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ABSTRACT

This study examined the effects of an advance organizer and background experience in science on the attainment of science concepts. Ninth-grade earth science students (N=90) were given the Dubbins Earth Science Test (DEST) and a Science Background Experience Inventory (SBEI) developed by the author. They were then placed into high, medium, and low experience groups, each group subdivided into a treatment (receiving an advance organizer on the rock cycle) and a control (receiving a placebo on the rock cycle) group. A DEST posttest was given after two weeks: in addition, data on sex, Differential Aptitude Test (DAT) scores, socioeconomic status, and grade point average were collected. It was concluded that: (1) neither the advance organizer nor the background experience of the student made a significant difference in achievement: (2) there was no significant interaction between method and background experience of the student: (3) there was a strong covariance relationship between the DAT section on Abstract Reasoning and achievement on the DEST. Interpretations include, among others, the possibility that the unit of study may not have been broad enough to allow for a maximum advance organizer effect and that the sample did not include the full spectrum of student abilities. (Author/JN)

THE EFFECT OF BACKGROUND EXPERIENCE AND AN ADVANCE ORGANIZER ON THE ATTAINMENT OF CERTAIN SCIENCE CONCEPTS

by
Mary Kathleen McAdaragh

A dissertation submitted in partial fulfillment
of the requirements for the degree of
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Doctoral Committee:

Professor Burton E. Voss, Chairman
Professor Carl F. Berger
Professor Calvin O. Dyer
Professor Donald F. Eschman

ABSTRACT

THE EFFECT OF BACKGROUND EXPERIENCE AND AN ADVANCE ORGANIZER ON THE ATTAINMENT OF CERTAIN SCIENCE CONCEPTS

by
Mary Kathleen McAdaragh

Chairman: Burton E. Voss

This study examined two major questions: (1) the effect of an advance organizer on attainment of science concepts, and (2) the effect of background experience in science on the attainment of science concepts.

A population of ninety ninth graders enrolled in an earth science class was given the Dubins Earth Science Test, form A, a published earth science test, which had been modified by the researcher for this study. The same students were also given the Science Background Experience Inventory, an instrument developed by the researcher. On the basis of the experience score, the students were placed into a high, medium and low experience group. Each of the experience groups was further divided into a treatment and a control group.

The treatment group was given an advance organizer on the topic of the rock cycle and the control group was given a placebo on the same topic. A two week unit on the rock cycle was then taught to all students. At the end of the two weeks, the

Dubins Earth Science Test, form B, was given to the students as a post test. Additional data on sex, Differential Aptitude Test scores, socioeconomic status and grade point were collected. Analyses were performed on the basis of these results.

The conclucsions of the study were: (1) the advance organizer made no significant difference in achievement as measured by the Dubins Earth Science Test; (2) the background experience of a student, as measured by the Science Background Experience Inventory, made no significant difference in achievement on the Dubins Earth Science Test. The background experience accounted for the variance on performance on the Dubins post test to a small degree; (3) there was no significant interaction between the method and the background experience of the student; (4) there was a strong covariance relationship between the Differential Aptitude Test section on Abstract Reasoning and achievement on the Dubins Earth Science Test.

The results showing no significant difference due to treatment or background experience may have a number of interpretations. These include: (1) The possibility that the test instruments may not have been sensitive enough to register significant changes; (2) The population did not include the full spectrum of student abilities. This exclusion may have affected the

outcome of the research; (3) The difficulties experienced in recording the time for completion may have masked an efficiency factor. That is, the amount of time necessary for completion of the unit may be significantly reduced by an advance organizer; (4) The teacher's presentation of the unit may have been so good that differences between students are reduced; (5) The unit of study may not have been broad enough to allow for a maximum advance organizer effect; and (6) The retention of the treatment group may have been significantly greater but testing after a longer period of time would be necessary to measure this. These interpretations lead to many possibilities for future research.

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Cooperation from the principal of East Junior High School, Mr. Alton Bennett, made this study possible. Other members of the school staff supported me by allowing their classes to be used for pilots. Mr. James Pardon was invaluable for his role in explaining the study to the students and keeping their responses anonymous. The students who participated were most cooperative and interested in the whole process of research. To them I give my final thanks.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS ii

LIST OF TABLES v

LIST OF APPENDICES ix

CHAPTER ONE: INTRODUCTION, BACKGROUND AND NEED FOR STUDY. 1

Need for Study
Statement of Problem
Research Hypotheses
Null Hypotheses
Limitations
Definitions

CHAPTER TWO: REVIEW OF THE LITERATURE 17

Meaningful Learning
Background Experience
Related Variables

CHAPTER THREE: PROCEDURES AND EXPERIMENTAL DESIGN 34

Introduction
Sample
Development of Instruments
Research Design

CHAPTER FOUR: STATISTICS. 46

Hypotheses
Summary

CHAPTER FIVE: SUMMARY, CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS. 96

Summary
Conclusicns
Discussion
Recommendations

TABLE OF CONTENTS (continued)

APPENDICES 107

BIBLIOGRAPHY 160

LIST OF TABLES

TABLE		
1	Cronbach Alpha Reliability Analysis for the Science Background Experience Inventory	35
2	Results of Reliability Analysis for the Dubins Earth Science Total and Sub Post Tests	37
3	Research Design	44
4	Comparison of Scores on the Dubins Total Pre Test and Dubins Total Post Test for the Treatment and Control Groups.	48
5	Means and Standard Deviations for All Ten Measurable Variables for Treatment and Control Groups.	49
6	Regression Analyses Using the Dubins Total Post Test Score for a Population of Ninety Students.	51
7	Regression Analyses Using the Dubins Total Post Test Score for the Treatment Group of Fifty.	52
8	Regression Analyses Using the Dubins Total Post Test Score for the Control Group of Forty-Six.	53
9	Regression Analyses Using the Dubins Total Post Test Score for the Forty Females	54
10	Regression Analyses Using the Dubins Total Post Test Score for the Fifty-Six Males	55
11	Analysis of Covariance of Experience Groups and Method Groups Using the Dubins Sub Post Test Score and Controlling for Dubins Sub Pre Test Score, Sex, DAT Abstract, DAT Numerical and DAT Verbal Scores	57

LIST OF TABLES (continued)

TABLE

12 Analysis of Covariance of Treatment and Control Groups Using the Dubins Total Post Test Score and Controlling With the Dubins Total Pre Test Score 58

13 Analysis of Covariance of Treatment and Control Groups Using the Dubins Sub Post Test Score and Controlling for the Dubins Sub Pre Test Score. 59

14 Comparison of Dubins Total Pre Test Score and Dubins Total Post Test Score For High, Medium and Low Background Experience Groups 61

15 Means and Standard Deviations for All Ten Measurable Variables for the Total Group 62

16 Means and Standard Deviations for All Ten Measurable Variables For High, Medium and Low Background Experience Groups. 63

17 Analysis of Variance of Background Experience Group Using Dubins Total Post Test Score 65

18 Background Experience Socres of High and Low Background Experience Groups for Dubins Pre, Post, Total and Sub Scores. 66

19 Analysis of Covariance of the Three Experience Groups and Two Method Groups Using the Dubins Total Post Test Score. . . 67

20 Means and Standard Deviations by Method and Background Experience Cells for Seven Measurable Variables. 69

21 T-Test for Treatment Versus Control Groups Using the Total Background Experience Scores 73

22 Comparison of Males and Females Using the Dubins Total Pre Test Scores and Dubins Total Post Test Scores 75

LIST OF TABLES (continued)

TABLE

23 Means and Standard Deviations for All Ten Measurable Variables for Males and Females 76

24 Analysis of Covariance of Males and Females Using the Dubins Total Post Test Score and Controlling for the Dubins Total Pre Test Score. 77

25 Analysis of Covariance of Males and Females Using the Dubins Sub Post Test Score and Controlling for the Dubins Sub Pre Test Score. 78

26 Comparison of Female and Male Science Background Experience Inventory Scores. . . 80

27 T-Test for Males and Females on the Total Science Background Experience Inventory Score 81

28 Means and Standard Deviations for All Ten Measurable Variables for High, Medium and Low Socioeconomic Status 83

29 Comparison of Scores on the Dubins Total Pre and Post Test Scores for High, Medium and Low Socioeconomic Groups 84

30 Analysis of Covariance of Socioeconomic Groups Using the Dubins Total Post Test Score and Controlling on the Dubins Total Pre Test Score. 85

31 Analysis of Covariance of Socioeconomic Groups Using the Dubins Sub Post Test Score and Controlling on the Dubins Sub Pre Test Score. 87

32 Background Experience for High and Low Socioeconomic Status Groups on Dubins Pre, Post, Total and Sub Test Scores. . . . 88

33 Analysis of Variance of the Three Socioeconomic Groups Using the Total Science Background Experience Inventory Score 90

LIST OF TABLES (continued)

TABLE

34 A Comparison of the Differential Aptitude Scores in Numerical, Abstract and Verbal for All Males and Females. . . . 92

35 Means and Standard Deviations on Twenty-Six Items of the Dubins Sub Post Test 109

36 Means and Standard Deviations for Items on the Science Background Experience Inventory 110

37 Chi Square Analysis for Twenty-Six Items on the Dubins Sub Post Test 112

38 Percentages of Correct and Incorrect Answers on the Dubins Sub Post Test By Methods. 113

LIST OF APPENDICES

APPENDIX

A	Additional Tables.	108
B	Twenty-Six Items From The Dubins Total Post Test.	115
C	Science Background Experience Inventory.	121
D	Earth Science Test, Form A	127
E	Earth Science Test, Form B	142
F	Rock Cycle Unit.	157

CHAPTER ONE

INTRODUCTION, BACKGROUND AND NEED FOR STUDY

How do we learn what we learn? That had many postulated answers from the time of the ancient philosophers to modern day psychologists. Joseph Novak commented that a definition of learning always includes the idea that learning is a change in the behavior of the organism resulting from previous experience.[1] Thus it seems that if a study is to be conducted about learning today, it should include the elements of background experience as well as the conceptual elements of the subject material to be learned. Shulman stated that, "any discussion of a psychology of instruction must deal with the three basic components of that process: (a) the entering characteristics of the students, (b) the teaching-learning activities and processes and (c) the instructional objectives."[2] The outcome or result of that instruction needs to be studied as well.

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[1]Joseph Novak, A Theory of Education (Ithaca: Cornell University Press, 1977), p. 64.

[2]Lee Shulman, "Psychology and Mathematics Education," National Scoiety for the Study of Education-Sixty-Ninth Yearbook (Chicago: University of Chicago Press, 1970), p. 34.

A number of views need consideration since learning involves the aptitude or ability of the learner. The distinction between intelligence and experience must be clarified. One does not guarantee the other although there is a relationship between them. Deprivation of experience has been shown to hinder the development of intelligence as measured by ability.[3] Hunt defined intelligence as the number of cell assemblies that are within our brain. Klausmeier and Schwenn defined a concept as, "ordered information about properties of one or more things--objects, events or processes--that enable any particular thing or class of things to be differentiated from and also related to other things or classes of things."[4] Carroll disagreed with the notion that a person's intelligence is his ability to acquire concepts, and defined aptitude as the amount of time required by the learner to attain mastery of a learning task.[5] There are many elements shared by both aptitude and intelligence. The extent of the sharing is an area for continuing research and debate.

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[3]J. M. Hunt, Intelligence and Experience (New York: Ronald Press Company, 1961), pp. 362-363.

[4]Herbert J. Kausmeier and Elizabeth Schwenn Chutala, Conceptual Learning and Development: A Cognitive View (New York: Academic Press, Inc., 1974), p. 87.

[5]Shulman, p. 48.

The manner in which these basic instructional components are approached in a learning situation can vary along a continuum from a process of independent discovery to dependent teacher structuring of learning. Bruner was the major proponent of the learning by discovery approach. A general description of learning by discovery is: "first the child finds in his manipulation of the materials, regularities that correspond with intuitive regularities he has already come to understand ... the child finds some sort of match between what he is doing in the outside world and some models or templates that he has already grasped intellectually. For Bruner, it was rarely something outside the learner that was discovered. Instead, the discovery involves an internal reorganization of previously known ideas in order to establish a better fit between those ideas and the regularities of an encounter to which the learner has had to accommodate."[6] Bruner based his rationale for manipulation activities on the developmental theory of Piaget.

Ausubel in contrast to Bruner, proposed the structuring of instructional experiences. "Ausubel saw no reason why problem solving activity must precede the internalization of new facts, concepts or principles."[7]

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[6]Ibid, p. 28.

[7]Ibid, p. 33.

"If the material can be meaningfully organized by the instructor, the need for student discovery is removed and the process of learning rendered far more efficient."[8] Ausubel saw either method as being able to result in meaningful learning, but stressed the point that teachers do not have the time to allow the student to re-invent the wheel for everything that is to be learned.

Ausubel specified that if we are to learn anything, it must be meaningful to us. Meaningful learning occurs when the material to be learned "is associated with existing general concepts in a nonarbitrary and substantive manner that allows for adequate internalization of the new information."[9] The existing concepts with which the new information was linked are called subsumers or subsuming concepts. Ausubel's explanation was that the new information that was acquired was stored in a slightly altered form from the original presentation. It was both changed and changes the subsumers with which it comes into contact. Over a longer period of time the vague concepts in our cognitive structure become progressively differentiated to varying levels of detail. This process is called progressive

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[8]Ibid, pp. 33-34.

[9]Carl J. Naegele, "Toward More Meaningful Learning in Science and Mathematics," Michigan Science Teachers Association Bulletin, 25 (1978), pp. 2-3.

differentiation.

Novak, in his book A Theory of Education, clarified rote versus meaningful learning. He stated that in order for learning to be rote it must have no related general concepts in the cognitive structure of the learner. "Except in newborn infants, absolute rote learning probably never occurs."[10] The debate that occurred about rote learning methods was actually a question of the amount of meaningfulness in a material to be learned. Shulman stated "the rote-meaningful dimension represents the degree to which what is learned articulates with the learner's prior knowledge and cognitive structure, with no reference to how he learns it." He continued ... "all that is discovered is not meaningful; all that is received is not rote."[11]

A number of variables were associated with the degree of meaningfulness in learning. One of these was the rate of forgetting. The greater the degree of meaningfulness, the slower the rate of forgetting. However, if the material to be learned needed to be recalled in the exact form in which it was presented, then rote learning was more useful. The concept that was presented was changed as it is subsumed in

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[10]Novak, p. 80.

[11]Shulman, p. 38.

meaningful learning. Ausubel called this integrative reconciliation as he refers to the cross-referencing that occurred within the cognitive structure of the learner.

Another process that was associated with the degree of meaningfulness of material to be learned was transfer. A study by Swadner and Lawton at the University of Wisconsin at Madison, demonstrated that the Ausubelian organization resulted in transfer of task performance at fourteen weeks after the instruction.[11]

Another important aspect of meaningful learning referred to by Novak, was the motivation or learning set. "If people are disposed toward trying to learn new information as meaningfully as possible, they will search for ways to form associations."[12] What was intended to be meaningful by the instructor would result in rote if there was no learning set or predisposition toward the learning task.

Ausubel proposed to set a learner's predisposition to the learning task rather than leaving it to chance. He called this aid an advance organizer.

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[11]Elizabeth Swadner and Joseph T. Lawton, "The Effects of Two Types of Advanced Organizer Presentations on Pre-School Children: Classification, Retention and Transfer of Task Performance" (Madison, Wisconsin: University of Wisconsin at Madison, 1977).

[12]Novak, p. 81.

It would perform the function somewhat similar to that of a chapter introduction, but went beyond that function. The difference was that the organizer presented ideas or concepts which were at the highest level of generality and inclusiveness and it therefore allowed students to subsume new related information under these concepts as they progress. The principal function of these organizers as stated by Ausubel in Educational Psychology-A Cognitive View "is to bridge the gap between what the learner already knows and what he needs to know before he can successfully learn the task at hand."[13] If information preceded the units, then new information was plarted into the ideational scaffolding of the learner to which the coming unit could relate. Inbody stated the following in the introduction to his article "Children's Understanding of Natural Phenomena," "The folly of attempting to teach children things for which they have not obtained an experiential background is commonly acknowledged."[14]

> Deliberately constructing a special organizer for each new unit of material, gives the advantage that the learner enjoys the advantage of a subsumer which both (a) gives him a general overview of

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[13]David Ausubel, Educational Psychology: A Cognitive View (New York: Holt, Rinehart, Winston, 1968), p. 148.

[14]Donald Inbody, "Children's Understandings of Natural Phenomena," Science Education 47 (1963): 270.

> the detailed material in advance of his actual confrontation with it and (b) provides organizing elements that are inclusive of and take into account most relevantly and efficiently, the particular content contained in the material.[15]

A good instructor would attempt to determine background experience before proceeding with instruction of the learner. One way to do this would be through the use of a background experience inventory. Such an inventory would require a yes or no answer to questions related to science experiences children might have. A number of studies have utilized this method, including those by Uhlhorn,[16] Wahla,[17] and Ryder.[18] An important result of the work done with this kind of instrument was a recognition of the importance of the discriminibility of the questions as they related to the topic and content area involved. The objectives of the material to be learned needed to be explicitly determined and the experience inventory developed along the lines of these objectives.

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[15]Ausubel, p. 144.

[16]Kenneth W. Uhlhorn, "The Preparation, Use and Application of a Science Experience Inventory (Unpublished dissertation, University of Iowa, 1963).

[17]James C. Wahla, "The Relationship Between Sixth Grade Science Background Experiences and Science Achievement in Selected Urban Elementary Schools" (Unpublished dissertation, University of Michigan, 1967).

[18]Exyie Chambliss Ryder, "Experience Background and Pupil Understanding of Science Concepts" (Unpublished dissertation, University of Michigan, 1970).

The questions about how concepts are learned, the role of background experience and how to structure learning could be answered only by controlled studies. No one study would answer all of the questions, but it would supply much needed, controlled situations in which the variables are manipulated. Novak stated that experimental studies are important since "the most powerful tool available to man for obtaining new knowledge is the scientific experiment; it is through measurement of changes in some variables when other variables are randomized that we obtain new information with the greatest veracity."[19] Criticism of past research was voiced by Tyler in a comment about science education studies. "In many cases, science teaching seems to be defined as shaping the student's behavior to conform to the particular objectives of the teacher of the curriculum. These conceptions are inadequate to explain the behavior of many students."[20]

Ausubel identified a lack of research as it related to the cognitive structure of the learner. "No effort was made to analyze the conceptual and

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[19]Joseph Novak, "A Preliminary Statement on Research in Science Education," Journal of Research in Science Teaching 1 (1963): 5.

[20]Ralph W. Tyler, "Research in Science Teaching in a Larger Context," Journal of Research in Science Teaching 2 (1974): 134.

propositional content of the passages to be learned to ascertain what kind of concepts are to be bridged to existing subsumers. In short, the analysis of both the learner's relevant subsumers and the concepts to be learned is missing, and hence it is very unlikely that an optimal advance organizer (or cognitive bridge) could be constructed."[21]

Need for Study

In general, educators would need to know what the learner was bringing to the classroom. One element would be background experience in the subject matter field. If successful use of an advance organizer was dependent on what the student already knew, knowledge of these experiences would be important to teachers. If students who have good experience backgrounds learned concepts better than those with poor backgrounds, an important educational finding would be made. Thus, there would seem to be an imperative need for the proposed study.

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[21]David P. Ausubel, "In Defense of Advance Organizers: A Reply to the Critics," Review of Educational Research 43 (Spring 1978): 255.

Statement of Problem

The purpose of this study was to research the effect of an advance organizer and the student's science background experience on the achievement of concepts in ninth grade earth science. Related variables which were investigated were sex, grade point average, science grade point average, socioeconomic status and Differential Aptitude Test Scores in numerical ability, verbal reasoning and abstract reasoning.

The research design was one of a controlled experiment. Ninth grade earth science students were given the Science Background Experience Inventory and the Dubins Earth Science Test, form A. They were divided into three experience groups from high to low. Within each of these groups, a treatment group was given the advance organizer and a control group a placebo. The unit was presented and form B of the Dubins Earth Science Test was given as a post test. Analyses were made on the basis of this design.

This type of study should have the ability to be generalized to other typical classroom settings where the teacher desires to utilize all knowledge about students for their benefit. "The object of research is generalization, that is, the discovery of or the formulation of something which has wider applicability than

a description of the particular case or cases which were the subjects of the study."[22]

Research Hypotheses

1. It is predicted that the students receiving the advance organizer will achieve significantly better than those not receiving the advance organizer, as measured by the Dubins Earth Science Test.

2. Those students having a richer experience background will achieve significantly better than those with less rich background experience, as measured by the Dubins Earth Science Test.

3. It is predicted that there will be a significant interaction between background experience and method of instruction as measured by the Dubins Earth Science Test.

4. The experience group with the highest score will achieve significantly greater on the Dubins Earth Science Test and the treatment group receiving the advance organizer will also achieve significantly greater on the Dubins Earth Science Test.

5. It is predicted that there will not be any significant difference between the method groups as measured by the Background Experience Inventory.

6. It is predicted that the males will achieve significantly better on the Dubins Earth Science Test.

7. It is predicted that the males will have a significantly higher score on the Background Experience Inventory.

8. The higher socioeconomic group will achieve significantly greater on the Dubins Earth Science Test.

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[22]Ralph W. Tyler, "Analysis of Strengths and Weaknesses in Current Research in Science Education," Journal of Research in Science Teaching 5 (1967): 54.

9. The higher socioeconomic group will achieve significantly higher on the Background Experience Inventory.

10. It is predicted that the higher experience group will also have higher scores on the DAT abstract reasoning, numerical and verbal. The method groups will not vary significantly on those same scores.

11. It is predicted that the higher experience group will be found to have a significantly higher overall grade point in the eighth grade and it is also predicted that the method groups will not have any significant difference between them.

12. The higher experience group will be found to have a significantly higher science grade point for the eighth grade and the method group will not have a significantly higher science grade point for the eighth grade, when compared to other experience and the control group.

Null Hypotheses

1. There is no significant difference in achievement between the students receiving the advance organizer and those that did not receive the advance organizer, as measured by the Dubins Earth Science Test.

2. There is no significant difference in achievement between those students having a rich background experience and those students with a less rich background experience, as measured by the Dubins Earth Science Test.

3. There is no significant interaction between the background experience and method of instruction as measured by the Dubins Earth Science Test.

4. There is no significant difference between the experience or method groups as measured by the Dubins Earth Science Test.

5. There is no significant difference between the method groups as measured by the Science Background Experience Inventory.

6. There is no significant difference between the sexes as measured by the Dubins Earth Science Test.

7. There is no significant difference between the sexes as measured by the Science Background Experience Inventory.

8. There is no significant difference between the three socioeconomic groups as measured by the Dubins Earth Science Test.

9. There is no significant difference between the three socioeconomic groups as measured by the Science Background Experience Inventory.

10. There is no significant difference between the experience and method groups as measured by the Differential Aptitude Test on Abstract Reasoning, Numberical and Verbal scores.

11. There is no significant difference between the experience and method groups as measured by the average overall grade point in the eighth grade.

12. There is no significant difference between the experience and the method groups as measured by the science grade point for the eighth grade.

Limitations

1. The population used in the study was limited to a segment of ninth graders enrolled in earth science.

2. The population used in the study contained only ninth graders enrolled in three sections of earth science and not the remaining four sections of earth science or alternate biology class.

3. The population used in the study covered only one section of one suburban school district.

4. The single teacher involved may have biased the results between method groups.

Definitions

Advance Organizer--a series of concepts that are introduced prior to the unit of study. The organizer presents ideas or concepts which are at the highest level of generality and inclusiveness.

Concept--ordered information about properties of one or more things, objects, or events, or processes that enable any particular thing or class of things to be differentiated from and also related to other things or classes of things.

Ideational Scaffolding--the series of hierarchially organized concepts within the cognitive framework of the learner.

Integrative Reconciliation--a cross referencing of new knowledge within the existing cognitive structure.

Meaningful Learning--learning that is associated with existing general concepts in a nonarbitrary and substantive manner and therefore allows the new information to be adequately internalized.

Progressive Differentiation--the process whereby vague concepts in our cognitive structure are subdivided into a hierarchical structure which is broken down to varying levels of detail.

Subsumption--the process whereby new concepts are linked with existing ones within the cognitive structure. This process may adapt or change the new concept some as it is related to existing information.

CHAPTER TWO

REVIEW OF THE LITERATURE

The literature that was pertinent to this study falls into two major categories; the area of making learning meaningful and the effect of experience on learning. Subtopics included I.Q., sex, success in school, success in science, socioeconomic status, time for completion of units, reading comprehension and earth science. Direction needed for science education research was referred to in the introduction. The statements by Tyler and Novak pointed out the need for experimental studies with controlled variables. If these conditions could be met, then the ability to generalize from them to other classrooms could be improved. Since that is a goal of all educational research, it seems crucial to design a study to follow just those recommendations.

Meaningful Learning

Meaningful learning, as defined by Ausubel, is learning that associates new material with concepts that exist within the cognitive structure of the learner. Bruner emphasized learning as meaningful that allows for process development as well as concept

acquisition. Shulman quoted Bruner from Toward A Theory of Instruction, "we teach a subject, not to produce little living libraries on that subject, but rather to get a student to think mathematically for himself, to consider matters as a historian does, to take part in the process of knowledge-getting. Knowing is a process, not a product."[23] Ausubel understood the results that Bruner was talking about but argued that it could be achieved equally as successfully and with much less time involvement for the student if the material was structured in advance to guide the learner.

The use of advance organizers and structured material to make learning meaningful was investigated by Kahle and Rastova. The results were measured by a summative achievement test. They found that there was a significant difference for the rural biology classes given the advance organizer. They also found that meaningful learning was increased by sequentially presented materials.[24] Specific types and lengths of advance organizers were investigated by Rickard and McCormic. Their results showed that long organizers were too cumbersome. Greater success was achieved by a

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[23]Shulman, p. 35.

[24]Kahle and Rastova, "The Effects of a Series of Advance Organizers on Increasing Meaningful Learning," Science Educator 60: 365-371.

series of short ones presented within the text. There was a qualification in their conclusions. They summarized that if the material itself was well organized, the success of an advance organizer was not seen. When the material was less well organized, the success was significant.[25]

Johnson's study, in 1967, showed that high achievers use a greater number of constrained associations than the low achievers. They defined constrained associations in terms of equational relationships between concepts.[26] Ausubel said "that organizers facilitate the learning of factual material more than they do learning of abstract, since abstractions in a sense, contain their own built in organizers for themselves and related detailed items."[27]

Ausubel was not the first person to say that providing students with relevant information prior to their instruction facilitated learning. The nineteenth century philosopher Herbart, according to Barnes and

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[25]John Rickards and Christine McCormic, "The Effects of Varying Types and Lengths of Advance Organizers," Journal of Educational Research 70 (January 1977): 147-149.

[26]Darrel L. Murray, "The Learning of Biology: A Structural Basis for Further Research," American Biology Teacher 39 (October 1977): 429.

[27]Ausubel, Educational Psychology: A Cognitive View, p. 144.

Clawson,[28] developed this theory. Ausubel, however, said "Both Herbart and Morrison taught that the learner's apperceptive mass or existing cognitive structure vitally affects his ability to comprehend and retain related new ideas. They did not advocate that more inclusive ideas related to existing ideas in cognitive structure should be deliberately introduced in advance of learning material to bridge the gap between what the learner already knows and what he needs to know in order to learn new subject matter effectively."[29] "Ausubel assumed that the learner's cognitive structure was well organized hierarchially in terms of highly inclusive conceptual traces under which are subsumed less inclusive subconcepts as well as specific informational data."[30]

Naegele supported the idea that deliberate attempts to organize instructional strategies along the lines of general to specific hierarchial concept development "should prove to have a significant impact in advancing the intellectual development of our

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[28]Buckly R. Barnes and Elmer U. Clawson, "Do Advanced Organizers Facilitate Learning? Recommendations for Further Research Based on Analysis," Review of Educational Research 45 (1975): 648.

[29]Ausubel, "In Defense of Advance Organizers," p. 253.

[30]Barnes and Clawson, p. 648.

students."[31] Lee Shulman did not go so far as to specifically support one philosophy. He did emphasize that research was needed to clarify the issue by stating, "Once well put in terms of psychologically meaningful variables rather than in terms of stirring slogans, these issues are amenable to systematic scientific investigation."[32]

West and Fensham investigated the use of advance organizers. They were interested in determining whether the role of prior knowledge was equivalent to the role of an external organizer. Their results were not conclusive but they do allow the authors to generalize in their summary by saying: "It is probably reasonable to postualte that the explicit use of organizational aids such as advance organizers post organizers, interspersed questions and so on, in curriculum materials will enhance meaningful learning."[33]

Still another study that investigated different types of organizational procedures was that of Santiesteban and Koran. They investigated three

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[31] Naegele, pp. 2-3.

[32] Shulman, p. 39.

[33] L. H. T. West and P. J. Fensham, "Prior Knowledge of Adavnce Organizers as Effective Variables in Chemical Learning," Journal of Research in Science Teaching 13 (1976): 306.

instructional methods; the advance organizer, adjunct questions, and behavioral objectives. They referred to Ausubel and Novak as the principal proponents of the advance organizer; Frase for the adjunct questions and Duchastel and Merrill for behavioral objectives. They found no evidence to support one of the three methods over the others. In discussing their data, they questioned student motivation, which they did not test, as being a major factor in their results.[34] This could be the learning set referred to by Ausubel as a necessary prerequisite for meaningful learning.

Still another study that attempted to determine the differential effects of types of organization was performed by Lawton and Wanska in 1978. Their research distinguished between content, concept and process concepts and then a combination of the two. They developed different types of advance organizers over the same type of material and tested the results. They showed that the process organizer produced the greatest influence on the task but a combination of process and concept was better than either alone.[35] Lawton did

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[34]Joseph A. Santiesteban and John J. Koran, Jr., "Instructional Adjuncts and Learning Science from Written Materials," Journal of Research in Science Teaching 14 (1977): 51.

[35]Joseph T. Lawton and Susan H. Wanska, "Transfer Effects of Different Types of Advanced Organizers" (Madison, Wisconsin: University of Wisconsin, 1978).

further research with Elizabeth Swadner titled "The Effects of Two Types of Advance Organizer Presentations on Pre-school Children; Classification, Retention and Transfer Task Performance." By using two types of expository instruction, expository alone and guided self-discovery, they found that both organizer groups out performed the control group and performance by the the expository group was significantly superior to the guided self-discovery. The duration of the training effect was up to ten weeks and the transfer of task performance was up to fourteen weeks after instruction.[36] Still another type of organization that was investigated was by Meyer and others. They presented a study titled "Use of Author's Textual Schema: Key for Ninth Grader's Comprehension." They found that less than fifty per cent of the students used the author's schema. Their explanation was that the good readers did the organizing anyway and the poor readers could use the help.[37]

In a workshop presentation at the 1979 NSTA

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[36]Elizabeth Swadner and Joseph T. Lawton, "The Effects of Two Types of Advance Organizer Presentations on Pre-school Children: Classification, Retention and Transfer Task Performance" (Madison, Wisconsin: University of Wisconsin Press, 1977).

[37]Bonnie Meyer and others, "Use of Author's Textual Schema: Key for Ninth Graders Comprehension" paper presented at American Education Research Association, March 1978.

convention, Joseph Novak emphasized that an advance organizer needs to be functional or meaningful. If it was not functional, it was not assimilated into the existing cognitive structure of the learner.[38] In looking at all of the research that has been done to determine the best procedure to use for making the advance organizers functional, there were many conflicting results. Ryder found that the use of an advance organizer to assist learning of specific science concepts was statistically significant at the .001 level. Throughout the reading, there was a continued interest in and reference to the structure of learning material, whether that structure took the form of an advance organizer or some other form. Since the advance organizer was so specific for each author and each unit of material, it became difficult to compare research done on the advance organizer. Its development was very subjective for an individual researcher and the subject matter. Ausubel, in reply to criticism of the use of the advance organizer, states that comparison of different studies has been difficult since each situation needed to be evaluated individually.

In 1975, Barnes and Clawson made recommendations

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[38]Joseph Novak, "Learning Theory and Science Teaching," paper presented at the National Science Teachers Association Convention, Atlanta Georgia, 1979, p. 1.

for further research based on analysis research on the use of advance organizers. In their article, they reviewed the following studies that involved advance organizers. Ausubel and Fitzgerald used college undergrads in a 1962 study to compare an advance organizer with an introduction. They found that there was no significant difference except with the lower third of the group and that was in favor of the group that received the advance organizer. They also concluded that the concepts in the advance organizer needed to be directly related to the concepts to be learned.[39] In contrast to those results, in 1969, a study by Grotelescher and Sjogren found the advance organizer to facilitate learning and transfer with intellectually gifted adults and graduate students in education. Allen's 1969 study used ninth graders and found higher ability level students helped and not the lower ability level. Scholz found in a 1966 study that the advance organizer helped only those who could not organize for themselves.[40]

Based on sometimes conflicting research findings, Barnes and Clawson made the following recommendations about advance organizer research:

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[39]Barnes and Clawson, p. 651.

[40]Ibid, p. 643.

1. Studies should be conducted to investigate the effects of operationally defined advance organizers;

2. ... to determine the long term effects of advance organizers;

3. ... with student of high ability provided that the organizers are operationally defined and that the studies last for more than ten days;

4. ... in a variety of subject areas that are within the construct of prose learning;

5. ... at all age and grade levels, not to determine if age is a significant variable at this point, but to determine if studies which include other appropriate recommendations offered in this review will lead to an eventual isolation of age or grade level as a significant variable;

6. ... use a wide variety of nonwritten advance organizers that are operationally defined and constructed according to the general criteria espoused by Ausubel;

7. ... to determine the facilitative effects of an advance organizer on learning at all levels of the cognitive domain;

8. ... that use recall type test;

9. ... carefully meet all random assignment of subjects to treatment groups, maintain independent of subjects, use the appropriate statistical test, test for mastery of the organizer prior to presentation of the material to be learned, be certain that the test of the advance organizer and all tests of the material to be learned are different from one another, include a retention measure if possible, follow established procedures for test construction and maintain high reliability and validity.[41]

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[41]Ibid, pp. 653-657.

They summarized the thirty-two studies reviewed, and reported that in twelve studies an advance organizer facilitated learning, in twenty it did not. Ausubel took exception to their recommendations. He claimed that their assertions were based on highly biased selection of reviews.[42] He also said that understanding of advance organizers would advance more rapidly if the authors of the critiques would first read the description and criteria of an organizer in his previously published articles.

Background Experience

Novak reduced all educational psychology to just one principle. "The most important single factor influencing learning is what the learner already knows. Ascertain that and teach him accordingly."[43] This was also Ausubel's philosophy. He stated that we need to take the students from where they are now to where we want them to go.[44] Inbody's study of children's understandings of natural phenomena concluded it is

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[42]Ausubel, "In Defense of Advance Organizers," p. 255.

[43]Novak, "Learning Theory and Science Teaching," p. 2.

[44]David Ausubel, Psychology of Meaningful Learning (New York: Grune and Stratton, 1963), pp. 81-87.

important to consider the student's background experience before even considering action.[45]

Lack of experience could be studied to determine a comparative effect. Passow concluded from his research that the more variable the environment to which the children were exposed, the higher the resulting level of effective stimulation. This in turn led to greater communication skills and often higher levels of success in school.[46] Intelligence was not equivalent to experience. There was a relationship between the two which varied from one study to another. One result that Hunt stated is that there is a direct correlation between the richness of experience and intelligence as measured by ability. Intelligence alone was a measure of the number of cell assemblies within the brain.[47] Watson reviewed science and experience in What Research Says to the Science Teacher, Volume I. He emphasized that it was not only the presentation of the experience that was crucial, but also the extent to which it was internalized.[48]

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[45] Inbody, p. 270.

[46] Harry Passow (Ed.), Education in Depressed Areas (New York: New York Teachers College, Columbia University, 1963), p. 102.

[47] Hunt, p. 363.

[48] Fletcher Watson, "Learning Science From Planned Experiences," What Research Says to the Science Teacher (Washington, D. C.: National Science Teachers Association, 1978), pp. 33-35.

The key to the study of experience, however, could be finding a way to measure or assess the student's current level in order to measure any possible growth. If there was not some measure of experience, it could not be used as a measurable variable in research. Uhlhorn's development and application of an "Experience Inventory" instrument had an interest in background experience and the way in which it related to other types of learning experiences that they structured. Its pilot study within the Minneapolis school system found it to be a useful tool but also one that needed to be refined if the results were to be generalized.[49]

Wahla investigated the use of background experience inventories with sixth graders in selected urban areas. He found that refinement of the inventory was needed. Refinement was in terms of the questions asked in the yes-no format. These questions needed to be developed so that their discriminability was tested for the objectives of the unit to be presented. His results showed that with an adjustment for intelligence, there was a significant difference due to background experience from place to place. Wahla stated that the science experience background

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[49]Uhlhorn, p. 217.

of the children was a significant factor in determining a child's science achievement.[50]

Ryder also investigated experience background and pupil understanding of science concepts. She came to some of the same conclusions as James Wahla about the discriminability of the questions as a necessary factor. She also determined that a wider population sample difference was needed if there was to be a spread of experience determined. When adjustments were made for age, sex and I.Q., she found that background experience made no significant difference.[51]

Related Variables

Within this area were a myriad of topics that have varying effects on learning. None of these were intended to be the major focus of the study, but all have some function that has been as yet undetermined on the learning of concepts.

Intelligence has been mentioned several times earlier in regard to experience inventories and concept acquisition. The relationship between intelligence and learning has been generally seen to be a direct

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[50] Wahla, p. 182.

[51] Ryder, p. 109.

correlation.[52] The child's ability to think has also been directly related to his reading ability as reported by Almy.[53] The implication of literature Wellman reviewed suggested that activity oriented science programs seem to strengthen the development of language reading skills. Such activity programs have much structure to them.[54]

Affective behavior was studied in a survey of the literature by Simpson. These findings were found to be important: (a) The interest or motivation which the student possessed had a direct effect on science achievement, as reported by Bloom.[55] (b) An interesting relationship that appeared was that as the grade level of the student increased, the correlation between motivation and achievement increased. Prediction of success was therefore more plausible in the later years of school.[56] (c) In a continuing

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[52]Hunt, p. 336.

[53]Ruth Wellman, "Science: A Basic for Language and Reading Development," What Research Says to the Science Teacher (Washington, D. C.: National Science Teachers Association, 1978), p. 3.

[54]Ronald Simpson, "Relating Student Feelings to Achievement in Science," What Research Says to the Science Teacher (Washington, D. C.: National Science Teachers Association, 1978), p. 46.

[55]Ibid, p. 42.

[56]Ibid.

reference to attitudes, it has been argued that interest in specific subjects is a direct reflection of the students interest in school.[57]

Ryder's study with advanced organizers and background experience found that males did significantly better than females on the same science achievement test.[58] Santiesteban and Koran also found this correlation to be true for science concepts although their study was on a different aspect of science instruction.[59]

The types of questions asked by the teacher should follow the taxonomy developed by Bloom if the concepts to be learned are to also develop to a higher level than recall.[60] In inquiry versus lecture demonstrations, Schlenker reported that the inquiry students developed significantly greater understanding of science and inquiry than the lecture-demonstration students although the content mastery or information retention was no different.[61] There was nothing that

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[57] Ibid.

[58] Ryder, p.

[59] Santiesteban and Koran, p. 53.

[60] Glenn McGlathery, "Analyzing the Questioning Behaviors of Science Teachers," What Research Says to the Science Teacher (Washington, D. C.: National Science Teachers Association, 1978), p. 15.

[61] Ibid, p. 20.

said that structured materials needed to generate only concept information results. They could also develop questioning or inquiring attitudes if the material was structured in that way.

The time necessary for the completion of a unit would be less with a more structured unit. There would be no argument on this from Bruner for he did not see time as a necessary factor. Ausubel emphasized the need for efficiency.[62] This efficiency could be attained by greater organization of the unit material. It was unrealistic to expect that there would be unlimited time for any unit or subject in our increasingly complicated and crowded curriculum.

Why then, would there be an interest in continuing to look into the effects of background experience when the results of research thus far have been inconclusive? Background experience was mentioned in many research studies as a critical factor but one that was as yet inadequately considered. Interaction of experience with an advance organizer could provide a basis for further study.

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[61]Novak, A Theory of Education, p. 228.

CHAPTER THREE

PROCEDURES AND EXPERIMENTAL DESIGN

Introduction

This chapter describes the selection and development of research instruments, the instructional materials and instruction and the general design procedure.

Sample

This study involves a population of ninth grade earth science students in a suburban junior high school. At the time of the study the school system had a population of about 9,000 students and a total city population of 65,000. The socioeconomic status of this school's attendance area was polarized having a blue collar population at one end of the district and a professional population at the other. Ninety students in three sections of earth science were involved in the study and were taught by the researcher.

Development of Instruments

Experience Inventory

The science background experience inventory was

developed from prototypes in studies of Ryder and Uhlhorn. A list of ninety items of science related experiences was given to 300 ninth graders in earth science and biology classes during the winter of 1979. Their responses were tabulated by adding the number of yes responses. The items were evaluated as a total score and as individual item scores. A jury of teachers evaluated the items on the basis of the objectives for the earth science course. Fifty-five of the items passed the criteria. Twenty-five more, dealing specifically with rocks, were developed and similarly evaluated. This work resulted in an eighty item science inventory. Table 1 shows that the Chronbach Alpha Reliability Coefficient for the inventory equals 0.88.

TABLE 1

CRONBACH ALPHA RELIABILITY ANALYSIS FOR THE SCIENCE BACKGROUND EXPERIENCE INVENTORY

Scale	Mean	N	Variance	Standard Deviation	Reliability
Science Background Experience Inventory	46.24	80	115.97	10.77	0.88

Dubins Earth Science Test

The Dubins Earth Science Test had two forms, A and B. The reliability of the Dubins, which was determined by the split-half method, is $r_1 = .85$ and $SE_m = 3.1$. This varied some from form A to form B and one test group to another in their study. The comment in the manual about validity is that "in relation to commonly accepted instructional emphasis, the Dubin's Earth Science Test may be considered as having a high degree of content validity."[62] This form of the Dubins Test, however, was modified to include more test items specific to the unit that was presented, namely the rock cycle. The total length of the test was not changed, for as a new item was added, an original item that did not relate to the unit was removed. The test length of sixty items was enough for a ninth grader to complete within one class period.

Validity of the test was determined by a jury of five earth science teachers who determined that the unit did follow the objectives and that the test items also followed the objectives. The items were given to another set of students prior to use in the final study to clarify any vocabulary or grammatical problems.

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[62] M. Ira Dubins, Dubin's Earth Science Test Manual (New York: Harcourt, Brace and World, Inc., 1969), p. 16.

The problems indicated were corrected and checked using the previous criteria. The reliability KR21 for the sixty items on the Dubins Earth Science Test was found to be 0.76. This information is also presented in Table 2.

TABLE 2

RESULTS OF RELIABILITY ANALYSIS FOR THE DUBINS EARTH SCIENCE TOTAL AND SUB POST TESTS

Scale	Mean	Variance	Standard Deviation	Reliability
Dubins Total Post Test	26.03	58.22		0.76
Dubins Sub Post Test	10.77	11.88	3.45	0.56

Dubins Sub Test

The reliability of the test was determined item by item on the sub test section which included twenty-six of the sixty items on the test. These were the specific items related to the rock cycle. The results of the reliability analysis for the sub test are

illustrated in Table 2. Cronbach's Alpha was found to be 0.56. Table 35 (see Appendix A) presents the means and standard deviations on the twenty-six items that were used.

An item analysis of the twenty-six items on the sub test was done. A Chi-Square analysis indicated that only one item, #22, showed a significant difference between treatment and control groups. Table 37, in Appendix A, shows these results. A problem resulted from the use of χ^2 analyses for the 26 individual items. In order to be significant at the .05 level, the Chi Square would have to be .0019 and at the .01 level, the χ^2 changes to .00039 in order to be significant. This was an inappropriate use of the χ^2 statistic.

Differential Aptitude Test (DAT)

The DAT scores were obtained from the school records and were given in percentile ranks. The sections called verbal reasoning, numerical ability and abstract reasoning were used. This test was given to all students as eighth graders. The DAT has reliability figures (r_a) for males and females separately in the eighth grade. Males r_a in verbal = .89, numerical = .88 and abstract = .94. For females verbal r_a = .93, numerical = .85 and abstract = .93. Median validity coefficient figures between DAT scores and course

grades in science are: for males on verbal = .45; numerical = .51; abstract = .38 and for females verbal = .47; numerical = .51; abstract = .43.

Development of Advance Organizer

The advance organizer used with the treatment group was written by the researcher following the guidelines of Ausubel: (1) that the material be organized on a high conceptual level; (2) that it present the material to be included in a very organized manner; (3) that it presents relevant material for an ideational scaffolding. To be maximally effective it must be in appropriate familiar language and illustrations; and (4) that it provides necessary anchorage for and differentiation of new ideas at a particular level before any of the new material is introduced.

The Advance Organizer was piloted with similar earth science classes for responses about vocabulary and grammar. Any problems related to these areas were resolved before use in the research study.

Advance Organizer

> The earth is in a constant state of change. That is true of the material of which the earth is made as well. We usually do not think of rock as changeable but it can change when subjected to activities of various kinds on and in the earth. According to the type of activity to which the rock is subjected, it is divided into one of three groups.

The first of these groups is called igneous. The earth has pockets of molten or liquid rock. It is thought that these occur due to heat from radioactive decay. This molten rock slowly cools. With this cooling, the liquid rock solidifies into material that we call igneous rock. The speed of cooling determines some of the characteristics of this type of rock.

The second type of rock is sedimentary. It is composed of tiny particles or sediments which have been eroded from existing rock or deposited from a mineral rich solution. These particles or minerals become cemented together thrcugh a natural cementing process.

The third type of rock is called metamorphic. This means rock that has changed. They started out as another type of rock and were changed by heat or pressure over a long period of time.

The way a rock reacts to the action to which it is subjected is due in a large part to the material of which the rock is made. Many rocks are composed of two or more minerals. The exception to this is the thick layers of materials such as limestone or rock salt. Each mineral has its own specific characteristics which may include melting point, hardness, cleavage planes and maximum levels of flexibility.

A cycle is an appropriate term for the changing types of rocks as any one type can become another if the activity appropriate for that rock type is applied. Therefore, the material of which the rock is made and the activity which it endures determines the type of rock that results. That resulting rock could just as easily be changed again at another time by a different activity.

Development of Placebo

The placebo was a list of terms from the unit; the difference from the advance organizer being that there was no conceptual organization. The terminology needed to be included so as to test only the difference between methods of organizing the information and not the vocabulary familiarity.

Placebo

CHEMICAL SEDIMENT--particles formed by settling of minerals from a liquid in the waters of the earth.

CYCLE--a repeated series of events.

EARTH--the land surface of the world, as separate from the ocean and air.

EARTHQUAKE--a series of springy movements of the earth, caused by sudden shifts of strains that build up along geologic faults and are caused by volcanic actions. They result in movements in the earth's surface.

FAULT--a crack along which the opposite sides have moved in relation to one another.

HEAT--a form of energy associated with the motion of atoms as molecules in solids and able to be moved through solids and liquids by something called conduction.

IGNEOUS--a type of rock formed by the cooling and hardening of magma.

METAMORPHIC--a type of rock formed within the earth's crust by change in the solid state of already existing rocks as a result of high temperature, high pressure or both.

MINERAL--a naturally occurring, crystalline, inorganic compound.

PHYSICAL SEDIMENTS--sediment formed by the wearing away of larger rocks and minerals into smaller pieces that are deposited in another location.

PRESSURE--the applying of constant force of one body on another that it is touching.

ROCK--any naturally formed, firm mass of mineral matter that makes up part of the earth's crust.

SEDIMENT--a type of rock formed from sediment by cementation or by other processes that act at ordinary temperatures at or near the earth's surface.

Development of Unit

The unit involved in this study covered the topic of the rock cycle. The specific areas within this topic were selected from the school system's performance objectives for ninth grade earth science. A variety of teaching strategies were used within the unit. They included hands on activities, reading and library research.

All treatment and control groups were given the same unit after the initial advance organizer or placebo. A list of the unit objectives, unit activity outline, and time frame is included in Appendix F.

Research Design

Another person, other than the researcher, introduced the format and explained the permission slips. He also collected the slips and assigned the students that participated a code that the teacher could not identify.

All students were given the Dubins Earth Science Test, forms A and B. It was modified slightly to include more items on the topic of the rock cycle.

All students were given the Background Experience Inventory. It consisted of a list of questions about science experiences and required a yes or no answer. The inventories were corrected based on the number of yes responses. Based on this score, the population was divided into three approximately equal groups of high, medium and low experience. They were not the same size, because groups of students with the same score were not separated.

Within each of the experience groups there was a random assignment of treatment and control. The treatment and control groups were similar sizes. All students, regardless of the experience group, were given the Dubins Earth Science Test, form A pre test. After the pre test was given, the treatment and control were given within each of the experience groups.

The treatment consisted of an advance organizer dealing with the rock cycle. It consisted of information organized on a high conceptual level. The control group received a placebo which was a list of definitions dealing with the rock cycle. The definitions were listed alphabetically and not conceptually. The remainder of the unit was the same for both groups. The unit consisted of about two weeks of reading, investigating and writing on the topic of the rock cycle. A specific outline of the unit is in Appendix F and a diagram of the research design is in Table 3.

TABLE 3

RESEARCH DESIGN

Total Population	R_1 (high background)	O_1 (Dubins pre)	X_1 (treatment)	O_2 (Dubins post)
		O_3	X_2 (control)	O_4
	R_2 (medium background)	O_1	X_1	O_2
		O_3	X_2	O_4
	R_3 (low background	O_1	X_1	O_2
		O_3	X_2	O_4

At the conclusion of the unit, the Dubins post test was administered. Analysis focused on two major research hypotheses dealing with treatment and experience. Secondary hypotheses were investigated that dealt with group characteristics, including sex; DAT scores in numerical ability, verbal and abstract reasoning; past success in school and specifically in science; socioeconomic status; and time for completion.

The only variable that was eliminated was the time for completion of the unit. A self-reporting method was attempted for each day of the unit. That method was found to be very inaccurate and incomplete. Efficiency is still an area to be investigated, but another method of measurement that is feasible within the classroom needs to be developed.

CHAPTER FOUR

ANALYSIS OF THE DATA

The use of statistics allow for the analysis of the data collected to show relationships among the variables and to provide information for prediction. The predictions aspect of statistics is important in education. It involves both careful investigation of all variables and projection of those variables into new situations. As the number of commonalities between several situations increases, the possibility of a significant prediction from one situation to another also increases. Research in education has a great number of variables to consider. The extent of each variable's effect on an outcome may change from one time to another. This makes prediction difficult and unreliable in some cases. As the amount of prediction in education increases, the accuracy attributed to research techniques may also improve.

Data were collected not only about the major areas of background experience and the advance organizer, but also about other characteristics of the students that might prove to be significant.

A chart of the research design of this project was presented in Chapter Three (see Table 3). It shows

the cells involved that were tested and gives an overall picture of the relationship between and among groups in this study. Also included are tables that show the variable test items, mean, population and standard deviation for groups within the total population as well as the total population.

Hypotheses

The major research hypothesis that was studied was the effect of the advance organizer on student achievement as measured by the Dubins Earth Science Test.

Hypothesis 1

> There is no significant difference in achievement scores between the students receiving the advance organizer and those that do not receive the advance organizer, as measured by the Dubins Earth Science Test.

Table 4 shows a comparison of the pre and post test scores for the treatment and control groups. Table 5 shows the means and standard deviations for the treatment (advance organizer) and control (placebo) groups on the Dubins Earth Science Test total score and the rock cycle sub test section.

The analysis indicated that there was no significant difference between the treatment and control groups.

TABLE 4

COMPARISON OF SCORES ON THE DUBINS TOTAL PRE TEST AND DUBINS TOTAL POST TEST FOR THE TREATMENT AND CONTROL GROUPS

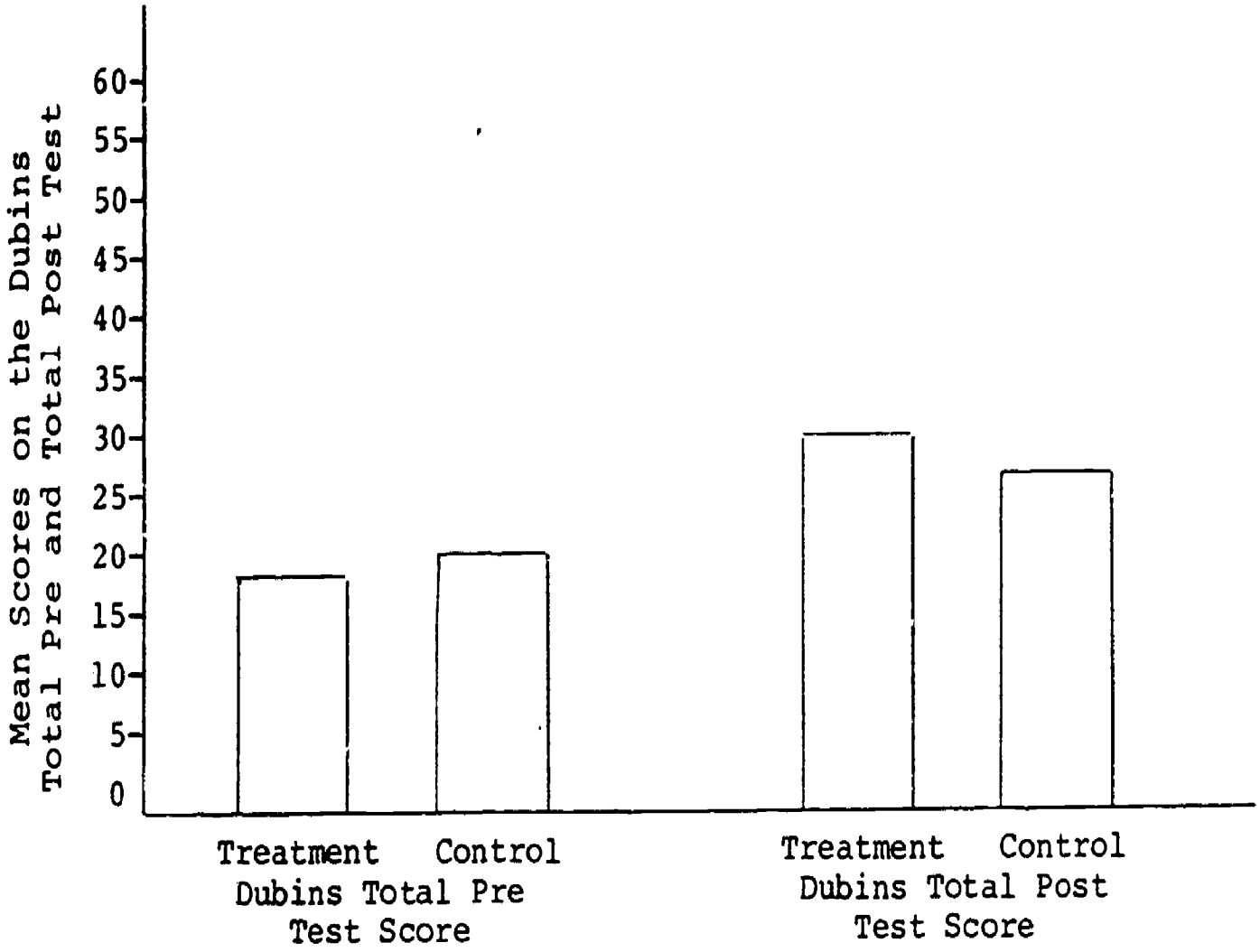


TABLE 5

MEANS AND STANDARD DEVIATIONS FOR ALL TEN MEASURABLE VARIABLES FOR TREATMENT AND CONTROL GROUPS

Variable	CASES		MEAN		STANDARD DEVIATIONS	
	Treatment	Control	Treatment	Control	Treatment	Control
Dubins Total Pre Test	50	46	18.28	18.54	7.34	6.37
Dubins Sub Pre Test	50	46	7.36	7.67	3.76	3.14
Dubins Total Post Test	50	46	26.52	25.28	8.25	7.32
Dubins Sub Post Test	50	46	11.46	11.35	3.92	3.63
Differential Aptitude Test Abstract	50	43	60.74	59.60	21.80	25.27
Differential Aptitude Test Numerical	50	43	51.58	50.30	22.77	21.72
Differential Aptitude Test Verbal	50	43	46.44	48.39	24.23	25.72
Total Background Experience Inventory	50	46	45.30	46.89	10.77	10.67
Total Eighth Grade Overall Average	50	46	2.30	2.26	0.79	0.77
Science Eighth Grade Average	50	46	2.28	2.20	1.01	0.93

Analyses were done using the total score on the Dubins Earth Science Test and on the sub section of that test specifically on the rock cycle, referred to as the Dubins sub test.

Regression analyses were performed to determine if the method (advance organizer or placebo) or the background experience could account for any variance on performance on the Dubins post test score. Neither of the methods were found to account for more than 11% in any of the five multiple regressions that were done. Tables 6, 7, 8, 9 and 10 show this.

An analysis of covariance was done with different covariates to determine strengths of covariance. By using the Dubins total post test score as the dependent variable by background experience and method, and controlling for the Dubins total pre test score, sex and DAT score, it was found that there were several variables that were significant. There was a significant relationship between the Dubins total post test score and the Dubins total pre test score at an alpha level of less than .05. The relationship between the DAT abstract reasoning and the Dubins total post test score was significant at the .05 level.

A second analysis of covariance was done that was similar to the one in the preceeding paragraph.

TABLE 6

REGRESSION ANALYSES USING THE DUBINS TOTAL POST TEST SCORE
FOR A POPULATION OF NINETY STUDENTS

VARIABLE*	MULTIPLE R	R SQUARE	R SQUARE CHANGE	B	BETA	ADJUSTED R SQUARE	STANDARD ERROR	DF	SUM OF SQUARES	MEAN SQUARE	F
Dubins Total Pre Test Score	0.47	0.23	0.23	0.43	0.37	0.22	6.76	1	1206.50	1206.50	26.43
-residual								91	4154.40	45.65	
Total Eighth Grade Average	0.58	0.34	0.11	2.75	0.28	0.32	6.29	2	1797.49	898.74	22.70
-residual								90	3563.42	39.59	
Total Background Experience Score	0.64	0.41	0.08	0.18	0.23	0.39	5.95	3	2208.87	736.29	20.79
-residual								89	3152.03	35.42	
DAT Abstract Score	0.66	0.44	0.03	0.68	0.21	0.42	5.83	4	2364.91	591.23	17.37
-residual								88	2996.00	34.05	
Medium Socioeconomic Status	0.68	0.46	0.02	2.07	0.13	0.43	5.78	5	2454.45	490.89	14.69
-residual								87	2906.45	33.41	
Constant				-0.79							

*Other variables left out.

TABLE 7

REGRESSION ANALYSES USING THE DUBINS TOTAL POST TEST SCORE FOR THE TREATMENT GROUP OF FIFTY

VARIABLE*	MULTIPLE R	R SQUARE	R SQUARE CHANGE	B	BETA	ADJUSTED R SQUARE	STANDARD ERROR	DF	SUM OF SQUARES	MEAN SQUARE	F
Dubins Total Pre Test Score	0.47	0.22	0.22	0.40	0.36	0.20	7.36	1	729.44	729.44	13.45
-residual								48	2603.04	54.23	
DAT Abstract Score	0.59	0.35	0.13	0.12	0.32	0.32	6.08	2	1158.76	579.38	12.53
-residual								47	2173.72	46.25	
Socioeconoimc Group #1 Professional	0.64	0.41	0.07	-14.69	-0.84	0.38	6.52	3	1379.83	459.94	10.84
-residual								46	1952.65	42.45	
Total Background Experience Score	0.69	0.47	0.06	0.19	0.25	0.42	6.26	4	1567.47	391.8,	9.99
-residual								45	1765.01	39.22	
Socioeconomic Group #3 Clerical/ Factory	0.71	0.50	0.03	-12.32	-0.68	0.44	6.16	5	1663.37	332.67	8.77
-residual								44	1669.11	37.94	
Socioeconomic Group #2 Managerial	10.72	0.52	0.02	-9.19	-0.55	0.45	6.12	6	1728.98	288.16	7.73
-residual								43	1603.50	37.29	
Total Eighth Grade Average	0.73	.5-	0.02	1.61	0.15	0.46	6.06	7	1792.25	256.04	6.98
-residual								42	154C.23	36.67	
Constant				11.16							

*Other variables left out.

TABLE 8

REGRESSION ANALYSES USING THE DUBINS TOTAL POST TEST SCORE FOR THE CONTROL GROUP OF FORTY-SIX

VARIABLE*	MULTIPLE R	R SQUARE	R SQUARE CHANGE	B	BETA	ADJUSTED R SQUARE	STANDARD ERROR	DF	SUM OF SQUARES	MEAN SQUARE	F
Total Eighth Grade Average	0.59	0.35	0.35	4.73	0.53	0.33	5.64	1	900.61	900.61	22.06
-residual								41	1302.09	31.96	
Dubins Total Pre Test Score	0.68	0.46	0.11	0.40	0.34	0.43	5.19	2	924.75	462.38	17.16
-residual								40	1077.94	26.95	
Total Background Experience Score	0.72	0.52	0.06	0.19	0.29	0.48	4.93	3	1037.38	345.79	13.97
-residual								39	965.31	24.75	
DAT Numerical Score	0.74	0.54	0.03	0.55	0.20	0.50	4.91	4	1088.13	272.03	11.30
-residual								38	914.57	24.07	
DAT Abstract Score	0.76	0.59	0.03	0.55	0.20	0.52	4.78	5	1157.81	231.66	10.14
-residual								37	844.89	22.83	
Constant				-1.31							

*Other variables left out.

TABLE 9

REGRESSION ANALYSES USING THE DUBINS TOTAL POST TEST SCORE FOR THE FORTY FEMALES

VARIABLE*	MULTIPLE R	R SQUARE	R SQUARE CHANGE	B	BETA	ADJUSTED R SQUARE	STANDARD OF ERROR	DF	SUM OF SQUARES	MEAN SQUARE	F
Total Eighth Grade Average	0.44	0.19	0.19	3.02	0.37	0.17	5.87	1	297.28	297.28	8.63
-residual								36	1240.12	34.45	
Total Background Experience Score	0.52	0.27	0.08	0.13	0.19	0.23	5.66	2	415.75	207.87	6.49
-residual								35	1121.65	32.05	
Socioeconomic Group #2 Managerial	0.56	0.32	0.05	0.81	0.26	0.26	5.56	3	485.30	161.77	5.23
-residual								34	1052.09	30.94	
DAT Abstract	0.61	0.37	0.06	0.81	0.26	0.30	5.40	4	574.18	143.55	4.92
-residual								33	963.21	29.19	
Constant				5.84							

*Other variables left out.

TABLE 10

REGRESSION ANALYSES USING THE DUBINS TOTAL POST TEST SCORE
FOR THE FIFTY-SIX MALES

VARIABLE*	MULTIPLE R	R SQUARE	R SQUARE CHANGE	B	BETA	ADJUSTED R SQUARE	STANDARD OF ERROR		SUM OF SQUARES	MEAN SQUARE	F
Dubins Total Pre Test Score	0.66	0.43	0.43	0.71	0.58	0.42	6.37	1	1649.14	1649.14	40.61
-residual								53	2152.38	40.61	
Total Background Experience Score	0.73	0.53	0.10	0.22	0.30	0.51	5.86	2	2014.48	1007.48	29.32
-residual								52	1786.56	34.36	
Total Eighth Grade Average	0.77	0.59	0.06	2.91	0.26	0.56	5.54	3	2234.60	744.87	24.24
-residual								51	1566.93	30.72	
Constant				-4.54							

*Other variables left out.

The difference was that the dependent variable was the Dubins sub post test score. Table 11 shows there was no significant relationship found between the main effects of background experience and method. The significance of F for the background experience was 0.37 and for method, 0.87.

A third analysis of covariance controlled only for the Dubins sub pre test score. Table 12 shows that a significant relationship was found to exist between the Dubins total post test score and the Dubins total pre test score at an alpha level of less than .05. There was no significant relationship found to exist between the Dubins total post test score and the method. Using the Dubins sub post test score as the dependent variable, controlling for the covariate of the Dubins sub pre test score and looking at the main effect of method in an analysis of variance found a significant relationship between the Dubins sub pre test score and the Dubins sub post test score at the .05 level. There was no significant relationship found between the Dubins sub post test score and the method. Table 13 shows this.

The analyses of these data indicated that the null hypothesis was accepted. It was concluded from these analyses that the method of presentation (advance organizer or placebo) made no significant difference in the achievement scores on the Dubins Earth Science Test.

TABLE 11

ANALYSIS OF COVARIANCE OF EXPERIENCE GROUPS AND METHOD GROUPS USING THE DUBINS SUB POST TEST SCORE AND CONTROLLING FOR DUBINS SUB PRE TEST SCORE, SEX, DAT ABSTRACT, DAT NUMERICAL AND DAT VERBAL SCORES

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F
COVARIATES	247.96	5	49.59	4.20	0.002
Dubins Sub Pre Test Score	33.14	1	33.14	2.81	0.10
Sex	4.53	1	4.53	0.38	0.54
DAT Abstract	26.67	1	26.67	2.26	0.14
DAT Numerical	0.03	1	0.03	0.00	0.96
DAT Verbal	51.92	1	51.92	4.40	0.04
MAIN EFFECTS	23.97	3	7.99	0.68	0.57
EXPERIENCE GROUP	23.89	2	11.95	1.01	0.37
METHOD	0.32	1	0.32	0.03	0.87
INTERACTIONS	13.49	2	6.75	0.57	0.57
RESIDUAL	967.61	82	11.80		
TOTAL	1253.03	92	13.62		

TABLE 12

ANALYSIS OF COVARIANCE OF TREATMENT AND CONTROL GROUPS USING THE DUBINS TOTAL POST TEST SCORE AND CONTROLLING WITH THE DUBINS TOTAL PRE TEST SCORE

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F
COVARIATES					
Dubins Total Pre Test Score	1468.69	1	1468.69	32.04	0.000
MAIN EFFECT					
Method	46.21	1	46.21	1.01	0.32
RESIDUAL	4263.52	93	45.84		
TOTAL	5778.42	95	60.83		

TABLE 13

ANALYSIS OF COVARIANCE OF TREATMENT AND CONTROL GROUPS USING THE DUBINS SUB POST TEST SCORE AND CONTROLLING FOR THE DUBINS SUB PRE TEST SCORE

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F
COVARIATES					
Dubins Sub Pre Test Score	75.36	1	75.36	5.52	0.02
MAIN EFFECTS					
Method	0.89	1	0.89	0.07	0.80
RESIDUAL	1268.90	93	13.64		
TOTAL	1345.15	95	14.16		

The second major research hypothesis examined was the effect of student background experience on achievement.

Hypothesis 2

> There is no significant difference in achievement between those students having a rich background experience and those students with a less rich background experience as measured by the Dubins Earth Science Test.

Primary analysis indicated that there was no significant difference in achievement on the Dubins Earth Science Test, based on the amount of previous background experience obtained by the student.

Table 14 shows a comparison of the Dubins total pre and post test scores by experience groups. Tables 15 and 16 show the means and standard deviations for the total group and the three background experience groups for the Dubins Earth Science Test.

Regression analyses using the Dubins total post score as the dependent variable for the entire population of ninety-six students showed that the total background experience as measured by the Science Background Inventory could account for 0.08 or eight percent of the total post score. Table 6 shows the complete set of data.

TABLE 14

COMPARISON OF DUBINS TOTAL PRE TEST SCORE AND DUBINS TOTAL POST TEST SCORE FOR HIGH, MEDIUM AND LOW BACKGROUND EXPERIENCE GROUPS

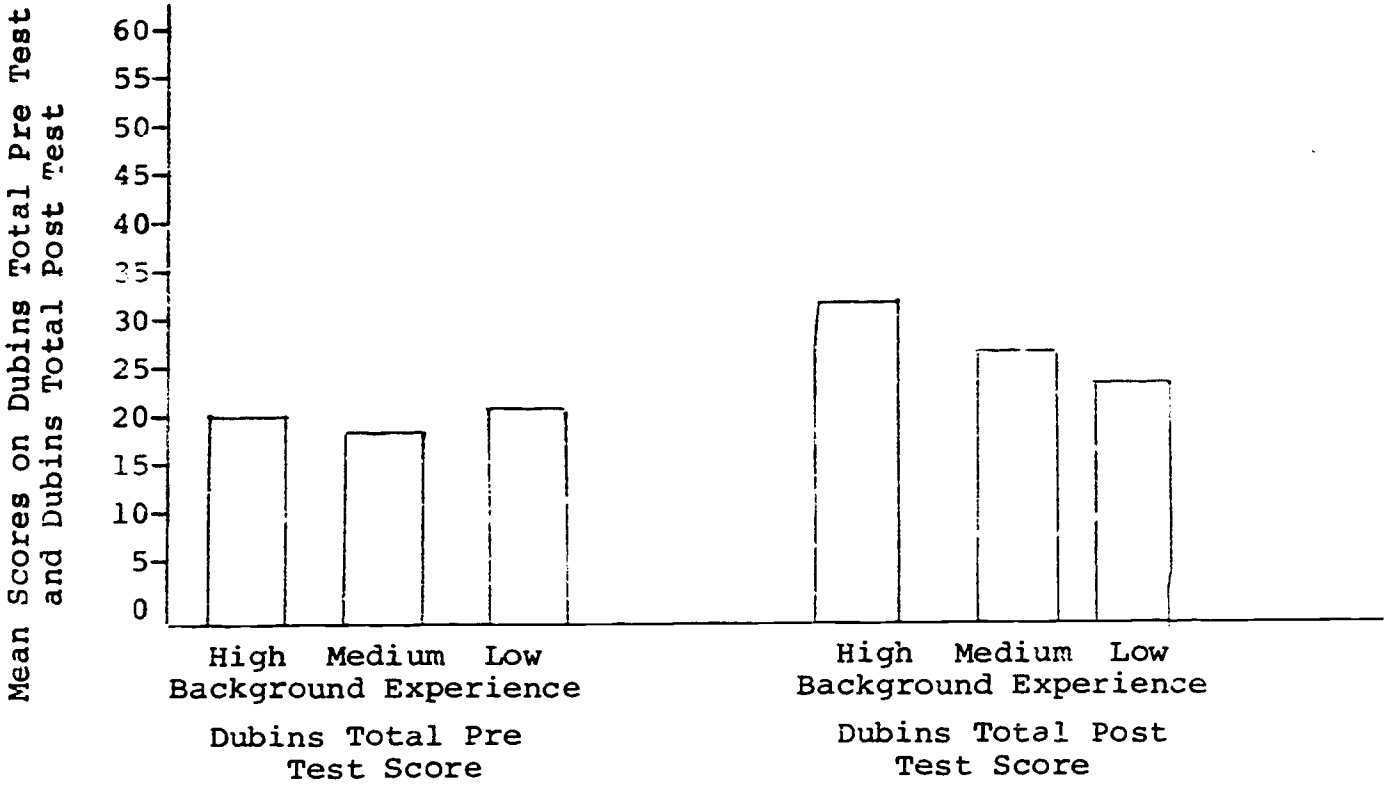


TABLE 15

MEANS AND STANDARD DEVIATIONS FOR ALL TEN MEASURABLE VARIABLES FOR THE TOTAL GROUP

Variable	No. of Cases	Mean	Standard Deviation
Dubins Total Pre Test	93	18.46	6.70
Dubins Sub Pre Test	93		
Dubins Total Post Test	93	26.03	7.63
Dubins Sub Post Test	93	11.41	
Differential Aptitude Test Abstract	93	60.22	23.34
Differential Aptitude Test Numerical	93	50.99	22.18
Differential Aptitude Test Verbal	93	47.34	24.81
Total Background Experience Inventory	93	46.33	10.63
Total Eighth Grade Overall Average	93	2.29	0.77
Science Eighth Grade Average	93	2.26	0.97

TABLE 16

MEANS AND STANDARD DEVIATIONS FOR ALL TEN MEASURABLE VARIABLES FOR HIGH, MEDIUM AND LOW BACKGROUND EXPERIENCE GROUPS

Variable	CASES			MEAN			STANDARD DEVIATION		
	High	Medium	Low	High	Medium	Low	High	Medium	Low
Dubins Total Pre Test	30	34	32	18.60	17.29	19.41	7.60	5.97	7.05
Dubins Sub Pre Test	30	34	32	8.03	6.85	7.72	3.80	2.95	3.64
Dubins Total Post Test	30	34	32	28.13	25.82	23.97	8.14	7.65	7.31
Dubins Sub Post Test	30	34	32	12.23	11.50	10.53	3.20	3.79	4.13
Differential Aptitude Test Abstract	30	32	31	64.40	59.66	56.74	21.24	21.75	26.75
Differential Aptitude Test Numerical	30	32	31	55.73	47.97	49.52	21.38	20.98	24.03
Differential Aptitude Test Verbal	30	32	31	50.70	45.16	46.34	25.69	20.06	28.58
Total Background Experience Inventory	30	34	32	58.27	46.24	34.44	6.29	2.58	4.78
Total Eighth Grade Overall Average	30	34	32	2.20	2.35	2.28	0.81	0.73	0.81
Science Eighth Grade Average	30	34	32	2.17	2.24	2.31	1.08	0.85	1.00

An analysis of variance was used to investigate the relationship between the experience groups and the Dubins total post test score. Table 17 shows that the F probability was 0.11.

An analysis of covariance was done using the Dubins total post test score as the dependent variable, by method and experience, controlling on the Dubins pre test score, sex and the three DAT scores. The results shown on Table 19 indicate that experience was not significant. The relationship between pre test score and the post test score shown on Table 19 was significant at the .05 level.

A second analysis of covariance was used with the Dubins sub post test score as the dependent variable but controlling on the Dubins pre sub test scores, sex, DAT abstract, verbal and numerical. Results shown on Table 19 indicated there was no significant relationship between the experience or method and the dependent variable.

The results of the analyses provided evidence that hypothesis 2 was accepted in its null form and it was concluded that the amount of the background experience of the student made no significant difference in achievement on the Dubins Earth Science Test.

TABLE 17

ANALYSIS OF VARIANCE OF BACKGROUND EXPERIENCE GROUP USING DUBINS TOTAL POST TEST SCORE

Source of Variation	Sum of Squares	DF	Mean Square	F Ratio	F Probability
Between Groups	269.11	2	134.56	2.27	0.11
Within Groups	5509.37	93	59.24		
Total	5778.48	95			

TABLE 18

BACKGROUND EXPERIENCE SCORES OF HIGH AND LOW BACKGROUND EXPERIENCE GROUPS FOR DUBINS PRE, POST, TOTAL AND SUB SCORES

Variable	No. of Cases	Mean	Stand. Dev.	Stand. Error	F Value	2-Tail Prob.	Pooled Variance Est. T Value	Pooled Variance Est. Degrees of Freedom	Pooled Variance Est. 2-Tail Prob.	Separate Variance Est. T Value	Separate Variance Est. Degrees of Freedom	Separate Variance Est. 2-Tail Prob.
Dubin Total Pre Score												
Group 1	32	19.4063	7.048	1.246	1.16	0.679	0.43	60	0.666	0.43	58.83	0.667
Group 2	30	18.6000	7.600	1.388								
Dubin Earth Science Pre Score												
Group 1	32	7.7188	3.639	0.643	1.09	0.810	-0.33	60	0.740	-0.33	59.29	0.741
Group 2	30	8.0333	3.801	0.694								
Dubin Total Post Score												
Group 1	32	23.9688	7.307	1.292	1.24	0.553	-2.12	60	0.038	-2.11	58.25	0.039
Group 2	30	28.1333	8.144	1.487								
Dubin Earth Science Post Score												
Group 1	32	10.5313	4.127	0.730	1.66	0.173	-1.81	60	0.076	-1.82	58.02	0.074
Group 2	30	12.2333	3.202	0.585								
Background Experience Total Score												
Group 1	32	34.4375	4.779	0.845	1.73	0.136	-16.86	60	0.000	-16.71	54.06	0.000
Group 2	30	58.2667	6.291	1.149								

TABLE 19

ANALYSIS OF COVARIANCE OF THE THREE EXPERIENCE GROUPS AND TWO METHOD GROUPS USING THE DUBINS TOTAL POST TEST SCORE

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F
COVARIATES	1803.41	5	360.68	8.98	0.000
Dubins Total Pre Test	746.97	1	746.97	18.59	0.000
Sex	0.071	1	0.071	0.002	0.98
DAT Abstract	170.40	1	170.40	4.24	0.04
DAT Numerical	0.99	1	0.99	0.23	0.88
DAT Verbal	79.16	1	79.16	1.97	0.16
MAIN EFFECTS	248.87	3	82.96	2.07	0.11
Experience Groups	213.45	2	106.72	2.66	0.08
Method	46.73	1	46.73	1.16	0.28
INTERACTIONS	13.68	2	6.84	0.17	0.84
RESIDUAL	3294.90	82	40.18		
TOTAL	5360.85	92	58.27		

An interesting sub problem that was studied was determining if there was any interaction between the amount of background experience students had and the kind of treatment (advance organizer or placebo) in relation to achievement.

Hypothesis 3

> There is no significant interaction between the background experience and method of instruction as measured by the Dubins Earth Science Test.

Table 20 shows the means and standard deviations for all of the Dubins scores. This table was set up to show the interaction of the experience groups with the method groups.

An analysis of covariance was done using the Dubins total post test score as the dependent variable, by method and experience, controlling for the Dubins total pre test score, the sex and the three DAT scores. Table 19 shows that the significance of F for the interactions was 0.84 and not significant. Table 11 shows the result of a similar analysis of covariance using the Dubins sub post test score as the dependent variable. The significance for that interaction was 0.57.

TABLE 20

MEANS AND STANDARD DEVIATIONS BY METHOD AND BACKGROUND EXPERIENCE CELLS FOR SEVEN MEASURABLE VARIABLES

Background Experience & Variable	Treatment Population	Mean	Stand. Dev.	Control Population	Mean	Stand. Dev.	Total Population	Mean	Stand. Dev.
HIGH EXPERIENCE									
Dubins Total Pre Test	15	17.40	8.28	15	19.80	6.93		18.60	7.60
Dubins Sub Pre Test	15	7.67	3.34	15	8.40	3.38	30	8.03	3.80
Dubins Total Post Test	15	28.80	9.00	15	27.47	7.44	30	28.13	8.14
Dubins Sub Post Test	15	12.53	3.36	15	11.93	3.12	30	12.23	3.20
DAT Abstract	15	68.07	18.61	15	60.73	23.65	30	64.40	21.24
DAT Numerical	15	56.93	23.88	15	54.53	19.32	30	55.73	21.38
DAT Verbal	15	51.73	26.57	15	49.67	25.67	30	50.70	25.69
MEDIUM EXPERIENCE									
Dubins Total Pre Test	17	18.29	6.49	17	16.29	5.42	34	17.29	5.97
Dubins Sub Pre Test	17	6.65	3.16	17	7.06	2.79	34	6.85	2.95
Dubins Total Post Test	17	27.00	8.28	17	24.65	7.02	34	25.82	7.65

Table 20 (continued)

Background Experience & Variable	Treatment Population	Mean	Stand. Dev.	Control Population	Mean	Stand. Dev.	Total Population	Mean	Stand. Dev.
Dubins Sub Post Test	17	11.71	3.75	17	11.29	3.93	34	11.50	3.79
DAT Abstract	17	59.35	24.00	15	60.00	19.73	32	59.66	21.75
DAT Numerical	17	45.29	21.25	15	51.00	20.98	32	47.97	20.98
DAT Verbal	17	42.35	18.21	15	48.33	22.17	32	45.16	20.06
LOW EXPERIENCE									
Dubins Total Pre Test	18	19.00	7.62	14	19.23	6.47	32	19.41	7.05
Dubins Sub Pre Test	18	7.78	3.95	14	7.64	3.34	32	7.72	3.64
Dubins Total Post Test	18	24.17	7.36	14	23.71	7.51	32	10.53	4.15
Dubins Sub Post Test	18	10.33	4.39	14	10.79	3.90	32	10.53	4.15
DAT Abstract	18	55.94	21.64	13	57.85	33.51	31	56.74	26.75
DAT Numerical	18	53.06	23.08	13	44.62	25.37	31	49.52	24.05
DAT Verbal	18	45.89	27.52	13	47.00	31.14	32	46.34	28.58

The results of the analysis give evidence that hypothesis 3 was accepted in its null form and it was concluded that there was no significant difference in achievement on the Dubins Earth Science Test due to an interaction between the background experience and the method of instruction.

Another sub problem that was tested was that of determining if there was any significant difference between experience and treatment groups (advance organizer and placebo) as measured by success on the Dubins Earth Science Test.

Hypothesis 4

> There is no significant difference between the experience or method groups as measured by the Dubins Earth Science Test.

Table 20 lists the Dubins scores by experience groups and by method or treatment.

The analysis of covariance using the Dubins total post test score as the dependent variable, by method and experience group, and controlling for the Dubins pre test score, sex and the three DAT scores, showed that there was no significant difference due to either the method or the experience group. The significance due to experience group, shown on Table 19, was 0.08 and the significance due to method, on the same table, was 0.28. A similar analysis of covariance

using the Dubins sub post test score as the dependent variable, showed a significance of 0.37 for the experience groups and 0.87 for the method groups. Those results were listed on Table 11.

The results of these analyses gave evidence that hypothesis 4 was accepted in its null form and it was concluded that there was no significant difference in achievement as measured by the Dubins Earth Science Test due to difference between the experience and method groups.

One of the major research hypotheses for the study was to determine the amount of background experience that was a predictor of success. Differences in background experience between method groups that existed before the study were sought.

Hypothesis 5

There is no significant difference between the method groups as measured by the Science Background Experience Inventory.

Results of the t-test on Table 21 that used the total background experience scores indicated there was no significant difference between the treatment and control groups on the total background experience score.

TABLE 21

T-TEST FOR TREATMENT VERSUS CONTROL GROUPS
USING THE TOTAL BACKGROUND EXPERIENCE SCORES

Variable	No. of Cases	Mean	Standard Deviation
Total Background Experience Inventory Score			
Group 1 (Treatment)	50	45.30	10.78
Group 2 (Control)	46	46.89	19.67

t value = -0.73

df = 94

2-tailed probability = 0.47

Therefore the hypothesis was accepted in its null form and it was concluded that there was no significant difference between the advance organizer and placebo groups as measured by the Science Background Experience Inventory.

A sub problem for this study that was tested was that of determining if the sex of the students made a significant difference in relation to achievement.

Hypothesis 6

> There is no significant difference between the sexes as measured by the Dubins Earth Science Test.

Difference between the sexes on the Dubins Earth Science Test was analyzed. Table 22 shows the Dubins total pre and post test scores for males and females and Table 23 shows the entire set of ten measurable items for males and females.

Table 24 shows that the results of an analysis of covariance for the Dubins total post test score, by sex, controlling only on the Dubins pre test total score was not significant.

A second analysis of covariance was done for the Dubins sub post test score, by sex, controlling only on the Dubins sub pre test score. The significance of F was 0.40. Table 25 shows the other numbers involved in that test.

TABLE 22

COMPARISON OF MALES AND FEMALES USING THE DUBINS TOTAL PRE TEST SCORES AND DUBINS TOTAL POST TEST SCORES

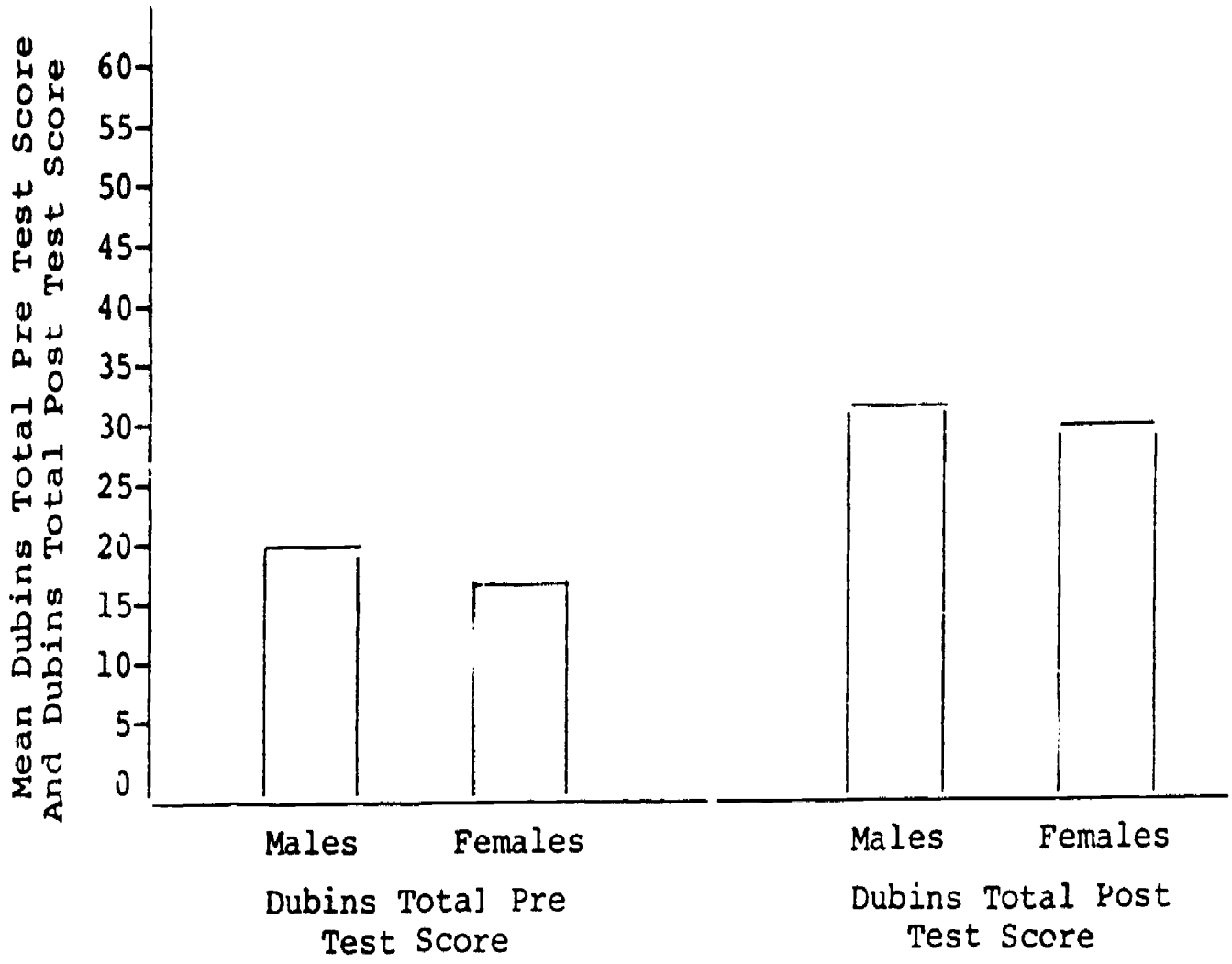


TABLE 23

MEANS AND STANDARD DEVIATIONS FOR ALL TEN MEASURABLE VARIABLES FO
MALES AND FEMALES

Variable	CASES		MEAN		STANDARD DEVIATIONS	
	Males	Females	Males	Females	Males	Females
Dubins Total Pre Test	56	40	19.48	16.90	7.00	6.44
Dubins Sub Pre Test	56	40	7.66	7.30	3.26	3.76
Dubins Total Post Test	56	40	26.30	25.40	8.37	6.99
Dubins Sub Post Test	56	40	11.18	11.73	4.01	3.40
Differential Aptitude Test Abstract	55	38	58.44	62.79	24.83	21.05
Differential Aptitude Test Numerical	55	38	53.31	47.63	21.66	22.77
Differential Aptitude Test Verbal	55	38	46.73	48.24	24.93	24.95
Total Background Experience Inventory	56	40	47.48	44.08	10.97	10.10
Total Eighth Grade Overall Average	56	40	2.16	2.45	0.76	0.78
Science Eighth Grade Average	56	40	2.25	2.23	1.03	0.89

TABLE 24

ANALYSIS OF COVARIANCE OF MALES AND FEMALES USING THE DUBINS TOTAL POST TEST SCORE AND CONTROLLING FOR THE DUBINS TOTAL PRE TEST SCORE

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F
COVARIATES					
Dubins Total Pre Test Score	1468.69	1	1468.69	31.75	0.000
MAIN EFFECTS					
Sex	8.06	1	8.06	0.17	0.68
RESIDUAL	4301.67	93	46.26		
TOTAL	5778.42	95	60.83		

TABLE 25

ANALYSIS OF COVARIANCE OF MALES AND FEMALES USING THE DUBINS SUB POST TEST SCORE AND CONTROLLING FOR THE DUBINS SUB PRE TEST SCORE

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F
COVARIATES					
Dubins Sub Pre Test Score	75.36	1	75.36	5.56	0.02
MAIN EFFECTS					
Sex	9.56	1	9.56	0.71	0.40
RESIDUAL	1260.24	93	13.55		
TOTAL	1345.15	95	14.16		

The results of these analyses gave evidence that hypothesis 6 is accepted in its null form and it was concluded that there was no significant difference in achievement on the Dubins Earth Science Test due to the sex of the student.

In a continuation of the earlier hypotheses which dealt with differences in achievement between the sexes, the following hypothesis tests the background experiences of the males and females in the class to determine if sex differences exist.

Hypothesis 7

> There is no significant difference between the sexes as measured by the Science Background Experience Inventory.

Table 23 shows the means and standard deviations for the sexes on the Science Background Experience Inventory. Table 26 presents the total background experience scores for males and females.

Differences between the sexes on the Background Experience Inventory were not found to exist. The results of the t-test on Table 27 show that there was no significant difference between males and females.

The null hypothesis, as written above, is accepted and it is concluded that there was no significant difference between the sexes as measured by the Science Background Experience Inventory.

TABLE 26

COMPARISON OF FEMALE AND MALE SCIENCE BACKGROUND EXPERIENCE INVENTORY SCORES

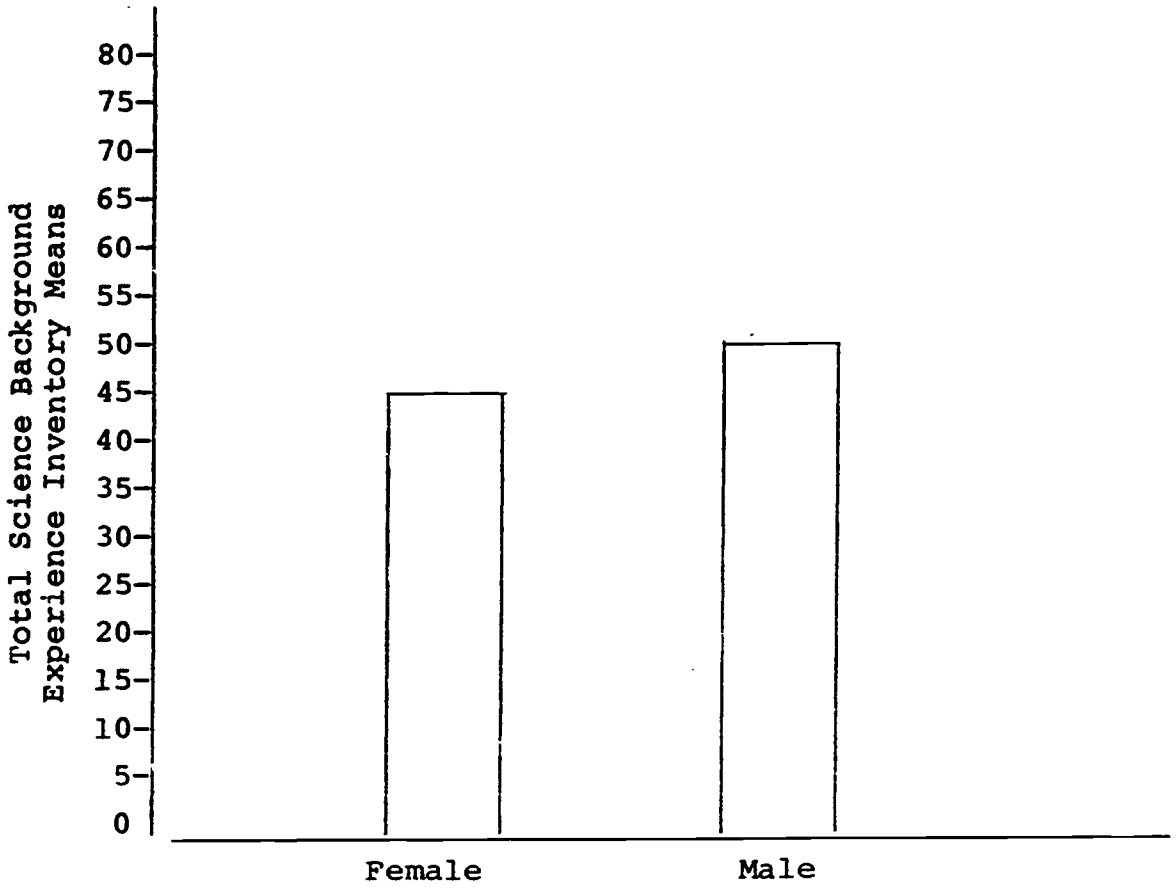


TABLE 27

T-TEST FOR MALES AND FEMALES ON THE TOTAL SCIENCE BACKGROUND EXPERIENCE INVENTORY SCORE

Variable	No. of Cases	Mean	Standard Deviation
Total Background Experience Inventory Score			
Group 1 (Male)	56	47.48	10.97
Group 2 (female)	40	44.08	10.10

t-value = 1.55

df = 94

2-tailed prob. = 0.13

The socioeconomic status of the parents of students involved in the study was investigated to determine whether significant differences in achievement were found between and among the groups.

Hypothesis 8

> There is no significant difference between the three socioeconomic groups as measured by the Dubins Earth Science Test.

The occupations of the parents were placed into three categories based on the U.S. Census divisions. The categories are described as high SES or professional, medium SES or managerial and low SES or clerical/ factory. Table 28 shows the breakdown of the Dubins pre and post scores according to the three levels. The table also includes the other measurable variables with their means and standard deviations. Table 29 shows the Dubins scores for the three SES levels. Observation of the data in the table shows an expected higher score on the post test. The results on both the pre and the post tests show the high SES group scored above the low SES group on the post test, and on the pre test. An analysis of covariance was performed for the Dubins total post test score by socioeconomic status, controlling on the total pre test score only. The results are shown on Table 30, with the F at 0.21 which was not significant.

TABLE 28

MEANS AND STANDARD DEVIATIONS FOR ALL TEN MEASURABLE VARIABLES FOR HIGH, MEDIUM AND LOW SOCICECONOMIC STATUS

Variable	CASES			MEAN			STANDARD DEVIATION		
	High	Medium	Low	High	Medium	Low	High	Medium	Low
Dubins Total Pre Test	26	36	29	19.08	19.08	17.03	8.34	6.33	6.01
Dubins Sub Pre Test	26	36	29	7.15	7.92	7.14	3.72	3.81	2.88
Dubins Total Post Test	26	36	29	26.38	27.83	23.83	8.23	6.95	7.20
Dubins Sub Post Test	26	36	29	11.77	12.56	10.10	4.17	2.96	3.52
Differential Aptitude Test Abstract	26	35	28	67.38	56.37	57.32	25.64	24.46	19.41
Differential Aptitude Test Numerical	26	35	28	51.46	49.11	53.39	24.11	22.20	21.90
Differential Aptitude Test Verbal	26	35	28	57.19	44.83	42.39	25.65	21.00	27.36
Total Background Experience Inventory	26	36	29	45.42	46.67	47.00	10.14	9.49	12.65
Total Eighth Grade Overall Average	26	36	29	2.42	2.42	2.21	0.70	0.77	0.80
Science Eighth Grade Average	26	36	29	2.31	2.31	2.21	0.93	0.92	1.00

TABLE 29

COMPARISON OF SCORES ON THE DUBINS TOTAL PRE AND POST TEST SCORES FOR HIGH, MEDIUM AND LOW SOCIOECONOMIC GROUP

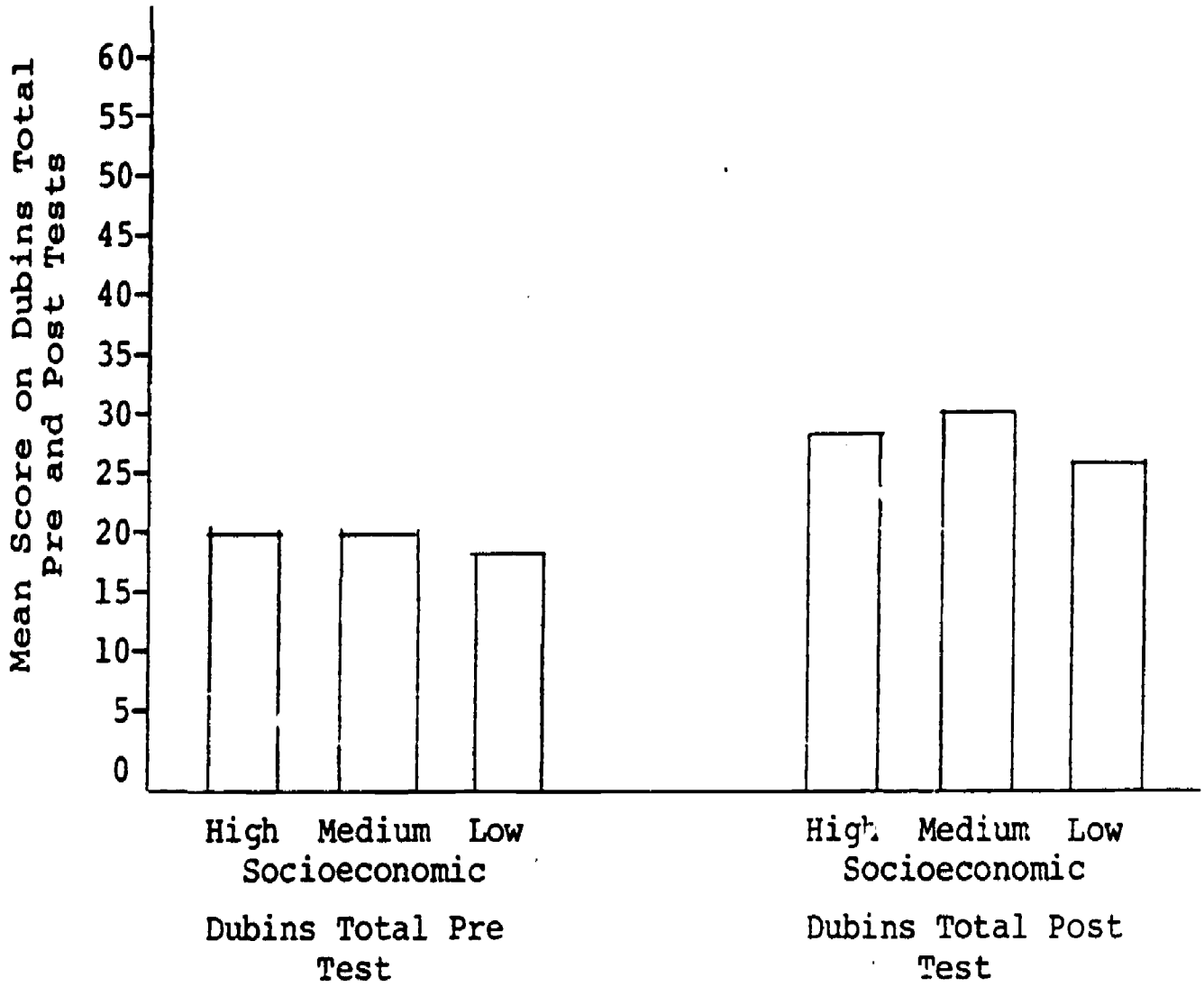


TABLE 30

ANALYSIS OF COVARIANCE OF SOCIOECONOMIC GROUPS USING THE DUBINS TOTAL POST TEST SCORE AND CONTROLLING ON THE DUBINS TOTAL PRE TEST SCORE

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F
COVARIATES					
Dubins Total Pre Test Score	1174.89	1	1174.89	27.04	0.000
MAIN EFFECTS					
Socio-economic Groups	140.05	2	70.02	1.61	0.21
RESIDUAL	3780.17	87	43.45		
TOTAL	5095.12	90	56.61		

A second analysis of covariance using the Dubins sub post test score was performed. The results also were not significant as Table 31 shows.

Table 32 shows the results of a t-test between the high and low SES groups, using the Dubins post test. It was not significant.

A regression analysis was done to determine if there might be a predictor of post test scores within the SES. The dependent variable was the Dubins total post test score. An analysis was for the total group and it was found that the middle SES predicted or accounted for two per cent of the Dubins total post test score. Table 7 shows the results. Regression analyses were also done on other groups such as males, females, treatment and control groups. The SES was found to predict again in the treatment group where the high SES equaled seven per cent, the low SES three per cent and the middle SES two per cent of the Dubins post test score. Table 7 shows those data. SES appeared again for the middle group in the females only analysis. Here five per cent of the Dubins post test score was predictable due to the SES. Table 9 lists the results. The data for the males and control group are also included to show the comparison. They are in Tables 8 and 10.

TABLE 31

ANALYSIS OF COVARIANCE OF SOCIOECONOMIC GROUPS USING THE DUBINS SUB POST TEST SCORE AND CONTROLLING ON THE DUBINS SUB PRE TEST SCORE

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F
COVARIATES					
Dubins Sub Pre Test Score	59.99	1	59.99	5.02	0.03
MAIN EFFECTS					
Socio-economic Groups	86.39	2	43.20	3.61	0.03
RESIDUAL	1040.14	87	11.96		
TOTAL	1186.52	90	13.18		

TABLE 32

BACKGROUND EXPERIENCE FOR HIGH AND LOW SOCIOECONOMIC STATUS GROUPS ON DUBINS PRE, POST, TOTAL AND SUB TEST SCORES

Variable	No. of Cases	Mean	Stand. Dev.	Stand. Error	F Value	2-Tail Prob.	Pooled Variance Est. T Value	Degrees of Freedom	2-Tail Prob.	Separate Variance Est. T Value	Degrees of Freedom	2-Tail Prob.
Dubin Total Pre Score												
Group 1	26	19.0769	8.342	1.636	1.93	0.094	1.05	53	0.299	1.03	44.98	0.308
Group 2	29	17.0345	6.009	1.116								
Dubin Earth Science Pre Score												
Group 1	26	7.1538	3.717	0.729	1.67	0.189	0.02	53	0.986	0.02	46.95	0.986
Group 2	29	7.1379	2.875	0.534								
Dubin Total Post Score												
Group 1	26	26.3846	8.232	1.614	1.31	0.491	1.23	53	0.225	1.22	50.04	0.228
Group 2	29	23.8276	7.202	1.337								
Dubin Earth Science Post Score												
Group 1	26	11.7692	4.169	0.818	1.40	0.383	1.61	53	0.114	1.59	49.21	0.118
Group 2	29	10.1034	3.519	0.653								
Background Experience Total Score												
Group 1	26	45.4231	10.144	1.989	1.56	0.268	-0.51	53	0.615	-0.51	52.39	0.611
Group 2	29	47.0000	12.649	2.349								

The results of the analyses gave evidence that the null hypothesis was accepted and it was concluded that there was no significant difference in achievement on the Dubins Earth Science Test due to the socioeconomic status.

Background experience, as related to socioeconomic status, was tested by the following hypothesis.

Hypothesis 9

> There is no significant difference between the three socioeconomic groups as measured by the Science Background Experience Inventory.

Table 28 shows the background experience inventory scores according to the three SES levels. Scores on the other measurable variables were also shown.

An analysis of variance was done with the three socioeconomic groups using the total background experience score as the dependent variable. Table 33 shows that the results were not significant. The F probability was 0.85. Table 32 lists other test results for the high and low SES groups.

The null hypothesis was accepted and it was concluded that there was no significant difference in scores on the Science Background Experience Inventory due to socioeconomic status.

TABLE 33

ANALYSIS OF VARIANCE OF THE THREE SOCIOECONOMIC GROUPS USING THE TOTAL SCIENCE BACKGROUND EXPERIENCE INVENTORY SCORE

Source of Variation	Sum of Squares	DF	Mean Square	F Ratio	F Probability
Between Groups	37.80	2	18.90	0.16	0.85
Within Groups	10202.33	88	115.94		
Total	10240.13	90			

The following hypothesis, though not a major research problem, tests results on the Differential Aptitude Tests on Abstract Reasoning and Numerical Ability and Verbal Reasoning, sub tests of the DAT, to determine if a significant difference exists between the method and experience groups.

Hypothesis 10

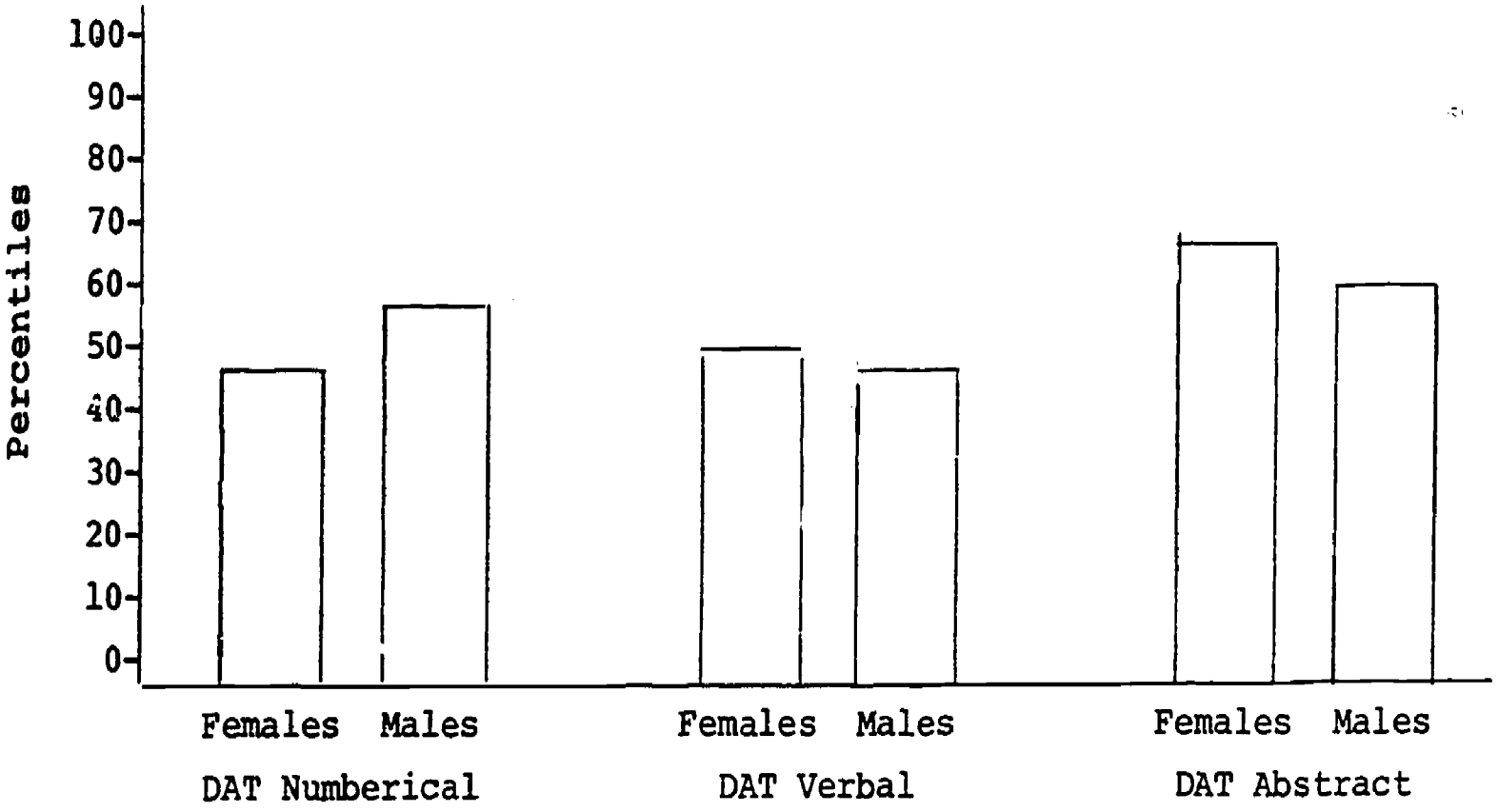
> There is no significant difference between the experience and method groups as measured by the Differential Aptitude Test on Abstract Test on Abstract Reasoning, Numerical Ability and Verbal Reasoning.

The individual means and standard deviations on the three DAT scores are shown on Table 5 for methods and Table 6 for background experience comparisons. Table 34 shows that females score slighly above the males on the verbal and abstract reasoning sections of the test. Males, however, scored above the females on the numerical section.

Analysis of covariance of the experience and method groups, using the Dubins total post test score as the dependent variable and controlling for the Dubins total pre test score, sex, and the three DAT scores, indicated that there was a significant relationship at an alpha level of .05 or less for the abstract reasoning section. That value of F was .04 and is shown on Table 19 with the other results. There was no significant relationship shown for the verbal or numerical sections.

TABLE 34

A COMPARISON OF THE DIFFERENTIAL APTITUDE SCORES IN NUMERICAL, ABSTRACT AND VERBAL FOR ALL MALES AND FEMALES



Therefore, the null hypothesis was accepted and it was concluded that there was no significant difference between method and background groups as measured by the DAT verbal reasoning and numerical ability sections. The exception to this conclusion was the DAT abstract reasoning score. There was a significant difference between method and background groups on the abstract reasoning section.

Another sub problem that was tested used the overall success of the student in the eighth grade as the measure of the difference between the method and experience groups.

Hypothesis 11

> There is no significant difference between the experience and method groups as measured by the average overall grade point in the eighth grade.

Table 15 shows the total population means and standard deviations for all ten measurable variables. This includes the overall grade point for the eighth grade. Table 5 shows the same figures for the treatment and control groups. When all of these figures were compared, there was no significant difference.

The null hypothesis is accepted and it is concluded that there is no significant difference between experience and method groups as measured by the average overall grade point in the eighth grade.

Success in science in eighth grade was a measure used to determine if significant differences existed between method and experience groups in the following hypothesis.

Hypothesis 12

> There is no significant difference between the experience and method groups as measured by the science grade point for the eighth grade.

Table 15 shows the total population means and standard deviations for all ten measurable variables. This included the science grade point for the eighth grade. Table 5 shows the same figures for the treatment and control groups. Table 16 shows more of the same figures for the high, medium and low experience groups. When all of these figures were compared, it was found that there was no significant difference between these groups.

Therefore, the null hypothesis was accepted and it was concluded that there is no significant difference between experience and method groups as measured by the science overall grade point for the eight grade.

Summary

The analyses performed for this study led to several major conclusions concerned with the development and use of an advance organizer and the role of

background experience.

The advance organizer made no significant difference in student achievement on the Dubins Earth Science Test. The prior experience of the students in earth science, as measured by the Science Background Experience Inventory, made no significant difference in achievement, which was measured by the Dubins Earth Science Test.

The secondary hypotheses showed no significant differences between method and experience groups with the exception of the DAT on Abstract Reasoning. There was a significant relationship between the Abstract Reasoning section and the method and experience groups.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

Summary

The purpose of this study was to determine if the presentation of an advance organizer at the beginning of a unit on the rock cycle resulted in significantly greater student achievement on the Dubins Earth Science Test than those students studying the same unit with a placebo.

A second concern for the study was to determine if the science background experience of a student had any significant effect on success on the Dubins Earth Science Test.

A population of ninety ninth graders enrolled in earth science was given the Dubins Earth Science Test, form A, a published earth science test, which had been modified by the researcher for this study. Students were also given the Science Background Experience Inventory, an instrument developed by the researcher. On the basis of the Experience Inventory, the students were placed into high, medium and low experience groups. Each of the experience groups were further divided into a treatment and a control group.

The treatment group was given an advance organizer on the topic of the rock cycle. The control group was given a placebo on the same topic. A two week unit on the rock cycle was presented to all students. At the end of the two weeks, the Dubins Earth Science Test, form B, was given as a post test to all students and analyses were performed on the basis of those results.

Variables studied in addition to the advance organizer, Dubins Earth Science Test and Experience Inventory, were sex, Differential Aptitude Test scores and socioeconomic status. Comparisons of the results on the Dubins pre and post test were made for the total population as well as subdivisions within the total population. The subdivisions included high, medium and low background experience; treatment and control; high, medium and low socioeconomic status and males or females.

The Null Hypotheses

> Hypothesis 1: There is no significant difference in achievement between the students receiving the advance organizer and those that did not receive the advance organizer, as measured by the Dubins Earth Science Test.

This hypothesis was accepted in the null form and it was concluded that the advance organizer did not significantly effect achievement on the Dubins Earth Science Test.

Hypothesis 2: There is no significant difference in achievement between those students having a rich background experience and those students with a less rich background experience, as measured by the Dubins Earth Science Test.

Hypothesis 2 was accepted and it was concluded that science background experience does not make a significant difference in achievement on the Dubins Earth Science Test.

Hypothesis 3: There is no significant interaction between the background experience and the method of instruction, as measured by the Dubins Earth Science Test.

Hypothesis 3 was accepted in its null form and it was concluded that there was not a significant difference in achievement on the Dubins Earth Science Test due to an interaction between background experience and the method of instruction.

Hypothesis 4: There is no significant difference between the experience or method groups as measured by the Dubins Earth Science Test.

Hypothesis 4 was accepted in its null form and it was concluded that there was no significant difference in achievement on the Dubins Earth Science Test, due to differences between the experience or method groups.

Hypothesis 5: There is no significant difference between the method groups as measured by the Science Background Experience Inventory.

Hypothesis 5 was accepted and it was concluded that there was no significant difference in background experience among the method groups, as measured by the Science Background Experience Inventory.

Hypothesis 6: There is no significant difference between the sexes as measured by the Dubins Earth Science Test.

Hypothesis 6 was accepted in its null form and it was concluded that there was no significant difference between males and females on the Dubins Earth Science Test.

Hypothesis 7: There is no significant difference between the sexes as measured by the Science Background Experience Inventory.

Hypothesis 7 was accepted in its null form and it was concluded that there was no significant difference in achievement on the Science Background Experience Inventory between males and females.

Hypothesis 8: There is no significant difference between the three socioeconomic groups as measured by the Dubins Earth Science Test.

Hypothesis 8 was accepted in its null form and it was concluded that the socioeconomic status of the student did not make a significant difference in achievement on the Dubins Earth Science Test.

Hypothesis 9: There is no significant difference between the three socioeconomic groups as measured by the Science Background Experience Inventory.

Hypothesis 9 was accepted and it was concluded that there was no significant difference in achievement on the Science Background Experience Inventory due to the socioeconomic status of the student.

Hypothesis 10: There is no significant difference between the experience and method groups as measured by the Differential Aptitude Test on Abstract Reasoning, Numerical Ability and Verbal Reasoning scores.

Hypothesis 10 was accepted in its null form for the Numerical Ability and Verbal Reasoning sections of the Differential Aptitude Test. The hypothesis related to the Abstract Reasoning section of the test was rejected. It was concluded that there is no significant relationship between DAT scores in Verbal Reasoning and Numerical Ability and method or experience groups but there was a significant relationship between those groups and the Abstract Reasoning section of the DAT.

Hypothesis 11: There is no significant difference between the experience and method groups as measured by the average overall grade point in the eighth grade.

Hypothesis 11 was accepted in its null form and it was concluded that there was no significant difference in overall eighth grade point between the experience and method groups.

Hypothesis 12: There is no significant difference between the experience and method groups as measured by the science grade point for the eighth grade.

Hypothesis 12 was accepted in the null form and it was concluded that there was no significant difference between method and experience groups as measured by the science grade point for the eighth grade.

Conclusions

The conclusions from this study are based on inferences from the statistical analyses presented in Chapter Four. The researcher attempted to determine if there were any significant differences between the treatment and experience groups on any of the measurable variables, before the treatment. It was found that there was no significant difference between the treatment and experience groups on any of the items investigated.

By using statistical procedures of analysis of variance, analysis of covariance, and regression analyses, differences that might be due to the treatment were investigated. The conclusions follow:

1. The advance organizer made no significant difference in student achievement. Regression analyses failed to show that there was a predictor to any degree.

2. The prior experience of students in earth science, as measured by an Experience Inventory, made no significant difference in achievement as measured by the Dubins Earth Science Test. Background experience did, however, account for eleven per cent of the variance on performance on the Dubins post test.

3. There was no significant interaction between the advance organizer or placebo and the background experience of the student. It might have been possible for either of the two variables, the method and background experience, to have no effect individually, but combined, the results could have been significant in influencing student achievement.

4. The descriptive variables for the population such as sex, socioeconomic status and Differential Aptitude scores did not make a significant difference in student achievement on the Dubins Earth Science Test. There was, however, a strong covariance relationship between the Abstract Reasoning section of the Differential Aptitude Test and the method and experience groups. The predictor values of the socioeconomic status and Differential Aptitude Test scores are minimal and therefore of questionable educational value.

Discussion

An interpretation of the results that showed no significant difference between the groups receiving the advance organizer and those receiving the placebo was that the Dubins Earth Science Test did not differentiate between success and failure on the conceptual level. It may have been too easy to test or possibly too difficult to discriminate better and poorer students.

The population of students was skewed by only including the earth science students in the study. High ability ninth graders as a rule, elected to take Biology, thus this lower ability population may have influenced the outcome if ability relates significantly to experience or treatment.

The teaching of the unit that was performed by the researcher, may have been so good that the students were able to pick up the information without the advance organizer. The teaching may have organized the material for the students to such an extent that the advance organizer was not needed.

The Background Experience Inventory may not have included some of the key experience items necessary for success.

The significant results of the Abstract Reasoning section of the Differential Aptitude Test gave the only hard evidence of relationships. The abstract section of the DAT tested for an element of intelligence or ability. The fact that there was significance meant that some elements of ability were tied into the success or failure of the advance organizer and the relationship to background experience. This was a glimmer of an area that could have given more information if the instruments could bring it out.

Regression analyses gave predictors for each of the groups investigated from the total group to treatment and control groups. The greatest predictor, however, was only eleven per cent. This means that eleven per cent of the Dubins post test score can be predicted from that variable that equaled eleven per cent on the regression analysis. The majority of the predictors were much smaller than that at five and two per cent. This is too small to be generalizable to a larger educational community.

The research population was found to have no significant differences due to sex, SES or grade point averages. This meant that any differences that showed were not in the population before the study.

Recommendations

The following recommendations are made on the basis of the findings of this study. They deal primarily with suggestions for future research.

1. Another earth science test instrument would be a good comparison for the Dubins Earth Science Test results. There were no other test instruments that this researcher could find. Even the Dubins is now out of print. Perhaps the development of a detailed test instrument would be a good research base for the future.

2. The same format for a continuation of the hypotheses investigation might include the total ninth grade population, rather than the earth science classes alone. In this study, the accelerated group of students were not included by virtue of their course selection.

3. Continued refinement of an instrument to measure background experience shows some future for another research project. The fact that the background experience showed as a predictor on the regression analyses lends some support to its value.

4. Continue to refine the advance organizer. The general directions for writing an advance organizer

can lead individual researchers in opposite directions. A number of forms, lengths and amount of topic inclusiveness might provide a good variation on the study of how students organize the material they learn.

5. Inclusion of a second post test after a longer period of time might show some results that did not show with the short term retention.

6. Test of the effect of an advance organizer immediately would determine if there was any difference between the advance organizer and placebo groups before the unit was presented.

APPENDICES

APPENDIX A

Additional Tables

TABLE 35

MEANS AND STANDARD DEVIATIONS ON TWENTY-SIX ITEMS OF THE DUBINS SUB POST TEST

Item No. on Test	Mean	Standard Deviation	Cases
1. (5)	0.61	0.49	96
2. (6)	0.72	0.45	96
3. (8)	0.35	0.48	96
4. (9)	0.47	0.50	96
5.(10)	0.61	0.49	96
6.(11)	0.46	0.50	96
7.(12)	0.57	0.50	96
8.(16)	0.15	0.37	96
9.(17)	0.10	0.31	96
10.(18)	0.23	0.42	96
11.(21)	0.53	0.50	96
12.(22)	0.47	0.50	96
13.(24)	0.56	0.50	96
14.(31)	0.16	0.37	96
15.(34)	0.57	0.50	96
16.(36)	0.25	0.44	96
17.(38)	0.15	0.35	96
18.(39)	0.22	0.42	96
19.(42)	0.46	0.50	96
20.(43)	0.31	0.39	96
21.(44)	0.25	0.44	96
22.(46)	0.39	0.49	96
23.(47)	0.59	0.49	96
24.(49)	0.43	0.50	96
25.(51)	0.26	0.44	96
26.(58)	0.39	0.49	96

TABLE 36

MEANS AND STANDARD DEVIATIONS FOR ITEMS ON THE SCIENCE BACKGROUND EXPERIENCE INVENTORY

Item Number	Mean	Standard Deviation	Cases
1.	0.66	0.48	96
2.	0.85	0.35	96
3.	0.32	0.47	96
4.	0.88	0.33	96
5.	0.91	0.29	96
6.	0.46	0.50	96
7.	0.94	0.24	96
8.	0.81	0.39	96
9.	0.43	0.50	96
10.	0.68	0.47	96
11.	0.25	0.44	96
12.	0.90	0.31	96
13.	0.69	0.47	96
14.	0.80	0.40	96
15.	0.94	0.24	96
16.	0.77	0.42	96
17.	0.29	0.46	96
18.	0.85	0.35	96
19.	0.54	0.50	96
20.	0.64	0.48	96
21.	0.14	0.34	96
22.	0.26	0.44	96
23.	0.46	0.50	96
24.	0.25	0.44	96
25.	0.94	0.24	96
26.	0.73	0.45	96
27.	0.59	0.49	96
28.	0.25	0.44	96
29.	0.95	0.22	96
30.	0.75	0.44	96
31.	0.85	0.35	96
32.	0.66	0.48	96
33.	0.31	0.47	96
34.	0.07	0.26	96
35.	0.33	0.47	96
36.	0.88	0.33	96
37.	0.69	0.47	96
38.	0.40	0.49	96
39.	0.67	0.47	96
40.	0.43	0.50	96

Table 36 (Continued)

Item Number	Mean	Standard Deviation	Cases
41.	0.64	0.48	96
42.	0.23	0.42	96
43.	0.91	0.29	96
44.	0.29	0.46	96
45.	0.14	0.34	96
46.	0.42	0.50	96
47.	0.89	0.32	96
48.	0.75	0.44	96
49.	0.21	0.41	96
50.	0.73	0.45	96
51.	0.75	0.44	96
52.	0.31	0.47	96
53.	0.91	0.29	96
54.	0.38	0.49	96
55.	0.90	0.31	96
56.	0.33	0.47	96
57.	0.29	0.46	96
58.	0.40	0.49	96
59.	0.83	0.37	96
60.	0.58	0.50	96
61.	0.38	0.49	96
62.	0.86	0.34	96
63.	0.70	0.46	96
64.	0.56	0.50	96
65.	0.65	0.48	96
66.	0.21	0.41	96
67.	0.75	0.44	96
68.	0.61	0.49	96
69.	0.66	0.48	96
70.	0.31	0.47	96
71.	0.27	0.45	96
72.	0.83	0.37	96
73.	0.94	0.24	96
74.	0.73	0.45	96
75.	0.46	0.50	96
76.	0.54	0.50	96
77.	0153	0.50	96
78.	0.10	0.31	96
79.	0.41	0.49	96
80.	0.69	0.47	96

TABLE 37

CHI SQUARE ANALYSIS FOR TWENTY-SIX ITEMS
ON THE DUBINS SUB POST TEST

Item No.	% Correct of Total Group	Correlation	Chi Square	Significance
1.	61.5	0.07	0.55	0.47
2.	71.9	0.19	3.41	0.06
3.	35.4	0.03	0.09	0.76
4.	46.9	0.02	0.03	0.86
5.	61.5	0.03	0.09	0.76
6.	45.8	0.05	0.20	0.66
7.	57.3	0.11	1.10	0.27
8.	15.6	0.13	1.51	0.22
9.	10.4	0.05	0.28	0.60
10.	22.9	0.17	2.83	0.09
11.	53.1	0.10	1.00	0.32
12.	46.9	0.02	0.05	0.82
13.	56.3	0.04	0.13	0.72
14.	15.6	0.16	2.50	0.11
15.	57.3	0.07	0.46	0.50
16.	25.0	0.07	0.50	0.48
17.	14.6	0.02	0.03	0.87
18.	21.9	0.10	0.92	0.34
19.	45.8	0.09	0.73	0.39
20.	81.3	0.09	0.72	0.40
21.	25.0	0.02	0.06	0.81
22.	38.5	0.37	13.43	0.00
23.	59.4	0.11	1.25	0.26
24.	42.7	0.69	0.46	0.50
25.	26.0	0.09	0.85	0.36
26.	38.5	0.12	1.31	0.25

TABLE 38

PERCENTAGES OF CORRECT AND INCORRECT ANSWERS ON THE DUBINS SUB POST TEST BY METHODS

Item Number	Wrong	Correct	Total
1. Treatment	21	29	50
Control	16	30	46
2. Treatment	10	40	50
Control	17	29	46
3. Treatment	33	17	50
Control	29	17	46
4. Treatment	27	23	50
Control	24	22	46
5. Treatment	20	30	50
Control	17	29	46
6. Treatment	26	24	50
Control	26	20	46
7. Treatment	24	26	50
Control	27	29	46
8. Treatment	40	10	50
Control	41	5	46
9. Treatment	44	6	50
Control	42	4	46
10. Treatment	42	8	50
Control	32	14	46
11. Treatment	21	29	50
Control	22	24	46
12. Treatment	26	24	50
Control	25	21	46
13. Treatment	21	29	50
Control	21	25	46
14. Treatment	45	5	50
Control	36	10	46
15. Treatment	23	27	50
Control	18	28	46
16. Treatment	36	14	50
Control	36	10	46
17. Treatment	43	7	50
Control	39	7	46

Table 38 (Continued)

Item Number	Wrong	Correct	Total
18. Treatment	41	9	50
Control	34	12	46
19. Treatment	25	25	50
Control	27	19	46
20. Treatment	11	39	50
Control	7	39	46
21. Treatment	38	12	50
Control	34	12	46
22. Treatment	22	28	50
Control	37	9	46
23. Treatment	23	27	50
Control	16	30	46
24. Treatment	27	23	50
Control	28	18	46
25. Treatment	35	15	50
Control	36	10	46
26. Treatment	28	22	50
Control	31	15	46

APPENDIX B

Twenty-Six Items From The Dubin Total Post Test

DUBIN EARTH SCIENCE SUB POST TEST

TWENTY-SIX ITEMS FROM THE DUBIN TOTAL POST TEST

(Number in parentheses is number from total post test.)

1. (5) All liquid rock within the earth is called-
   (a) lava
   (b) igneous
   (c) sedimentary
   (d) magma
   (e) do not know

2. (6) Igneous rocks are most likely to be found at which of these locations?
   (a) ocean floor
   (b) river bed
   (c) volcano
   (d) sand dune
   (e) do not know

3. (8) Metamorphic rocks-
   (a) change the type of elements in the original rock
   (b) rearrange the same elements
   (c) weather the existing rocks
   (d) occur at the surface first
   (e) do not know

4. (9) Igneous rocks change to sedimentary by-
   (a) erosion by rain
   (b) melting from heat or pressure
   (c) burial and compression
   (d) recrystallization
   (e) do not know

5. (10) Methmorphic rocks change to igneous by-
   (a) erosion by rain
   (b) melting from heat or pressure
   (c) burial and compression
   (d) recrystallization
   (e) do not know

6. (11) Metamorphic rocks are most likely to be found at which of these locations?
   (a) fault zones
   (b) volcanoes
   (c) waterfalls
   (d) old sea floors
   (e) do not know

7. (12) Igneous rocks may be changed to either sedimentary or metamorphic rocks by forces found in which of these locations?
   (a) on the surface of the earth
   (b) below the surface of the earth
   (c) both of these
   (d) neither of these
   (e) do not know

8. (16) Sedimentary rocks are most likely to be found at which of these locations?
   (a) old sea floor
   (b) fault zones
   (c) waterfalls
   (d) glaciers
   (e) do not know

9. (17) As igneous rock forms, the rate of cooling determines-
   (a) the size of crystals
   (b) the amount of water in the rock
   (c) the rate of erosion
   (d) the type of rock
   (e) do not know

10. (18) Sedimentary rocks form-
   (a) at the surface of the earth
   (b) beneath the surface of the earth
   (c) both of these
   (d) neither of these
   (e) do not know

11. (21) Metamorphic rocks form-
   (a) at the surface of the earth
   (b) beneath the surface of the earth
   (c) both of these
   (d) neither of these
   (e) do not know

12. (22) The change of sedimentary rock to igneous rock takes place by-
   (a) erosion by rain
   (b) compression by earthquakes
   (c) recrystallization
   (d) melting from heat or pressure
   (e) do not know

13. (24) If excess heat or pressure is added to a metamorphic rock, which of the following is likely to happen?
(a) remelt
(b) erosion
(c) burial
(d) uplift
(e) do not know

14. (31) Igneous rocks change to metamorphic rocks by-
(a) erosion by rain
(b) melting from heat and/or pressure
(c) burial and compression
(d) recrystallization
(e) do not know

15. (34) Using the key below, answer number 34.
A-marble and flint
B-shale and slate
C-granite and gabbro
D-obsidian and basalt

In which pair of specimens is the second rock formed from the first?
(a) A
(b) B
(c) C
(d) D
(e) do not know

16. (36) Sedimentary rocks change to metamorphic rocks by-
(a) erosion by rain
(b) compression by earthquakes
(c) recrystallization
(d) melting from heat and/or pressure
(e) do not know

17. (38) Metamorphic rocks change to sedimentary by-
(a) erosion by rain
(b) melting from heat or pressure
(c) burial and compression
(d) recrystallization
(e) do not know

18. (39) A natural process of cementing particles of sediment together is most likely to occur in which of these locations?
    (a) oceans
    (b) volcanoes
    (c) deserts
    (d) fault zones
    (e) do not know

19. (42) In an earthquake area, which of the following rock types is most likely to be found?
    (a) igneous
    (b) sedimentary
    (c) metamorphic
    (d) none of these
    (e) do not know

20. (43) A cycle refers to motion that is-
    (a) horizontal
    (b) vertical
    (c) circular
    (d) rectangular
    (e) do not know

21. (44) Molten rock is found within the earth-
    (a) in pockets
    (b) throughout the core
    (c) throughout the crust
    (d) in the oceans
    (e) do not know

22. (46) Rocks which are deposited from solutions rich in minerals are called-
    (a) igneous
    (b) sedimentary
    (c) metamorphic
    (d) none of these
    (e) do not know

23. (47) Igneous rock can change to-
    (a) sedimentary only
    (b) metamorphic only
    (c) either depending on the activity
    (d) neither regardless of activity
    (e) do not know

24. (49) The rocks within the earth are thought to be melted by heat from-
    (a) pressure
    (b) sun
    (c) radioactivity
    (d) erosion
    (e) do not know

25. (51) The surface of the earth-
    (a) changes and the interior does not
    (b) is one location of change
    (c) changes more than the interior
    (d) changes less than the interior
    (e) do not know

26. (58) A cave is likely to be a place where rocks of one type are seen forming more than others. That type is-
    (a) igneous
    (b) sedimentary
    (c) metamorphic
    (d) none of these
    (e) do not know

APPENDIX C

Science Background Experience Inventory

Science Background Experience Inventory

The following questions will not be graded. Their purpose is to find out what types of common experiences students in this class have in science. To answer the question, circle the yes or no at the end of each question. If you do not understand the question or are not sure if you have done what the question asks, circle no.

Science Background Experience Inventory

1.	Have you seen a worn tombstone?	yes	no
2.	Have you watched a lake during a thunderstorm?	yes	no
3.	Have you seen a volcano erupt?	yes	no
4.	Have you tried to catch a butterfly?	yes	no.
5.	Have you found a fossil?	yes	no
6.	Have you watched the same river in all seasons?	yes	no
7.	Have you watched a waterfall?	yes	no
8.	Have you helped plant a flower garden?	yes	no
9.	Have you observed river patterns from an airplane?	yes	no
10.	Have you observed the different leaf arrangements on plants?	yes	no
11.	Have you seen a rock with a volcanic intrusion in it?	yes	no
12.	Have you been camping in a tent?	yes	no
13.	Have you seen a rock with tightly packed layers?	yes	no
14.	Have you gone to a national park or monument?	yes	no
15.	Have you seen a plant die from too little water?	yes	no
16.	Have you collected leaves?	yes	no
17.	Have you observed chemical weathering?	yes	no
18.	Have you collected rocks?	yes	no
19.	Have you identified rocks that you found?	yes	no

20.	Have you observed frozen water cracking or breaking something?	yes	no
21.	Have you made a natural fossil?	yes	no
22.	Have you looked at soil under a microscope?	yes	no
23.	Have you wired an electrical appliance?	yes	no
24.	Have you observed mechanical weathering?	yes	no
25.	Have you studied about glaciers?	yes	no
26.	Have you changed snow to ice?	yes	no
27.	Have you seen a hill cut open for a road?	yes	no
28.	Have you made a crystal?	yes	no
29.	Have you observed frost on the windshield of a car?	yes	no
30.	Have you predicted the weather?	yes	no
31.	Have you observed the texture of a rock?	yes	no
32.	Have you polished a rock?	yes	no
33.	Have you observed how a rock reflects light?	yes	no
34.	Have you used HCl on a rock?	yes	no
35.	Have you observed sediment formation around your home?	yes	no
36.	Have you observed an eclipse of the sun?	yes	no
37.	Have you been swimming in the Great Lakes?	yes	no
38.	Have you observed sediments that have been cemented together?	yes	no
39.	Have you changed a liquid to a solid by removing heat?	yes	no

40.	Have you studied about radioactive materials?	yes	no
41.	Have you kept up an aquarium?	yes	no
42.	Have you studied about the origin of gold and silver?	yes	no
43.	Have you walked around earthworms on the sidewalk after a rain?	yes	no
44.	Have you studied about ores?	yes	no
45.	Have you ever seen volcanic glass?	yes	no
46.	Have you seen rock salt as it is in the earth?	yes	no
47.	Have you observed rust on something metallic?	yes	no
48.	Have you read about nuclear energy?	yes	no
49.	Have you seen sound waves?	yes	no
50.	Have you watched clouds form and grow?	yes	no
51.	Have you played a piano?	yes	no
52.	Have you watched a satellite move across the sky?	yes	no
53.	Have you observed a bird eating a seed or a worm?	yes	no
54.	Have you made a model rocket and launched it?	yes	no
55.	Have you seen the Big Dipper?	yes	no
56.	Have you seen a geyser?	yes	no
57.	Have you visited a hot springs?	yes	no
58.	Have you climbed a mountain?	yes	no
59.	Have you split open a rock?	yes	no
60.	Have you observed the way a rock breaks?	yes	no

61.	Have you identified a rock by its color?	yes	no
62.	Have you watched the mercury in a thermometer?	yes	no
63.	Have you observed fog only in low places?	yes	no
64.	Have you identified a planet in the sky?	yes	no
65.	Have you seen a space capsule?	yes	no
66.	Have you observed stalagmites and stalacities?	yes	no
67.	Have you watched icicles form?	yes	no
68.	Have you seen a piece of lava that has become rock?	yes	no
69.	Have you seen the Straits of Mackinac and bridge?	yes	no
70.	Have you traveled to the Rocky Mountains?	yes	no
71.	Have you visited the Appalachian Mountains?	yes	no
72.	Have you paddled a canoe?	yes	no
73.	Have you been on a hike?	yes	no
74.	Have you held two rocks of the same size, one in each hand to compare their weight?	yes	no
75.	Have you skiied downhill?	yes	no
76.	Have you scratched a rock with your fingernail?	yes	no
77.	Have you used a black light?	yes	no
78.	Have you dissolved a rock?	yes	no
79.	Have you observed sediment settling from a river or a lake?	yes	no
80.	Have you been swimming in the ocean?	yes	no

APPENDIX D

Earth Science Test, Form A

Earth Science Test

On the following questions, there are different answers to choose between. If none of the answers seem to fit or if you simply do not know the answer, choose the dk answer for don't know and fill in the space (e) on the answer sheet.

Earth Science Test, Form A

1. In which pair below were both specimens formed by volcanic action?
   (a) chalk and chert
   (b) granite and gabbro
   (c) limestone and marble
   (d) obsidian and pumice
   (dk)

2. Coral reefs and coral islands are made of-
   (a) rocks and soil deposited by the sea
   (b) hardened lava from volcanoes
   (c) red sandstone
   (d) skeletons of small sea animals
   (dk)

3. Igneous rocks are most likely to be found at which of these locations?
   (a) ocean floor
   (b) river bed
   (c) volcano
   (d) sand dune
   (dk)

USE THE TABLE BELOW IN ANSWERING QUESTION 4

Planet	Millions of miles from Sun	Mass	Volume	Surface gravity
E Earth	93.0	1	1	1
F Mars	141.5	0.11	0.15	0.38
G Saturn	886.1	95	760	1.17
H Jupiter	483.3	318	1312	2.64

4. On which of the above planets would you weigh the most?
   (a) E
   (b) F
   (c) G
   (d) H
   (dk)

5. Igneous rocks may be changed to either sedimentary or metamorphic by forces found in which of these locations?
   (a) on the surface of the earth
   (b) below the surface of the earth
   (c) both of these
   (d) neither of these
   (dk)

6. All liquid rock within the earth is called-
   (a) lava
   (b) igneous
   (c) sedimentary
   (d) magma
   (dk)

7. As igneous rock forms, the rate of cooling determines the-
   (a) size of crystals
   (b) amount of water in the rock
   (c) rate of erosion
   (d) type of rock
   (dk)

8. The earth's crust is composed largely of-
   (a) marble
   (b) granite
   (c) slate
   (d) lava
   (dk)

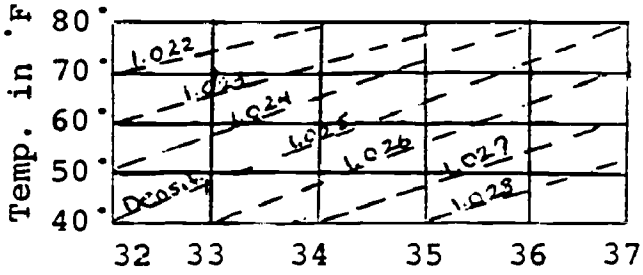
9. Metamorphic rocks are most likely to be found at which of these locations?
   (a) fault zones
   (b) volcanoes
   (c) waterfalls
   (d) old sea floors
   (dk)

10. Sedimentary rocks form-
   (a) at the surface of the earth
   (b) beneath the surface of the earth
   (c) both of these
   (d) neither of these
   (dk)

11. Metamorphic rocks-
   (a) change the type of elements in the original rock
   (b) rearrange the same elements
   (c) weather the existing rocks
   (d) occur at the surface first
   (dk)

12. Sedimentary rocks change to metamorphic by-
   (a) erosion by rain
   (b) melting by heat or pressure
   (c) burial and compression
   (d) recrystallization
   (dk)

USE THE GRAPH BELOW TO ANSWER QUESTIONS 13, 14, 15.



Density of Water at Different Temperatures and Salinities

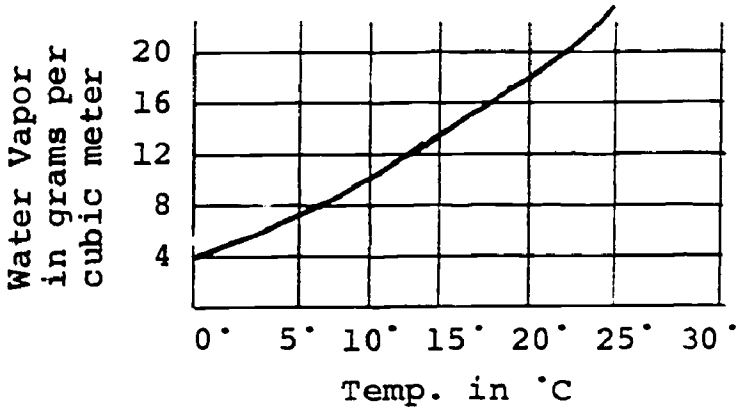
13. At a temperature of 70 degrees F and a salinity of 33 parts per 1,000, the density of ocean water is-
(a) 1.023 grams per cc
(b) 1.024 grams per cc
(c) 1.025 grams per cc
(d) 1.026 grams per cc
(dk)

14. At a salinity of 34.5 parts per 1,000 and a density of 1.026 grams per cc, the temperature of ocean water is-
(a) 60 degrees F
(b) 55 degrees F
(c) 50 degrees F
(d) 45 degrees F
(dk)

15. At a temperature of 60 degrees F and a salinity of 31.5 parts per 1,000, the density of ocean water would probably be-
(a) 1.023 grams per cc
(b) 1.024 grams per cc
(c) 1.025 grams per cc
(d) 1.026 grams per cc
(dk)

16. Sedimentary rocks are most likely to be found at which of these locations?
(a) old sea floors
(b) fault zones
(c) waterfalls
(d) glaciers
(dk)

USE THE GRAPH BELOW TO ANSWER QUESTION 17.

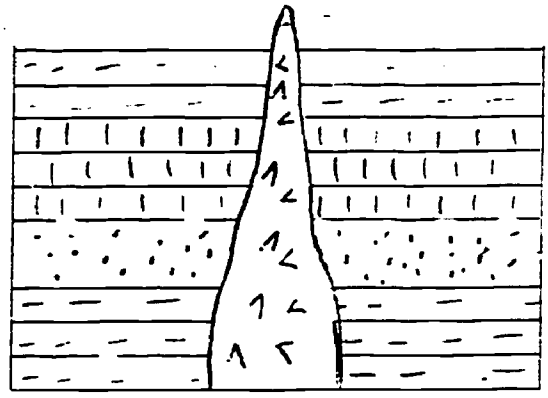


Water Vapor in Grams per cubic meter When Air is Saturated

17. If the amount of water vapor in saturated air is 9.4 grams per cubic meter, the temperature of the air is-
(a) 100 degrees C
(b) 16 degrees C
(c) 10 degrees C
(d) 0 degrees C
(dk)

18. Each of the following is produced by earthquakes except a-
(a) drumlin
(b) tsunami
(c) landslide
(d) fault scarp
(dk)

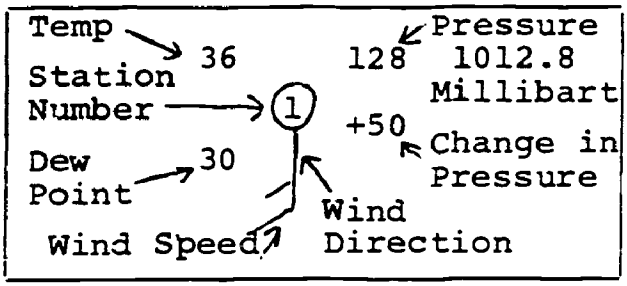
19. In the diagram below of a stratified rock formation, structure A represents a-

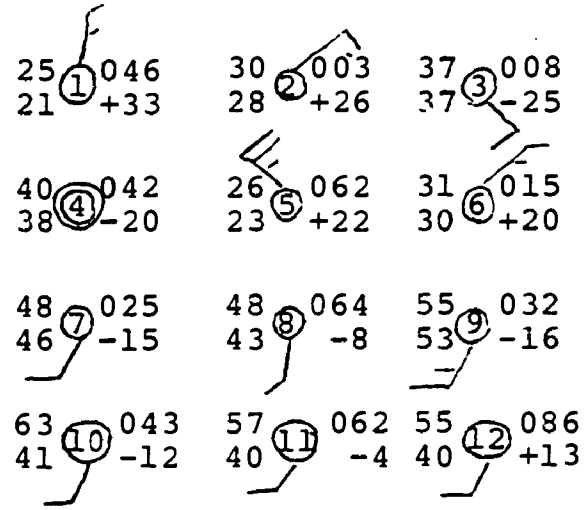


(a) lopolith
(b) sill
(c) laccolith
(d) dike
(dk)

20. A scientist who regularly uses an anemometer, a hygrometer, and a barometer is-
(a) a geologist
(b) a meteorologist
(c) an astonomer
(c) an oceanographer
(dk)

USE THE WEATHER MAP BELOW IN ANSWERING QUESTIONS 21 & 22.





21. At which of the stations does the highest pressure occur?
(a) 4
(b) 7
(c) 9
(d) 12
(dk)

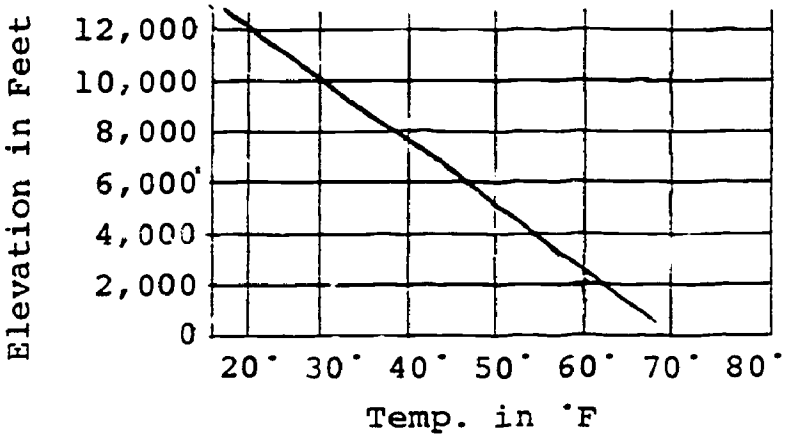
22. The greatest pressure change within the past three hours of map time occurred at which one of the following situations?
(a) 5
(b) 9
(c) 11
(d) 12
(dk)

23. Metamorphic rocks form-
(a) at the surface of the earth
(b) beneath the surface of the earth
(c) both of these
(d) neither of these
(dk)

24. To which one of the following land features are mid-ocean ridges comparable in size?
(a) hills
(b) eskers
(c) plateaus
(d) mountain chains
(dk)

25. Metamorphic rocks change to desimentary by-
(a) erosion by rain
(b) melting from heat or pressure
(c) burial and compression
(d) recrystallization
(dk)

USE THE GRAPH BELOW IN ANSWERING QUESTION 26.



Temperatures at Different Elevations

26. The lowest level at which icing would occur on an airplane is-
(a) 9,200 feet
(b) 8,200 feet
(c) 7,200 feet
(d) 6,200 feet
(dk)

27. Which of the following types of surfaces is heated most by the sun?
(a) an ocean surface
(b) a lake surface
(c) soil with no vegetative covering
(d) soil with a vegetative covering
(dk)

28. Venus, Mars and the moon are alike in that each-
(a) has no atmosphere
(b) shines by reflected light
(c) is made up of hot gases
(d) has a very dense atmosphere
(dk)

29. Which one of the following celestial bodies makes one complete rotation in the same time that it makes one complete revolution?
(a) the moon
(b) Mars
(c) Jupiter
(d) the sun
(dk)

30. If a pipe could be driven from the surface of the earth to its center, the longest section of pipe would be through the earth's-
(a) outer core
(b) inner core
(c) mantle
(d) crust
(dk)

31. Which of the following minerals contains the two most abundant elements in the earth's crust?
(a) halite
(b) feldspar
(c) magnetite
(d) galena
(dk)

32. Which one of the following is closely associated with sunspot activity?
(a) a meteor shower
(b) a solar eclipse
(c) an abnormal tide
(d) a magnetic storm
(dk)

33. If excess heat or pressure is added to a metamorphic rock, which of the following is likely to happen?
(a) remelt
(b) erosion
(c) burial
(d) uplift
(dk)

34. A river flowing slowly through a flat area is in its-
(a) rejuvenation stage
(b) old stage
(c) mature stage
(d) young stage
(dk)

35. The change of sedimentary rock to igneous takes place by-
(a) erosion by rain
(b) compression by earthquakes
(c) recrystallization
(d) melting from heat or pressure
(dk)

36. Which one of the following is deposited on a plain by water flowing down a steep slope?
(a) a delta
(b) an alluvail fan
(c) a levee
(d) a bar
(dk)

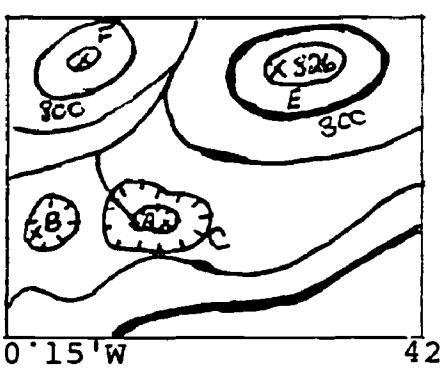
37. Metamorphic rocks change to igneous by-
(a) erosion by rain
(b) melting from heat or pressure
(c) burial and compression
(d) recrystallization
(dk)

38. Igneous rocks change to sedimentary by-
(a) erosion by rain
(b) melting from heat or pressure
(c) burial and compression
(d) recrystallization
(dk)

39. Which of the following rocks contain the largest amounts of iron and magnesium?
(a) shale
(b) slate
(c) pumice
(d) gabbro
(dk)

40. In an earthquake area, which of the following rock types are most likely to be found:
    (a) igneous
    (b) sedimentary
    (c) metamorphic
    (d) none of these
    (dk)

USE THE MAP BELOW IN ANSWERING QUESTION 41.



Scale: 1 inch = 1 mile

This is a 15 minute quadrangle

41. The contour interval is-
    (a) 5 feet
    (b) 10 feet
    (c) 20 feet
    (d) 100 feet
    (dk)

42. A cycle refers to motion that is-
    (a) horizontal
    (b) vertical
    (c) circular
    (d) rectangular
    (dk)

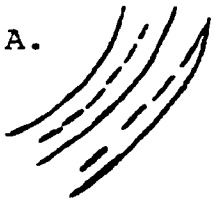
43. On a July day in the Northern Hemisphere, with scattered clouds but no percipitation, the maximum temperature occurs at about-
    (a) 6 p.m. standard time
    (b) 3 p.m. standard time
    (c) noon standard time
    (d) 10 a.m. standard time
    (dk)

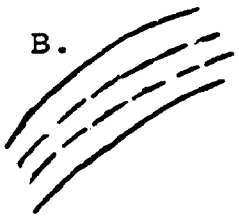
44. Igneous rocks change to metamorphic by-
(a) erosion by rain
(b) melting from heat or pressure
(c) burial and compression
(d) recrystallization
(dk)

45. Molten rock is found within the earth-
(a) in pockets
(b) throughout the core
(c) throughout the crust
(d) in the oceans
(dk)

46. Rocks which are deposited from solutions rich in minerals are called-
(a) igneous
(b) sedimentary
(c) metamorphic
(d) all of these
(dk)

47. Which of the diagrams below shows how a star trails would look at the equator?

A. 

B. 

C. 

D. 

(a) A
(b) B
(c) C
(d) D
(dk)

48. The rocks within the earth are thought to be melted by heat from-
(a) pressure
(b) sun
(c) radioactivity
(d) erosion
(dk)

49. The surface of the earth-
(a) changes and the interior does not
(b) is one location of change
(c) changes more than interior
(d) changes less than the interior
(dk)

50. If you visited a mountainous area that had been glaciated you would most likely see-
(a) a fumarole
(b) an oxbox
(c) a cirque
(d) a braided stream
(dk)

51. A natural process of cementing particles of sediment together is most likely to occur in which of these locations?
(a) oceans
(b) volcanoes
(c) deserts
(d) fault zones
(dk)

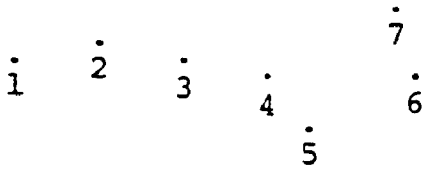
52. Igneous rock can change to-
(a) sedimentary only
(b) metamorphic only
(c) either depending on activity
(d) neither regardless of activity
(dk)

53. The minerals of which a rock is composed determine-
(a) the color of the rock
(b) the way it reacts to heat and pressure
(c) how it eroses
(d) all of these
(e) none of these

54. Erosion on the surface of the earth can be caused by-
(a) wind
(b) liquid water
(c) ice
(d) all of these
(e) none of these

55. Radio reception between two cities which are a great distance apart depends primarily on conditions in the-
(a) ionosphere
(b) stratosphere
(c) troposphere
(d) hydrosphere
(dk)

56. As shown below in the diagram of the Big Dipper, the pointer starts indicating the direction of Polaris are numbered-



(a) 2 and 1
(b) 4 and 7
(c) 5 and 6
(d) 6 and 7
(dk)

57. Which one of the following is not evidence of the earth's rotation?
(a) the deflection toward the east of air moving north in the Northern Hemisphere
(b) the earth's shadow on the moon during an eclipse
(c) the apparent clockwise motion of a pendulum in the Northern Hemisphere
(d) the daily rising and setting of the stars
(dk)

58. The diagram below represents the time during which certain fossils are alive.

Cretaceous		B	
Jurassic	A		C
Triassic			

Fossil A, B, and C were found embedded in a rock of Cretaceous age. The most probable explanation is-
(a) B and C lived together, and A is a result of erosion and later deposition.
(b) A and C lived together and B is a result of erosion and later deposition
(c) A and B lived together and C is a result of erosion and later deposition
(d) all of these fossils lived together
(dk)

59. If the number of sunspots is at a minimum in a specific year, then in how many years will the number again be at a minimum?
(a) 5 years
(b) 7 years
(c) 11 years
(d) 17 years
(dk)

60. A cave is likely to be a place where rocks of one type are seen forming more than others. That type is-
(a) igneous
(b) sedimentary
(c) metamorphic
(d) all of these
(dk)

APPENDIX E

Earth Science Test, Form B

Earth Science Test

On the following questions, there are different answers to choose between. If none of the answers seem to fit or if you simply do not know the answer, choose the d' answer for don't know and fill in the space (e) on the answer sheet.

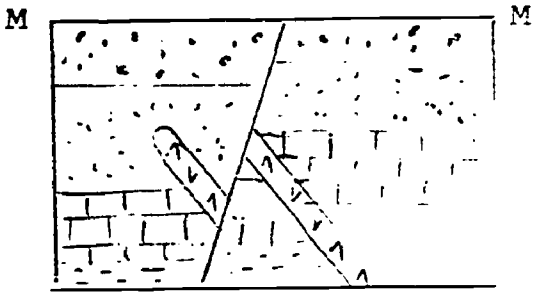
Earth Science Test, Form B

USE THE TABLE BELOW IN ANSWERING QUESTION 1.

Planet	Millions of miles from Sun	Mass	Volume	Surface gravity
A Earth	93.0	1	1	1
B Venus	67.2	0.81	0.90	0.88
C Saturn	886.1	95	760	1.17
D Neptune	2793	17.2	42	1.40

1. On which of the above planets would you weigh the least?
   (a) A
   (b) B
   (c) C
   (d) D
   (dk)

USE THE DIAGRAM BELOW IN ANSWERING QUESTION 2.



2. The most recent event in the geological history as shown above is-
   (a) faulting
   (b) igneous intrusion
   (c) folding
   (d) deposition of bed M
   (dk)

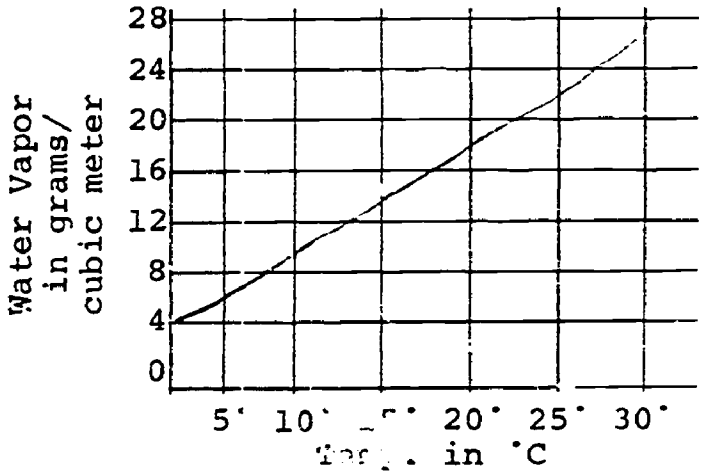
3. The reflection of radio waves from the moon can be used to determine the-
   (a) thickness of the moon's crust
   (b) phase of the moon
   (c) angular diameter of the moon
   (d) distance of the moon from the earth
   (dk)

4. The earth's crust is thinnest beneath-
   (a) plains
   (b) mountains
   (c) lakes
   (d) oceans
   (dk)

5. All liquid rock within the earth is called-
   (a) lava
   (b) igneous
   (c) sedimentary
   (d) magma
   (dk)

6. Igneous rocks are most likely to be found at which of these locations?
   (a) ocean floor
   (b) river bed
   (c) volcano
   (d) sand dune
   (dk)

USE THE GRAPH BELOW IN ANSWERING QUESTION 7.



Water Vapor in Grams per Cubic Meter When Air is Saturated

7. If the temperature of saturated air is 26 degrees C, the amount of water vapor in the air is-
   (a) 20 grams per cubic meter
   (b) 24 grams per cubic meter
   (c) 27 grams per cubic meter
   (d) 100 grams per cubic meter
   (dk)

8. Metamorphic rocks-
   (a) change the type of elements in the original rock
   (b) rearrange the same elements
   (c) weather the existing rocks
   (d) occur at the surface first
   (dk)

9. Igneous rocks change to sedimentary by-
   (a) erosion by rain
   (b) melting from heat or pressure
   (c) furinal and compression
   (d) recrystallization
   (dk)

10. Metamorphic rocks change to igneous by-
   (a) erosion by rain
   (b) melting from heat or pressure
   (c) burial and compression
   (d) recrystallization
   (dk)

11. Metamorphic rocks are most likely to be found at which of these locations?
   (a) fault zones
   (b) volcanoes
   (c) waterfalls
   (d) old sea floors
   (dk)

12. Igneous rocks may be changed to either sedimentary or metamorphic rocks by forces found in which of these locations?
   (a) on the surface of the earth
   (b) below the surface of the earth
   (c) both of these
   (d) neither of these
   (dk)

13. Brachiopods live only in the sea, yet fossil brachipods have been found in shale as high as 7,000 feet above sea level. The most logical explanation for this occurrence is-
   (a) sediment containing brachiopods was raised above the ocean's surface and formed shale
   (b) the brachiopods migrated from the sea during heavy and lengthy rains
   (c) birds flying at 7,000 feet above sea level dropped the brachiopods in mud, which later became shale
   (d) a tidal wave lifted the brachiopod fossils from the ocean bottom to the mountains
   (dk)

14. Which one of the features below is primarily a result of glacial activity?
    (a) a V-shaped valley
    (b) a U-shaped valley
    (c) a meander
    (d) a braided channel
    (dk)

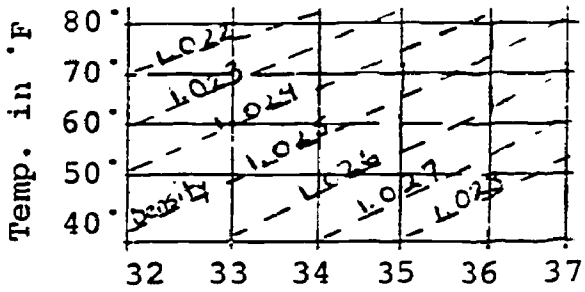
15. The very bright colors in a sunset are due chiefly to-
    (a) dust in the earth's atmosphere
    (b) the blending of light from many stars
    (c) changes in gases surrounding the sun
    (d) the reflection of the sun's rays from brightly colored rocks
    (dk)

16. Sedimentary rocks are most likely to be found at which of these locations?
    (a) old sea floors
    (b) fault zones
    (c) waterfalls
    (d) glaciers
    (dk)

17. As igneous rock forms, the rate of cooling determines-
    (a) the size of crystals
    (b) the amount of water in the rock
    (c) the rate of erosion
    (d) the type of rock
    (dk)

18. Sedimentary rocks form-
    (a) at the surface of the earth
    (b) beneath the surface of the earth
    (c) both of these
    (d) neither of these
    (dk)

USE THE GRAPH BELOW IN ANSWERING QUESTIONS 19 AND 20.



Density of Water at Different Temperatures and Salinities

19. At a temperature of 60 degrees F and a salinity of 34 parts per 1,000, the density of ocean water is-
(a) 1.022 grams per cc
(b) 1.023 grams per cc
(c) 1.024 grams per cc
(d) 1.025 grams per cc
(dk)

20. At a temperature of 50 degrees F and a salinity of 31.5 parts per 1,000, the density of ocean water would probably be-
(a) 1.027 grams per cc
(b) 1.026 grams per cc
(c) 1.025 grams per cc
(d) 1.024 grams per cc
(dk)

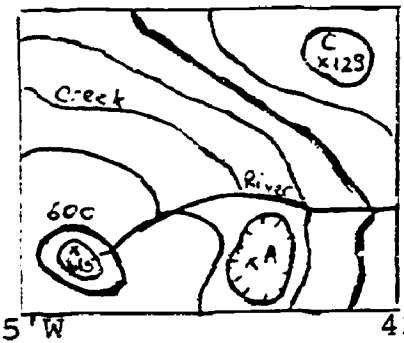
21. Metamorphic rocks form-
(a) at the surface of the earth
(b) beneath the surface of the earth
(c) both of these
(d) neither of these
(dk)

22. The change of sedimentary rock to igneous rock takes place by-
(a) erosion by rain
(b) compression by earthquakes
(c) recrystallization
(d) melting from heat or pressure
(dk)

23. Which of the following instruments is based on the principle that hair becomes longer when moist?
(a) a hygrometer
(b) a seismograph
(c) a thermograph
(d) an anemometer
(dk)

24. If excess heat or pressure is added to a metamorphic rock, which of the following is likely to happen?
(a) remelt
(b) erosion
(c) burial
(d) uplift
(dk)

USE THE MAP BELOW TO ANSWER QUESTIONS 25 AND 26.



71°15'W 42°30'N

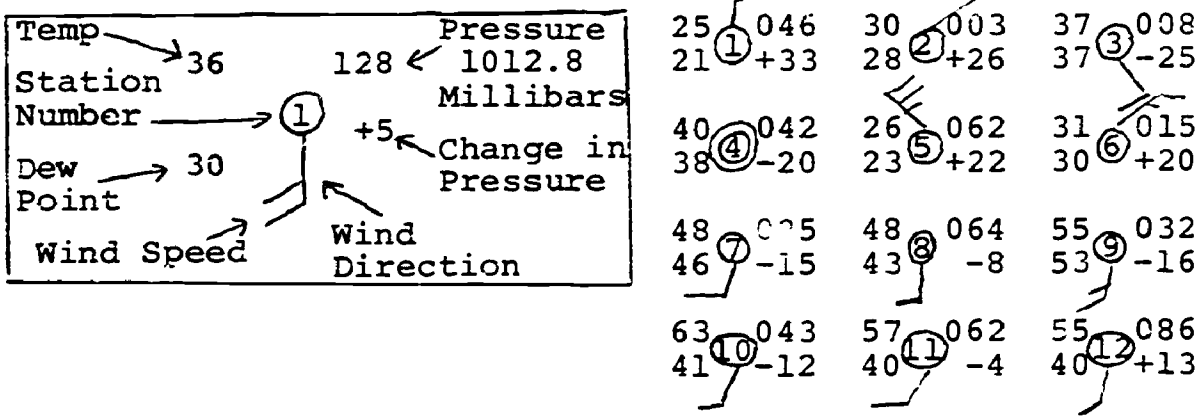
Scale: 1" = ½ mile
This is a 7½ min. quadrangle

25. Which of the following points on the map has the lowest latitude?
(a) A
(b) B
(c) C
(d) D
(dk)

26. The contour interval is-
(a) 5 feet
(b) 10 feet
(c) 20 feet
(d) 100 feet
(dk)

27. Which of the following minerals contains the two most abundant elements in the earth's crust?
(a) halite
(b) feldspar
(c) magnetite
(d) galena
(dk)

USE THE WEATHER MAP BELOW IN ANSWERING QUESTIONS 28, 29 and 30.



28. The lowest pressure occurs at which of the following stations?
    (a) 1
    (b) 2
    (c) 11
    (d) 12
    (dk)

29. Which of the following four stations is not in the same air mass as the other three?
    (a) 6
    (b) 7
    (c) 9
    (d) 10
    (dk)

30. Within the past three hours of map time, at which of the following stations did the pressure change the least?
    (a) 2
    (b) 6
    (c) 11
    (d) 12
    (dk)

31. Igneous rocks change to metamorphic rocks by-
    (a) erosion by rain
    (b) melting from heat and/or pressure
    (c) burial and compression
    (d) recrystallization
    (dk)

32. The era in which we are now living is the-
(a) Proterozoic
(b) Paleozoic
(c) Mesozoic
(d) Cenozoic
(dk)

33. The amount of chloride ion in ocean water is used as a test of the ocean's-
(a) turbidity
(b) specific gravity
(c) density
(d) salinity
(dk)

USE THE KEY BELOW IN ANSWERING QUESTIONS 34 AND 35.

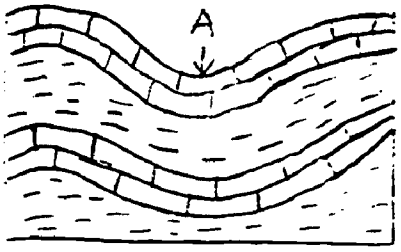
KEY: A-marble and flint
B-shale and slate
C-granit and gabbro
D-obsidian and basalt

34. In which pair of specimens is the second rock formed from the first?
(a) A
(b) B
(c) C
(d) D
(dk)

35. Which pair of specimens are coarse-grained igneous rocks?
(a) A
(b) B
(c) C
(d) D
(dk)

36. Sedimentary rocks change to metamorphic rocks by-
(a) erosion by rain
(b) compression by earthquakes
(c) recrystallization
(d) melting from heat or pressure
(dk)

37. In the diagram of rockfolding shown below, structure A represents-



(a) a cirque
(b) a dome
(c) an anticline
(d) a syncline
(dk)

38. Metamorphic rocks change to sedimentary by-
(a) erosion by rain
(b) melting from heat or pressure
(c) burial and compression
(d) recrystallization
(dk)

39. A natural process of cementing particles of sediment together is most likely to occur in which of these locations?
(a) oceans
(b) volcanoes
(c) deserts
(d) fault zones
(dk)

40. At which latitude must an observer be for all the stars to appear circumpolar?
(a) 0 degrees
(b) 45 degrees N
(c) 45 degrees S
(d) 90 degrees N
(dk)

41. Which of the following features is most characteristic of a mature stream?
(a) V-shaped valleys
(b) potholes
(c) meanders
(d) many rapids
(dk)

42. In an earthquake area, which of the following rock types is most likely to be found?
(a) igneous
(b) sedimentary
(c) metamorphic
(d) none of these
(dk)

43. A cycle refers to motion that is-
(a) horizontal
(b) vertical
(c) circular
(d) rectangular
(dk)

44. Molten rock is found within the earth-
(a) in pockets
(b) throughout the core
(c) throughout the crust
(d) in the oceans
(dk)

45. We always see the same side of the moon because the moon-
(a) makes one complete rotation for each revolution
(b) does not rotate while making a revolution
(c) rotates at the same rate as the earth
(d) revolves at the same rate as the earth
(dk)

46. Rocks which are deoposited from solutions rich in minerals are called-
(a) igneous
(b) sedimentary
(c) metamorphic
(d) none of these
(dk)

47. Igneous rock can change to-
(a) sedimentary only
(b) metamorphic only
(c) either depending on activity
(d) neither regardless of activity
(dk)

48. Every 48 days a certain star regularly undergoes an increase in brightness from an apparent magnitude of 5 to 3. This star is a-
(a) nova
(b) variable star
(c) white dwarf
(d) nebula
(dk)

49. The rocks within the earth are thought to be melted by heat from-
(a) pressure
(b) sun
(c) radioactivity
(d) erosion
(dk)

50. The minerals of which a rock is composed determine-
(a) the color of the rock
(b) the way it reacts to heat and pressure
(c) how it erodes
(d) all of these
(e) none of these

51. The surface of the earth-
(a) changes and the interior does not
(b) is one location of change
(c) changes more than the interior
(d) changes less than the interior
(dk)

52. Erosion on the surface of the earth can be caused by-
(a) wind
(b) liquid water
(c) ice
(d) all of these
(e) none of these

53. Which scientist determined that, in its orbit around the sun, a planet sweeps over equal areas in equal time intervals?
(a) Newton
(b) Einstein
(c) Kepler
(d) Copernicus
(dk)

54. The diagram below represents the time during which certain fossils were alive.

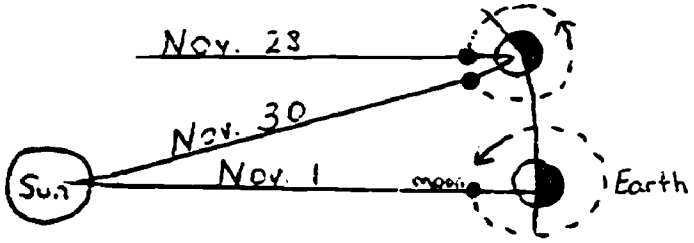
Cretaceous	A		
Jurassic		B	
Triassic			C

Fossils A, B, and C were found embedded in a rock of cretaceous age. The most probable explanation for this occurrence is-
(a) all of these fossils lived together
(b) A and C lived together and B is a result of erosion and later deposition
(c) B and C lived together and A is a result of erosion and later deposition
(d) A and B lived together and C is a result of erosion and later deposition
(dk)

55. If the moon is full when seen from the earth, in what phase is the earth as seen from the moon?
(a) new
(b) full
(c) first quarter
(d) last quarter
(dk)

56. The Van Allen Belts are composed of-
(a) cosmic dust
(b) micrometeoroids
(c) electrically neutral particles
(d) electrically charged particles
(dk)

USE THE DIAGRAM BELOW IN ANSWERING QUESTION 57.



57. As the moon revolves from X to X, the earth will rotate-
(a) once
(b) 27 1/3 times
(c) 29 1/2 times
(d) 365 1/4 times
(dk)

58. A cave is likely to be a place where rocks of one type are seen forming more than others. That type is-
(a) igneous
(b) sedimentary
(c) metamorphic
(d) none of these
(dk)

59. A weather report states that the barometer is falling and the temperature is rising. What kind of weather would a meteorologist predict?
(a) clear and colder, becoming clear and warmer
(b) clear and warmer, becoming clear and colder
(c) cloudy, becoming rainy and warmer, then colder
(d) cloudy, becoming rainy and colder, then warmer
(dk)

60. The elements in which one of the following pairs form compound which are relatively insoluble in ocean water?
(a) sodium and aluminum
(b) sodium and calcium
(c) silicon and aluminum
(d) calcium and silicon
(dk)

APPENDIX F

Rock Cycle Unit

Rock Cycle Unit

Objectives

By the end of the unit, the students will be able to:

1. give definitions of the three groups of rocks.
2. identify four samples in each of the three groups of rocks.
3. list forces that operate within the earth.
4. explain the effect of those forces on the rocks which they contact.
5. demonstrate the effects of slow and fast cooling on crystal size.
6. demonstrate the use of a stream table.
7. demonstrate the process of changing snow to ice.
8. identify the areas on earth where specific forces operate the most.
9. identify the economically important rocks and list their uses.
10. describe the changing of one rock type into another until all three rock types have been included in the cycle.

Unit Outline

I. Control group is presented with the placebo story. Treatment group is presented with the advance organizer.

II. Both groups are given samples of rocks from all three divisions (igneous, sedimentary, metamorphic). The sample to be examined descriptively are:
   Igneous: granit, obsidian, pumice, basalt
   Sedimentary: sandstone, shale, conglomerate, salt
   Metamorphic: slate, gneiss, schist, marble

III. Forces that operate within the earth are defined. The effect of these forces on rock is investigated experimentally by the students.

Heat and cooling--investigated by growi crystals in different temperatures.
Erosion--investigated by use of a strea table.
Deposition--investigated by the crystal growing experiment with super-saturated solutions.
Heat and pressure--investigated by compressing snow into ice.

IV. Location of the forces on and within the earth is investigated.
Maps are made of the areas of volcanism, earthquakes, high percipitation, ancient seas and recent and/or continuing deposition.
The order with which these forces have operated within an area is marked on the maps as well as the areas of overlap between current forces.

V. Economic uses of the rocks; research in the library will correlate the uses of the rocks in our society with their physical and chemical characteristics. The specific rocks to be used are those presented in the sample and any additional ones that the student can find within the allotted time.

Time Frame for Unit

Section I = 1/2 period

Section II = 2 1/2 periods

Section III = 4 periods

Section IV = 2 periods

Section V = 2 periods

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