal moraine
  - D Medical moraine
21. Fjord are a feature of a:
- A Non-glaciated highland area
  - B Non-glaciated lowland area
  - C Glaciated highland area

- D      Glaciated lowland area
22.    Fjords are to be found:
- A      In Norway only
  - B      In Norway and Scotland only
  - C      On the western side of all continents
  - D      On the western side of all continents at high latitudes
- \*23.   The term 'recession of a glacier' means that:
- A      The snout of the glacier moves back up the valley while the ice continues to move down
  - B      The place where the ice melts is progressively higher up the valley, but the ice continues to move down or may be standing still
  - C      The ice stays where it is, but melts progressively further down the valley
  - D      The whole glacier moves back up the valley
24.    The power of a glacier to erode depends on:
- A      The type of rock over which it flows
  - B      Its volume
  - C      Its speed
  - D      Its thickness
- \*25.   Today some mountains in glaciated areas have rounded tops. These were formed by:
- A      The surface being smooth before the glaciers came
  - B      The sea smoothing the surface at some stage

- C Water smoothing the surface at some stage
- D An ice-sheet smoothing the surface at some stage
- \*26. In other glaciated highland areas the mountain tops are very jagged. This is because:
- A They were jagged before glaciation
- B Of frost shattering during or since glacial times
- C They were never covered by the ice
- D Of chemical weathering
27. An ice-sheet may deposit a half-egg shaped mass of morainic material. This is called:
- A A kame
- B An esker
- C A drumlin
- D A kettle
28. Ground moraine, or till, is a fertile material, generally, because:
- A The particles have not been ground up very small by the glacier
- B The particles have been ground up very small by the glacier
- C Man has made it so
- D It contains a large variety of minerals from many different rocks
29. Many corries (cirques, cwms) have a small lake in the depression behind the lip. This lake is filled by:

- A Modern rain-water
  - B Water from the last of the ice that formed the corrie
  - C Water from the previous winter's snows
  - D Water from the permanent snow fields
- \*30. On the side of a terminal moraine away from the glacier may be found outwash sands and gravels. These are deposited by:
- A Streams flowing parallel to the moraine
  - B Streams of melt-water flowing away from the glacier and through the moraine
  - C Streams originating on the moraine, and flowing away from it
  - D Streams having no connection with the moraine or glacier at all
31. Loess is a wind-born material which came from:
- A Arid areas
  - B Morainic material
  - C Sand dunes
  - D Sand seas
32. In highland glaciated areas are sometimes found very deep, steep-sided V-shaped valleys. These are:
- A Normal river valleys
  - B Melt-water overflow channels
  - C Glacial troughs
  - D Valleys formed by the sea when it was at a

higher level

33. Generally in a highland glaciated area the soil is not very good for agriculture because:
- A The weather is bad for agriculture
  - B The altitude prevents good soil forming
  - C Most of the soil has been eroded away by ice
  - D The soil is too thin because of the low temperatures
34. The most important industry in many glaciated highland areas is:
- A Sheep pasturing
  - B Forestry
  - C Development of electricity
  - D Tourism
35. The erosive action of a valley glacier depends most upon
- A The gradient and width of its valley
  - B The width and thickness of the ice
  - C The height of the glacier above sea level
  - D The length of the glacier
  - E The rate of movement of the glacier
36. Crevasses, which are cracks in the surface of glaciers, are produced by:
- A The glacier moving over level land
  - B The melting of ice
  - C Differential movement in the ice

- D           The thickness of ice
- E           The rain action on the surface of the glacier
37. A region which has not been glaciated may show:
- A           U-shaped valleys
- B           Corries in the mountains
- C           Waterfalls rushing down the steep sides of  
            valleys
- D           Ox-bow lakes
- E           Hanging valleys
- 
38. Which one of the following is most associated with  
ice action:
- A           Deltaic plain
- B           Loess deposits
- C           Outwash plains
- D           Tombolo
- E           Laterite plain
- 
39. The first requirement for the formation of glaciated  
U-shaped valley is:
- A           A glacier
- B           Heavy and continuous falls of snow
- C           A mountainous terrain
- D           A river valley
- 
40. All the following features are produced by glacial  
deposition except:
- A           Drumlin

- B Moraine
- C Esker
- D Roche moutonee

\*41. Of the several features produced by the action of ice, some are the product of both erosion and deposition. Which of the following features is of this type?

- A Arete
- B Hanging valley
- C Erratic
- D Rochee moutonee

\*42. Figure 2 is of a crag and tail. In which direction did the ice predominantly move?

- A East to west
- B West to east
- C South to north
- D North to south

\*43. Figure 3 represents a glacier emerging from a valley near the foot of the mountains. The end of the glacier has melted without it retreating, and has deposited a feature at X which is called a:

- A Medial moraine
- B Boulder clay
- C Terminal moraine
- D Drumlin

44. A glacier is 'a river of ice' which moves down hill to

the valley below. Its rate of movement is greatest:

- A On both sides of the glacier
- B Where the surface is level
- C Where the slope is steepest
- D At the snowfield on the top

\*45. Figure 4 shows a typical bergschrund in a corrie.

Its development is due to:

- A Frost action on glacial surface
- B A glacier moving down the hill slope
- C Heavy snowfall in winter
- D Rain-water freezing the snowfield

\*46. Figure 5 shows the snowline of four mountains in the southern hemisphere. Which one is located furthest north? A, B, C or D.

\*47. Figure 6 shows a section through a lake in a mountainous region with many steep ridges and sharp peaks. This section shows that the lake occupies a basin probably formed by:

- A A landslide dam
- B Downfaulting
- C Ice scouring
- D Solution of the limestone rock
- E Wind erosion

Instruction: In the following items (48 and 49) more

than one of the alternatives offered may be correct. A complete answer should contain only the correct alternatives.

- \*48. Figure 7 is a sketch of part of a glaciated area. Not all the features of glaciation are shown. Which of the features present in the sketch are evidence that the area has been glaciated?
- A A steep sided, flat floored valley
  - B Corries
  - C Hanging valley
  - D Truncated spurs
  - E Meandering river
- \*49. The mountain area shown in figure 7 lies in a humid temperate country. If it had not been glaciated it would have looked very different. In which of the following ways would it have appeared different?
- A There would have been no river
  - B The sides of the valley would not be so straight
  - C The valley would be less deep
  - D The valley sides would be gentler
  - E The valley floor would slope more steeply towards the observer
50. Figure 8 shows a glaciated upland area with certain parts numbered 1-10. Write the letter of the feature in the list below which corresponds to the number.

A	Corrie	B	Pyramidal peak
C	Arete	D	Tarn
E	Hanging valley	F	Ribbon lake
G	Truncated spurs	H	Lateral moraine
I	Ground moraine	J	Steepened sides

References: Brian F. and Stan S. (1970)  
 Burnett R.B. (1965)  
 Cuff C. C. (1970)  
 Leong G.C. (1983)  
 Ogunyemi M.A. (1969)

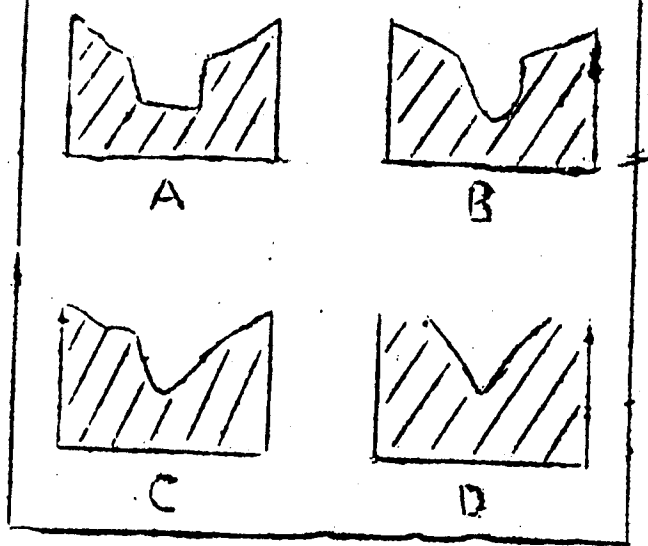


Fig. 1

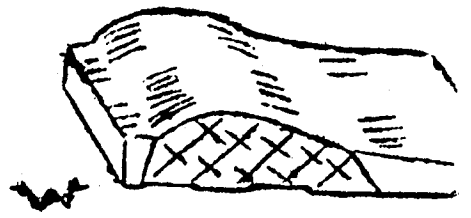


Fig. 2

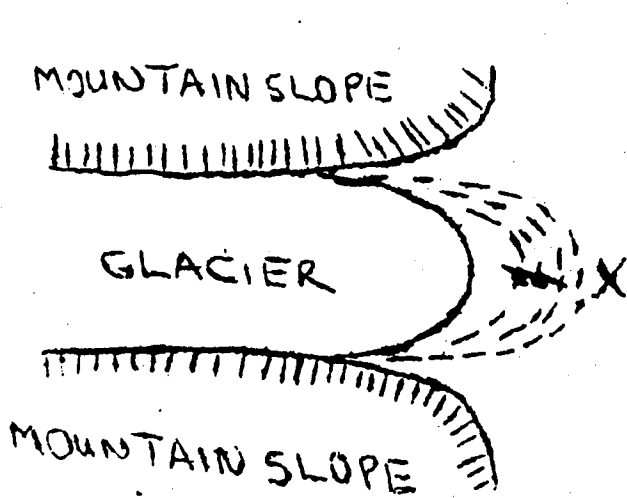


Fig. 3

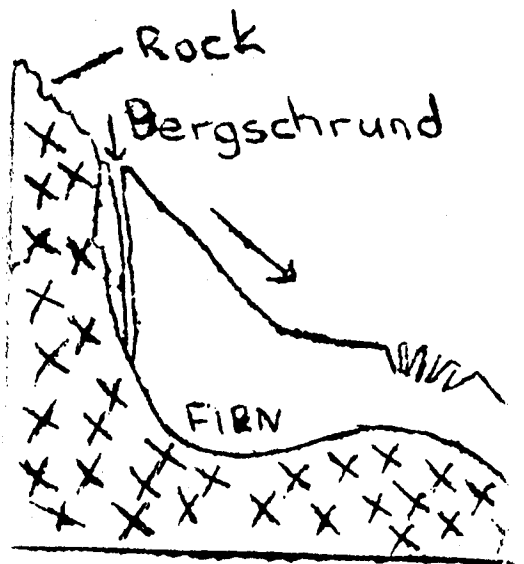


Fig. 4

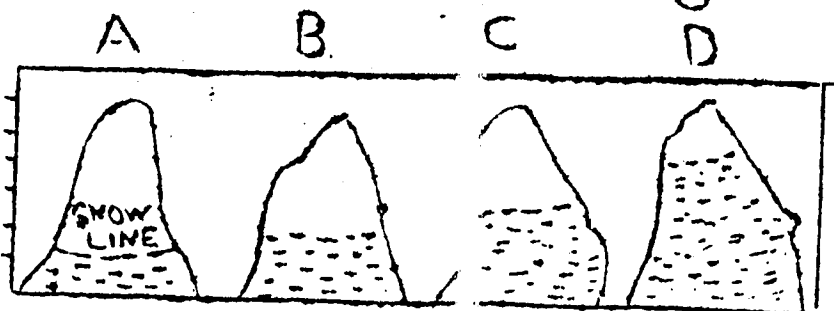


Fig. 5

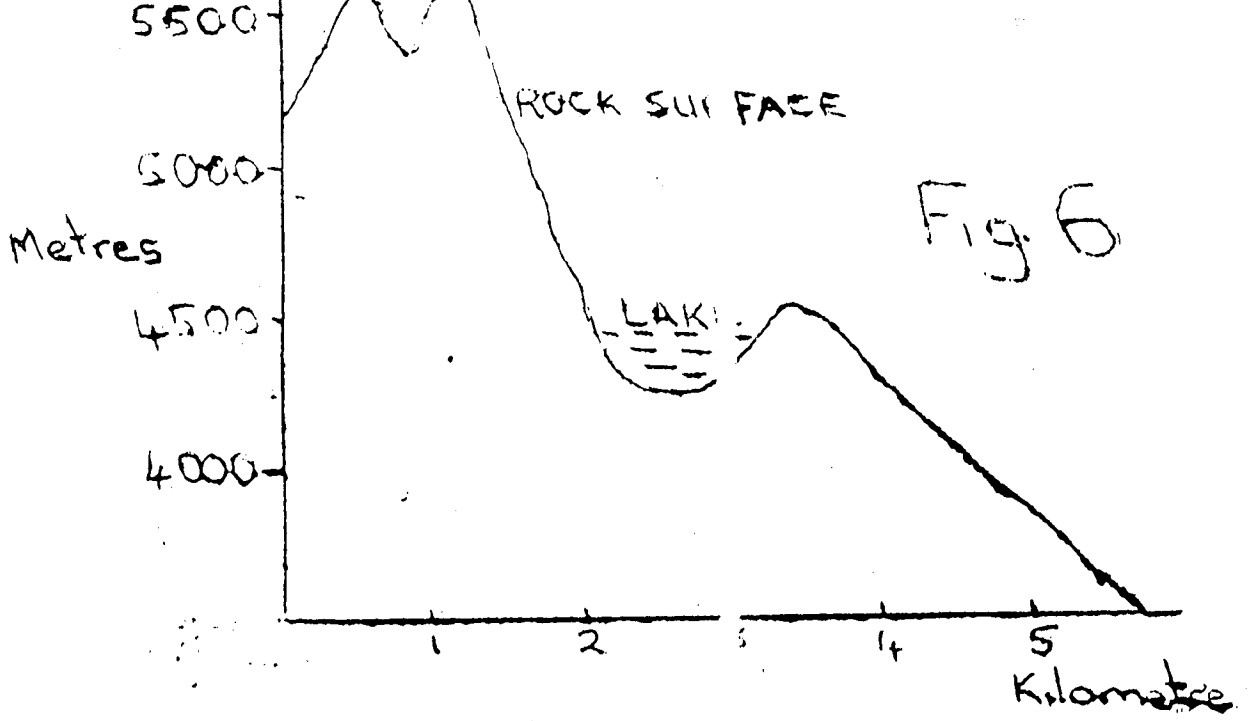


Fig. 7

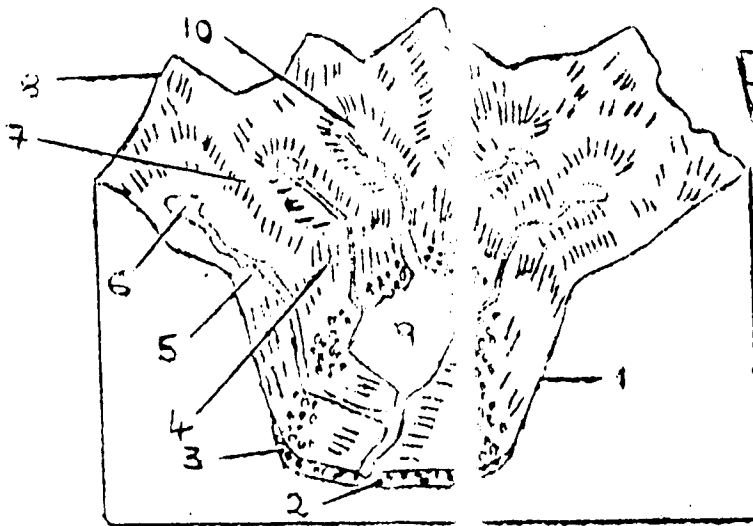
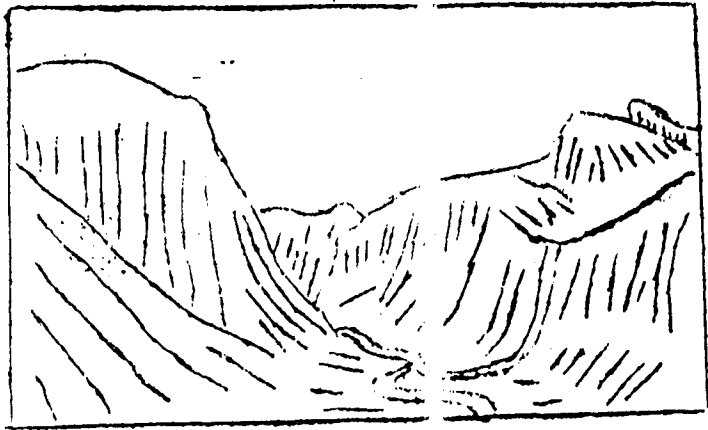


Fig. 8

## APPENDIX C

### STRATEGIES FOR INTRODUCING CONCEPT MAPPING

#### A ACTIVITIES TO PREPARE FOR CONCEPT MAPPING

1. Make two lists of words on the blackboard or overhead projector using list of familiar words for objects and another list for events. For example, object might be car, dog, chair, tree, cloud, book; and event words could be raining, playing, washing, thinking, thunder, birthday party. Ask the students if they can describe how the two lists differ. Try to help them recognise that the first list is things or objects and the second list is happenings or events, and label the two lists.
2. Ask the students to describe what they think of when they hear the word car, dog, etc. Help them recognise that even though we use the same words, each of us may think something a little different. These mental images we have for words are our concepts; introduce the word concept.
3. Repeat the activities in step 2, using event words. Again, point out the differences in our mental images, or concepts, or events. You may want to suggest at this point that one reason we have trouble understanding each other sometimes is that our concepts are never quite identical even though we know

the same words. Words are labels for concepts, but each of us must acquire our own meaning for words.

4. Now list words such as are, where, the, is, then with. Ask students what comes to their minds when they hear each of these words. These are not concept words; we call them linking words and we use them in speaking and writing. Linking words are used together with concept words to construct sentences that have meaning.
5. Proper nouns are not concept words but rather names of specific people, events, places, or objects. Use some examples and help students to see the distinction between labels for regularities in events or objects and those for specific events or objects (or proper nouns).
6. Using two concept words and linking word (s), construct a few short sentences on the board to illustrate how concept words plus linking words are used by humans to convey meanings. Examples would be: The dog is running. or, There are clouds and thunder.
7. Have students construct a few short sentences of their own, identify the concept words and tell whether each is an object or event, and also identify the linking words.
8. If you have bilingual students in the class, have them

present some foreign words that label the same events or objects. Help the students recognise that language

does not make the concept, but only serves as the label we use for the concept.

9. Introduce some short but unfamiliar words to the class such as *dire*, *terse*, or *caris*. These are words that stand for concepts they already know, but have somewhat special meaning. Help students see that meanings of concepts are not rigid and fixed, but can grow and change as we learn more.
10. Choose a section of a textbook (one page is sufficient) and duplicate copies for the students. Choose a passage that conveys a definite message. As a class, ask them to read the passage and identify key concepts. (Usually 10 to 20 relevant concept can be found in single page of text material). Also have the students note some linking words and concept words that are less important to the story line.

## **B CONCEPT MAPPING ACTIVITIES**

1. Select a particularly meaningful paragraph or two from a text or other printed material. Have the students read the text and select the key concepts, that is, those concepts necessary for understanding the meaning of the text. List these concepts on

board (or overhead projector) as they are identified. Now discuss with the students which concept is the most important, most inclusive idea in the text.

2. Put the most inclusive concept at the head of a new list of rank-ordered concepts. List the next most general, most inclusive concept, working through the first list until all concepts are rank ordered. There will not always be agreement among the students on the ordering, but usually only a few major differences in ranking of the concepts will arise. This is OK because it suggests that there may be more than one way to see the meaning of the text.
3. Now begin constructing a concept map, using the rank-ordered list as a guide in building the concept hierarchy. Have students help in choosing good linking words to form the propositions shown by the lines on the map. One good way to have them practice map making is to have students write concept words and linking words on paper rectangles and then rearrange these rectangles as they get new insights on the map organisation.
4. Now look for cross links between concepts in one section of the map and concepts in another part of the concept "tree". Have students help to choose linking words for the cross links.

5. Most first effort maps have poor symmetry or some concept clusters poorly located relative to other more closely related concepts or clusters of concepts. Reconstruct the map if this would be helpful. Point out to students that at least one and sometimes two or three reconstruction of a map are needed to show a good representation of propositional meanings as they understand them.
6. Discuss the concept map scoring criteria and score the concept map constructed. Point out possible structural changes that might improve the meaning and perhaps the scores of the map.
7. Have the students select a section of text or other material and repeat steps 1-6 on their own (or in groups of two or three).
8. Student-constructed maps can be presented to the class on the blackboard or overhead projector. "Reading" the map should make clear to other students in the class what the text was about, as interpreted by the map maker.
9. Have students construct a concept map for ideas important in a hobby, sport, or special interest they have. These might be posted around the room and informal discussion encouraged.
10. Incorporate one or two concept mapping questions in your next text to illustrate that concept mapping is

a valid evaluation procedure that demands hard thinking and can illustrate understanding of the subject matter.

Source: Novak J.D. and Gowin D.B. (1984).

## APPENDIX D

### CONTENT INSTRUCTION OF LANDFORMS OF GLACIATION

#### UNIT ONE:

General Introduction of the topic

- the Ice Ages
- Types of Ice Masses

#### UNIT TWO:

Landforms of Highland Glaciation

Formation of features and characteristics

- : Corrie
- : Aretes and pyramidal peaks
- : Bergschrund
- : Crevasses

#### UNIT THREE:

Landforms of Highland glaciation (continued)

- : U-shaped glacial trough
- : Hanging valleys
- : Rock basins and rock steps
- : Moraines
- : truncated spurs

#### UNIT FOUR:

Landforms of Glaciated Lowlands

- Formations of features and characteristics
  - : Roche Moutonee
  - : Crag and tail
  - : Boulder clay or glacial tilt

: Erratics

**UNIT FIVE:**

Landforms of Glaciated Lowlands (continued)

- : Drumlins
- : Eskers
- : Terminal moraines
- : Outwash plains

**UNIT SIX:**

The value of glaciated regions to Man.

- : Glacial features of value of Man
- : Glacial features of little value to Man

## APPENDIX E

### HIERARCHY OF CONCEPTS AND POINTS AWARDED

LEVEL 1 (10 points)

Glacier, Highland glaciation, Ice,

Lowland glaciation, Snow,

Human aspects of glaciated landforms,

Spatial distribution of glaciated landforms,

Ice age

LEVEL 2 (5 points)

Plucking, Abrasion, Moraine,

Glacial transportation, Fluvio glacial deposits,

LEVEL 3 (2 points)

Fertile plains, Natural routeways,

Tourist attraction, Transhumance (pasture),

Outwash plains, Marshy landscape,

Reservoirs, Hydroelectric power,

LEVEL 4 (1 point)

Hanging valley, Corrie Arrete, Pyramidal peak,

Roche moutonnee, Crag and tail, Boulder clay,

Drumlin, Erratic, Kames, Kettle, Tarn, Ribbon lakes

Iceberg, Rock basin, Rock step, Truncated spurs,

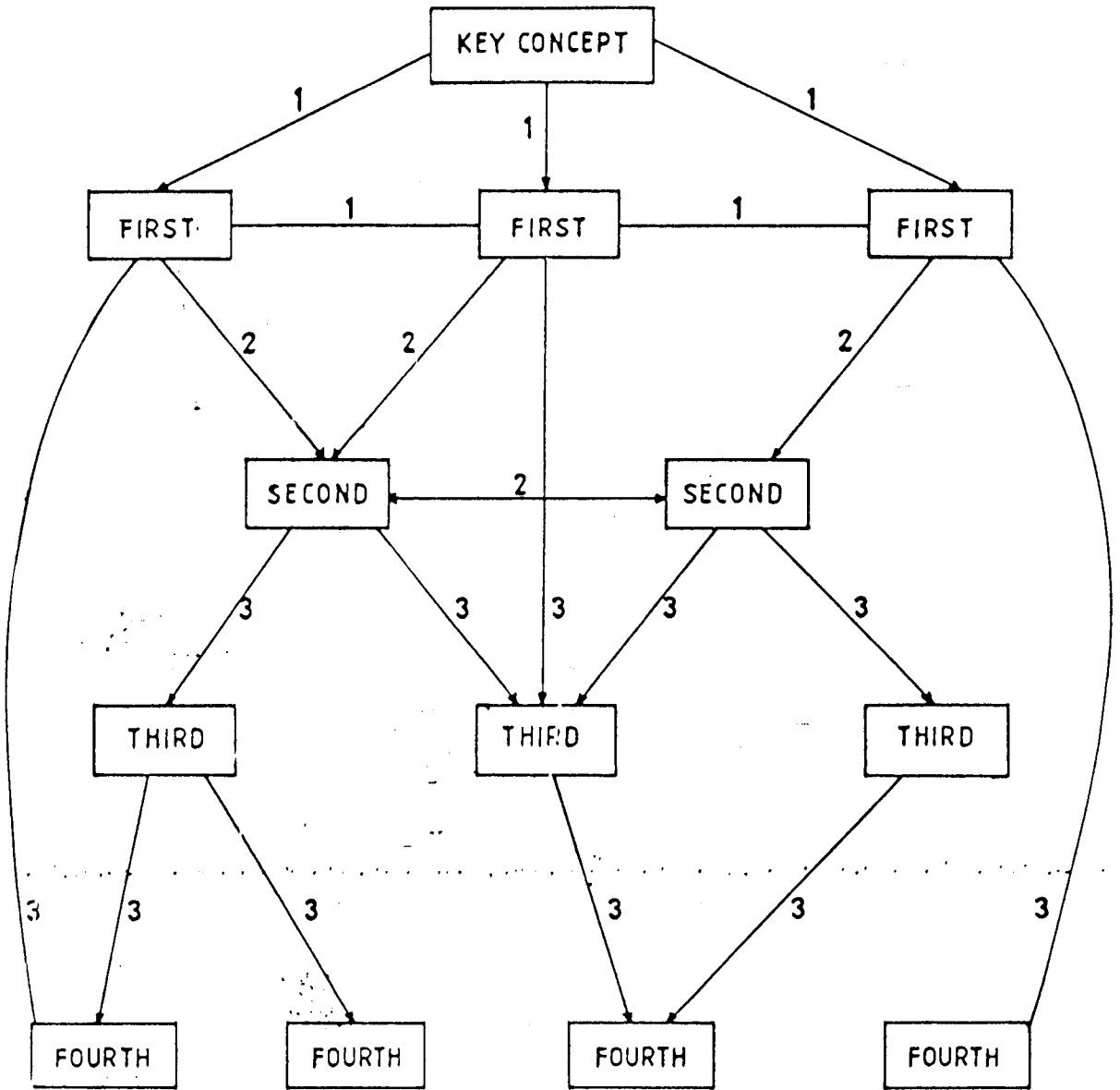
Bergschrund, U-shaped valley, Lateral, Terminal,

Ground, Medial, and Recessional moraines.

Other Concepts and Examples.

APPENDIX F

SCORING ALGORITHM FOR INTERLINKAGES BETWEEN CONCEPT



1 : 5 x 20 points

2 : 4 x 10 points

3 : 11 x 5 points







**APPENDIX H**  
**STUDENTS' RAW SCORES AND PERCENTAGES**

**1. EXPERIMENTAL GROUP**

No.	PRETEST		POSTTEST- ONE		POSTTEST- TWO		CONCEPT MAPPING SCORES	
	RAW	%	RAW	%	RAW	%	RAW	%
1	17	28.81	31	52.54	31	52.54	286	85.1
2	24	40.68	39	66.10	36	61.02	209	62.2
3	20	33.9	31	52.5	27	45.8	221	65.8
4	21	35.6	27	45.8	31	52.6	257	76.5
5	15	25.4	32	54.2	28	47.5	197	58.6
6	17	18.8	29	49.2	29	49.2	265	78.9
7	20	33.9	29	49.2	28	47.5	172	51.2
8	19	32.2	31	52.5	30	50.9	252	75.0
9	23	39.0	30	50.9	34	57.6	225	67.0
10	17	28.8	30	50.9	34	57.6	184	54.8
11	25	42.4	29	49.2	33	55.9	235	69.9
12	24	40.7	29	49.2	30	50.9	173	51.5
13	21	35.5	37	62.7	36	61.0	184	54.8
14	13	22.0	33	55.9	38	64.4	232	69.0
15	24	40.7	36	61.0	32	54.2	158	47.0

1. CONTROL GROUP

No.	PRETEST		POSTTEST- ONE		POSTTEST- TWO	
	RAW	%	RAW	%	RAW	%
1	14	23.7	29	49.2	30	50.9
2	16	27.1	37	62.7	34	57.6
3	21	35.6	28	47.5	29	49.2
4	18	30.5	20	33.9	26	44.1
5	20	33.9	32	54.2	31	52.2
6	13	22.0	29	49.2	33	55.9
7	22	37.3	26	44.1	24	40.7
8	24	40.7	31	52.5	23	39.0
9	16	27.1	26	44.1	26	44.1
10	21	35.6	34	57.6	39	66.1
11	11	18.6	35	59.3	33	55.9
12	20	33.9	27	45.8	27	45.8
13	14	23.7	24	40.7	26	44.1
14	19	32.2	27	45.8	33	55.9
15	18	30.5	35	59.3	34	57.6

APPENDIX I

T-TEST RESULTS

Two-Sample Analysis Results

	EXT2	COT2	Pooled
Sample Statistics: Number of Obs.	15	15	30
Average	31.5333	29.3333	30.4333
Variance	11.4095	21.8095	16.6095
Std. Deviation	3.3778	4.67007	4.07548
Median	31	29	30
Conf. Interval For Diff. in Means:	95	Percent	
(Equal Vars.) Sample 1 - Sample 2	-0.849064	5.24906	28 D.F.
(Unequal Vars.) Sample 1 - Sample 2	-0.862589	5.26259	25.5 D.F.
Conf. Interval for Ratio of Variances:	0	Percent	
Sample 1 ÷ Sample 2			
Hypothesis Test for H0: Diff = 0	Computed t statistic = 1.47834		
vs Alt: GT	Sig. Level = 0.0752393		
at Alpha = 0.05	so do not reject H0.		

Two-Sample Analysis Results

	EXT3	COT3	Pooled
Sample Statistics: Number of Obs.	15	15	30
Average	31.8	29.8667	30.8333
Variance	10.8857	20.2667	15.5762
Std. Deviation	3.29935	4.50185	3.94667
Median	31	30	31
Conf. Interval For Diff. in Means:	95	Percent	
(Equal Vars.) Sample 1 - Sample 2	-1.01936	4.88603	28 D.F.
(Unequal Vars.) Sample 1 - Sample 2	-1.03148	4.89814	25.7 D.F.
Conf. Interval for Ratio of Variances:	0	Percent	
Sample 1 ÷ Sample 2			
Hypothesis Test for H0: Diff = 0	Computed t statistic = 1.34155		
vs Alt: GT	Sig. Level = 0.0952611		
at Alpha = 0.05	so do not reject H0.		

One-Sample Analysis Results

---

---

Sample Statistics:	Number of Obs.	15	COMA-EXT2P
	Average	10.372	
	Variance	212.497	
	Std. Deviation	14.5773	
	Median	4.36	
Confidence Interval for Mean:		95	Percent
Sample 1		2.29733	18.4467 14 D.F.
Confidence Interval for Variance:		0	Percent
Sample 1			
Hypothesis Test for $H_0$ : Mean = 0		Computed t statistic = 2.7557	
vs Alt: NE		Sig. Level = 0.0154709	
at Alpha = 0.05		so reject $H_0$ .	

APPENDIX I

T-TEST RESULTS ON TEST ITEMS COMPARISON

Two-Sample Analysis Results

	expost1a	copost1a	Pooled
Sample Statistics: Number of Obs.	15	15	30
Average	45.8333	40.8333	43.3333
Variance	132.068	172.247	152.158
Std. Deviation	11.4921	13.1243	12.3352
Median	43.75	43.75	43.75
Conf. Interval For Diff. in Means:	95	Percent	
(Equal Vars.) Sample 1 - Sample 2	-4.22858	14.2286	28 D.F.
(Unequal Vars.) Sample 1 - Sample 2	-4.23584	14.2358	27.5 D.F.
Conf. Interval for Ratio of Variances:	0	Percent	
Sample 1 ÷ Sample 2			
Hypothesis Test for H0: Diff = 0	Computed t statistic = 1.11008		
vs Alt: GT	Sig. Level = 0.138204		
at Alpha = 0.05	so do not reject H0.		

Two-Sample Analysis Results

	expost2a	copost2a	Pooled
Sample Statistics: Number of Obs.	15	15	30
Average	46.6667	48.3333	47.5
Variance	127.604	97.4702	112.537
Std. Deviation	11.2962	9.8727	10.6084
Median	43.75	50	46.875
Conf. Interval For Diff. in Means:	95	Percent	
(Equal Vars.) Sample 1 - Sample 2	-9.60329	6.26996	28 D.F.
(Unequal Vars.) Sample 1 - Sample 2	-9.60971	6.27638	27.5 D.F.
Conf. Interval for Ratio of Variances:	0	Percent	
Sample 1 ÷ Sample 2			
Hypothesis Test for H0: Diff = 0	Computed t statistic = -0.43026		
vs Alt: GT	Sig. Level = 0.66485		
at Alpha = 0.05	so do not reject H0.		

Two-Sample Analysis Results

	expostib	copostib	Pooled
Sample Statistics: Number of Obs.	15	15	30
Average	55.6393	53.0233	54.3313
Variance	49.2108	76.6619	62.9364
Std. Deviation	7.01504	8.75568	7.93325
Median	55.81	53.49	54.65
Conf. Interval For Diff. in Means:	95	Percent	
(Equal Vars.) Sample 1 - Sample 2	-3.31925	8.55125	28 D.F.
(Unequal Vars.) Sample 1 - Sample 2	-3.332	8.564	26.7 D.F.
Conf. Interval for Ratio of Variances:	0	Percent	
Sample 1 ÷ Sample 2			
Hypothesis Test for H0: Diff = 0	Computed t statistic = 0.903062		
vs Alt: GT	Sig. Level = 0.187098		
at Alpha = 0.05	so do not reject H0.		

Two-Sample Analysis Results

	expost2b	copost2b	Pooled
Sample Statistics: Number of Obs.	15	15	30
Average	55.3493	51.4747	53.412
Variance	45.7587	67.1114	56.435
Std. Deviation	6.76452	8.19215	7.51232
Median	55.81	53.49	53.49
Conf. Interval For Diff. in Means:	95	Percent	
(Equal Vars.) Sample 1 - Sample 2	-1.74567	9.495	28 D.F.
(Unequal Vars.) Sample 1 - Sample 2	-1.75475	9.50408	27.0 D.F.
Conf. Interval for Ratio of Variances:	0	Percent	
Sample 1 ÷ Sample 2			
Hypothesis Test for H0: Diff = 0	Computed t statistic = 1.41251		
vs Alt: GT	Sig. Level = 0.0844099		
at Alpha = 0.05	so do not reject H0.		

