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A STUDY OF THE EFFECT OF TEACHING AND EXPECTANCY TO TEACH UPON THE COGNITIVE LEARNING OF THE TEACHER

Dissertation for the Degree of Ph. D.
MICHIGAN STATE UNIVERSITY
BARRY DUANE BRATTON
1975

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ABSTRACT

A STUDY OF THE EFFECT OF TEACHING AND EXPECTANCY TO TEACH UPON THE COGNITIVE LEARNING OF THE TEACHER

By

Barry Duane Bratton

The purpose of the study was to test the hypothesis that teaching is a beneficial learning activity for the teacher. In essence, the oft-quoted axiom, "If you really want to learn something, teach it." was tested. A review of the literature revealed that while few efforts had been made to investigate the axiom it is used widely to justify such educational practices as tutorial, learning cell, peer-mediate-instruction and other related activities involving students in the teacher role.

Two hypotheses were developed and tested in the study: (1) subjects who study materials which they expect to teach to others will learn more than subjects who study the same materials an equivalent amount of time in preparation for a test and (2) subjects who study with the expectation of teaching and who in fact do teach the materials to a peer will learn more than subjects who study the same materials an equivalent amount of time in order to take a test.

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Three related questions were included in the study: (1) How well do the students who are taught by the "teachers" learn the content compared to subjects who study privately the same material an equivalent amount of time? (2) Is there a difference in learning achievement for subjects who study expecting to teach but do not and subjects who study expecting to teach and do teach? and (3) Will differences emerge among experimental groups on an achievement test which reflects the levels of a cognitive learning taxonomy?

Two experiments were conducted in the study, the only variation being the use of different population samples. The 82 volunteer subjects in Experiment I were university graduate students with classroom teaching experience while the 84 volunteer subjects in Experiment II were community college students with no classroom teaching experience.

In each experiment subjects (Ss) were randomly divided into six groups: Teach, Anticipate Teach, Study Once, Study Twice, Receive and Control. Ss in both the Teach and Anticipate Teach groups studied assigned materials in preparation to teach the contents to a peer. At the conclusion of the study period the Anticipate Teach Ss were given a post-test while the Teach Ss taught the material to the Receive Ss. Both the Teach and Receive Ss we

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were then tested. Ss in both the Study Once and Study Twice groups studied the same material an equivalent amount of time as the above groups but with the expectation of being tested on the content. After the study period, the Study Once group was tested while the Study Twice group was permitted to re-study the materials for a time period equivalent to that consumed by the Teach Ss while teaching. The Study Twice Ss were then administered the post-test. The Control group took only the post-test.

Both experiments included the six groups of Ss and two types of instructional reading materials to produce a 2 x 6 factorial design. Post-test scores from Experiment I were subject to an analysis of variance statistical test for group differences while a covariate measure in Experiment II allowed the use of analysis of covariance procedures.

The major findings of the study failed to support either hypothesis. There was no significant difference in the post-test scores of the Anticipate Teach compared to the Study Once group or between the Teach group and the Study Twice group in both experiments.

With regard to the three related questions: (1) Ss in the Receive group achieved scores not significantly different from those of the Study Once group; (2) There was no significant difference in the scores of the Teach ar

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and Anticipate Teach groups; and (3) No significant differences among the groups were uncovered on test items at the several levels of the learning taxonomy.

The following general conclusions were reached:

1. The act of teaching, whereby one individual overtly instructs another by verbal interaction, does not appear to enhance the learning of the teacher beyond that attained by study over an equivalent time period in preparation for an examination. The axiom that teaching necessarily benefits the teacher appears suspect under controlled preparation time conditions.
2. Studying new material under the expectation of teaching it to another individual also apparently does not significantly increase learning beyond that attained by study over an equivalent period of time in preparation for an examination.
3. Individuals who are taught in dyadic learning environments seemingly learn as much from their peer teachers as they do from studying the material directly.
4. The amount of time spent studying in preparation to teach may be an important variable in determining how much the teacher learns.

The study concluded with some specific recommendations for educators and researchers based upon the present experiments and selected related studies.

A STUDY OF THE EFFECT OF TEACHING AND EXPECTANCY TO TEACH UPON THE COGNITIVE LEARNING OF THE TEACHER

by

Barry Duane Bratton

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Instructional Development and Technology

College of Education

1975

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BARRY DUANE BRATTON

1975

DEDICATION

To my parents

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ACKNOWLEDGMENTS

The author owes more debts of gratitude than he can every repay to those who unselfishly gave their time and energies to assist in the completion of this study:

To members of the Guidance Committee: Dr. Erling Jorgensen, Chairman, Dr. Lawrence Alexander, Dr. Kent Gustafson and Dr. Henry Kennedy. A special note of gratitude to Dr. Alexander who served as Dissertation Advisor;

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CHAPTER I

STATEMENT OF THE PROBLEM

Introduction

The purpose of the study was to determine the ffects, if any, of teaching or the expectancy to teach pon learning of the material taught. Specifically, the tudy measured the performance of students on a written xamination after they had (1) studied a written passage th the expectation of teaching the content to a peer,) studied and taught to a peer the content of the same itten passage, or (3) studied the passage with the pectation of taking a written examination on the ntent.

Gagne and Rohwer (1969) cite the commonly held lief that a good way to learn material is to teach it. lis in Gagne and Gephart (1968) postulate that teaching y aid in the learning of a subsequent related skill or sk. Testing Ellis' hypothesis, Long (1971) reports that aching enhanced the transfer learning of a paired-sociate task. The idea that teaching may generally cilitate learning has been discussed by Bruner (1965). fact, a plethora of authors ascribe to the notion that learning of an individual is enhanced by that

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ividual teaching what he has learned (Wayne, 1956; der, 1967; Johnson, 1969; Bugelski, 1971; Postman and ngartner, 1971; Allen and Feldman, 1972; Glavin, 1974).

In spite of the bountiful references in the erature suggesting the positive effects of teaching on teacher's learning, little experimentation has been ied out to test the assumption. The present study, in nce, was a controlled experiment to determine if ents who "teach" other students learn more than peer ents who study in a more traditional manner.

Importance of the Study

While the study is presented above in terms of an rimental paradigm, its raison d'etre and the findings result have important practical considerations for ation.

It is apparent that education today is in a period trenchment (Group for Human Development in Higher tion, 1974). It is beset by financial troubles ng from general economic inflation to tax revolts by itizens from whom support is needed. At the same the number of students is declining. This is due in to a lowering percentage of the school-age population, specifically for higher education institutions, fewer rs of students are choosing to attend college. The for the declining enrollments, especially in higher

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ucation, may be due to the general economic recession or may simply be that more students are questioning the lue of spending four years in college. The problem is rther compounded by the fact a new type of student is tering higher education. Cross (1971) describes these udents as those scoring in the lowest third among tional samples on academic achievement tests and many ving "failure-threatened personalities." These students ll require different instructional methods to accommodate eir idiosyncratic learning needs.

Thus, educators face the dilemma of upgrading or proving their present instructional programs with fewer ources at their disposal. Add to this the cry for more ividualization of instruction and the situation looks ak indeed. Educational institutions must search for ricular options which (1) do not draw heavily on sting programs or resources, (2) can be demonstrably cessful in helping students learn, and (3) attract dents by offering the individual more control over his rning.

A resource for developing options which meet these delines already exists in all educational institutions if often overlooked. This resource is students. loping effective, validated instructional procedures eby students become centrally involved in the

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:eaching-learning process should be a serious considera-
:ion of educators. This study was an attempt to examine
he efficacy of active student participation in one aspect
f this process.

Another important element of the study was that
t focused on an axiom which many educators have quoted
ıt few have paused to test. The axiom, stated in one
ɔrm, is "If you really want to learn something, teach
:." In essence, the assumption is made that teaching
ıhances the learning of the teacher.

Goldschmid (1971), Schmerhorn (1972) and Donahue
974) each cite a form of the axiom as a rationale for
e learning cell--a technique whereby students teach and
arn from each other as they study in dyads. Thelen
968) and Gartner, Kohler and Riessman (1971), advocates
the tutorial model of instruction, argue that one
ason for the success of tutorials is the positive effect
teaching on the tutor. Rosenbaum (1973) supports the
ıcept of peer-mediated instruction--another type of
ıdic learning environment--by the generalization,
ıere is no better way to learn something than to teach
(p. 149).

The gist of the present study was an empirical
t of this axiom. If the results were positive, those
cational practices mentioned above would be given a

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ound basis for their existence and additional methods of
aking practical use of the findings might become evident.
onversely, negative findings would suggest a fallacy in
he axiom and undermine the arguments of those who would
ake use of it to support a particular instructional
trategy or program.

Theories Underlying the Study

A substantial mass of research evidence now
ists to support the contention that active participation
the part of the learner is a key ingredient to improve
arning (Davis, Alexander and Yelon, 1974). Convinced
the critical importance of active learner involvement,
thkopf (1973) suggests that instructional designers
ould treat instructional materials as givens and concen-
ate their energies on promoting those activities in the
udent that will allow him to achieve instructional goals
th available materials (Rothkopf, 1970). Rothkopf (1973)
ates:

> Rational improvement in instruction can be approached not only through the systematic design of instructional products and instructional methods but also through the enlightened creation of instructional environments that are designed to foster effective learning activities. (p. 126)

Rothkopf (1970) believes this is truly a student-
tered approach to learning (p. 334). According to
erson (1970), "The trick is to arrange a task that

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equires full processing from the learner" (p. 364).

Ausubel and Robinson (1969) say that a large part f the learner's time in school is spent in reception earning, i.e., that the learner's task is to incorporate aterial given to him in expository fashion into his gnitive structure in order for it to be available for ter reproduction, related learning or problem solving. ey write:

> The main danger in meaningful reception learning is not so much that the learner will knowingly adopt a rote approach, but rather that he will delude himself into believing that he has really grasped precise intended meanings when he has grasped only a vague and confused set of empty verbalisms . . . A central task of pedagogy, therefore, is to develop ways of facilitating an active variety of reception learning characterized by an independent and critical approach to the understanding of subject matter. This involves, in part, the encouragement of motivations for and self-critical attitudes toward acquiring precise and integrated meanings, as well as the use of other techniques directed toward the same end. (p. 101)

If one accepts for purposes of the present study efinition of teaching as the transmission of meaningful ormation from a source (teacher) to a receiver (student) n the intent of instructing the receiver, then one can ue that by teaching or expecting to teach an individual orced to actively process the material and that it is active processing that enhances learning. However, e are numerous ways a student may actively process to-be-

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-be-learned material without being in the teaching role. npleting a programmed text or responding to questions serted in the material are examples of situations where student must actively process the information. Simple :balization is also an active process.

Johnson (1972), however, hypothesizes that . . learning is more efficient when the learner puts relevant information into words for communication to ers . . ." (p. 204). The key phrase seems to be "for munication to others." The learning effect may arise m the fact that another human is also involved in the cess and that the subject in the teacher role must pare differently prior to and act differently during encounter than the student he teaches.

Allen and Feldman (1972) support his argument:

> Successful enactment of the role of a teacher (or tutor) requires that a person engage in a behavior clearly distinguishable from the behavior of a person enacting the role of a student (or tutee). First, it is necessary for a teacher to adopt a completely different point of view from that taken by a student. It is thus likely that a restructuring and reorganizing of the material to be taught will occur when a person enacts the role of teacher. (p. 1)

However, an attempt by Allen and Feldman (1972) to over any "restructuring and reorganizing of the rial" failed when the recall responses of subjects ng as teachers were compared to the responses of students

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ıdents who studied alone. It should be noted that the ee-recall test was administered to the teachers prior the actual teaching; no comparable measures were en after the teaching act had occurred.

A theoretical position advanced by Flavell (1968) aks to the issue of the effect different roles might y in <u>increasing</u> the active processing of information. ply put, Flavell postulates at least two types of munication: egocentric and non-egocentric. The lowing extended description is taken from Flavell 58, pp. 8-9):

<u>Egocentric Communication</u>

1. S (speaker) cognizes X (data) and covertly codes them so that they are meaningful and "communicable" to himself.

2. S sends L (listener) a message about X. The message is in all important respects unrecoded, that is, it is essentially a simple externalization without modification of his private coding and is hence an egocentric communication (see Figure 1).

Figure 1. Schema of egocentric communication.

<u>Nonegocentric Communication</u>

1. S cognizes X and covertly codes them for himself, just as in step 1 above.

2. Prior to and/or during his communication to L (step 3 below), S attempts to discriminate those role attributes of L which appear to be pertinent to L's ability to decode the communicative input regarding X.

3. S recodes X and externalizes it as a message to L about X. This recoding-and-externalization process occurs under the aegis of two concurrent (and related) activities: (a) S uses the information gained in step 2 to

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shape and fashion the message in such a way as to maximize the likelihood that it will meet L's communicative needs; (b) S actively suppresses the insistent and recurring tendency to allow his message to drift or "regress" toward the initial coding of step 1 (the egocentric error), a tendency which exists by virtue of the fact that this initial coding is both continuously and intrusively present in S's consciousness and, by definition, is communicatively adequate for him, that is, communicatively satisfying from his point of view (see Figure 2).

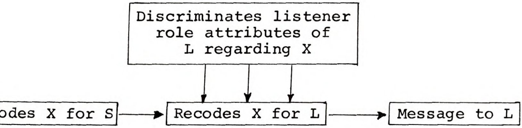

Figure 2. Schema of nonegocentric communication.

Flavell acknowledges that the major components of n type of communication most likely do not occur in a gle, fixed sequence, but, rather, alternate and inter-ve in diverse ways throughout the course of the entire nunicative act. Flavell speculates further about the .ons of a nonegocentric communicator:

> For instance, after a part of the message has already been sent, the speaker may return to the data, code some hitherto unnoticed aspect, recode it, perhaps reject that recoding on the basis of a further look at the listener's role attributes, recode again, externalize this recoding as a new addition to the message, return again to the data, etc., etc. (p. 10)

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Flavell, who says his schematization applies
marily to oral communication, believes that the
crimination of role attributes is not an end in itself:

> The discrimination of role attributes is normally an initial instrumental act within a (larger) context, a first step in a chain of events directed toward some ulterior goal. Thus, we discriminate another's role attributes, not for its own sake, but for some reason, and what we do next with the information so obtained will depend upon what that reason was. (p. 6)

The receiver does not have to be physically present
the sender to go through the recoding process, accord-
to Flavell:

> He (the sender) may rehearse . . . anticipated interchanges with others, mentally recoding when an imagined interlocutor fails to understand . . . covertly readjusting his actions in the face of new behavior by an imagined other occupying some complementary role, etc. (p. 23)

In summary, Flavell's argument rests on the notion
by engaging in communication with another or anticipa-
such communication the sender, for example, a
er, must "put himself in the receiver's shoes"
requires covert cognitive processing different
the processing which occurs if the sender does not
t such communication to occur.

Moore and Anderson (1969), in a discussion of
ning learning environments, advance a theoretical
iple which supports Flavell. Labeled the perspectives
iple, it states that "one environment is more

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onducive to learning than another if it both permits and
acilitates the taking of more perspectives toward whatever
s to be learned" (p. 586).

The theoretical argument being presented suggests
nat individuals in the teaching role are in a more
onducive educational environment because to carry out the
ole they must engage in non-egocentric communication
equiring multiple perspectives toward the information to
presented. This is not to say that students studying
the "traditional" way cannot learn as well as students
o may teach. As Rosenbaum (1973) asserts, the terms
eacher" and "Student" when employed in the context of
e teacher-student role have merely procedural signifi-
nce and the activities each engages in while in this
le can lead to learning for both (p. 64).

Based on the above theoretical perspectives, the
esent study investigated the degree of learning
ieved by students who taught other students, by
dents who were taught by peers and by students who
died alone. It was hypothesized that students in the
cher role would demonstrate greater achievement than
dents in the other groups.

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Hypotheses and Questions

The preceding discussion generated the following

o hypotheses. These hypotheses, stated in statis-

cally testable form, appear in Chapter III.

: Subjects who study meaningful written material with the expectation of teaching it to a peer will have a significantly higher mean post-test score than subjects who study the same material over an equivalent period of time with the expectation of taking an examination.

Subjects who study meaningful written material with the expectation of teaching it to a peer and, in fact, teach it will have a significantly higher mean post-test score than subjects who study the same material over an equivalent period of time with the expectation of taking a written examination.

The data resulting from the study were also

mined in an effort to collect preliminary information

several related questions:

How well do the subjects who serve as Receivers in the study, that is, who are taught, learn the material?

The learning achievement of the Receivers is

nane if the instructional strategy of students teaching

er students is to have practical value. To determine

Receivers' achievement, test scores from this group

compared to the results achieved by students who

ied alone an equivalent period of time.

Is there a significant difference in the amount of learning gained by subjects who expect to teach but are instead given a test and subjects who are tested after they teach?

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Unlike Q_1 above which addresses a practical
ern, this question is oriented toward a theoretical
nt to parcel out two possible sources of the effect:
study preparation undertaken in anticipating to teach
us the interaction between the teacher and student
ng the teaching process. No research was uncovered
he literature review which directly examined this
tion.

Do subjects in the teacher role who are tested before they teach, others in the same role who are tested after they teach and subjects who study alone in preparation for an examination score differently on subtests within the overall post-test where each subtest elicits responses reflecting a type of taxonomic learning?

It was felt that if a "recoding" or "restructuring
organizing" of the material occurs as suggested by
ll (1968) and Allen and Feldman (1972) the effect
ppear as differentiated responses to test items
ring higher-order cognitive processes.

Summary

The foregoing sections have attempted to provide
d overview of the study. It was pointed out that
a number of authors support the position that
ng is a means of enhancing the learning of the
r little research is reported in the literature
g the assumption. A case for the importance of the

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' was made in terms of more effective utilization of
:ing resources (students). A theoretical position
ıdvanced which draws from a number of cognitive
ologists; the position, developed from Flavell
) and Moore and Anderson (1969), postulated that
iduals in the teaching role learn better because they
multiple perspectives toward the to-be-learned
ial and subsequently cognitively process it in a
on different than persons in the student role.
ly, several hypotheses and questions were developed
e foci of the study.

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CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

This chapter is devoted to a critical review of hed literature relevant to the topic under inves- on. It should be noted that only a few studies ocated which explicitly examined the effect of ng on the teacher's learning. However, studies eral related areas were uncovered which provided ct but relevant information. The pertinent ch is reported below under four headings: (1) of teaching on learning, (2) effect of expectancy h on learning, (3) effect of tutoring on learning other relevant research.

The Effect of Teaching on Learning

Four research reports were located which gated directly the effect of teaching upon the g of the teacher.

Moody, Bausell and Crouse Study

Moody, Bausell and Crouse (1974), using college n and sophomores attending a required elementary ics course, formed the subjects into groups of four

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Thirty-eight (matched pair) groups resulted. One
ct (S) from each group was randomly selected to serve
e teacher of that group; the remaining Ss were
ned by default as the students. All Ss were given
o-be-learned materials prior to the experiment, told
udy them and informed that they would be later
d on them. In one-half of the groups, the Ss were
in advance whether they would be teachers or
nts during the two periods of instruction; in the
half, Ss were informed their roles would be assigned
start of each period of instruction.

Results showed that Ss who knew in advance they
oing to teach studied the material for a longer
of preparation time and learned more than Ss who
n advance they were going to be students; Ss who
t know in advance they were going to teach neither
d more nor learned more than Ss who also did not
n advance that they were not going to teach.

ations and Criticisms:

"substantive" mortality rate of subjects during
e experiment may have tempered the results.
operational definition of teaching was not given
the experimenters. The report stated only that,
eachers were told that they could not relegate

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eir teaching responsibilities to their students, and
at they should answer all questions themselves,
liciting help from other students only when they were
mpletely ignorant of the answer." It may be inferred
at the teacher-subjects acted as discussion leaders
ile the members of the groups discussed the material
ey had been directed to study. Unlike the present
udy, the teachers were apparently not in a position
communicate to the students information which the
udents did not already know.

e study results suggest that more study time in
eparation for teaching may account for the increased
arning of the teacher rather than the pedagogical
teraction between the teacher and his student.

e experimental materials (a unit on mathematics)
l the environment (traditional classroom) were more
al-world" oriented than laboratory-centered.

subjects, students in a college course taught
the experimenters, were told prior to the experi-
t that their performance would not affect their
al course grade.

subjects participated during the same two-day
iod.

n discussion group was acoustically independent.

dependent variables were (a) amount of study time

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and (b) subjects' scores on an experimenter-constructed test of the content material.

Allen and Feldman Study

Allen and Feldman (1972) measured content gnition and recall of meaningful prose material of r-achieving fifth grade Ss who taught the material hird grade Ss (Experimental Condition) compared to Ss who studied the same material alone (Study-Alone tion). Subjects in both conditions studied the rials each day for 8 minutes, received a three-e, free-recall test and then either taught the n to a student or studied alone for 20 minutes. cts in the teacher role were given freedom to ize their tutoring sessions. In all, ten lessons used over ten consecutive weekdays.

Standardized scores on immediate post-tests, sting of multiple-choice, fill-in and matching ions related to the lesson content, showed the ers' performance was somewhat better (though not ficantly so) than Ss who studied alone. The results e experiment were equivocal. While in the first on studying alone produced better results than ng, the difference reversed direction over the two-time period so that in the last two sessions the

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rimental Condition was superior to the Study-Alone ition. Analysis of the free-recall test data failed iscern any significant differences in cognitive nization of the material.

rvations and Criticisms:

The act of teaching was not explicitly described by the experimenters. At one point the authors wrote, 'Subjects were given complete freedom in organizing their tutoring session." Later, it is reported that, "The tutor was required to administer short exercises and questions to the tutee during the ession, and the tutor had answer sheets in his ossession." It remains to the reader to infer if, s in the case of the studies reported by Long (1971) nd Myers, Travers and Sanford (1965), the teacher erely managed the tutee's activities by giving im the materials to study and supplying appropriate eedback with a minimum of verbal exchange or, as in he present study, the tutors engaged in substantial erbal interaction with the tutee to impart to him formation known by the tutor as a result of having reviously studied the material.

e results seem to indicate that as the tutors quired more practice in teaching they became

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increasingly successful in mastering the material they taught.

By controlling study preparation time (8 minutes) as well as teaching time (20 minutes) for all groups, the experimenters suggested that the interaction between teacher and student may be a critical variable.

While the experimental materials (lessons on science, language arts and reading) were adopted from texts and workbooks designed for the third- and fourth-grade levels, the experiment was carried out in a quasi-laboratory setting.

It is inferred from the published description of the study that the tutor-tutee sessions were acoustically independent.

The tutor subjects were paid volunteers who had been identified by their school principals and recruited by mail.

The dependent variable was the subjects' answers to multiple-choice, matching and completion items testing the recall of the content material. A dependent variable of secondary interest was the responses to an open-ended free recall test of the subjects' cognitive organization and structure of the material.

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Myers, Travers and Sanford Study

Myers, Travers and Sanford (1965) investigated amount of recall for upper elementary students who ght peer students English-German equivalent words. S in the teacher role presented an index card with a nan word and two English responses to his student. The cher pronounced the German word, asked the student to which English word he thought was correct, and then onded with the right answer. A total of 60 items were ented four times on three successive days. The stigators found that on immediate and delayed reten- tests calling for recognition of the English valent from four choices the teachers performed less ctively than either their students or subjects who had ied the words alone.

rvations and Criticisms:

Teaching, as described by these experimenters, did not permit extensive verbal interaction between the teacher and student. In the study, the information to be learned by the student was contained on index cards; the teacher merely exposed the card, presented orally the information and acknowledged the student's response with appropriate feedback.

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he teacher was told prior to the start of the experiment that he was expected to learn the material long with his pupil.

he experimental situation was more laboratory-riented than classroom-centered. The materials ere English-German equivalent words, similar to a aired-associate learning task.

our pairs of subjects were seated at one table uring the course of the experiment. Each pair ember faced one another across the table with all yads within a few feet of another. Thus, each air did not work independently and may have been nfluenced by the other groups at the table.

e dependent variable was the subjects' responses a multiple-choice test requiring recognition of e English equivalent of German words.

Long Study

Long (1970) measured the amount of transfer e students demonstrated in learning new paired-ate lists after they had taught similar lists to students. The act of teaching required the mental subject (teacher) to present four sets of ulus cards three times to another student. On the round of presentations the teacher showed the stude

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t the side of an index card containing the stimulus nd then turned it over to show the pair of words. second and third presentations the teacher rmed the same task; in addition, he said the pair of to the student. Comparing the teacher's ability call such lists prior to teaching and after teaching number of control conditions, Long concluded that reatment had a beneficial effect on subsequent ing.

vations and Criticisms:

imilar to the Myers, Travers and Sanford (1965) xperiment, the teachers in this study engaged in ttle verbal interaction with the students. The nformation to be learned by the student was ntained on index cards; the teacher merely exposed e card, presented orally the information and knowledged the student's response with appropriate edback. Unlike the present study, the teachers d not enter into extensive verbal communication teach the student information possessed by the acher.

e experiment was conducted in a laboratory-setting opposed to a classroom environment. The materials be learned were experimenter-generated paired-ociate learning lists.

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he dependent variable was the subjects' ability to earn and recall lists of paired-associate words imilar to those taught.

The Effect of Expectancy to Teach on Learning

Three published reports were uncovered which ned the effect of expectancy to teach upon the ing of the teacher.

Hillier, Deichmann and Pirkle Study

illier, Deichmann and Pirkle (1973) reported the ts of two experiments which demonstrated that tancy to teach did not significantly enhance ing for Ss beyond that gained by Ss who studied ting to be tested. In Experiment 1, all Ss, graduate females in a university introductory ology class, listened to an audiotape recorded n; one-half of the Ss expected to be tested and to the lesson to two peers while the other half ted only to be tested. Experiment 2 replicated the except that all Ss read the lesson and increased ives were announced by the investigators to those expected to teach. They were told that (a) their ng performance would be taped for review by a large ce and (b) their performance would be evaluated and, if

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f satisfactory, would add points to their class
Test results from both experiments failed to show
ificant difference in learning between the two
s.

vations and Criticisms:

may be argued that the incentive to pass the test emained stronger than the incentive to teach for the xperimental Ss due to the nature of the instructions iven. The four points of the instructions were (a) isten to (or read) the material, (b) take the test, c) prepare a lecture on the material and (d) ollowing the preparation period the experimenter ill select at random one-third of the Ss to teach ne remaining two-thirds and E. Inclusion of the est requirement before the act of lecture preparaion and teaching may have negated the incentive of pectancy to teach. Each S would surely realize at he definitely would be tested but there was a 6 probability he would not be selected to teach. us, the Ss may have studied only to meet the most mediate and likely task, that is, pass the test. e teaching task, as described by the instructions, quired Ss to prepare to lecture to peer Ss and the erimenter who were already familiar with the cont

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ontent. Thus, Ss did not anticipate engaging in
erbal interaction with their students to insure
hat the students learned material.
t is inferred from the published report that the
tudy was conducted in a quasi-laboratory environ-
ent and made use of traditional classroom materials,
imilar to the Allen and Feldman (1972) experiment.
ll Ss participated in the study to fulfill a
niversity course requirement.
he dependent variable was the responses on a 60-
tem multiple-choice test based on material
eveloped by Kropp and Stoker (1966).

Reynolds Study

Reynolds (1968) hypothesized that the expectation
ansmit knowledge may reduce the capacity of an
idual to acquire (learn) the material. Subjects,
rsity undergraduate women volunteers, were assigned
of three conditions: Study Alone, Teach a Peer
ch a Child. Subjects in each condition received
ctions for completing a concept attainment task.
h Teach conditions, each S was required to instruct
e individual (a peer or a young child) how to
te the task. Then the S was asked to complete the
sk. Results showed no significant difference

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en the three experimental groups. In addition, no rences were found in the performance of the ers and their students.

vations and Criticisms:

ince each Teach S was tested after he had transmitted he information to his receiver, it may be argued hat Reynolds did not adequately test the hypothesis egarding expectancy--to do so would have required esting after initial learning but prior to trans- ission.

he results of the study seemed to indicate the dual ffects of the expectancy to transmit and the trans- ission did not reduce the teacher's ability to learn he material. The results also indicated students an learn when taught by peer students.

ll Ss were undergraduate women volunteers.

ie act of teaching for this study was one-way verbal ommunication from the transmitter to the receiver. eachers and receivers sat back-to-back during the eaching session. "No visual cues or any verbal terances on the part of the receiver were allowed." us, unlike the present study, no verbal interaction ok place between the teacher and his student.

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A test ceiling effect confounded the study's results. Over half of all the teachers attained maximum scores on the test.

Unlike Hillier, et al (1973), the investigator did not sensitize the teachers to the fact that they would be tested thereby insuring the effect would not be contaminated by an expectancy to be tested.

The experiment was more laboratory-centered than classroom-centered.

The dependent variable was responses to a sorting task requiring concept mastery.

Zajonc Study

Zajonc (1960) hypothesized that Ss who anticipate municating information to others activate different nitive structures than Ss who expect to receive information. To test the hypothesis, the investigator eloped a method for the description of cognitive ictures, and in the experiment persons expecting to ismit information were compared with others expecting receive information for the extent of differentiation, lexity, unity and organization. A total of 45 TC students participated in the experiment. All Ss given a short written passage to read for a predermined period after which the material was collected.

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proximately one-half of the Ss, designated as nsmitters, were then told that they were to communicate information they had just read to naive persons; the er Ss, designated as receivers, were told that they e to listen while other persons related the content the material to them. In reality, however, following se instructions, Zajonc distributed an experimenter-duced instrument to measure the properties of nitive structure. The results showed that "transters activate cognitive structures which are more ferentiated, complex, unified and organized than those ivated by receivers."

ervations and Criticisms:

Unlike the present study, Zajonc did not measure the amount of learning gained by the experimental groups. Each S was designated a transmitter or a receiver only after reading the materials. The Ss were thus unaware of their roles as they initially read the passage, and it is assumed that the cognitive structuring occurred as a result of the experimenter's instructions and was based on their recall of the passage.

The procedures and materials of the study were laboratory-oriented as opposed to classroom-centered.

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;ubjects were volunteer university students. 'he dependent variable was responses on an ›xperimenter-produced measure of cognitive structures.

The Effect of Tutoring on the Tutor

Historically, most tutoring studies have been rned with the impact on the students being tutored. tly, though, a few peer tutoring reports have red which emphasize the learning achievements of utor. Rosenshine and Furst (1969) indicate the need ore research focusing on the tutor:

ithin the current review, we do not have a ection on the effects of tutoring upon tutors ecause we found only two studies which resented hard data. Thus, although we would ave liked to write more about the effects of utoring upon the tutors, there is insufficient vidence for such a review, at present. Introduction)

The two studies focusing on the tutor mentioned by shine and Furst were conducted in 1967 and 1968. rd (1967) randomly selected high school students to elementary students. Alternate forms of the Iowa : Reading Test were used as pre- and post-tests. On re-test both experimental and control Ss were judged able, reading an average of seven months below grade .

After seven months of tutoring, there were icant post-test differences favoring the tutors.

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pressing the difference scores between pre- and post-
sts as grade level equivalents, the control Ss showed a
an growth of 1.7 years; the experimental Ss (tutors)
ined 3.4 years. Cloward suggested that "a substantial
rtion of the increase for both groups was due to their
creased familiarity with the complex directions for
king (the alternate form of) the test" (p. 22). A high
trition rate of Ss in both experimental and control
oups also limited the generalizability of the study's
sults.

Werth (1968) used 32 high school seniors to tutor
freshmen and a control group of the same number of
iors and freshmen not engaged in any tutoring
ivities. All Ss were given standardized reading tests
pre- and post-test measures. The results showed no
nificant difference between experimental and control
ors in the improvement of reading comprehension,
guage usage or spelling skills.

Four other reports which focus on tutors were
reviewed by Rosenshine and Furst; in each case,
ever, either no control Ss were used or objective data
not reported. For the most part, subjective and
dotal data were used to support the outcomes.

Rosenshine and Furst concluded three issues
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ıdies. One, the existence of strong community pressure the tutorial program to succeed restricted the ıeralizability of the results. Two, the age-equivalency ›res on the standardized tests were difficult to inter-ɛt. Three, the study by Werth suggested that practice :hout tutoring may be as effective as tutoring itself. ·th reported control Ss who studied the tutoring erials made gains equivalent to the tutors' who both died and taught the materials.

Dillner (1971) cited a number of studies related cross-age tutoring and its effect upon the tutor. The lowing are among the studies described by Dillner:

Elder (1966) found students who acted as tutors in an after-school study center revealed high motivation toward achievement and a greater understanding of basic subject matter and methods of learning.

Rosner (1970) matched upper elementary students with a like number of lower grade subjects. All participants in the study were considered remedial reading students. After a ten-week program of tutoring mornings and receiving remediation in the afternoon, the tutors gained a year or more on the MacGinite Vocabulary and Comprehension Tests.

McWhorter and Levy (1971) asked high school seniors to tutor lower elementary students with reading p

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problems. As measured by the Phonics Test for Teachers, the tutors gained 2.4 years in one semester.

Burrow (1970) found that pupils who tutored showed no significant achievement in arithmetical computational skills over students who did not tutor.

Rust (1961) compared the academic achievement of low-achieving, disruptive, unpopular sixth graders who served as tutors to third graders against matched peers who studied alone. The results indicated a statistically significant difference in achievement scores for the tutor group.

Rosenshine and Furst (1969) speculated why there een little controlled research on tutoring:

> he selection of experimental and control groups s a difficult procedure, and many teachers and utors are reluctant to deprive a pupil who pparently needs tutoring of that additional nstruction by placing him in a control group. n addition, the problems of administering pre- nd post-tests are wearisome and testing takes class time. Finally, controlled objective esting appears unnecessary to many in view of the verwhelmingly favorable reports given both by the tors and the teachers involved in tutoring ograms. (p. 3)

Observations and Criticisms

arly all tutoring studies have taken place in a assroom setting under less than ideal conditions

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for controlling the multitude of factors which may affect the results.

The data reported in the majority of studies were anecdotal observations as opposed to objective results of empirical investigations. The question arises whether the reported learning achievements were produced solely by the tutoring experience. In addition, the reports did not attempt to identify the source of the observed effect. For example, can the effect be traced to the study time used by the tutors in preparation to tutor, or to the verbal exchanges between the tutor and tutee, or both, or some unidentified factor(s)?

When objective data were gathered, student scores on standardized tests were often the means of measuring the cognitive growth of tutors.

from the few empirical investigations which were reported, the effect of teaching on the tutor appears to be positive but the results are inconclusive. Werth's study, for example, suggested that the ncreased learning may be a result of simply spending dditional time studying the material.

oticeable by its absence was a theoretical orientation o explain why tutors gain from the tutoring xperience.

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Other Relevant Research

Several studies in the area of verbalization
e germane to the present study. Much of the research
the "effects of verbalization" is concerned with the
fect of requiring experimental subjects to give reasons
r what they do or to state general rules abstracted
om the task (Hallgren, 1974).

Gagne and Smith (1962) required Ss to state a
ason for each move when solving a puzzle; other Ss were
t asked to verbalize their moves. On a transfer
oblem during which no Ss were required to verbalize,
ose who had previously stated reasons performed better
terms of fewer unnecessary moves and faster solution
es. At the end of the experiment, all Ss were asked to
te a rule about how such problems should be solved,
their answers were judged for adequacy. Ss who had
n required to verbalize during training generally
e better answers than those who had not verbalized.

Gagne and Smith suggested that Ss who had been
uired to give reasons for moves were more likely to
lyze the problem and try to find "good reasons," and,
sequently, were more likely to discover the general
nciples which could be used for maximally efficient
formance. They concluded:

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It would appear that requiring verbalization somehow "forced the subjects to think." In other words, this treatment may have had the effect of constantly prodding the Ss to think of new reasons for their moves, particularly since they may have gotten tired of using the same reasons over and over again. (p. 17)

A study by Davis et al (1968) replicated and firmed the investigation of Gagne and Smith. Ervin 0) also found that verbalization aided subjects when were called upon to perform a transfer task.

While the above experiments are examples of basic hological research, several applied studies on verbalion have been carried out. A study of mastery learning heppard and McDermot (1970) asked students to partici- in an interview either with the instructor or ner student who had already demonstrated mastery. ng the inverview the student had to describe fluently naterial he was studying. The students also received odic written quizzes which were immediately reviewed discussed with the student. Compared with a control , the experimental group did significantly better on jective final evaluation. Similar results were ned by McMichael and Corey (1969) and Keller (1968).

Davis (1970) offered the following explanation for uccess of the experimental subjects in the Sheppard cDermot study:

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As individuals, they are required to generate sentences using newly learned concepts and principles. This means that the new concepts and principles must be integrated into the long term (memory) store, and that students must have encoded and transformed the messages contained in the text. (p. 25)

Research on the learning cell--a term coined by dschmid (1971) to describe a peer-assisted learning ironment--also provided some relevant information. learning cell is described as "a dyadic unit in which ners mutually teach and learn from each other" xander et al, 1973, p. 1). Goldschmid (1970) ared the learning cell to three other instructional ons--seminar, independent study and discussion ps. Although there were no differences between groups he final examination, the findings did indicate that students in the learning cell group performed ificantly better on an unannounced essay exam nistered at the end of the course" (p. 4).

Schmerhorn (1972) studied the use of learning s with elementary, junior high and college students. researcher reported significant post-test gains ared to pre-test scores.

Alexander, Gur, Gur and Patterson (1973) ared students in learning cells to individual learners rforming a problem-solving task. Students in the learni

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rning cells scored higher on the criterion task than
dents who studied alone.

Observations and Criticisms

The basic research on verbalization requires the S to verbalize as he learns. Verbalization is assumed to affect initial learning.

The applied studies on verbalization ask the S to verbalize the material after he has initially learned it. Verbalization in these instances is assumed to reinforce initial learning.

Studies to date on the learning cell are few and exploratory. The dynamics and underlying factors are not yet well understood. The descriptive literature and exploratory studies, though, suggest further study may be warranted.

Discussion

The preceding review of published literature demon-
ted the varied approaches past investigators have
n toward studying the effect of teaching on learning.
e ranged from the highly controlled experimental
ing (Zajonc, 1960) to anecdotal reports of
ructional classroom programs (Rosenshine and Furst,
. The studies reflected a wide disparity in student
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evaluative procedures. As might be expected, there little consensus among the results reported.

The literature review, however, alerted the earcher to several factors to be considered in the ign of the present study:

Interaction Between Teacher and Student--In a number of previous studies the interaction between the teacher and student was limited by the situational task devised by the experimenter. In some instances, the teacher only presented cards on which the to-be-learned material was printed; in others, the teacher acted as a discussion leader with peers who had previously studied the material. In the present study, however, the task required verbal interaction between the teacher who had studied in preparation to teach and a naive peer who expected to be tested after the session. Subjects in the teacher role were constrained to presenting the information verbally and subjects in the student role were encouraged to ask questions. Unlike some previous studies, subjects in the student role were not permitted access to the to-be-learned material prior to the dyadic encounter. It was thus assumed that the teachers were verbally transmitting information to the students for the pu

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purpose of instruction--an activity consistent with the operational definition of teaching presented in Chapter I.

Instructions to Subjects--In a previously cited study instructions to the experimental (teacher) subjects may have influenced their behavior away from teaching. In the present study, instructions to each group were carefully prepared to insure that the subjects engaged in the desired activity. Teachers were blinded to the fact that they would be tested on the content of the material they were teaching but were told that their students would be tested. The students also were told they would be given an examination on the content. The potential contaminating variable of accoustical independence among teacher-student dyads, noted in a previous study, was also taken into account.

Study Time--Several experimenters noted the effect of study time on the results obtained. Werth (1968) concluded that practice or additional study time may be as important as teaching. Allen and Feldman (1972) controlled the amount of study time for both experimental and control groups and achieved equivocal results. Moody, Bausell and Crouse (1974) said that subjects who taught learned more but that they also

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studied longer. They further suggested that students expecting to teach may be motivated to spend more time in study preparation and noted that the amount and quality of learning have been shown to be positive monotonic functions of study time (Carroll, 1963; Sjogren, 1967). In the present study, study time was a controlled independent variable for subjects in all conditions.

Achievement Measures--All studies cited in this chapter used paper-and-pencil tests of learner achievement. In the majority of cases the examinations tested the learner's recall and recognition skills. Both the Allen and Feldman report and the Zajonc study examined the higher-order cognitive process. In light of the theoretical position postulated in Chapter I, the present study also employed achievement measures to investigate higher-order learning skills such as comprehension, synthesis and critical evaluation.

Summary

The chapter contained a review of the relevant ished literature relating to the effect of teaching expectancy to teach upon the learning of the teacher. a dearth of studies exists on this topic, those were reported demonstrated various approaches and proce

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ocedures. No conclusive evidence emerged to support or fute the hypothesis that teaching enhances the learning the teacher.

In addition to a critical report of each previous vestigation, the chapter also contained a brief scription of some pertinent factors culled from the view which were given attention in the present study.

The design and procedures of the study are scribed in Chapter III while the results are reported in apter IV.

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CHAPTER III

DESIGN OF THE STUDY

Introduction

The following aspects of the study are presented his chapter: hypotheses and questions of interest, rimental design, subject population and sample and rumentation. The procedures are described and ral limitations of the research study are considered.

Statistical Hypotheses

To examine the effects of expectancy to teach and ning upon the learning of the teacher, two statis- l hypotheses were generated for testing. Each null thesis is presented below followed by a directional rnate hypothesis.

No difference will be found between the mean post-test scores of subjects who study with the expectation of teaching (ET) and subjects who study the same material an equivalent amount of time with the expectation of taking an examination (EE).

Symbolically: $\overline{\mu}_{ET} = \overline{\mu}_{EE}$

Subjects who study with the expectation of teaching (ET) will achieve a higher mean post-test score than subjects who study the same material an equivalent amount of time with the expectation of taking an examination (EE).

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Symbolically: $\overline{\mu}_{ET} \geq \overline{\mu}_{EE}$

No difference will be found between the mean post-test scores of subjects who teach (T) and subjects who study the same material an equivalent amount of time in preparation for an examination (EE').

Symbolically: $\overline{\mu}_{T} = \overline{\mu}_{EE'}$

Subjects who teach (T) will achieve a higher mean post-test score than subjects who study the same material an equivalent amount of time in preparation for an examination (EE').

Symbolically: $\overline{\mu}_{T} \geq \overline{\mu}_{EE'}$

Related Questions

In addition to the above hypotheses, three related tions were posed to seek further information about the ct under study.

How well do subjects who serve as Receivers in the study, that is, who are taught, learn the material compared to peers who study alone an equivalent amount of time? The amount of learning achieved by the receiver is germane if the study is to have practical classroom value.

Is there a significant difference in the amount of learning gained by subjects who expect to teach but are instead given a test and subjects who are tested after they teach? The results may shed some light on the interesting question of where in the process of preparing to teach and teaching the learning, if any, occurs.

Is there a significant difference in the achievement of selected groups who take tests which yield scores corresponding to the levels of Bloom's Taxonomy? The four selected groups are (1) those who teach, (2) those who anticipate teaching, (3) those who study for one period and (4) those who study for two periods. It is felt that if a

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"recoding" or "restructuring and reorganizing" of the material occurs as suggested by Flavell (1968) and Allen and Feldman (1972) it may appear as differentiated responses to test items requiring higher-order cognitive processes.

Design of the Study

Two experiments were planned to test the
ɔothesized effects of teaching on learning achievement.
ɜ only planned difference between the two experiments
; the subject populations. Each experiment incorporated
: experimental groups and two materials, producing a
: 6 factorial design as shown in Figure 1.

:roups	Materials M_1 Glaciers	M_2 Lisbon	
G_1 - Teach	7	7	14 Ss
G_2 - Anticipate Teach	7	7	14 Ss
G_3 - Study Once	7	7	14 Ss
G_4 - Study Twice	7	7	14 Ss
G_5 - Receive	7	7	14 Ss
G_6 - Control	7	7	14 Ss
	42 Ss	42 Ss	N=84 Ss

ɪre 1.--Design of the Study.

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Two experimental factors are shown in Figure 1, first being "Groups" and the second being "Materials". six groups in the design refer to the following: :h Group, Anticipate Teach Group, Study Once Group, ly Twice Group, Receive Group and Control Group. The materials refer to reading passages entitled Glaciers Lisbon Earthquake. Each level of "Materials" occurs in each level of "Groups" to produce a completely sed and balanced experiment.

The design, as shown in Figure 1, called for seven ects (Ss) per each group x material cell, producing teen Ss for each experimental group. Such was the in Experiment II with an N of 84. In Experiment I, ver, with an N of 82, only six Ss were assigned to two "Materials" cells in the Control group.

The following diagram shows the sequence of vities occurring during each experiment:

rimental Conditions	Activity 1	2	3
Teach Group (n=14)	Studies	Teaches	Post-test
Anticipate Teach Group (n=14)	Studies	Post-test	---------
Study Once Group (n=14)	Studies	Post-test	---------
Study Twice Group (n=14)	Studies	Studies	Post-test
Control Group n=12 or 14)	Post-test	---------	---------

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A sixth group of Ss, not presented in the diagram of interest in the study, was the Receive Group (n=14). ects in this group did not study the material; rather, received instruction from Ss in the Teach Group.

Subjects in the Teach Group, following the rimenter's directions, studied the assigned material 25 minutes in preparation to teach it to a peer. At conclusion of the time period each S met privately for inutes with a peer (a S from the Receive Group) for purpose of instructing the peer. At the end of this vity both Ss were given a post-test on the material.

Subjects in the Anticipate Teach Group, following ame directions given the Teach Group, studied the ned material for 25 minutes in preparation to teach a peer. At the conclusion of the time period, er, the Ss were given a post-test.

Subjects in the Study Once Group, following the imenter's directions, studied the assigned materials 5 minutes in preparation to take an examination. At onclusion of the time period, the Ss were given a test.

Subjects in the Study Twice Group, following the directions given the Study Once Group, studied the ned material for two 25-minute periods in preparation to tak

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take an examination. At the conclusion of the time iod, the Ss were given a post-test.

Subjects in the Control Group were given only post-test.

Subjects in the Receive Group, as mentioned above, ved as students for Ss in the Teach Group for a period 25 minutes. At the conclusion of the time period, the were given a post-test.

The time allotted for study was controlled for all ditions. The Anticipate Teach and Study Once Groups studied the material for a 25-minute period. The ch Group studied for 25 minutes then spent 25 minutes ching the material to a peer while the Study Twice p studied the material for two 25-minute periods. subject in the Receive Group received 25 minutes of truction from his peer teacher. No study time was tted the Control Group.

To enhance wider generalizability of the study's lts, one-half of the Ss in each experimental ition was given the Glaciers passage to study while remaining half received the Lisbon Earthquake. Since type of study materials (physical science content us social science content) was a dependent variable nly incidental interest in the study it was not ected in the above diagram.

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An additional design element was included in xperiment II. This was the administration of the passage ntitled Stages of Economic Growth and its accompanying est to each S one week prior to the experiment. It was elt that the test results might serve as a covariate easure since it has been suggested elsewhere (Kropp and toker, 1966) that the cognitive processes reflected in taxonomy of learning transcend subject matter. A strong" correlation between the covariate test and the ost-test reduces the size of the mean square error in the est of significant differences among groups, thereby chieving a more sensitive analysis technique. Since in the present study were randomly assigned, all groups re considered equivalent prior to the treatment. Thus, y adjustments in the mean scores resulting from an alysis of covariance was considered to account for fferences produced by the treatment. While the analysis covariance method demanded the loss of one additional gree of freedom (df) in the "F" test compared to alysis of variance, the relatively large sample size = 84 in Experiment II) minimized the subsequent effect the significance test.

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Subject Population and Sample

In Experiment I, the population of interest was tudents enrolled at Michigan State University in School earning I (ED 411) during summer term 1974. The tudents were predominantly graduate students in the ollege of Education with several years of classroom eaching experience. The specific sample for Experiment was 82 students who volunteered to participate in the tudy.

In Experiment II, the population of interest was tudents enrolled at Lansing Community College in Social cience I (SS 101) and American Government (SS 104) during ummer term 1974. The students were predominantly reshmen and sophomores with no previous teaching experence. The specific sample for Experiment II was 84 tudents who volunteered to participate in the study in turn for incentive points added to their final grade by e class instructors.

The purpose of replicating the experiment across o different population samples was to increase the neralizability of the findings. Specifically, the two mples differed in terms of prior teaching experience d an interesting sidelight of the study was to observe e effects of the treatment upon these two samples.

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Instrumentation

The same materials were used in both Experiment I Experiment II. These materials, including study des and evaluation instruments, were produced by Kropp Stoker (1966), psychologists at Florida State versity working under a U.S. Office of Education grant develop and validate test materials to measure the onomy of Educational Objectives, Handbook I: Cognitive ain.

While outside the purview of the present eriment, it may be useful to describe briefly the ure and procedures of the work by Kropp and Stoker. investigators outlined the purpose of their study the following manner:

> The study focused on three specific problems: (a) to test the hierarchial structure of the taxonomy; (b) to determine whether the six major processes, aptitudes or abilities which are described in the taxonomy transcend subject matter content; and (c) to determine the psychological structure of each of these major processes or abilities. (p. 11)

The "six major processes" in the Taxonomy include ledge, Comprehension, Application, Analysis, hesis and Evaluation. A brief description of the nomy appears in Appendix A. A detailed discussion of e taxonomic categories may be found in Bloom (1956).

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Kropp and Stoker constructed four special tests cause none was available commercially or from other estigators which would yield scores corresponding to levels of the taxonomy" (p. 165). Each test was lt around the content of four written passages of roximately 2,000 words which were also produced by the estigators. Two of the passages dealt with the social ence area--Lisbon Earthquake and Stages of Economic th--and two incorporated physical science content--ic Structure and Glaciers.

Teams composed of a content specialist, a urement specialist and a generalist initially ared and classified items for each reading passage . All items and their classifications were reviewed he teams. When an agreement could not be reached the in question was discarded (p. 48). The remaining of items constituted the preliminary forms of each . The preliminary forms were field tested at least e times on groups of secondary students (p. 49).

Based on the prototype tyrout data, the reading ages were edited and revised and the final test forms en. The method of selecting items for inclusion on inal form of each test was as follows:

>n the basis of item analysis data from the
>reliminary forms, students' comments and
>roctor observations, all items were ridded,

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hopefully, of technical deficiencies and items were discarded which failed to correlate positively with the subtest of which they were a part. When these two steps were achieved, then the item was placed in a pool of items for that subtest and form. When the number of items to appear in the final form was determined, items were sampled from the pool until the needed number was obtained. (p. 56)

The final versions of the four tests produced by opp and Stoker were identical in appearance. Part A each test contained items which reflected the first ur levels of the Taxonomy: Knowledge, Comprehension, plication and Analysis. All Knowledge level items peared first, then items from the other three levels random order. Each level was measured by twenty ltiple-choice items. Each item was made up of a stem d four forced-choice alternatives, only one of which was rrect. Part B was composed of five free-response items the Synthesis level and ten free-response items for Evaluation level. The free-response items elicited ef written statements for answers.

The final forms of the materials and tests were inistered to approximately 5,000 students in grades e through twelve in five Florida school systems. The a indicated that nearly all item-level correlations on multiple-choice subtests fell in the range between .30 .80 which, according to Fruchter and Guilford (1973), sho

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ıld provide tests of both reliability and validity.

reliability data for the four tests appear in Table 1.

le 1.--Reliability Coefficients for Taxonomy Test Raw Scores* as Reported by Kropp and Stoker (1966)

Taxonomic Level	Atomic Structure	Glaciers	Lisbon Earthquake	Economic Growth
vledge	.836	.816	.758	.824
prehension	.693	.677	.743	.745
ication	.694	.731	.689	.731
ysis	.632	.539	.684	.614
hesis	.89	.72	.71	.79
uation	.83	.75	.81	.72

*For the Knowledge, Comprehension, Application Analysis items, Kuder-Richardson 20 coefficients are rted and each is based on approximately 5,000 onses. For the Snythesis and Evaluation items, the ficients are computed interjudge reliabilities.

Kropp and Stoker drew the following conclusions d on their results: (a) There seemed to be clear ort for the imputed hierarchial structure of the nomy; (b) Convincing evidence could not be provided upport the transcendence of the taxonomic processes ss subject matter; (c) Statements regarding the tionship of the taxonomic levels and cognitive tude must await further research.

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Turning back to the present study, it was felt by
s researcher that the Kropp and Stoker materials might
appropriately utilized in the planned experiments.
s reasoning was based on several factors. First, the
erials had undergone extensive development and testing.
ond, the subject matter of the passages was assumed to
l outside the area of "common knowledge" of the experi-
tal subjects. Third, previous researchers, Hillier,
chmann and Pirkle (1973), report using the <u>Lisbon</u>
<u>thquake</u> and a modified version of its accompanying test
investigate the effect of expectancy to teach upon
rning. Fourth, the materials lent themselves to an
estigation of the third question listed under the
lated Questions" section of this chapter; since each
t was made up of subtests which corresponded to Bloom's
onomic levels, the scores yielded by the subtests
mitted comparisons between experimental groups for each
el of learning. Finally, the use of content materials
resenting both the physical and social science
ciplines would help enhance the generalizability of
results.

Selected for use in the present study were the
<u>iers</u>, <u>Lisbon Earthquake</u> and <u>Stages of Economic Growth</u>
erials. (The passage entitled <u>Atomic</u> <u>Structure</u> was
ected since its outdated content was not deemed

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elevant for the participants in the study.) The Glaciers
nd Lisbon Earthquake passages constituted the experi-
ntal materials while the Stages of Economic Growth
s selected to provide the covariate data in Experiment
.

All three passages were used in the original form,
at is, as developed by Kropp and Stoker. However, each
companying test was modified to meet time constraints
r administering the examination. In the case of the
aciers and Lisbon Earthquake tests, the modifications
tailed reducing by approximately one-half the total
mber of test items provided by the original authors.
ecifically, the multiple-choice items in the four
otests of Knowledge, Comprehension, Application and
alysis were reduced from twenty to ten; the five free-
sponse Synthesis subtest items were reduced to two; and
e ten free-response Evaluation items were reduced to
ur. Items were eliminated on a random basis. Thus,
ch of these two tests consisted of 46 multiple-choice
l free-response questions as opposed to 95 items in the
pp and Stoker version. A copy of the Glaciers and
bon Earthquake passages and tests used in the study is
ated in Appendix B and C, respectively.

The Stages of Economic Growth test, which provided
ovariate score for each S in Experiment II, included

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ıly the four subtests of Knowledge, Comprehension, ɔplication and Analysis. Again, as in the other two ɘsts, the twenty multiple-choice items comprising each f these subtests were reduced to ten on a random basis. copy of the Stages of Economic Growth passage and test ; located in Appendix D.

Scoring the Tests

The two post-tests in the study--Glaciers and sbon Earthquake--were identical in format. Part A, compassing the taxonomic levels of Knowledge, mprehension, Application and Analysis, was multiple-oice; Part B, containing the Synthesis and Evaluation tegories was free-response. The covariate test used Experiment II, based on the Stages of Economic Growth, ntained Part A multiple-choice items only.

Scoring procedures suggested by Kropp and Stoker re followed throughout. Table 2 summarizes the type of st item, weight and scoring range for each subtest in e present study.

Each of the forty multiple-choice items was a rced-choice decision among four alternatives. The ɔring weight for each of these items was either 0 ıcorrect) or 1 (correct). The maximum possible score on h subtest was 10. Participants were asked to mark their resp

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responses to Part A of the test directly on optical-scan cards so that the scoring keys provided by Kropp and Stoker could be used for computer analysis.

Table 2.--Subtest Items, Weights and Scoring Ranges

Subtest	Test Items	Weights	Possible Score Range
Knowledge	10 Multiple-Choice	0, 1	0 - 10
Comprehension	10 Multiple-Choice	0, 1	0 - 10
Application	10 Multiple-Choice	0, 1	0 - 10
Analysis	10 Multiple-Choice	0, 1	0 - 10
Synthesis	2 Free-Response	0,1,2,3,4	0 - 8
Evaluation	4 Free-Response	0,1,2	0 - 8

Scoring the Part B free-response items required independent judgements of the answers given. The Synthesis items carried scoring weights from 0 to 4 and the Evaluation items were scored on a scale from 0 to 2. Thus, the maximum possible score for the Synthesis subtest and the Evaluation subtest each was 8.

Three judges, unknowledeable about the nature and purpose of the study and blind to the identity and group assignment of the respondents, were trained to rate the free-response items. The training followed the procedures suggested by Kropp and Stoker. The judges studied (1) the summary of the Taxonomy located in Appendix A,

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(2) detailed descriptions of the Synthesis and Evaluation categories (from Kropp and Stoker), (3) the reading passages, (4) the pertinent test stems from each test, (5) characteristics which suggested the proper score for responses (provided by Kropp and Stoker), and (6) sample scored responses (also provided by Kropp and Stoker). Following initial training, sample responses were presented to the judges for independent scoring. Calculated interjudge reliability estimates (Ebel, 1972) on these training items exceeded .75 which was deemed sufficient.

During the rating of the actual post-test responses each judge worked independently. The mean rating of the judges for each test item was computed and marked appropriately on each subject's optical-scan card. The completed cards were then submitted for computer analysis. The interjudge reliability estimates (Ebel, 1972) calculated for each subtest exceeded .71 as shown in Table 3.

Table 3.--Interjudge Reliability Coefficients for Ratings of Evaluation and Synthesis Subtest Items

Taxonomic Level	Passage Materials	
	Glaciers	Lisbon Earthquake
Synthesis	.78	.78
Evaluation	.73	.71

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Data Analysis

Since the hypotheses and questions in the study lled for the comparison of selected group means, analysis variance (Experiment I) and analysis of covariance xperiment II) were appropriate statistical procedures r making such comparisons. The test statistic in both ses was the "F" ratio for difference among means. The vel of rejection of the null hypothesis (alpha level) r the study was .05.

If either the analysis of variance or analysis covariance yielded a significant "F" ratio, the null pothesis was rejected and it was concluded that the fferences between means resulted from the treatment fect. If, on the other hand, the null hypothesis could be rejected, it was assumed that the differences tween means resulted from sampling error rather than the eatment. Failure to reject the null hypothesis lead the conclusion of no significant difference among the oup means.

A significant "F" ratio produced by an omnibus lysis of variance or analysis of covariance technique ified only that overall differences between the means sted; it did not indicate which means produced the nificant difference. Kirk (1968) states that "data oping" is appropriate following rejection of the null hyp

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pothesis to seek the source of the finding. One such posteriori suggested by Kirk is the Scheffe method of king pairwise comparisons among specific group means of terest.

Briefly stated, the Scheffe method permitted the nstruction of confidence intervals around the assumption at the sample means were equal to zero and, therefore, ere was no difference between the groups being compared. the confidence interval failed to cover zero, the mparison was said to be significant and identified as e possible contributor to the overall significance nding. If the confidence interval did include zero, was concluded that there was no significant difference tween the compared groups.

Data from both experiments were analyzed using the n computer program for Univariate and Multivariate alysis of Variance, Covariance and Regression as adapted r use on the CDC 6500 computer at Michigan State iversity. Results of the analyses are presented in apter IV.

Procedures

Pilot Study

Prior to the conduct of the two experiments a lot study was carried out. The purposes of the pilot wer

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were twofold: (1) to observe the subjects' reactions to the experimental materials and (2) to tryout the complex logistical procedures necessary to administer an experiment involving over 80 subjects divided among six groups.

The pilot was conducted in June 1974 with volunteer students enrolled in the Justin Morrill College of Michigan State University. The fourteen students (N=14) who participated were randomly assigned to five conditions; because of the small N, no subjects were assigned to the Control group.

Informal interviews with selected participants following the experiment indicated the students found the materials were interesting and challenging. From the researcher's viewpoint, even with a small N it became readily apparent that the scope of the logistical require-ments for carrying out the experiments had been under-estimated. As a result, six persons, primarily doctoral students in Instructional Development and Technology at Michigan State University, were trained as aides to assist in conducting the two experiments.

Experiment I

The first experiment was performed in July 1974 during the summer term of instruction in the College of

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Education at Michigan State University. Eighty-two students from an educational psychology class--School Learning I--volunteered to serve as subjects. The course instructor, Dr. Donald Freeman, encouraged (but did not require) all 117 students enrolled in the class to participate in the study. The students were told only that the researcher was testing a new instructional method; the focus of the study was not revealed. They were assured the researcher would meet with the class after the experiment was completed to discuss the study.[1]

From the 82 volunteers, 14 were randomly assigned to each experimental condition (Teach, Anticipate Teach, Study Once, Study Twice, and Receive) and 12 to the Control group.

Due to class schedule conflicts for the subjects, the experiment was carried out at two sessions on successive days. Approximately one-half of the 82 subjects attended each session. Several procedures were employed to curb the possible contaminating effects of socialization since there was no way to control the interaction of subjects who attended the first session with those waiting to participate in the second. Participants

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[1]A similar pledge of feedback by the researcher was made to participants in Experiment II. In both instances, visits were made within four weeks when preliminary data became available.

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n each session were randomly assigned to one of the six xperimental conditions thereby insuring each condition ontained subjects from both days. By this procedure any ocialization effects which may have occurred between essions were assumed to be randomly distributed among all onditions. Other precautions included directions to the s in the first session not to discuss the materials or rocedures with anyone until the conclusion of the study nd the retrieval of all study materials and evaluation nstruments from each subject prior to dismissal from the xperimental situation. Despite these efforts at ontrolling the spurious effects of socialization, it ust be considered a potential source of contamination n the study.

Each session followed the same general format with l Ss meeting together at the beginning of the experiment o receive general instructions, clarify questions and e assigned to groups. Each group then met privately with research aide who was responsible for communicating the xperimenter-prepared instructions to his group and ministering the evaluation instrument.

Independence among groups was controlled by ssigning each group to a different study area. In dition, at the point when Ss from the Teach group were quired to teach Ss from the Receive group, each teache

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eacher-student dyad was placed in a room acoustically and isually independent of the other dyads and other experi- ental groups.

It is important to note that the nature of the irections given to the Ss influenced the "set" they aintained during the experiment. For example, the nstructions to the Teach and Anticipate Teach groups ere identical, namely, study the material in preparation o teach it to a peer student who has not seen it and who ill be given a test about its contents later. Likewise, ne instructions to the Study Once and Study Twice groups ere similar, namely, study the material in preparation to ake an examination of its contents. Subjects in the eceive group were told they were going to be taught some aterial by a peer student after which they would be ested on the lesson content. The controls were adminis- ered the test only. The instructions given to each group re presented in detail in Appendix E.

Throughout the course of the experiment, the esearcher served as overall coordinator of the various ctivities by noting the passage of time periods, oordinating the movement of subjects to assigned areas d assisting the research aides when requested.

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Experiment II

The second experiment was completed in July 1974 during the summer term of instruction in the Department of Social Science at Lansing Community College. Subjects who participated in the study were 84 volunteer students (N=84) from the Social Science I and American Government classes taught by Mr. John Ducat and Mr. Jim McClure, respectively. A total of 129 students were enrolled in the two classes. As an incentive, each instructor offered additional course credit to those who participated in the study.

The 84 participants were randomly distributed among all groups so that 14 Ss were assigned to each of the six experimental conditions.

Experiment II differed from Experiment I in one important aspect. A covariate measure was obtained for each S prior to the treatment in Experiment II. The measure was Ss scores on a test after studying for 25 minutes the passage produced by Kropp and Stoker entitled Stages of Economic Growth. Collection of the covariate data was accomplished one week prior to the treatment.

Like Experiment I, conflicts in student class schedules required that the experiment be held at two sessions on successive days. Approximately one-half of the 84 volunteers attended each day. The general

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procedures described above for Experiment I, including precautions against socialization, were also followed in this experiment.

Delimitations of the Study

Several factors delimited the generalizability of the study. One was the nature of the sample. All subjects were students in post-secondary educational institutions. In addition to their advanced academic status, each S in the study voluntarily chose to participate. Others in the classes from which these Ss came had a similar opportunity to participate but elected not to. The "volunteers" may be a biased sample in terms of the study's outcomes. Hence, without further research, it is inadvisable to generalize the results beyond students with similar academic backgrounds and characteristics as those in the sample.

The specific nature of the sample holds true also for the materials used in the study. This delimitation notes that the reading passages were chosen arbitrarily and used intact from the work of previous researchers. Also, the specialized content of the passages may influence the achievement levels; however, any systematic effect of content on the groups scores would appear as interactions during the data analysis.

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In addition, it was assumed that the content of the passages was unknown to the Ss and that the groups were thus equivalent prior to the treatment in their (lack of) knowledge about glaciers and the Lisbon earthquake. The degree to which these assumptions were false obviously influenced the results.

The short period of time during which the experiment was conducted may have been a limitation. There was little time for Ss in any of the groups to reflect on the content of the passages after reading them. Also, those Ss in the Teach group were pressed by a time limitation to pass on the knowledge they had gained from studying; they had little or no opportunity to get to know their students.

Another possible limitation was the inability of the researcher to control for "socialization" among the participating subjects. It will be recalled that in both cases the experiments were completed over a two-day period. While the researcher exhorted all subjects who participated on the first day not to discuss the nature or content of the experiment with others, the efficacy of this request is not known.

Summary

Two experiments, each using different sample populations, were devised to test two hypotheses and three rel

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lated questions concerning the effect of teaching upon e learning of the teacher. Subjects, volunteer students both instances, were randomly assigned to one of six nditions.

Subjects in the Control group completed a post-st and subjects in the Receive group engaged in topical scussions while subjects in the other four conditions udied a written passage for equal specified time periods. o of the groups (Teach and Anticipate Teach) studied e material with the expectation of teaching the content a peer; the other two groups (Study Once and Study ice) studied with the expectation of taking an examina-on on the content. At the conclusion of the study riod, subjects in the Teach group taught the passage a peer in the Receive group; subjects in the Study ice group studied the material for an additional equiva-it time period followed by a post-test; and subjects in Anticipate Teach and Study Once groups received an lediate post-test.

The mean post-test scores of the Teach Group Study Twice Group were compared to determine the effect teaching while data from the Anticipate Teach and Study e groups were compared to note the effect of expectancy teach. In addition, data for the Receive group were mined; the difference in mean scores for the Teach and

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ıticipate Teach groups were observed; and subjects' :ores on subtests reflecting a hierarchy of learning :re noted.

The materials, instructional passages and evaluaon instruments used in the study were produced by a team psychologists as part of a research project to develop d validate test materials to measure the Taxonomy of ucational Objectives, Handbook I: Cognitive Domain.

Subjects participating in Experiment I were lunteer students from an educational psychology course Michigan State University during summer term 1974. periment II participants were volunteer students from e Department of Social Science at Lansing Community llege during summer term 1974.

Judges were trained to rate subject responses to veral free-response test items; the multiple-choice ems were scored according to scoring keys provided by original authors. The statistical techniques ployed to analyze the data from the two experiments were lysis of variance and analysis of covariance, pectively.

Several delimitations of the study were described terms of the narrow population sample, arbitrarily ected learning materials, shortness of time exposure to materials and possible socialization of subjects.

CHAPTER IV

ANALYSIS OF RESULTS

Introduction

A compilation of the findings of the study are presented in this chapter. The data generated by the two experiments are analyzed in terms of the two research hypotheses and three related questions posed in Chapter III. Conclusions based on the findings are reported in the final chapter.

Findings

In Experiment I, 82 Ss, volunteers from a university educational psychology course, were randomly assigned to six conditions. All conditions contained 14 Ss, except the control group which contained 12 Ss. In Experiment II, 84 Ss, volunteers from two community college social science classes, were randomly assigned to the same six conditions with 14 Ss in each group.

It will be recalled that a major interest in conducting two experiments was to observe the effects of the treatment on Ss who possessed prior teaching experience compared to Ss with no such experience. Demographic data obtained from Experiment I showed that 77 of the 82

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(94%) had completed a student teaching training program d had taught professionally. The extent of teaching perience ranged from 1 year to 20 years with the average lling at 3.2 years. Data from Experiment II revealed at 82 of the 84 Ss (98%) had no prior professional aching experience. More extensive demographic informa- on, including sex, age and student status, on the pulation sample from each experiment is located in pendix F.

Experiment I

It must be pointed out that the responses from y 62 of the 82 Ss in the Experiment I sample were ilable to test the hypotheses of interest. The rtality was due to the failure of 20 Ss to properly plete one subtest comprising the total score.[2] Table shows the planned number of Ss per group and the actual ber per group as a result of the loss. Note the ferential mortality; all groups were affected by the s of subjects.

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[2]Test items in the Evaluation subtest, unlike all ler test items, called for two responses. All Ss made first response, but 20 did not make the necessary cond. Subjects completed this subtest last and those did not do so fully may have fallen victim to a sponse set of one response for each test item.

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'able 4.--Planned and Actual Number of Subjects per Group Available for Mean Post-test Score Analysis in Experiment I

Groups	Planned No. of Ss (N=82)		Actual No. of Ss (N=62)	
	Glaciers	Lisbon	Glaciers	Lisbon
each Group	7	7	4	4
nticipate Teach Group	7	7	5	6
tudy Once Group	7	7	6	7
tudy Twice Group	7	7	3	6
eceive Group	7	7	4	6
ontrol Group	6	6	5	6
	41	41	27	35

The general procedure followed for hypothesis esting was to test for group main effects (as well as ther effects) by way of an omnibus "F" test for statisti-al significance. If significant group differences or nteractions appeared as a result of the omnibus test, ost-hoc procedures were employed to seek the source of ne finding.

The results of the analysis of variance "F" test or significant differences among groups in Experiment I an be found in Table 5.

Since the p value for both the material and roup main effects in Table 5 was less than the chosen

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ılpha level of .05, the assumption of no significant lifferences was rejected. Rejection of the null hypothe- ;is, however, did not indicate which materials or groups lifferered nor the direction of the difference; hence, a 'urther analysis of the group means was undertaken. 'ables 6 and 7, respectively, contain the means of nterest related to materials and groups.

able 5.--Analysis of Variance for the Mean Post-test Scores for All Groups in Experiment I

Source	Mean Square	df	F ratio	p value*
aterials	406.13	1	20.918	.0001**
roups	230.42	5	11.868	.0001**
aterials x Groups	41.62	5	2.144	.0754
rror	19.42	50	------	-----

*The p value is the probability of achieving an ratio equal to or greater than the given F ratio under he assumption that the Ho is true. If the p value is less han the chosen alpha level (.05), reject the Ho; if the value is greater than the chosen level, fail to reject he Ho.

**Significant beyond the .05 level.

able 6.--Raw Mean Post-test Scores for the Two Materials in Experiment I

Materials	Mean
laciers (N=27)	29.67
isbon Earthquake (N=35)	34.83

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ble 7.--Marginal Post-test Mean Score for Each Group in Experiment I

Groups	Post-test Mean
ach Group	37.00
ticipate Teach Group	32.45
udy Once Group	35.38
udy Twice Group	36.00
ceive Group	31.80
ntrol Group	24.09

Based on the positive results of the "F" test for fferences between materials shown in Table 5 and a mparison of the material means presented in Table 6, Ss rformed better who studied the Lisbon Earthquake material n those who studied about glaciers.

Table 7 presents the computed marginal mean post-t score for each group. The marginal mean is the led mean across both kinds of material for each group. erved cell means and standard deviations are reported Appendix G.

While a cursory examination of the data in Table howed a difference of approximately thirteen units ween the highest and lowest mean score, a more formal t-hoc procedure, utilizing the Scheffe technique, was

employed to test for differences among the means for the different groups. Nine post-hoc pairwise contrasts among means were selected for testing at the .05 level:

Contrast #1:	Anticipate Teach Group	- Study Once Group
Contrast #2:	Teach Group	- Study Twice Group
Contrast #3:	Receive Group	- Study Once Group
Contrast #4:	Teach Group	- Anticipate Teach Group
Contrast #5:	Teach Group	- Control Group
Contrast #6:	Anticipate Teach Group	- Control Group
Contrast #7:	Study Once Group	- Control Group
Contrast #8:	Study Twice Group	- Control Group
Contrast #9:	Receive Group	- Control Group

Note that Contrast #1 reflected the first hypothesis of interest in the study, namely,

Ho_1: No difference will be found between the mean post-test scores of subjects who study with the expectation of teaching a peer and subjects who study the same material an equivalent amount of time with the expectation of taking an examination.

A post-hoc comparison of the means of the two groups of interest, Anticipate Teach and Study Once, reflected in the hypothesis and in Contrast #1, is shown in Table 8.

Since the confidence interval in Table 8 produced by the post-hoc comparison of means covered zero, the hypothesis of no significant difference between the two groups could not be rejected. The conclusion based on this

evidence was that expectancy to teach did not significantly improve learning beyond the level achieved by traditional study.

Table 8.--Post-hoc Comparison of Means of the Anticipate Teach Group and the Study Once Group in Experiment I

Contrast	Estimated Contrast Value	95% Confidence Interval
Anticipate Teach - Study Once	2.930	(-3.25, 9.12)

Contrast #2 reflected the second hypothesis of the study, that is,

Ho_2: No difference will be found between the mean post-test scores of subjects who study with the expectation of teaching and teach a peer and subjects who study the same material an equivalent amount of time in preparation for an examination.

The two groups of interest in this hypothesis were the Teach and Study Twice groups. A post-hoc comparison of the means from these two groups is given in Table 9.

Table 9.--Post-hoc Comparison of Means of the Teach Group and the Study Twice Group in Experiment I

Contrast	Estimated Contrast Value	95% Confidence Interval
Teach - Study Twice	1.00	(-8.332, 6.332)

The confidence interval in Table 9 covered zero; herefore, the hypothesis of no significant difference ould not be rejected and the conclusion was drawn from his data that teaching did not significantly improve earning over traditional study when the amount of study ime was controlled.

Contrast #3 provided an answer to the first uestion of the study raised in Chapter III, namely,

1: How well do the Receiver Ss, i.e., those who are taught, learn in comparison to those who study the same material alone for an equivalent amount of time?

ne means from the Receive Group and the Study Once Group ere of interest in Contrast #3. The post-hoc comparison f these means is contained in Table 10.

able 10.--Post-hoc Comparison of Means of the Receive Group and the Study Once Group in Experiment I

Contrast	Estimated Contrast Value	95% Confidence Interval
eceive - Study Once	3.58	(-2.767, 9.927)

The data from Table 10 meant the null hypothesis uld not be rejected since the confidence interval tended across zero. It was assumed that the Ss who were ught by a peer learned as well as Ss who studied alone r an equivalent period of time.

The second question of the study was reflected n Contrast #4. This question was stated as follows:

2: Is there a significant difference in the amount of learning gained by subjects who expect to teach but are instead given a test and subjects who are tested after they teach?

This question called for a comparison of the Teach roup and the Anticipate Teach Group. Table 11 presents post-hoc comparison of the means from these two groups.

able 11.--Post-hoc Comparison of Means of the Teach Group and the Anticipate Teach Group in Experiment I

Contrast	Estimated Contrast Value	95% Confidence Interval
each - Anticipate Teach	4.55	(11.561, -2.461)

The confidence interval in Table 11 produced by his comparison covered zero; the null hypotheses could ot be rejected. The evidence thus suggested there was no ifference in the amount of learning gained by Ss who aught and Ss who studied anticipating to teach.

Contrasts #5 through #9 compared each of the five xperimental groups with the Control group. A post-hoc omparison of these means is located in Table 12.

Since each of the confidence intervals in Table 12 id not cover zero, the null hypothesis could be rejected or each comparison. This was interpreted as indicating

:hat each of the experimental groups benefited significant-.y from the treatments compared to the Control group.

:able 12.--Post-hoc Comparison of Means of Each Experimental Group and the Control Group in Experiment I

Contrast	Estimated Contrast Value	95% Confidence Interval
:each - Control	12.91	(5,899, 19.921)
\nticipate Teach - Control	8.36	(1.926, 14.794)
;tudy Once - Control	11.29	(5.109, 17.472)
;tudy Twice - Control	11.91	(5.128, 18.692)
₹eceive - Control	7.71	(1.117, 14.303)

The finding was important since it demonstrated :hat Ss who studied the materials learned. It was thus assumed that the no-significant-difference results of :omparisons between selected experimental groups reported .n earlier tables could not be attributed to a test "floor effect." Had such an effect been operating in the study, .11 groups, including the Control group, would have scored equally low indicating they had learned nothing during the xperiment.

The third related question posed in Chapter III nvestigation in the study was the following:

Q_3: On a test which scores responses at various levels of a learning hierarchy, do subjects who study expecting to teach and subjects who teach achieve different scores at each level compared to subjects who study expecting to take a test?

In essence, the question called for a comparison of the Anticipate Teach and Teach groups with the Study Once and Study Twice groups, respectively, on each of the six subtests comprising the total post-test. The reader will recall that each subtest reflected one of six categories of Bloom's *Taxonomy*: Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation.

It must be pointed out that all 82 participating Ss properly completed five of the six subtests; on the Evaluation subtest, however, 20 Ss failed to respond according to directions. Therefore, analyses of the first five subtest scores included 82 respondents while analysis of the Evaluation subtest scores included only the 62 Ss who responded as the instructions indicated.[3]

The method of statistical analysis was similar to that employed previously. For each subtest an omnibus analysis of variance "F" test was conducted to test for differences between groups with appropriate post-hoc examinations when significant findings were uncovered.

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[3] See the footnote on page 72 for explanation of subject mortality.

The analysis of variance test for group differences on the Knowledge subtest is presented in Table 13.

Table 13.--Analysis of Variance for the Mean Score of Each Group on the Knowledge Subtest in Experiment I

Source	Mean Square	df	F ratio	p value
Materials	.000	1	.000	1.000
Groups	36.676	5	30.289	.0001*
Materials x Groups	2.781	5	2.297	.0544
Error	1.211	70	------	------

*Significant beyond the .05 level.

The p value for the group main effect in Table 13 was less than the selected .05 alpha level. The assumption of no significant difference was rejected thus calling for a post-hoc analysis of the group means. Table 14 presents the marginal mean scores for each group on the Knowledge subtest.

A cursory examination of the Table 14 data showed the five experimental groups achieved nearly equal scores and the control group scored lower. Formal Scheffe post-hoc procedures, testing each of the nine pairwise contrasts listed on page 76, produced significant differences only between each of the experimental conditions and the control

›up; no differences among specific experimental groups interest were uncovered. Data for each of these ıtrasts are located in Appendix H.

›le 14.--Marginal Mean Score for Each Group on the Knowledge Subtest in Experiment I

Group	Mean Score
ıch Group	8.93
icipate Teach Group	9.07
dy Once Group	8.64
dy Twice Group	9.14
eive Group	8.36
trol Group	4.67

The "F" test for group differences on the prehension subtest is located in Table 15.

le 15.--Analysis of Variance for the Mean Score of Each Group on the Comprehension Subtest in Experiment I

Source	Mean Square	df	F ratio	p value
›rials	144.890	1	65.304	.0001*
ıps	9.401	5	4.237	.0021*
rials x Groups	6.182	5	2.786	.0237*
r	2.219	70	------	-----

*Significant beyond the .05 level.

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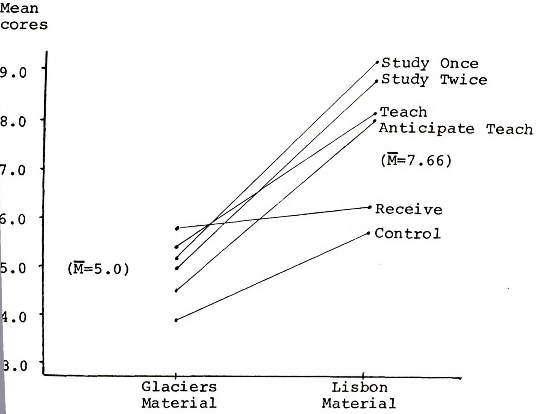
From Table 15, both materials and groups main
fects as well as the interaction effect were significant
ond the .05 level. The significant interaction was
eworthy since it indicated the relationship between
e treatment groups for one of the materials was
ferent than the relationship between the same groups
the other material. The relationship of the groups
hin both materials is demonstrated graphically in
ure 2.



ure 2.--Plot Distribution of Group Mean Scores for Each Material on the Comprehension Subtest in Experiment I.

An example of the differential relationships between groups and materials could be observed from Figure 2 in the relationship of the Study Once group and the Receive group within each of the materials. Note the relatively small distance between these two groups within the Glaciers materials compared to the distance between them within the Lisbon material. Also from Figure 2, the mean score for the Lisbon materials ($\overline{M}$=7.66) exceeded the average score for the Glaciers materials ($\overline{M}$=5.00).

Because the focus of the study was on group relationships, a finding of significant interaction called for a re-parameterization of analysis so that group differences within each material could be observed (Kirk, 1968). Table 16 contains the analysis of variance test for group differences on each of the two materials--Glaciers and Lisbon Earthquake.

Table 16.--Analysis of Variance for the Mean Score on Each Material on the Comprehension Subtest in Experiment I

Source	Mean Square	df	F ratio	p value
Materials	144.890	1	65.304	.0001*
Groups within Glaciers	3.319	5	1.496	.2023
Groups within Lisbon	12.263	5	5.527	.0003*
Error	2.219	70	------	-----

*Significant beyond the .05 level.

The data in Table 16 showed the group differences within the Glaciers material were not significant at the .05 level while the group differences within the Lisbon Earthquake material were significant at the chosen alpha level.

Again from Figure 2, the range of mean scores for the treatment groups of most interest (Teach, Anticipate Teach, Study Once, Study Twice) was nearly identical within each material--about one unit. Since the "F" test for group differences within the Glaciers material in Table 16 was not significant and approximately the same variation among the specific groups of interest within the Lisbon materials was observed in Figure 2, it appeared that the significant groups within Lisbon effect reported in Table 16 could be traced to pairwise contrasts between the treatment groups and the Control or Receive groups. Thus, in light of this informal analysis, it was concluded that significant differences did not exist among the specific treatment groups of interest on the Comprehension subtest.

Statistical analyses of the data for the Application, Analysis, Synthesis and Evaluation subtests followed the established procedures, that is, employment of an omnibus analysis of variance "F" test for significance among means followed by Scheffe post-hoc analyses when appropriate.

For the Application subtest a significant group main effect (p=.0127) was uncovered in the analysis of variance test. A formal post-hoc examination, utilizing the nine contrasts listed on page 76, however, produced only one confidence interval which did not cross zero and therefore was deemed significant. This contrast compared the mean scores of the Receive Group and the Control Group. Since this contrast did not include the specific experimental groups of interest, computation figures for the "F" test and the Scheffe contrasts for the Application subtest are located in Appendix I.

The omnibus test for significance with the Analysis subtest data uncovered a significant materials main effect (p=.0001) and a significant group main effect (p=.0033). An examination of the material means showed the Lisbon ($\bar{M}$=6.56) exceeded the Glacier ($\bar{M}$=4.78). The formal Scheffe post-hoc on the group means using the nine group contrasts, however, produced only two significant contrasts: the Teach group exceeded the Control group and the Study Once group also surpassed the Control. These findings were not directly related to the question of interest; therefore, the procedures are reported in Appendix J.

The "F" test for differences among means from the Synthesis and Evaluation subtests were not significant for

either main effects or interaction effects. The statistical procedures are presented in Appendix K.

The data resulting from the analyses of the mean scores on each of the six subtests in Experiment I produced few significant differences, and those differences which did appear were traced to post-hoc pairwise contrasts involving the Control group. None of the significant findings involved comparisons among the specific experimental groups of interest--Teach, Anticipate Teach, Study Once and Study Twice. These results on each of the subtests were consistent with the findings reported earlier from analyses of the total post-test scores in Experiment I.

Experiment II

Experiment II replicated the first experiment in terms of procedures followed and materials utilized. However, while the subjects in the previous experiment were noted for their previous teaching experience, the 84 Ss in Experiment II reported no prior professional teaching service.

The two experiments were also alike in another respect. In both instances, 20 Ss did not properly complete one subtest according to directions and the data were subsequently unavailable for testing the hypotheses

and questions of interest requiring total post-test scores. As a result, only 64 Ss were included in these analyses.[4] Table 17 shows the planned number of Ss per group and the actual number due to the loss of some Ss.

Table 17.--Planned and Actual Number of Subjects per Group Available for Mean Post-test Score Analysis in Experiment II

Groups	Planned No. of Ss (N=84)		Actual No. of Ss (N=64)	
	Glaciers	Lisbon	Glaciers	Lisbon
Teach Group	7	7	4	6
Anticipate Teach Group	7	7	4	2
Study Once Group	7	7	7	4
Study Twice Group	7	7	7	6
Receive Group	7	7	7	6
Control Group	7	7	6	5
	42	42	35	29

The general analysis and reporting procedures established for Experiment I were also used to analyze the Experiment II data. An omnibus "F" test was conducted to observe group mean differences. If significant differences were uncovered, post-hoc analyses were performed to seek the source of the effects.

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[4]See the footnote on page 72 for explanation of subject mortality.

An additional element of Experiment II was the use of a covariate measure to gain statistical precision. Each S completed a pre-test which provided a covariate total score and a score for each of the four subtests comprising the pre-test. The four subtests included the taxonomic levels of Knowledge, Comprehension, Application and Analysis. The covariate marginal mean total score for each group is given in Table 19. The reader will recall that since 20 Ss were removed from analyses of the treatment post-test data, it was necessary to remove these same Ss from the covariate pre-test data resulting in an N of 64. Observed cell means and standard deviations for the covariate measure are presented in Appendix L.

An appropriate statistical technique when employing a covariate measure is an analysis of covariance "F" test to test for mean differences. The results of this test for significant post-test differences among groups in Experiment II are located in Table 18.

The correlation coefficient between the covariate mean scores and the treatment post-test scores was calculated to be .52 which Kerlinger (1966) states is sufficient to reduce the error variance and improve the sensitivity of the statistical test.

Since the p value for the group main effect in Table 18 was greater than the chosen .05 alpha level, the

null hypothesis could not be rejected. However, the p value for group differences as shown in Table 18 (p=.078) was sufficiently close to the .05 level of rejection to warrant a further examination of the mean scores. Table 19 presents the marginal raw mean post-test score and the adjusted mean score based on the covariate for each group. Observed treatment cell means and standard deviations are reported in Appendix M.

Table 18.--Analysis of Covariance of the Mean Post-test Scores for All Groups in Experiment II

Source	Adjusted Mean Square	df	F ratio	p value
Materials	9.724	1	.380	.5407
Groups	54.384	5	2.123	.0777
Materials x Groups Interaction	31.908	5	1.245	.3020
Error	25.623	51	-----	-----
Correlation Coefficient = .52				

Since the groups showing nearly identical means in Table 19 were the same groups which would be compared in a formal post-hoc pairwise analysis, such a follow-up comparison between the treatment means seemed unwarranted. The conclusion was drawn that any significant differences which might be uncovered by formal post-hoc analyses at

the .078 level would be due in part to contrasts between the treatment groups and the Control group.

Table 19.--Marginal Covariate Mean, Post-test Mean and Adjusted Post-test Mean Scores for Each Group in Experiment II

Groups	Covariate Mean	Post-test Mean	Adjusted Post-test Mean
Teach Group	25.20	31.30	31.45
Anticipate Teach Group	28.67	29.17	27.10
Study Once Group	24.00	26.45	27.38
Study Twice Group	26.38	30.77	31.35
Receiver Group	24.38	26.54	27.22
Control Group	25.64	25.36	25.24

Re-stated below are the two null hypotheses and two of the three questions posed for the study followed by conclusions based on the evidence from Tables 18 and 19.

H_o1: No difference will be found between the mean post-test scores of subjects who study with the expectation of teaching a peer and subjects who study the same material an equivalent amount of time with the expectation of taking an examination.

Conclusion: This hypothesis, relating to a comparison of the Anticipate Teach and Study Once groups, could not be rejected. Expectancy to teach apparently did not significantly improve learning beyond the level achieved by traditional study in this experiment.

Ho_2: No difference will be found between the mean post-test scores of subjects who study with the expectation of teaching and teach a peer and subjects who study the same material an equivalent amount of time in preparation for an examination.

Conclusion: This hypothesis, relating to the Teach and Study Twice groups, could not be rejected. Subjects who taught and those who studied apparently learned comparable amounts of the materials.

Q_1: How well do the Receiver Ss, i.e., those who are taught, learn in comparison to those who study the same material alone for an equivalent amount of time?

Conclusion: Since no significant differences among group means were found in the "F" test, it was concluded that the Ss who were taught (Receive group) learned as well as Ss who studied alone (Study Once group).

Q_2: Is there a significant difference in the amount of learning gained by subjects who expect to teach but are instead given a test and subjects who are tested after they teach?

Conclusion: From the data observed it was concluded that there was no difference in the amount of learning gained by Ss who taught (Teach group) and Ss who studied anticipating to teach (Anticipate Teach group).

The negative results of the "F" test for group differences on the overall post-test measure (see Table 18)

indicated the treatment groups performed no better than the control group. Possible causes for the no-significant-difference findings included the loss of data from 25 percent of the total N, the reduced degrees of freedom and the lower power of the statistical test. A further discussion of these findings and their implications are presented in the final chapter.

The third question of interest in the study related to comparisons of the Anticipate Teach group with the Study Once group and the Teach group with the Study Twice group in each of the six subtests comprising the total post-test. The subtest analyses were strengthened by the fact that in all but one case data from all 82 participating Ss were available. The question was stated as follows:

Q_3: On a test which scores responses at various levels of a learning hierarchy, do subjects who study expecting to teach and subjects who teach achieve different scores at each level compared to subjects who study expecting to take a test?

The reader will recall that the treatment post-test consisted of six subtests each of which reflected one of the six categories of Bloom's Taxonomy: Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation.

The analysis procedure, as in the previous experiment, was to subject group means scores on each

subtest to an omnibus "F" test for mean differences. Analysis of covariance was utilized to analyze the data from the four subtests (Knowledge, Comprehension, Application and Analysis) for which a covariate measure was available. The dependent variable was the group mean score on each subtest and the covariate was the pre-test mean score on a corresponding subtest. To test the remaining two subtests (Synthesis and Evaluation), for which no pre-test score was available, analysis of variance was the appropriate statistical technique. Where significant differences in the "F" tests were uncovered, appropriate post-hoc examinations were employed. It will be recalled that all 82 Ss in Experiment II properly completed five of the six subtests; 20 Ss, however, failed to respond according to instructions for the Evaluation subtest. As a result, N equals 84 for all subtest analyses except in the case of the Evaluation subtest where N equals 64.

The analysis of covariance test for group differences on the Knowledge level subtest is presented in Table 20.

Since the p value (p=.0001) for the groups main effect in Table 20 was less than the .05 alpha level, the assumption of no significant differences was rejected. A further analysis of the means was necessary to ascertain

which groups differed significantly and the direction of the differences. Table 21 contains the group marginal mean scores and adjusted mean scores on the Knowledge subtest.

Table 20.--Analysis of Covariance for the Mean Score of Each Group on the Knowledge Subtest in Experiment II

Source	Adjusted Mean Square	df	F ratio	p value
Materials	6.597	1	3.116	.0819
Groups	29.141	5	13.761	.0001*
Materials x Groups Interaction	1.363	5	.644	.6671
Error	2.118	71	------	-----
Correlation Coefficient = .10				

*Significant at the .05 alpha level.

Table 21.--Marginal Covariate Mean, Post-test Mean and Adjusted Post-test Mean Score for Each Group on the Knowledge Subtest in Experiment II

Group	Covariate Mean	Post-test Mean	Adjusted Post-test Mean
Teach Group	6.86	8.71	8.74
Anticipate Teach Group	7.57	8.00	7.95
Study Once Group	6.36	7.71	7.79
Study Twice Group	7.29	8.36	8.34
Receive Group	6.79	7.57	7.69
Control Group	7.57	4.71	4.66

The "F" test in Table 20 suggested significant group differences at the .0001 level. However, Scheffe post-hoc examinations of the means shown in Table 21, testing the nine contrasts listed on page 76, revealed significant differences only between each of the experimental conditions and the Control group; no statistically significant differences among specific experimental groups of interest were found. Data for each of these post-hoc comparisons can be found in Appendix N.

The analysis of covariance test for significant group differences on the Comprehension subtest is located in Table 22.

Table 22.--Analysis of Covariance for the Mean Score of Each Group on the Comprehension Subtest in Experiment II

Source	Adjusted Mean Square	df	F ratio	p value
Materials	88.175	1	34.431	.0001*
Groups	8.169	5	3.1704	.0122*
Materials x Groups Interaction	3.059	5	1.187	.3242
Error	2.577	71	------	-----
Correlation Coefficient = .21				

* Significant beyond the .05 alpha level.

Since the p value for both the materials and the groups main effect in Table 22 was less than the chosen .05 alpha level, the assumption of no significant difference in both cases was rejected. To determine which materials and groups differed and the direction of the differences required follow-up analyses of the means. Table 23 contains the means related to the materials main effect.

Table 23.--Covariate, Post-test and Adjusted Post-test Means for the Materials from the Comprehension Subtest in Experiment II

Materials	Covariate Mean	Post-test Mean	Adjusted Post-test Mean
Glaciers (N = 42)	6.52	4.67	4.64
Lisbon Earthquake (N = 42)	6.24	6.67	6.61

Based on the significant materials mean effect on the "F" test from Table 22 and a comparison of the means in Table 23, it was apparent that Ss achieved the higher scores who studied the Lisbon Earthquake material than those who studied about glaciers.

Table 24 reports the marginal raw mean scores and the adjusted mean scores for each group on this subtest.

Formal post-hoc comparisons of the means from Table 24, following the nine contrasts on page 76,

produced only one confidence interval which did not cross zero and therefore was deemed significant. This contrast compared the mean scores of the Study Twice group and the Control group. Because the post-hoc analyses failed to uncover significant differences among the specific experimental groups of interest, computations are presented in Appendix O.

Table 24.--Marginal Covariate Mean, Post-test Mean and Adjusted Post-test Mean Scores for Each Group on the Comprehension Subtest in Experiment II

Groups	Covariate Mean	Post-test Mean	Adjusted Post-test Mean
Teach Group	6.00	5.86	5.94
Anticipate Teach Group	7.21	5.79	5.61
Study Once Group	6.29	5.71	5.74
Study Twice Group	6.36	6.93	6.43
Receive Group	6.29	5.00	5.02
Control Group	6.14	4.71	4.83

For the Application subtest data a significant materials main effect ($p=.0004$) was revealed in the analysis of covariance test. Observation of the material means showed the Glacier ($\overline{M}=6.29$) exceeded the Lisbon ($\overline{M}=4.79$). Since the groups main effect in the "F" test was not significant, no post-hoc activity was warranted

and it was concluded that no significant differences existed among the groups on this subtest. Computational details for the analyses are given in Appendix P.

The analysis of covariance "F" test for differences among means for the Analysis subtest was not significant for either main or interaction effects. The computation procedures are presented in Appendix Q.

Pre-test scores were available for the analysis of covariance test of each of the preceding four subtests. For the remaining two subtests--Synthesis and Evaluation--no pre-test measures were taken and the appropriate statistical technique was analysis of variance. Since the "F" test for the Synthesis subtest scores were not significant at any level, the computations are located in Appendix R. The omnibus analysis of variance "F" test for mean differences for the Evaluation subtest appears in Table 25.

Table 25.--Analysis of Variance for the Mean Score of Each Group on the Evaluation Subtest in Experiment II

Source	Mean Square	df	F ratio	p value
Materials	.022	1	.009	.9271
Groups	1.591	5	.605	.6960
Materials x Groups Interaction	7.058	5	2.685	.0312*
Error	2.628	52	-----	-----

*Significant beyond the .05 alpha level.

From Table 25 it was noted that only the interaction effect was significant beyond the chosen .05 level. The finding indicated a differential relationship between some of the groups within each material. The relationship of the groups within both materials on the Evaluation subtest is demonstrated graphically in Figure 3.

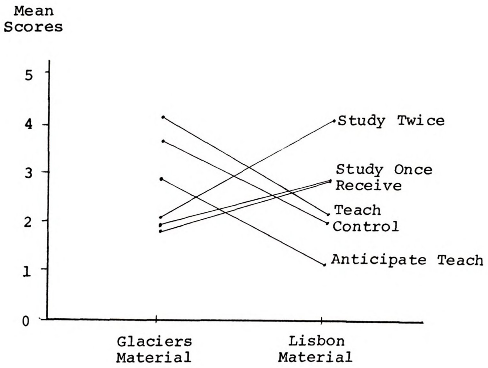

Figure 3.--Plot Distribution of Group Mean Scores for Each Material on the Evaluation Subtest in Experiment II.

A significant interaction indicated treatment differences existed in the Evaluation subtest, but to determine how the treatments differed required further investigation within levels of the two factors. A test

for simple effects was appropriate (Kirk, 1968), which compared the groups within each level of materials. This test is shown in Table 26.

Table 26.--Analysis of Variance for the Mean Score on Each Material for the Evaluation Subtest in Experiment II

Source	Mean Square	df	F ratio	p value
Materials	.022	1	.009	.9271
Groups within <u>Glaciers</u>	4.841	5	1.482	.1209
Groups within <u>Lisbon</u>	3.808	5	1.449	.2227
Error	2.628	52	-----	-----

The Table 26 data showed no significant differences among the groups within either the Glaciers or Lisbon Earthquake materials. This indicated that while a significant interaction appeared in the omnibus "F" test in Table 25 the source of the interaction did not lie within the simple effect of groups within materials. The interaction may have been caused by higher-order complex contrasts which were outside the purview of the study. The conclusion was drawn that there were no significant differences among the groups on the Evaluation subtest.

The data resulting from the analyses of the mean scores on each of the six subtests in Experiment II

produced few significant differences, and those differences which did appear were traced to post-hoc pairwise contrasts involving the Control group. None of the significant findings involved comparisons among the specific experimental groups of interest, namely, Teach versus Study Twice and Anticipate Teach versus Study Once. These results were consistent with the findings reported for the Experiment I data.

Summary

Analyses of the data collected from the two experiments and the findings were reported in the chapter. For Experiment I, analysis of variance was the statistical technique employed; covariate data in Experiment II allowed the use of analysis of covariance. The following diagram shows a summary analysis of the post-test data.

Effects	Experiment I	Experiment II
Materials	+	0
Groups	+	0
Materials x Groups Interaction	0	0

+ = Significant at the .05 alpha level.

0 = Not significant at the .05 alpha level.

The significant materials effect in Experiment I was due to higher scores achieved on the Lisbon Earthquake

test than on the Glaciers test. The significant group effect in Experiment I could be traced to differences between each of the treatment groups compared to the Control group. Significant differences between specific treatment groups of interest (Teach versus Study Twice, Anticipate Teach versus Study Once) were not evident in either experiment. Thus, the two null hypotheses posed for the study were not rejected and it was concluded that teaching and expectancy to teach did not improve learning beyond traditional study methods.

Analysis of the data with regard to three related questions showed:

1. Subjects who were taught by peers learned as much as subjects who studied the same material alone for an equivalent period of time.
2. There was no difference in the amount of learning between subjects who taught and those who studied with the expectation of teaching.
3. No evidence of differential higher-order learning among the specified experimental groups, as reflected in Bloom's Taxonomy, was found in the study. Those few significant group effects which did emerge from analyses of the subtest scores were traced to differences between treatment groups and the Control group.

CHAPTER V

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

Introduction

In this final chapter a discussion of the findings reported in Chapter IV is presented. The findings are briefly related to selected studies reported in the literature. The thesis concludes with a summary of observations and conclusions pertinent for educational applications and future research.

Discussion of the Findings

Two experiments were conducted to test the hypotheses that (1) students who study expecting to teach will learn more than peers who study the same material an equivalent period of time to take a test and (2) students who study with the expectation of teaching and who in fact do teach will learn nore than peers who study the same material an equivalent amount of time in preparation to take a test.

The first hypothesis compared immediate post-test scores from subjects in an _Anticipate Teach_ group and a _Study Once_ group. The second hypothesis compared scores from a _Teach_ group and a _Study Twice_ group. Scores from

two other groups, Receive and Control, were also included in the study.

Statistical analyses of the data from both experiments failed to support either hypothesis. From such evidence as these two experiments provided, it was not possible to conclude that (1) studying with the expectancy to teach or studying with the expectation of taking a test results in significantly different learning or (2) teaching improves learning beyond that achieved by traditional study in preparation for a test.

A re-examination of the mean score profiles from each experiment provided additional insight into the results achieved--see Figure 4.

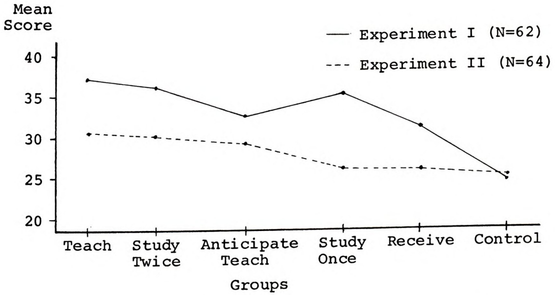

Figure 4.--Plot of Post-test Mean Scores for All Groups from Experiments I and II.

From Figure 4, the following points were noted:

1. In both experiments the Teach group exceeded all other groups--an indicator that teaching improved (though not significantly) the scores of subjects in this condition above all others.
2. The two groups which were permitted the most study time (Teach and Study Twice) exceeded all others thus supporting the contention that achievement is positively related to study time.
3. The relative scores of the Anticipate Teach and the Study Once groups were reversed across the two experiments. In Experiment I, the Study Once group scored higher, but in the second experiment the Anticipate Teach exceeded the former. This situation provided no clues as to the effect of expectancy to teach upon the teacher's learning.

One must, of course, be cautious about drawing conclusions based on sample means; the above discussion based on the Figure 4 data is relevant only to the extent that it helps explicate the general findings of the study.

The reader will also note from Figure 4 that subjects in all conditions, except the control, from Experiment I achieved higher scores than subjects from Experiment II. An informal intent of the study was to observe the differential effects on two population samples

(experienced teachers in Experiment I versus non-teachers in Experiment II) to the experimental treatments. From the data observed in this study the treatments affected the two groups in approximately the same fashion with regard to relative group scores. It was clear, however, that the treatments did not have as great an impact on the non-teachers.

Three questions were also posed in the study. The first sought to compare the learning achievement of the Receive Group (Ss who were taught by Ss in the Teach group) compared to the Study Once group (Ss who studied the material alone for an equivalent time period). The results of both experiments showed no significant difference in the immediate post-test scores of these two groups. It was concluded that students who were taught by other students learned the material as well as students who studied alone.

The second question asked if a difference existed between the Anticipate Teach and Teach groups in terms of learning achievement. The purpose of the question was to seek an indication of the specific points in the process which might be responsible for the effect: Did the learning occur as a result of studying with the expectancy to teach? Or, did the learning occur as a result of the verbal interaction between teacher and student? Both

experiments produced no-significant-difference findings thus indicating that neither phase of the process was primarily responsible for the effect.

The final question related to the six taxonomic levels (Bloom, 1956) which made up the post-test. It asked if the performance of four specific experimental groups (Teach, Study Twice, Anticipate Teach and Study Once) differed on each of the six subtests. The findings in all cases across both experiments were congruent with previous results: no significant difference among the groups of interest.

Several reasons were posited for the overwhelming evidence from the study of no significant difference among the treatment groups in both experiments. First, the study sought to isolate in one brief (approximately three-hour) setting a general phenomenon which would reveal itself across a random sample of students. Others (Dubin and Taveggia, 1968) have warned that studies in education which seek pervasive results are historically doomed to the "no significant difference" outcome. Second, the researcher assumed that the contents of the experimental materials were unfamiliar to the subjects. If this assumption was invalid (which may be so in light of the scores achieved by the control groups) the test scores were biased by the respondents' prior knowledge about the

two content areas. Other considerations, such as the efficacy of the instructions given to each group at the start of the experiment, the amount of study time permitted, the degree of sensitivity of the instruments, and the "volunteer" nature of the subjects, also must be taken into account when re-examining the forces affecting the outcome of the experiments. Several of these potentially influencing factors are discussed further in the section of this chapter dealing with considerations for future research.

Relation of the Findings to Previous Research

The present study joined the research efforts cited in Chapter II in failing to establish the oft-quoted axiom that teaching aids the learning of the teacher. Similar no-significant-difference findings were reported by Allen and Feldman (1972), Hillier, Deichmann and Pirkle (1973) and Reynolds (1968). Considered together, these findings and the present study results indicated that teaching (or the expectancy to teach) does not significantly improve the learning of the teacher. If future research findings continue to support these indications it will invalidate the commonly held belief that teaching is a beneficial learning activity for the teacher.

The results of the present study did not support Reynold's hypothesis (1968) that studying under the expectation to teach may interfere with the learning of the teacher. In the present study Ss who studied anticipating to teach performed as well as Ss who studied alone.

The motivational effects of teaching on learning, as suggested by Moody, Bausell and Crouse (1974), were evident in the present study. It was informally observed during the course of both experiments that Ss who studied in anticipation of teaching spent more time reading the materials, took more notes and underlined the passages more extensively than Ss who expected to be tested.

Conclusions and Recommendations for Educators and Researchers

The following conclusions were reached in light of the results of the present experimental study:

1. The act of teaching, whereby one individual overtly instructs another by verbal interaction, does not appear to enhance the learning of the teacher beyond that attained by study over an equivalent time period in preparation for an examination. Thus, the oft-quoted axiom that teaching benefits the teacher is thrown into question.

2. Studying new material under the expectation of teaching it to another individual also apparently does not significantly increase learning beyond that attained by study over an equivalent period of time in preparation for an examination.
3. Individuals who are taught in dyadic learning environments seemingly learn as much from their peer teachers as they do from studying the material directly.
4. The amount of time spent studying in preparation to teach may be an important variable in determining how much the teacher learns.

From these conclusions and added personal reflections about the present study, the researcher recommends to the practicing educator or instructional development specialist that the instructional strategy of students teaching other students is a viable one. The students in the teaching role will learn as well as their counterparts who study alone in a more traditional manner and, in addition, they will be highly motivated which may be reflected in intensive study preparation and enthusiasm to do a good job. The students who are taught in a dyadic experience will also learn as much as if they had studied the material directly. The true value of learning in student dyads is that the method gives the

classroom teacher another proven option to create an exciting, varied, effective learning environment. The fact that educational institutions, presently reeling from severe economic pressures, are seeking alternative, low-cost, effective ways of teaching enhances the viability of students instructing other students.

The instructional development specialist is sometimes called upon to show evidence regarding a particular instructional practice. The evidence is often lacking. The present study, coupled with those that preceeded it, documents the efficacy of dyadic learning. Based on this data, the instructional development specialist can justifiably report that when students teach each other learning will at least be equivalent to other conventional methods and student motivation may increase.

The developer should note that the student dyadic learning cell concept does not require the production of software materials or the utilization of specialized hardware. In this instance the instructional materials are accepted as givens and the role of the developer and the teacher is one of structuring the learning environment for maximum learner involvement (Rothkopf, 1970).

In addition to the applied aspects of the study, there are a number of factors which interested future

researchers may wish to consider. Several suggestions are presented without regard to order of importance:

1. The basic research paradigm followed in the present experiments should be replicated in future studies. The paradigm called for the comparison of experimental groups with traditional study groups. Also the procedures employed in the study of (a) receive instructions, (b) study, (c) teach and (d) test are believed to be sound. The addition of a pre-test would give added strength to the paradigm; the pre-test could be used as part of an overall pre- and post-test design, as a covariate measure for increased precision or as a mechanism to screen subjects already knowledgeable about the content area. The covariate measure used in the present study correlated only marginally with the post-test.
2. The present study placed restrictions on the amount of study time the "teachers" had to initially learn the material. Such restrictions may be artificial. Future studies might allow the "teachers" to determine their own study time.
3. Also, in this study the students learned the new material and were then required to immediately teach it to other students. There was no intervening time for the "teachers" to reorganize or integrate the

material into their cognitive structures. Provisions for a time period between original learning and subsequent teaching may permit cognitive integration to occur which would be reflected in the test scores.

4. Another time dimension is that of immediate versus long-term learning. In the present study scores from an immediate post-test were used as the basis for drawing inferences. No data has been published regarding the effects on long-term retention.

5. As noted earlier, the present study was of limited duration, required only one teaching opportunity per subject and took only one measure of learning. Several participants (non-experienced teachers) told the researcher at the conclusion of the study that they wished they had had a second opportunity to teach because they felt they learned from the first experience.

6. The present study focused only on measures of cognitive learning. However, during the course of the experiments the researcher noted strong positive affective responses on the part of the "teachers" and the intensity with which they prepared their lesson. Future studies should investigate other effects in addition to cognitive outcomes.

7. An aptitude-treatment-interaction approach might be more successful in ferreting out the phenomenon. Flavell (1968) theorized that the ability to see oneself in another's perspective is important and Feffer and Suchotliff (1966) have suggested such "de-centering" ability is a measurable variable of human behavior. It may well be that individuals with high de-centering ability will benefit by serving as teachers in a teaching-learning dyad.
8. Consideration should be given to supplying the student "teacher" with specific objectives for his peer learner. The objectives would provide a skeleton around which the "teacher" could organize his lesson and may result in better performance by teacher and student.
9. The use of volunteer subjects create a potential for a biased sample and unexpected mortalities; they are to be cautioned against in future studies.
10. Future researchers might wish to consider alternatives to the expository, descriptive nature of the to-be-learned materials in the present study. Problem-solving tasks or discovery-type exercises may produce significant results.

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APPENDICES

APPENDIX A

APPENDIX A

Condensed Version of Taxonomy of Educational Objectives[1]

Cognitive Domain

KNOWLEDGE

1.00 KNOWLEDGE

Knowledge, as defined here, involves the recall of specifics and universals, the recall of methods and processes, or the recall of a pattern, structure, or setting. For measurement purposes, the recall situation involves little more than bringing to mind the appropriate material. Although some alteration of the material may be required, this is a relatively minor part of the task. The knowledge objectives emphasize most the psychological processes of remembering. The process of relating is also involved in that a knowledge test situation requires the organization and reorganization of a problem such that it will furnish the appropriate signals and cues for the information and knowledge the individual possesses. To use an analogy, if one thinks of the mind as a file, the problem in a knowledge test situation is that of finding in the problem or task the appropriate signals, cues, and clues which will most effectively bring out whatever knowledge is filed or stored.

1.10 KNOWLEDGE OF SPECIFICS

The recall of specific and isolable bits of information. The emphasis is on symbols with concrete referents. This material, which is at a very low level of abstraction, may be thought of as the elements from which more complex and abstract forms of knowledge are built.

1.11 KNOWLEDGE OF TERMINOLOGY

Knowledge of the referents for specific symbols (verbal and non-verbal). This may include knowledge of the most generally accepted symbol referent, knowledge of the variety of symbols which may be used for a single referent, or knowledge of the referent most appropriate to a given use of a symbol.

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[1] B. J. Bloom (ed.), Taxonomy of Educational Objectives, Handbook I: Cognitive Domain (New York: David McKay & Co., 1956), pp. 201-207.

*To define technical terms by giving their attributes, properties, or relations.

*Familiarity with a large number of words in their common range of meanings.

1.12 KNOWLEDGE OF SPECIFIC FACTS

Knowledge of the dates, events, persons, places, etc. This may include very precise and specific information such as the specific date or exact magnitude of a phenomenon. It may also include approximate or relative information such as an approximate time period or the general order of magnitude of a phenomenon.

*The recall of major facts about particular cultures.

*The possession of a minimum knowledge about the organisms studied in the laboratory.

1.20 KNOWLEDGE OF WAYS AND MEANS OF DEALING WITH SPECIFICS

Knowledge of the ways of organizing, studying, judging, and criticizing. This includes the methods of inquiry, the chronological sequences, and the standards of judgment within a field as well as the patterns of organization through which the areas of the fields themselves are determined and internally organized. This knowledge is at an intermediate level of abstraction between specific knowledge on the one hand and knowledge of universals on the other. It does not so much demand the activity of the student in using the materials as it does a more passive awareness of their nature.

1.21 KNOWLEDGE OF CONVENTIONS

Knowledge of characteristic ways of treating and presenting ideas and phenomena. For purposes of communication and consistency, workers in a field employ usages, styles, practices, and forms which best suit their purposes and/or which appear to suit best the phenomena with which they deal. It should be recognized that although these forms and conventions are likely to be set up on arbitrary, accidental, or authoritative bases, they are retained because of the general agreement or concurrence of individuals concerned with the subject, phenomena, or problem.

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*Illustrative educational objectives selected from the literature.

*Familiarity with the forms and conventions of the major types of works, e.g., verse, plays, scientific papers, etc.

*To make pupils conscious of correct form and usage in speech and writing.

1.22 KNOWLEDGE OF TRENDS AND SEQUENCES

Knowledge of the processes, directions, and movements of phenomena with respect to time.

*Understanding of the continuity and development of American culture as exemplified in American life.

*Knowledge of the basic trends underlying the development of public assistance programs.

1.23 KNOWLEDGE OF CLASSIFICATIONS AND CATEGORIES

Knowledge of the classes, sets, divisions, and arrangements which are regarded as fundamental for a given subject field, purpose, argument, or problem.

*To recognize the area encompassed by various kinds of problems or materials.

*Becoming familiar with a range of types of literature.

1.24 KNOWLEDGE OF CRITERIA

Knowledge of the criteria by which facts, principles, opinions, and conduct are tested or judged.

*Familiarity with criteria for judgment appropriate to the type of work and the purpose for which it is read.

*Knowledge of criteria for the evaluation of recreational activities.

1.25 KNOWLEDGE OF METHODOLOGY

Knowledge of the methods of inquiry, techniques, and procedures employed in a particular subject field as well as those employed in investigating particular problems and phenomena. The emphasis here is on the individual's knowledge of the method rather than his ability to use the method.

*Knowledge of scientific methods for evaluating health concepts.

*The student shall know the methods of attack relevant to the kinds of problems of concern to the social sciences.

1.30 KNOWLEDGE OF THE UNIVERSALS AND ABSTRACTIONS IN A FIELD

Knowledge of the major schemes and patterns by which phenomena and ideas are organized. These are the large structures, theories, and generalizations which dominate a subject field or which are quite generally used in studying phenomena or solving problems. These are at the highest levels of abstraction and complexity.

1.31 KNOWLEDGE OF PRINCIPLES AND GENERALIZATIONS

Knowledge of particular abstractions which summarize observations of phenomena. These are the abstractions which are of value in explaining, describing, predicting, or in determining the most appropriate and relevant action or direction to be taken.

*Knowledge of the important principles by which our experience with biological phenomena is summarized.

*The recall of major generalizations about particular cultures.

1.32 KNOWLEDGE OF THEORIES AND STRUCTURES

Knowledge of the body of principles and generalizations together with their interrelations which present a clear, rounded, and systematic view of a complex phenomenon, problem or field. These are the most abstract formulations, and they can be used to show the interrelation and organization of a great range of specifics.

*The recall of major theories about particular cultures.

*Knowledge of a relatively complete formulation of the theory of evolution.

INTELLECTUAL ABILITIES AND SKILLS

Abilities and skills refer to organized modes of operation and generalized techniques for dealing with materials and problems. The materials and problems may be of such a nature that little or no specialized and technical information is required. Such information as is required can be assumed to be part of the individual's general fund of knowledge. Other

problems may require specialized and technical information at a rather high level such that specific knowledge and skill in dealing with the problem and the materials are required. The abilities and skills objectives emphasize the mental processes of organizing and reorganizing material to achieve a particular purpose. The materials may be given or remembered.

2.00 COMPREHENSION

This represents the lowest level of understanding. It refers to a type of understanding or apprehension such that the individual knows what is being communicated and can make use of the material or idea being communicated without necessarily relating it to other material or seeing its fullest implications.

2.10 TRANSLATION

Comprehension as evidenced by the care and accuracy with which the communication is paraphrased or rendered from one language or form of communication to another. Translation is judged on the basis of faithfulness and accuracy, that is, on the extent to which the material in the original communication is preserved although the form of the communication has been altered.

*The ability to understand non-literal statements (metaphor, symbolism, irony, exaggeration).

*Skill in translating mathematical verbal material into symbolic statements and vice versa.

2.20 INTERPRETATION

The explanation or summarization of a communication. Whereas translation involves an objective part-for-part rendering of a communication, interpretation involves a reordering, rearrangement, or a new view of the material.

*The ability to grasp the thought of the work as a whole at any desired level of generality.

*The ability to interpret various types of social data.

2.30 EXTRAPOLATION

The extension of trends or tendencies beyond the given data to determine implications, consequences, corollaries, effects, etc., which are in accordance with the conditions described in the original communication.

*The ability to deal with the conclusions of a work in terms of the immediate inference made from the explicit statements.

*Skill in predicting continuation of trends.

3.00 APPLICATION

The use of abstractions in particular and concrete situations. The abstractions may be in the form of general ideas, rules of procedures, or generalized methods. The abstractions may also be technical principles, ideas, and theories which must be remembered and applied.

*Application to the phenomena discussed in one paper of the scientific terms or concepts used in other papers.

*The ability to predict the probable effect of a change in a factor on a biological situation previously at equilibrium.

4.00 ANALYSIS

The breakdown of a communication into its constituent elements or parts such that the relative hierarchy of ideas is made clear and/or the relations between the ideas expressed are made explicit. Such analyses are intended to clarify the communication, to indicate how the communication is organized, and the way in which it manages to convey its effects, as well as its basis and arrangement.

4.10 ANALYSIS OF ELEMENTS

Identification of the elements included in a communication.

*The ability to recognize unstated assumptions.

*Skill in distinguishing facts from hypotheses.

4.20 ANALYSES OF RELATIONSHIPS

The connections and interactions between elements and parts of a communication.

*Ability to check the consistency of hypotheses with given information and assumptions.

*Skill in comprehending the interrelationships among the ideas in a passage.

4.30 ANALYSIS OF ORGANIZATIONAL PRINCIPLES

The organization, systematic arrangement, and structure which hold the communication together. This includes the "explicit" as well as "implicit" structure. It includes the bases, necessary arrangement, and the mechanics which make the communication a unit.

*The ability to recognize form and pattern in literary or artistic works as a means of understanding their meaning.

*Ability to recognize the general techniques used in persuasive materials, such as advertising, propaganda, etc.

5.00 SYNTHESIS

The putting together of elements and parts so as to form a whole. This involves the process of working with pieces, parts, elements, etc., and arranging and combining them in such a way as to constitute a pattern or structure not clearly there before.

5.10 PRODUCTION OF A UNIQUE COMMUNICATION

The development of a communication in which the writer or speaker attempts to convey ideas, feelings, and/or experiences to others.

*Skill in writing, using an excellent organization of ideas and statements.

*Ability to tell a personal experience effectively.

5.20 PRODUCTION OF A PLAN, OR PROPOSED SET OF OPERATIONS

The development of a plan of work or the proposal of a plan of operations. The plan should satisfy requirements of the task which may be given to the student or which he may develop for himself.

*Ability to propose ways of testing hypotheses.

*Ability to plan a unit of instruction for a particular teaching situation.

5.30 DERIVATION OF A SET OF ABSTRACT RELATIONS

The development of a set of abstract relations either to classify or explain particular data or phenomena, or the deduction of propositions and relations from a set of basic propositions or symbolic representations.

*Ability to formulate appropriate hypotheses based upon an analysis of factors involved, and to modify such hypotheses in the light of new factors and considerations.

*Ability to make mathematical discoveries and generalizations.

6.00 EVALUATION

Judgments about the value of material and methods for given purposes. Quantitative and qualitative judgments about the extent to which material and methods satisfy criteria. Use of a standard of appraisal. The criteria may be those determined by the student or those which are given to him.

6.10 JUDGMENTS IN TERMS OF INTERNAL EVIDENCE

Evaluation of the accuracy of a communication from such evidence as logical accuracy, consistency, and other internal criteria.

*Judging by internal standards, the ability to assess general probability of accuracy in reporting facts from the care given to exactness of statement, documentation, proof, etc.

*The ability to indicate logical fallacies in arguments.

6.20 JUDGMENTS IN TERMS OF EXTERNAL CRITERIA

Evaluation of material with reference to selected or remembered criteria.

*The comparison of major theories, generalizations, and facts about particular cultures.

*Judging by external standards, the ability to compare a work with the highest known standards in its field--especially with other works of recognized excellence.

APPENDIX B

APPENDIX B
GLACIERS

Ice plays a critical role in the water economy of the earth. About 86 percent of it is in the Antarctic, where it exerts a profound influence on the weather in all parts of the world.

by William O. Field

Water is one of the few substances on earth existing in nature in all three physical states--liquid, solid, and gaseous. Altogether our planet contains some 350 million cubic miles of water, most of it, of course, in the oceans. Of the earth's total water budget, not much more than one percent is in the solid form of ice or snow, and far less than that in the form of water vapor in the atmosphere. Yet these proportions make up a delicate balance which is immensely important to life on the earth. Any appreciable change in the ratios of water, ice and atmospheric moisture would have catastrophic consequences for man and his economy. The ice piled in glaciers on the lands, for instance, exercises a vital control over sea levels, climate and the continents' water supplies.

Glaciers now cover about ten percent (nearly six million square miles) of the world's land area. Our estimate of the total amount of water in them is only a rough guess, mainly because we have only a hazy notion of the thickness of the Antarctic ice sheet. This vast icecap accounts for about 86 percent of the world's glacial area. The Greenland icecap makes up another ten percent. The remaining four percent is not minor, as far as its effects go, for it includes tens of thousands of square miles of glaciers

on mountains in the temperate zones, where they intimately influence man's climate and water supplies.

Estimates of the total volume of water in the world's glaciers range from about 2.4 million to more than six million cubic miles. If all this ice melted, the level of the world's oceans would rise by something like 65 to 200 feet!

Glaciers can grow only in areas where the snowfall is great enough year after year to exceed the annual rate of melting. Consequently, the ice sheet is not necessarily thickest where the climate is coldest. In Alaska the greatest concentration of glaciers is along the southern coast, which is the warmest part of the Territory but has the heaviest winter snowfall. Parts of northern Greenland are barren of glaciers because there is not enough snowfall.

As snow accumulates, the pressure of the mountainous layers compacts it into ice. Under its own weight ice begins to flow to lower elevations. The rate of flow of glaciers varies tremendously: some move very slowly while others slide as much as 50 feet per day during the summer. At the lower elevations, the glacier melts or discharges icebergs into the sea. But under suitable conditions, the glacier front may advance over the land year after year. It takes only a slight change in the combination of annual snowfall, melting-season temperatures and other meteorological conditions to produce an advance or retreat of a glacier.

Probably during most of the earth's history it has been free of glaciers. We are in an exceptional era--neither glacial nor nonglacial. During the last million years there have been at least four great ice ages; at their

maximum, ice covered about 32 percent of the world's land surface. The ice ages were separated by long warm intervals during which the glaciers nearly disappeared. At present we seem to be in an in-between stage, somewhere between a glacial and an inter-glacial age. Some glaciers are growing; others are disappearing.

During the last Ice Age the sea level probably was more than 300 feet lower than now. Over the world the temperatures averaged 7 to 14 degrees colder. There were five continental ice sheets of more than one million square miles each. Three of these, in North America, Europe and Siberia, have disappeared, but the two in Greenland and Antarctica remain. Mountain glaciers have all shrunk.

Human civilizations began to arise in Western Asia and North Africa just as the European and North American sheets were disappearing. About 3000 B.C. the climate in many, if not all, parts of the world was drier and warmer by two or three degrees than at present. The sea level was apparently five to six feet higher. The glacial region in the Alps was at least 1,000 feet higher than today. Ice in the Artic Ocean probably melted completely each summer. Parts of the temperature regions where small mountain glaciers now furnish the summer water supply must have been arid.

Conditions began to change drastically about 1000 B.C. The climate became colder and more stormy in many parts of the world, and by about 500 B.C. glaciers began to grow again. Then, in the first millennium of the Christian era, came a period of glacier recession. After that glaciers advanced again to a maximum in the 17th and 19th centuries. This resurgence of glaciers was noted directly by observers in the Alps,

Scandinavia and Iceland. Since the latter half of the 19th century, glaciers throughout the world have tended to shrink once again. As a result the sea level has apparently been rising recently at the rate of approximately 2.5 inches per century. Some glaciers, however, have advanced, contrary to the general trend. In parts of the western U.S. there is a growth of glaciers at present which may indicate a changing climate.

Glaciers have been studied seriously for a little more than 100 years. Beginning in 1919 Hans Wison Ahlmann of the University of Stockholm (now Sweden's Ambassador to Norway) introduced a new era in glaciology. He to took a new look, in greater detail, at glaciers in Scandinavia, Iceland, Spitsbergen and northeast Greenland, and his examination led to new methods of measuring their nourishment and wastage. Observations of glaciers are now being made on a systematic basis in several parts of the world. During the last decade, important studies have been carried out in Greenland, especially by Paul Victor's French Polar Expeditions, which determined the volume of the Greenland ice sheet and studied its regimen over a broad area.

The little-known Antarctic ice sheet is more than one and a third times the size of the U.S. and its territories. It covers practically the whole continent of Antartica. Fully three million square miles of the continent have never been seen even from the air. The continent's icecap is known to rise as high as 10,000 feet, but the thickness of the ice has been measured in only a few places.

Adapted from

William O. Field, "Glaciers," Scientific American, September, 1955, pp. 84-92.

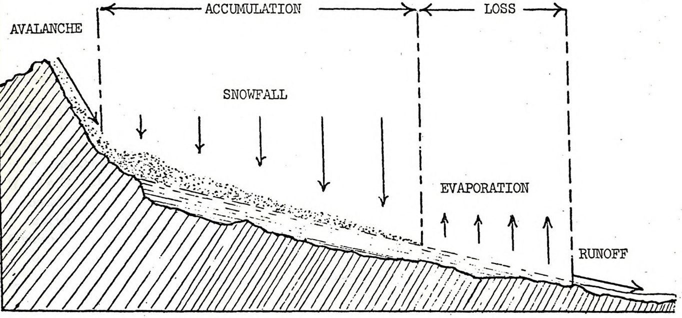

Figure 1. LIFE OF A GLACIER is depicted in this cross section of an ideal valley glacier. Falling snow carried by avalanche is compressed into ice, which begin to move by its own weight. The line dividing the areas of accumulation and loss is the firn line, where total accumulation equals total melting. Variations in snowfall, temperature and other conditions determine whether the glacier advances.

NOTE: The figure above and the tables on the next page are included as appendix material only to assist your understanding of the article. Examine these materials quickly; do not attempt to learn or memorize all the information presented.

TABLE 1. Distribution of Water Volume

LOCATION	CUBIC MILES
Water in the oceans (close estimate)	329,000,000
Water in the atmosphere (rough estimate)	3,600
Water in glaciers (average of high and low estimates)	4,200,000
Water in lakes and rivers (rough estimate)	55,000
Ground water above 12,500 feet (very rough estimate)	1,080,000
Ground water below 12,500 feet (very rough estimate)	19,700,000

TABLE 2. Distribution of Ice by Area

LOCATION	SQUARE MILES
Africa	8
Antarctica	5,019,000
Asia	42,200
Canadian Arctic Islands	45,000
Europe	4,370
Greenland	666,300
North America	30,890
Northern Atlantic and European Arctic Islands	45,400
Pacific Islands	392
South America	9,650
Sub-Antarctica Islands	1,160
World Total	5,864,370

Experiment in Learning II
GLACIERS

TEST DIRECTIONS

Attached are the test and answer sheets to accompany the passage .lled "Glaciers."

The test consists of two parts. The first part is 40 multiple-choice ıestions; the second is 6 short-answer questions. Please answer all ıestions. Although there is no time limit, you should finish the entire st in about 35 minutes. Therefore, do not spend a great amount of me on any one question.

1. Do the multiple-choice section of the test first. Mark your answers on the answer sheet with the scoring pencil provided. Do not make any stray marks on the scoring sheet. If you make an error, erase it completely before marking another answer. Do not mark in the test booklet.

2. After completing all the multiple-choice items proceed to the short-answer questions which are attached to the scoring sheet. Write your answers to these questions directly on the sheets of paper.

3. When you have read these directions, please wait for further instructions.

rry Bratton
chigan State University
ıy 1974

Which of the following is one of the natural physical states of matter?
1. ice
2. frozen
3. solid
4. hard

In which physical state is most of the earth's water?
1. liquid
2. frozen
3. gaseous
4. ice

The ice in glaciers does <u>not</u> control
1. sea level
2. climate
3. wind speed
4. water supply

The thickness of glaciers is primarily determined by the
1. land surface
2. altitude of the glacier
3. average temperature of the area
4. amount of snowfall

There are fewer glaciers in northern Alaska than in southern Alaska because northern Alaska has
1. colder weather
2. less snowfall
3. more snowfall
4. fewer valleys in which glaciers could form

Icebergs are formed by
1. the freezing of sea water
2. glaciers advancing into the oceans
3. glaciers forming over the oceans
4. snow falling into the oceans

How many ice ages have occurred during the last million years?
1. 1
2. 2
3. 3
4. 4

Of the five continental ice sheets formed during the last ice age two remain. One of them is located in
1. Canada
2. Greenland
3. Norway
4. Siberia

As compared with our present climate, the climate of the world in 3000 B.C. was
1. drier and colder
2. drier and warmer
3. damper and colder
4. damper and warmer

Where is most of the world's water?
1. in the oceans
2. in the atmosphere
3. below the ground
4. in glaciers

The great continental ice sheets disappeared from the United States and Europe about
1. 3,000 years ago
2. 5,000 years ago
3. 250,000 years ago
4. 500,000 years ago

What might happen if the earth's glaciers were to melt during the next decade?
1. Greenland would develop into an important nation.
2. The great seaports of the world would disappear under water.
3. Antarctica would emerge as a large continental mass.
4. Australia would submerge.

If one wished to estimate from the information in the passage the amount of water in the Antarctic ice sheet, then what assumption would have to be made?
1. The average thickness of the Antarctic ice sheet is equal to the average thickness of all the world's glaciers.
2. The average temperature of Antarctica is about the same as the average temperature of other glacial areas.
3. Snowfall in Antarctica is about equal to the snowfall in other areas.
4. The ratio of growth of the Antarctic ice sheet is about the same as that of other glaciers.

The fact that the great Alaskan glaciers are located in forested areas implies that these glaciers are
1. part of a vast ice cap
2. the world's thickest glaciers
3. remaining portions of a receding ice cap
4. temperate zone glaciers

During the last ice age, the highest summer temperature in what is now the southeastern United States was
1. 70 degrees
2. 85 degrees
3. 110 degrees
4. 120 degrees

Which of the following best describes the entire article?
1. It presents evidence that we are in an interglacial period.
2. It describes in scientific language the growth and decline of glaciers.
3. It presents arguments to show the need for increased study of glaciers.
4. It shows the critical role ice plays in the economy of the earth.

Suppose that one inch of snow per year fell in a barren land, and that the temperature never exceeded the freezing point, and that no glaciers ever formed. One possible explanation for the absence of glaciers is
1. the absence of avalanches
2. that the snow evaporates
3. that runoff is greater than snowfall
4. that the snow is immediately converted to ice

The <u>least</u> important factor in glacier formation is
1. annual snowfall
2. low temperature
3. atmospheric pressure
4. distance from the equator

If you saw a piece of ice, weighing about 100 pounds, floating in the Gulf of Mexico, which of the following would be the most reasonable explanation for its presence?
1. It was artifically formed and had just been dropped from a passing boat.
2. It was an iceberg which was formed off the coast of Greenland and drifted to the Gulf.
3. It was formed in the Rocky Mountains and was carried to the Gulf.
4. It was the result of hail massing as it fell into the Gulf.

The size and number of glaciers have remained relatively unchanged during the past two thousand years; however,
1. There have been substantial changes from century to century during the period.
2. Sea level has increased by $2\frac{1}{2}$ inches each century for the last five centuries.
3. Glaciers in the United States have disappeared but those in Europe have increased in number and size.
4. The volume of water in the atmosphere has increased substantially.

The process of converting snow to ice in the formation of a glacier is similar to the process of making
1. steam from water
2. wool by sheep
3. rayon from chemicals
4. coal from vegetation

What is the relationship between
A. Amount of glaciation in the world, and
B. Surface area of land.
1. An increase in A is accompanied by an increase in B.
2. An increase in A is accompanied by a decrease in B.
3. A and B are unrelated.
4. The relationship cannot be determined from the passage.

If all of the ice in Antarctica were melted by artificial means and all other ice areas remained the same then the maximum rise in the world's oceans would be
1. 60 feet
2. 170 feet
3. 240 feet
4. 210 feet

* * * * * * * * * *

TE: The following information applies to questions 24-26. Assume the following about the conditions of a geographic area:
a. Average annual snowfall is 10,000 cubic feet per square mile.
b. Average daily high temperature is 70 degrees F. in the summer months.
c. Average annual melt is 10,000 cubic feet per square mile.
d. These conditions have existed for 100 years.

This region probably
1. has no glaciers
2. is highly glaciated
3. is near a glaciated area
4. has a few small glaciers

If the annual melt were to be reduced to 9,500 cubic feet per year, how would the conditions change?
1. The annual snowfall would decrease to less than 9,500 cubic feet per square mile.
2. Glaciers would begin to form.
3. The annual snowfall would increase.
4. The glaciers would begin to disappear.

What would cause a decrease in the annual melt?
1. Increase in annual snowfall.
2. Decrease in average daily summer temperature.
3. Decrease in average atmospheric pressure.
4. Increase in average daily winter temperature

* * * * * * * * * *

A glacier can best be described as a
1. snow field
2. moving ice field
3. product of low temperature
4. valley packed with ice

What is the relationship between
A. Average world temperature, and
B. Amount of water in the oceans.
1. An increase in A is accompanied by an increase in B.
2. An increase in A is accompanied by a decrease in B.
3. A and B are unrelated.
4. The relationship cannot be determined from the passage.

What is the relationship between
A. Amount of snowfall, and
B. Amount of glaciation.
1. An increase in A is accompanied by an increase in B.
2. An increase in A is accompanied by a decrease in B.
3. A and B are unrelated.
4. The relationship cannot be determined from the passage.

Approximately 96 percent of the glacial area of the world is located
1. in the southern hemisphere
2. outside the temperate zone
3. in the eastern hemisphere
4. in Antarctica

An increase of 10 percent in the average world temperature would have which of the following effects?
1. Increase the water in the atmosphere.
2. Cause over 4,500,000 cubic miles of water to freeze into glaciers.
3. Lessen the 300 million cubic miles of water in the oceans.
4. Decrease average annual rain fall.

What is the relationship between
A. Number of glaciers near the coast, and
B. Number of icebergs in the ocean.
1. An increase in A is accompanied by an increase in B.
2. An increase in A is accompanied by a decrease in B.
3. A and B are unrelated.
4. The relationship cannot be determined from the passage.

Assume that the average temperature in the United States will drop 50 degrees F. tomorrow and remain the same for 500 years. Where would you expect to see the first new valley glaciers?
1. Kansas-Nebraska wheat belt
2. Texas-Oklahoma cattle country
3. Northern Alaska
4. Central eastern seaboard

If all glaciers melted, which one of the following predictions would be false?
1. Coastal resorts would be flooded.
2. The climate would be warmer.
3. The salt content of the oceans would be increased.
4. Mass migration of people would take place.

The total volume of water in the world's glaciers is approximately
1. one million cubic miles
2. two million cubic miles
3. four million cubic miles
4. seven million cubic miles

The serious study of glaciers began about the time of the
1. Civil War
2. Golden Age of Greece
3. French Revolution
4. discovery of America

What is the primary reason that glaciers do not exist in central Canada?
1. The altitude of this region is less than 13,500 feet.
2. The temperature reaches 80 degrees F. in the summer months.
3. The temperature reaches 30 degrees F. below zero.
4. It is too far from the polar ice cap.

Glaciers stopped advancing over North America when
1. They reached the mild climate south of the Tropic of Cancer.
2. Accumulation exceeded loss.
3. The snowfall failed to keep pace with the annual melt.
4. The edges reached the sea and formed icebergs.

Suppose that a scientist calculated that if a certain proportion of the glaciers melted, then a city now 500 feet above sea level would be only 250 feet above sea level. He probably assumed which one of the following in making his calculations?
1. The volume of a kilogram of water varies directly with temperature.
2. One cubic foot of ice, when melted, produces one cubic foot of water.
3. Some of the melted ice would remain in mountain lakes.
4. The slope of shore lines is relatively constant around the world.

The author states that we are living in an exceptional era with regard to glaciation. Which one of the following would substantiate this statement the <u>least</u> from the physical standpoint?
1. A new continental glacier is forming.
2. The world is partially glaciated.
3. The Arctic Ocean is open water.
4. A systematic study of glaciers is taking place.

STIONS 41-46 ARE ATTACHED TO THE ANSWER SHEET. PLEASE GO
CTLY TO THESE QUESTIONS.

GLACIERS
Short-Answer Questions

DIRECTIONS: Your answers to items 41-46 should be legibly written directly on these sheets in the space provided below each item. Should you need additional space for your answer, write the remainder on the back of the page.

Suppose you knew that an advancing glacier would reach town in 12 months. Outline a plan which could be followed to prevent the glacier from reaching the town.

A scientist believes that advancing glaciers slide on a thin layer of water which lies between the bottom of the glacier and the earth. Outline a plan to test whether his belief is true or false.

* * * * * * * * * *

NOTE: The following information must be used in answering the following questions.

Suppose that you have been asked to evaluate the author's qualifications to write an article on Glaciers. Listed below are several statements which could be true about the author. Assume each statement to be true. Do not consider any relationships which might exist between the statements.

A. On the line following the statement place an X in the space after:

"qualified"--if the statement leads you to believe the author is qualified to write about glaciers.

"not qualified"--if the statement leads you to believe the author is not qualified to write about glaciers.

"no effect"--if you believe the statement has no bearing on the author's qualifications, or lack of them, to write about glaciers.

B. In the space provided below each item write a brief statement giving the reason(s) why you marked the answer you did.

This was the first article written by the author published in Scientific American.
qualified_____ not qualified_____ no effect_____

He won a Nobel prize for his work on the geology of Haiti.
qualified_____ not qualified_____ no effect

His name is not included in the Directory of American Scholars.
qualified_____ not qualified_____ no effect_____

He is an amateur mountain climber.
qualified_____ not qualified_____ no effect

APPENDIX C

APPENDIX C
THE LISBON EARTHQUAKE

Some catastrophes demand of man far more than relief and rehabilitation: they literally call for rethinking on a universal scale. This was so with the man-made disaster of Hiroshima. Similarly, the great earthquake at Lisbon on November 1, 1755, shook the minds of men.

While controversy surrounds most statistics dealing with the Lisbon earthquake, there is little doubt that it is one of the most severe recorded. Voltaire's classic description in the story, Candide, vividly paints the tragic scene after the earth started to tremble under the feet of the people of Lisbon: "The sea rose in foaming masses in the port and smashed the ships which rode at anchor. Whirlwinds of flame and ashes covered the streets and squares; the houses collapsed, the roofs were thrown upon the foundations, and the foundations were scattered; thirty-thousand inhabitants of every age and both sexes were crushed under the ruins."

In all, there were three shocks. The first, which lasted two minutes, shook the earth so slightly that an eyewitness recalled that he thought it had been caused by a passing vehicle. Two minutes later a second quake was felt, and this time its violence left no doubt as to what it was. During its ten minute visitation of terror, the dust from falling buildings was so great it obscured the sun. Next came another awful tremor, and the buildings which still remained standing now came tumbling down, bringing added dust, and plunging the city into total darkness. After twenty minutes of death-spelling noises, all became quiet. Then, to quote an eyewitness,

"a very boisterous wind" suddenly arose, fanning the flames of the candle-fed fires which had broken out all over the city.

Unfortunately, a combination of circumstances made the disaster greater than it might otherwise have been. For one thing, the quake occurred on All Saints' Day, which meant that candles had been burning since early morning in homes and churches. Then, to make matters worse, the earthquake struck at a bad time: shortly before ten in the morning--an hour when most of the people were at church. The violent movements of the earth caused the roofs of heavy stone to topple on the congregants, who, if they were not crushed to death, died in the flames.

The people experienced all the possible elements of horror. To falling stones and fires must be added the forty foot tidal wave which engulfed those who rushed to the quays after having escaped the earlier shocks. Furthermore, man, or at least a lower species, contributed looting and murder to the scene of despair. Valuable records, irreplaceable documents were lost, and, since there exists no inventory of Lisbon's art treasures of that time, we cannot even guess what the world has lost.

The older, medieval section of Europe's westernmost capital was completely destroyed. So, for that matter, were the towns within a distance of 20 leagues. "I write to you from the depths of the country," complained a survivor, "for there is not a habitable house left. Lisbon has vanished!" Built on a more substantial foundation of basalt, the newer section of Lisbon survived the earthquake.

The Lisbon earthquake, whose tremors were reportedly felt as far north as Norway and as far south as North Africa, made a profound impression on Europe. Great Britain was the first to offer help. Parliament voted the then tremendous sum of one hundred thousand pounds to aid the victims, in addition to gifts of food and clothing. Spain changed her tariff laws to favor Portugal's recovery. Also, large sums of money and provisions from all over Europe were generously offered by sympathetic nations and individuals.

Like today's moral and intellectual repercussions from man-made disastrous weapons, Lisbon's disaster registered severely on the mental seismographs of some of the outstanding thinkers of the eighteenth century. A noted historian of Portugal declares that to the little country on the Iberian Peninsula, the earthquake was "more than a cataclysm of nature; it was a moral revolution."

So shattered was the moral and material structure of Lisbon society that it was seriously proposed that the government be transferred to Rio do Janeiro, the capital of its great colony! Fortunately, the crisis brought to complete power a ruthless, but exceedingly capable dictator, Pombal.

He was appointed Minister of Foreign Affairs and War by King Jose I in 1750 and quickly established himself as a dominant figure in Portuguese politics. The earthquake provided an opportunity for him to obtain complete power. On the day after the earthquake he told the Chief Justice to appoint a special magistrate for each of the twelve wards of the city. These magistrates were given authority to carry out the government's

emergency directives. Troops were rushed to Lisbon in order to maintain law and order and to assist in clearing up the ruins. Pombal's immediate concern was to prevent a plague; steps were taken to remove the bodies of men and animals from the ruins as quickly as possible, pools of stagnant waters were drained and contaminated food was destroyed. A most urgent matter was providing food and shelter for the survivors. Food centers were established and field kitchens were built. Prices of food and building materials were strictly controlled to prevent profiteering. Steps were taken to prevent looting. On November 4 immediate public execution after a summary trial was ordered for those caught looting the ruins.

Although many of Pombal's reforms were short lived, his great schemes and actual reforms shook Portuguese society loose from its medieval foundations. Starting with physical reconstruction while Lisbon was still smouldering, he built a new and more modern city. Temporary wooden structures were constructed outside the city to provide emergency housing and governmental offices. In early 1756 Pombal ordered unauthorized building in stone or brick stopped and the city was rebuilt according to a master plan. Taxation, civil law and public administration were reformed, new industries were set up, communications were improved, colonial relationships were re-evaluated, and education was revamped. Above all, by his ensuing power conflicts with the nobility and the clergy, Pombal helped Portugal advance on the road to a more modern society.

Meanwhile, elsewhere in Europe numerous accounts of the great earthquake were being published in virtually all languages. More than

20 reports, not including magazine articles, were published in 1755 in England alone! The great philosopher Immanuel Kant took time out from his studies to write a book on the theory of earthquakes. But the intellectual crisis in which Europe was embroiled for almost all the rest of the century took place mainly in France. Basically, the great quarrel of the age concerned the validity of the popular optimistic philosophy of Leibniz, who believed that "What is, is Right," and that this is the "best of all possible worlds."

Leibniz stated that man could have no free will in a perfect world and that, "Our world is suited to our desires and appetites." He believed that the world was built on a plan which harmonizes with the moral government of its inhabitants and theorized that the past, present, and future have already been set with as much order and harmony as possible. Leibniz surmised that, "the world must be destroyed and repaired by natural means, at such times as the government of spirits may demand it for the punishment of some and the reward of others." He felt that evil tends to evoke a greater good in the long run and maintained, "It is impossible to make the world better than it is, not only as a whole and in general, but also for ourselves in particular."

Voltaire, in his long poem, "The Lisbon Earthquake," vigorously attacked the Leibniz philosophy. He regarded it as unprogressive in that "physical evil deserved man's attention." It was also a cruel dogma, he believed, in that it implied that "your particular misfortune is nothing; it contributes to the universal good." Voltaire expressed faith in progress

which, he said, depended upon the good sense of mankind.

Leibniz, however, held that we should be content with the order of the past because it is in conformity with the absolute will of God. Although Leibniz suggested that we should make the future in conformity with the presumed will of God, he cautioned against becoming upset if we were unsuccessful.

Rousseau, in an impassioned refutation, maintained an "all is good" theme. Man must be patient and recognize evil as the consequence of his own nature. Furthermore, Rousseau claimed that civilization had corrupted man. Although Rousseau looked to the past and said progress was an illusion, he was later to expound, in his Social Contract, a theory of rule by the consent of the governed and actually advocated revolt by the people if they were unfairly ruled.

In Candide Voltaire, as we know, returned to the fray with slashing attacks on Rousseau and Leibniz for their views concerning human progress. Practically all the philosophers of the eighteenth century took sides in what has been called the "theology of earthquakes." Such was the exchange of arguments, in fact, that the wordy Dr. Johnson complained that he was weary of hearing about the subject.

While no such clear-cut philosophical discussion fills our twentieth century air, we scarcely need be reminded that, once again, recent catastrophes have sent man to meditate on life's eternal questions. Obviously, man is worried about possible misuse of fission and fusion.

In addition, Nature, with her unlady-like hurricanes of recent years,

and the devastating floods of the past summer, has intruded into what had begun to seem to many like a man-manipulated world. While we are, today, better equipped for relief and rehabilitation than the Portuguese were two hundred years ago, it is well to remember that as in the case of the Lisbon disaster, the Northeast floods were not even predicted, much less staved off.

Nature's calamities and their aftermath of re-evaluation are still very much with us.

Adapted from

Albert Alexander, "The Lisbon Earthquake," Social Education, Vol. XX, No. 1, January, 1956, pp. 27-28.

and

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Experiment in Learning II
LISBON EARTHQUAKE

TEST DIRECTIONS

Attached are the test and answer sheets to accompany the passage alled "The Lisbon Earthquake."

The test consists of two parts. The first part is 40 multiple-choice 1estions; the second is 6 short-answer questions. Please answer all 1estions. Although there is no time limit, you should finish the entire st in about 35 minutes. Therefore, do not spend a great amount of me on any one question.

1. Do the multiple-choice section of the test first. Mark your answers on the answer sheet with the scoring pencil provided. Do not make any stray marks on the scoring sheet. If you make an error, erase it completely before marking another answer. Do not mark in the test booklet.

2. After completing all the multiple-choice items proceed to the short-answer questions which are attached to the scoring sheet. Write your answers to these questions directly on the sheets of paper.

3. When you have read these directions, please wait for further instructions.

arry Bratton
ichigan State University
ay 1974

How many earth shocks were felt in the Lisbon earthquake?
1. 2
2. 3
3. 4
4. 5

How long was the first earthquake shock at Lisbon?
1. two minutes
2. ten minutes
3. twenty minutes
4. thirty-two minutes

Which of the following was not true of the Lisbon earthquake?
1. It happened during evening services.
2. A tidal wave also struck.
3. The sun was obscured part of the time.
4. It occurred about 10 o'clock in the morning.

The first country to offer aid to Lisbon was
1. France
2. Great Britain
3. Norway
4. Spain

Which of the following was not offered by Great Britain to help Portugal?
1. clothing
2. food
3. lowering of trade tariffs
4. money

King Jose I appointed Pombal to the position of
1. Minister of Foreign Affairs and War
2. Chief Justice
3. Dictator
4. Chief Magistrate

Before the earthquake, Pombal was
1. dictator of Portugal
2. a dominant figure in Portuguese politics.
3. Influential among the common people.
4. a noted philosopher.

Immediately following the earthquake Pombal's major concern was to
1. rebuild the city
2. prevent looting
3. provide shelter
4. prevent a plague

Voltaire's poem, "The Lisbon Earthquake," was an attack on
1. Pombal's emergency directives
2. Leibniz's philosophy
3. Kant's philosophy
4. King Jose I's lack of action

Rousseau considered that the misfortunes resulting from the earthquake were nothing compared with the good which ultimately resulted from it. Which one of the following agreed with him?
1. Johnson
2. Kant
3. Leibniz
4. Voltaire

If the earthquake had not occurred, which of the following would have been most likely?
1. King Jose I would have become an absolute monarch.
2. Pombal would have lost his power and influence.
3. Pombal would have had a less profound influence on Portugal's future.
4. The Chief Justice would have become the most powerful person in Portugal.

What is the relationship between the following statements?
A. Pombal's conflict with the nobility and the clergy.
B. Modernization of Portugal.
1. A caused by B
2. B caused by A
3. A and B are related, but one did not cause the other.
4. A and B are unrelated.

"Man or at least a lower species contributed looting and murder to the scene of despair." In this sentence "lower species" most nearly means
1. non-noblemen and working men
2. looters and robbers
3. animals of high order
4. morally inferior men

What is the relationship between the following statements?
A. Charging of unreasonable prices for rent.
B. Rent control following the earthquake.
1. A caused B.
2. B caused A.
3. A and B are related, but one did not cause the other.
4. A and B are unrelated.

Which of the following philosophers would have most likely supported Pombal's policies?
1. Kant
2. Leibniz
3. Rousseau
4. Voltaire

If man were to misuse nuclear fission and fusion which person's philosophy would have the least relevance?
1. Leibniz
2. Pombal
3. Rousseau
4. Voltaire

Which one of the following conditions would have resulted in the reduction of damage to the older section of Lisbon?
1. The existence of a basalt foundation under all of Lisbon.
2. The occurrence of the earthquake on a non-religious holiday.
3. The use of wooden roofs for buildings.
4. The location of the center of the earthquake ten leagues away.

Which one of the following would most likely not have been a "good Samaritan"?
1. Kant
2. Leibniz
3. Pombal
4. Voltaire

What is the relationship between the following statements?
A. Voltaire's poem "The Lisbon Earthquake."
B. Leibniz's philosophy.
1. A caused B.
2. B caused A.
3. A and B are related, but one did not cause the other.
4. A and B are unrelated.

The number of persons killed in the earthquake was undoubtedly increased because stone was used for
1. sea walls
2. streets and sidewalks
3. sidewalls of buildings
4. roofs of buildings

A viewpoint which cannot be found in the reading passage is that of
1. an observer
2. a scientist
3. a philosopher
4. an historian

If you lived in a country where most of the citizens were poor and lived in slums and the rulers were rich and lived in palaces, what would you do if you believed in the later teachings of Rousseau?
1. Urge the people to revolt against the rulers.
2. Urge your fellow citizens to let well enough alone.
3. Urge the government to build schools for the poor.
4. Remind your fellow citizens that progress is bound to occur.

Which of the following statements best represents Pombal's philosophy of life?
1. What is to be will be.
2. Might makes right.
3. God punishes guilty and innocent alike.
4. Bury the dead and feed the living.

"What is, is right," is most nearly equivalent to
1. "What is to be, will be."
2. "The end justified the means."
3. "Might makes right."
4. "The sky is the limit."

What characteristic of a medieval society discouraged modernization of Portugal?
1. Political and economic power of the nobles and clergy.
2. The existence of an old section in the towns.
3. Great emphasis on religion.
4. Lack of trade with other countries.

Why were most of the discussions of the Lisbon earthquake philosophical?
1. Few written accounts were available.
2. There were few survivors.
3. There was no accurate means of describing the disaster.
4. Philosophers were the spokesmen of the time.

Which of the following statements is best supported by the philosophy of Voltaire?
1. Social welfare programs should be curtailed.
2. The American foreign aid program should be eliminated.
3. People with children in school should pay a tax to support education.
4. Big cities should start slum clearance projects.

What action, if any, would Pombal probably have taken if most of the skilled craftsmen like carpenters and bricklayers had left Lisbon immediately following the earthquake?
1. None, because there would have been fewer people to feed and shelter.
2. None, because other areas needed these people more than Lisbon did.
3. Action to return them so they could help rebuild the city.
4. Action to return them so they could be punished for leaving.

What is the relationship between the following statements?
   A. There were many fires in Lisbon after the earthquake.
   B. Most of the inhabitants of Lisbon observed religious holidays.
1. A caused B.
2. B caused A.
3. A and B are related, but one did not cause the other.
4. A and B are unrelated.

How could you best describe the statement that "Lisbon has vanished?" It is
1. absurd
2. accurate
3. exaggerated
4. unsubstantiated

Which one of the following statements could be attributed to Voltaire?
1. Research is more important than application.
2. Benefit to man is the primary goal of science.
3. Science serves the purpose of discovering the natural harmony and order of the world.
4. The study of science is not a proper activity for man.

Which fact about Pombal is most consistent with the belief that he accepted the philosophy of Voltaire?
1. He did not move the capital to Rio de Janeiro.
2. He was ruthless.
3. He broke with tradition.
4. He used Voltaire's poem, "The Lisbon Earthquake," as his guide to reconstruct Lisbon.

Pombal was able to assume complete power following the earthquake because he was
1. a member of the nobility
2. the spokesman of the people
3. established in the power structure of Portugal
4. well liked by the king and his court

Which of the following is both a sequential relationship and a cause-and-effect relationship?
1. All Saints' Day celebration--Lisbon earthquake.
2. Consideration of moving to Rio de Janeiro--Pombal's rise to power.
3. "Theology of Earthquakes"--extensive news coverage of the Lisbon earthquake.
4. The Lisbon earthquake--European aid to Portugal.

Assume that flood waters have ruined the agricultural area of a foreign country and millions will starve unless aid is received. Were he living now, which one of the following individuals would most likely advocate the U.S. surplus crops be made available to the distressed country?
1. Kant
2. Leibniz
3. Rousseau
4. Voltaire

Which one of the following contributed most toward the continuing discussion of the "Theology of Earthquakes"?
1. The issue was very controversial and many philosophers were interested in it.
2. The progress of science was at stake for the rest of the century.
3. Acceptance or rejection of Leibniz's philosophy would govern man's attitude toward his world.
4. The common man was interested in having a better life.

The greatest damage to articles such as books, tapestries, and paintings was probably caused by
1. fire
2. tremors
3. water
4. wind

Which one of the following would have been most likely to break with tradition?
1. Kant
2. Leibniz
3. Rousseau
4. Voltaire

The article states that there were four primary causes of death in the Lisbon earthquake. Which one probably took the fewest lives?
1. falling objects
2. fire
3. murder
4. tidal wave

What is the relationship between the following statements?
- A. Voltaire, Rousseau, and other prominent philosophers were Frenchmen.
- B. The center of controversy regarding the "Theology of Earthquakes" was in France.

1. A caused B.
2. B caused A.
3. A and B are related, but one did not cause the other.
4. A and B are unrelated.

STIONS 41-46 ARE ATTACHED TO THE ANSWER SHEET. PLEASE GO
CTLY TO THESE QUESTIONS.

DIRECTIONS: Your answers to items 41-46 should be legibly written directly on these sheets in the space provided below each item. Should you need additional space for your answer, write the remainder on the back of the page.

The article implies that the nobility opposed Pombal's reforms. Suppose you were a member of the Portuguese nobility. In a few sentences describe why you would have opposed Pombal.

Suppose a political cartoonist wished to make the philosophy of Leibniz appear foolish. Draw or describe a cartoon which would accomplish the above purpose.

* * * * * * * * * *

NOTE: The following information must be used in answering the following questions.

Suppose that you have been asked to evaluate the author's qualifications to write an article on the Lisbon earthquake. Listed below are several statements which could be true about the author. Assume each statement to be true. Do not consider any relationships which might exist between the statements.

A. On the line following the statement place an X in the space after:

"qualified"--if the statement leads you to believe the author is qualified to write about the Lisbon earthquake.

"not qualified"--if you believe the statement leads you to believe the author is not qualified to write about the Lisbon earthquake.

"no effect"--if you believe the statement has no bearing on the author's qualifications, or lack of them, to write about the Lisbon earthquake.

B. In the space provided below each statement write a brief statement giving the reason(s) why you marked the answer you did.

He has never been outside the United States.
qualified_____ not qualified_____ no effect_____

He is a well known philosopher and has written many books and articles.
qualified_____ not qualified_____ no effect_____

Pombal and he were good friends.
qualified_____ not qualified_____ no effect_____

He has been blind since birth.
qualified_____ not qualified_____ no effect_____

APPENDIX D

APPENDIX D
STAGES OF ECONOMIC GROWTH

In several magazine articles and in one book, W.W. Rostow stated that it is possible to identify each nation, with respect to its economic development, as lying in one of five categories:

(1) The traditional society

(2) The precondition for take-off

(3) The take-off

(4) The drive to technological maturity

(5) The age of high mass-consumption

The basic principle of his theory is that, at any given time in an economy, the rapid rate of growth in a relatively few leading industries contributes toward maintaining the over-all strength of that economy. Rostow considers economic change to be a result of political and social as well as economic forces. Pursuing this thought further, Rostow quotes Keynes' dictum: "If human nature felt no temptation to take a chance, no satisfaction (profit apart) in constructing a factory, a railway, a mine or a farm, there might not be much investment merely as a result of cold calculation."

The Traditional Society

The main economic fact about the first stage, traditional society, is the existence of a ceiling on the level of attainable production per head. This ceiling stems from the fact that the potentialities which flow from modern science and technology either are not available or are not applied in a regular fashion. Traditional societies undergo constant change in

production due to harvests, plagues, discoveries of new crops and so on. Varying degrees of manufacture develop and agricultural activity rises with improvements like irrigation, but production is still limited by the inaccessibility of modern science and the lack of a systematic understanding of the physical environment capable of making invention a regular flow.

The traditional society is basically agricultural with food production typically absorbing 75% or more of the working force. From this situation follows a social structure which thwarts a man's attempts toward improving his lot in life. Wealth and power are concentrated in the hands of those who control the land, with the real political power tending to lie in the regions rather than in the central government. Clan and family ties play a significant role.

The Precondition for Take-off (Transitional Period)

The second state, the precondition for take-off, is also referred to as the transitional period. Usually, this period begins as a result of aggression by more advanced societies. Essentially, the difference between the traditional society and a more modern society is related to the rate of investment. The traditional society's rate of investment is low (under 5% national income) in comparison to its rate of population increase.

To get the rate of investment up, three sectors--agriculture, export, and social overhead--of the economy are particularly important.

Agriculture--An increased food supply is required to meet the likely rise in population and the growing urban population. Agriculture must help meet the foreign exchange bill for capital development. This can be done directly by selling surplus abroad or indirectly by reducing food imports.

Rising farm income must furnish taxes to finance governmental functions and farm surplus income must be controlled by men who will invest in trade and industry and who will reinvest their profits as productivity rises.

Exports--Exports can provide a quick source of money for investment in industry. It takes time for industry to gather strength and there are big bills to pay; therefore, a good part of the investment money must come from rapid increases in production and exportation. Quick-yielding changes in productivity can most readily be applied to the extraction and processing of natural resources.

Social overhead capital--Large outlays must be made for education, transportation, sources of power, and the like. Such investments require a relatively long time for pay-offs, require large sums of money, and generally benefit the community as a whole. This indicates that government must generally play an important role in the process of providing money for social overhead. In fact, the most important precondition for take-off is often political. An effective government must maintain a tax and fiscal system which directs resources into modern uses and it is likely that only a vigorous central leadership can achieve this.

When the period of transition has begun, new types of enterprising men come forward and show an ability to raise money and a willingness to take risks in pursuit of profit or modernization. Banks appear, investment increases, and modern factories spring up. The people learn to operate a constantly changing economic system and come to accept progress as not only possible but necessary. This activity may proceed, however, at a limited pace within a society mainly characterized by traditional, low

productivity methods and by the old social-political values and structures.

The Take-off

In the third stage, take-off, old resistance to steady growth is overcome and growth becomes the normal condition. Take-off is concentrated within two or three decades and its beginning can usually be traced to some sharp stimulus; for example, a political revolution, a technological improvement, a newly favorable international environment, or a shift to a very unfavorable position in terms of world trade. The most powerful single initiator of take-offs has been the railroad, which has performed the vital tasks of lowering internal transportation costs, developing a new export sector, and leading toward development of coal, iron, and engineering industries.

The following conditions are required for take-off: (a) a rise in the rate of productive investment to at least 10% of national income, (b) the development of one or more substantial manufacturing industries with a high rate of growth, and (c) the existence or quick emergence of a political, social, and institutional framework so developed as to keep up a continued growth. This further implies a capacity for raising money from domestic sources.

The take-off usually witnesses a social, political, and cultural victory for those who favor modernization of the economy over those who would either cling to the traditional society or seek other goals. New industries expand rapidly, encouraging still other industries, and increasing income in the hands of those who reinvest in the economy.

Drive to Technological Maturity

About forty years after a society ends take-off, technological maturity is usually achieved. During this drive to maturity, the make-up of the economy changes as constantly as technology improves. The economy finds its place in international trade. Goods formerly imported are produced at home. New import requirements develop along with new export commodities. Old industries level off and new industries accelerate, often with a shift toward more complex processes such as machine tools, chemicals, and electrical equipment. Thus, maturity is attained when an economy demonstrates its capacity to move beyond the original industries which powered its take-off and apply modern technology to virtually the whole range of its resources.

Three important non-economic aspects accompany the development of a maturing society.

First, the working force changes in composition, in real wages, in outlook, and in skills. By maturity, the percentage of the working force in agriculture has dwindled to a figure as low as 20% in many classes. Not only does the urban population grow, but also there is generally an increase in the proportion of white collar workers, highly trained technicians, and semi-skilled workers. These people realize that they can exert power, by organizing, to achieve higher real wages and greater security; hence, the process of moving toward maturity generates social and political pressures which lead toward humane modifications of the process.

Second, the character of the leadership changes from the industrial tycoon to the efficient professional manager of a highly bureaucratized machine.

Third, the society as a whole takes for granted the miracle of industrialization and begins to question the merits of industrialization as an overriding objective. These changes pose new questions concerning future objectives.

High Mass-Consumption

In the final stage, the age of high mass-consumption, the society has ceased to accept the extension of modern technology as a primary objective. Real income per person increases and so does the effective demand for the products of a mature economy. Each society which has attained this stage of development has struck a unique balance, determined by geography, resources, values, and political leadership, among three broad objectives; (a) the pursuit of external power; (b) the welfare state with a good deal of social legislation designed to redistribute income, to decrease working hours, and to increase social security in general, and (c) the expansion of consumer goods distribution.

Since growth normally proceeds by geometric progression, similar to a savings account if interest is left to compound with principal, the era of high mass-consumption will continue to gather momentum and vary its patterns.

Adapted from

W. W. Rostow, The Stages of Economic Growth. Cambridge Press, London, 1960, pp. 4-92.

Experiment in Learning I
Test

DIRECTIONS

Attached are the test and answer sheets to accompany the passage called "Stages of Economic Growth."

The test consists of 40 multiple-choice questions. Please answer all questions. Although there is no time limit, you should finish the entire test in about 35 minutes. Therefore, do not spend a great amount of time on any one question.

1. Put your name, student number, campus address and phone number at the top of the answer sheet.

2. Mark your answers on the answer sheet with the scoring pencil provided. Do not make any stray marks on the scoring sheet. If you make an error, erase it completely before marking another answer. Do not mark in the test booklet.

3. When you have finished, return all test materials to the proctor.

Barry Bratton
Michigan State University
May 1974

Which of the following is in the correct order regarding the stages of economic growth?
1. take-off, precondition for take-off, drive to maturity
2. precondition for take-off, take-off, traditional
3. take-off, drive to maturity, high mass-consumption
4. precondition for take-off, high mass-consumption, drive to maturity

Rostow considers economic change to be the result of
1. economic and social forces
2. economic and political forces
3. economic, political, and social forces
4. "cold calculation" alone

The stage of development which frequently begins as a result of aggression is
1. precondition for take-off
2. take-off
3. drive to technological maturity
4. age of high mass-consumption

Which of the following is most likely to produce quick-yielding changes in productivity?
1. building a hydroelectric plant
2. manufacturing raw steel products
3. manufacturing heavy equipment
4. processing natural resources

Which of the following is a social overhead expense?
1. interstate highway
2. department store
3. watch factory
4. farm

About how many decades does the take-off stage usually last?
1. one
2. two or three
3. four or five
4. between five and ten

What has been the most powerful single starter of the take-off stage?
1. railroads
2. agriculture
3. complex industries
4. coal, iron, and engineering industries

The minimum rate of productive investment of a country in the take-off stage is
1. 5%
2. 8%
3. 10%
4. 20%

How many years does it usually take a nation to achieve maturity after it enters drive-to-maturity?
1. 20
2. 30
3. 40
4. 60

Economic growth usually progresses
1. geometrically
2. arithmetically
3. logarithmically
4. inversely

Which of the following would most likely be a major export from a country in the transitional stage of economic growth?
1. farm machinery
2. paper products
3. furniture
4. crude oil

Which of the following occupations would most teenagers living in a traditional society desire?
1. factory manager
2. farm owner
3. bank president
4. research laboratory director

In which stage of economic development would the productive rate of investment most likely exceed 15% of the national income?
1. traditional
2. precondition for take-off
3. take-off
4. drive to maturity

* * * * * * * * * *

:: The following information must be used in answering questions 14-15.
Suppose a country exists which has the following four characteristics:
a. It is very large and is controlled by a strong dictator.
b. 80% of the population are farmers.
c. The rate of investment is about 5% of the national income.
d. The education level of the general population is low.

This country is like countries in the traditional stage in how many of the four characteristics?

1. 1
2. 2
3. 3
4. 4

This country is like countries in high mass-consumption in how many of the four characteristics?

1. 0
2. 1
3. 2
4. 3

* * * * * * * * * *

A country which just built its first public university is probably in what stage?

1. precondition for take-off
2. take-off
3. drive to maturity
4. high mass-consumption

Suppose that in a particular country the "Jones Textile Company" has established three branch factories. This country is most likely in

1. precondition for take-off
2. take-off
3. drive to maturity
4. high mass-consumption

In which stage of economic development is the relative power of the central government the weakest?

1. traditional
2. precondition for take-off
3. take-off
4. technological maturity

Suppose that in a particular country a 40-year bond plan has just been approved for obtaining money to build a hydroelectric plant. This country is most likely in

1. precondition for take-off
2. take-off
3. drive to maturity
4. high mass-consumption

Which of the following is <u>not</u> characteristic of a country in the traditional stage?
1. Average family size increased over last year.
2. 95% of the land is owned by 15% of the population.
3. National corn harvest was the largest ever.
4. Manufacture of tractors showed a 200% increase over last year.

Which of the following actions would do <u>least</u> to move a nation from the traditional to the transitional stage?
1. Strengthen the central government
2. Encourage landowners to invest most of their income in industries
3. Introduce modern farming techniques to increase production
4. Reduce the compulsory retirement age

Which of the following actions would most quickly move a country from the traditional to the transitional stage?
1. Build a technical college
2. Have a war with a neighboring country that is in the maturity stage
3. Hire an outstanding scientist from a country in the transitional stage.
4. Build a national system of airports

Unionization, the labor movement, or the banding together of workers to protect their rights is probably most characteristic of which stage?
1. traditional
2. take-off
3. drive to maturity
4. high mass-consumption

Suppose you know the following information about a country:
a. Half of the employed citizens are farmers.
b. The number of banks has doubled in the past 5 years.
c. Its chief export is wheat and its chief import is farm machinery.

This country is probably in the
1. traditional stage
2. precondition for take-off stage
3. take-off stage
4. drive to maturity stage

During drive-to-maturity, labor unions would
1. lose membership
2. be controlled by the government
3. change the social structure
4. increase their influence

Which of the following events would most likely move a country from the traditional to the transitional stage?
1. The discovery of a new strain of corn.
2. The overthrow of the government by army officers.
3. The establishment of a new industry to manufacture rifles.
4. The building of canals to provide inexpensive transportation.

In which stage is the economy most dependent on weather conditions?
1. traditional
2. precondition for take-off
3. take-off
4. drive to maturity

Suppose that in a particular country the government subsidizes the printing of books. This country is most likely in
1. precondition for take-off
2. take-off
3. drive to maturity
4. high mass-consumption

A country which had just won independence made up a constitution that included the following statements:
a. There will be no compulsory social security.
b. There will be no payments to unemployed persons.
c. The federal government will adopt a "hands off" policy toward the national economy.

Which of the following statements would best describe the economic characteristics of the country?
1. There are no large land owners.
2. Most of the population is employed in industry.
3. Over 50% of the population is involved in agriculture.
4. The rate of investment is 15% of the national income.

A country that has 40% of its population working in agriculture and the remainder working in heavy industries (machines, locomotives, etc.) is ruled by a dictator. The country has been in maturity for 60 years. Which of the following courses of action would probably lead to movement into high mass-consumption?
1. Overthrow the dictator.
2. Start a war with neighboring country.
3. Manufacture and sell consumer goods.
4. Make the agricultural program more efficient.

In which stage would the occupation of "social worker" be the most common?
1. transitional
2. take-off
3. drive to maturity
4. high mass-consumption

Which of the following is <u>least</u> characteristic of a country in the stage of maturity?
1. Half of the population is involved in agriculture.
2. Demands for consumer goods exceed production.
3. Factories are expanding rapidly.
4. Heavy industry is emphasized.

Strong labor unions will be found only in countries in which stage(s) of development?
1. high mass-consumption
2. drive to maturity
3. drive to maturity and high mass-consumption
4. take-off, drive to maturity, and high mass-consumption

When the United States gives economic assistance to an underdeveloped country, that aid is least likely intended to change the country from
1. traditional to transitional
2. transitional to take-off
3. take-off to maturity
4. maturity to high mass-consumption

Before take-off can begin the citizens must accept
1. a lower standard of living
2. government control of business
3. control by the land owners
4. constant change

If progress is defined as movement from the traditional society to the age of high mass-consumption, then progress does not necessarily provide for increased
1. leisure time
2. material goods
3. religious dedication
4. standard of living

Several countries, for example, the United States and France, have foreign aid programs which are intended to stimulate the technical and industrial progress of underdeveloped nations. Which one of the following reasons for their doing so agrees best with the information in the reading passage?
1. Wealthy countries are morally obligated to help poor countries.
2. New markets and trade agreements can be developed in the underdeveloped countries.
3. World power can be gained by installing your political viewpoints in the underdeveloped countries.
4. Foreign aid is a convenient way of getting rid of surplus products.

Which one of the following countries most likely has more than 50% of its labor force in agriculture at the present time?
1. Argentina
2. Australia
3. Canada
4. Sweden

In which stage of economic development would the occupation of "college professor" be <u>least</u> common?
1. traditional
2. precondition for take-off
3. take-off
4. drive to maturity

Prior to the Civil War, cotton was the most important product of the South. What is the most advanced stage in which the pre-Civil War South could be properly classified?
1. traditional
2. precondition for take-off
3. take-off
4. drive to maturity

APPENDIX E

APPENDIX E

INSTRUCTIONS TO ALL EXPERIMENTAL GROUPS

A. General Instructions.

You are about to participate in a study which focuses on the different ways students learn. I appreciate your help and cooperation since they will help insure the results of the study are valid and useful.

During the next several hours we will break you into small groups and engage in a number of activities. First, let me introduce some assistants...

I should point out that all results from this study are confidential. Moreover, the study is not focused on individual test scores as such. You will be asked to give your name and student number for research purposes only. The names of the participants will not be published...

Any questions?

B. Specific Instructions to Teach Group.

Part 1. The directions for this part of the experiment are written on the front page of the handout you just received. Follow along as I read the directions:

You will have 25 minutes to read the article contained in this handout. After you have studied the material for 25 minutes you will be asked to teach another student, a peer who has not seen the handout, the contents of the article. He has been told that another student like himself will be teaching him some new material. He has been encouraged to ask you questions and discuss with you points he does not understand.

He has also been told that he will be tested on the material. The test, part multiple-choice and part short-answer, will cover all aspects of the article...from recalling facts to drawing conclusions based on the facts to making evaluations about the handout.

Scratch paper is available should you wish to take notes as you study. When you are teaching you may use both the handout and notes as references. However, you may not read the handout verbatim nor give the handout or your notes for your student to read. Other than abiding by these two conditions, you may organize the material any way you wish and teach in any style you feel appropriate.

Part 2. During this part of the experiment each of you will individually teach a peer student the material you have just studied. He or she is a student like yourself but who has not seen nor read the handout. Your job for the next 25 minutes is to teach him or her the contents of this article.

He has been told that another student like himself will be teaching him some new material. He has been encouraged to ask you questions and discuss with you points he does not understand.

When you are teaching you may use both the handout and your notes as references. However, you may not read the handout verbatim nor give the handout or your notes for him to read. Other than that, you may organize the materials any way you wish and teach in any style you feel is appropriate.

One final point... remember only 25 minutes is allowed so be sure to budget your time to cover all your points.

Part 3. Your task during this part of the experiment is to complete this examination. Please read the directions written on the front page of the test. When you have finished, please look up at me so that I can give you further instructions.

Remember, there are two parts to the test. Do the multiple-choice section first, then the short-answers. Also, please answer every question--even if you must guess! There are no penalties for incorrect responses, therefore, guess whenever you're not sure! This rule is true for the short-answers as well.

Now--please turn to the scoring sheet and let's complete the necessary information. First, legibly print your name in the upper left-hand corner. (pause) Second, complete the name boxes in the upper right-hand corner. (pause) Third, give your student number where indicated. (pause)

Under the column labeled "Day" (the white column), mark 2.

Please now begin the test. When you are finished bring all materials to me.

C. Specific Instructions to Anticipate Teach Group.

Part 1. The directions for this part of the experiment are written on the front page of the handout you just received. Follow along as I read the directions:

You will have 25 minutes to read the article contained in this handout. After you have studied the material for 25 minutes you will be asked to teach another student, a peer who has not seen the handout, the contents of the article. He has been told that another student like himself will be teaching him some new material. He has been encouraged to ask you questions and discuss with you points he does not understand.

He has also been told that he will be tested on the material. The test, part multiple-choice and part short-answer, will cover all aspects of the article. . .from recalling facts to drawing conclusions based on the facts to making evaluations about the handout.

Scratch paper is available should you wish to take notes as you study. When you are teaching you may use both the handout and notes as references. However, you may not read the handout verbatim nor give the handout or your notes for your student to read. Other than abiding by these two conditions, you may organize the material any way you wish and teach in any style you feel appropriate.

Part 2. Your role in this experiment is a particularly important one. Indeed, your group's performance during this phase of the experiment will be a yardstick against which other groups will be measured. Your full cooperation is vital to the success of this study. Instead of teaching as previously announced, we are now going to ask you to take a test on the material you've just studied.

Your task during this part of the experiment is to complete this examination. Please read the directions written on the front page of the test. When you have finished, please look up at me so that I can give you further instructions.

Remember, there are two parts to the test. Do the multiple-choice section first, then the short-answers. Also, please answer every question--even if you must guess! There are no penalties for incorrect responses, therefore, guess whenever you're not sure! This rule is true for the short-answers as well.

Now--please turn to the scoring sheet and let's complete the necessary information. First, legibly print your name in the upper left-hand corner. (pause) Second, complete the name boxes in the upper right-hand corner. (pause) Third, give your student number where indicated. (pause)

Under the column labeled "Day" (the white column), mark 3.

Please now begin the test. When you are finished bring all materials to me.

D. Specific Instructions to Study Once Group.

Part 1. The directions for this part of the experiment are written on the front page of the handout you just received. Follow along as I read the directions.

You will have 25 minutes to read the article contained in this handout. After you have studied the material for 25 minutes the handout will be turned in and you will be given a test on the material. The test is comprehensive, that is, it will cover all aspects of the material...from recalling facts to drawing conclusions based on the facts to making evaluations about the handout. The test will be part multiple-choice and part short-answer.

Scratch paper is available should you wish to take notes as you study. However, no notes or study aids will be permitted during the test.

Part 2. Your task during this part of the experiment is to complete this examination of the material you just studied. Please read the directions written on the front page of the test. When you have finished, please look up at me so that I can give you further instructions.

Remember, there are two parts to the test. Do the multiple-choice section first, then the short-answers. Also, please answer every question--even if you must guess! There are no penalties for incorrect responses, therefore, guess whenever you're not sure! This rule is true for the short-answers as well.

Now--please turn to the scoring sheet and let's complete the necessary information. First, legibly print your name in the upper left-hand corner. (pause) Second, complete the name boxes in the upper right-hand corner. (pause) Third, give your student number where indicated. (pause)

Under the column labeled "day" (the white column), mark 1.

Please now begin the test. When you are finished bring all materials to me.

E. Specific Instructions to Study Twice Group.

Part 1. The directions for this part of the experiment are written on the front page of the handout you just received. Follow along as I read the directions.

You will have 25 minutes to read the article contained in this handout. After you have studied the material for 25 minutes the handout will be turned in and you will be given a test on the material. The test is comprehensive, that is, it will cover all aspects of the material...from recalling facts to drawing conclusions based on the facts to making evaluations about the handout. The test will be part multiple-choice and part short-answer.

Scratch paper is available should you wish to take notes as you study. However, no notes or study aids will be permitted during the test.

Part 2. During this part of the experiment you will have another opportunity to study the handout. Additional scratch paper is available if you need it. A total of 25 minutes is allowed for this study period.

Part 3. Your task during this part of the experiment is to complete this examination of the material you just studied. Please read the directions written on the front page of the test. When you have finished, please look up at me so that I can give you further instructions.

Remember, there are two parts to the test. Do the multiple-choice section first, then the short-answers. Also, please answer every question--even if you must guess! There are no penalties for incorrect responses, therefore, guess whenever you're not sure! This rule is true for the short-answers as well.

Now--please turn to the scoring sheet and let's complete the necessary information. First, legibly print your name in the upper left-hand corner. (pause) Second, complete the name boxes in the upper right-hand corner. (pause) Third, give your student number where indicated. (pause)

Under the column labeled "Day" (the white column), mark 4.

Please now begin the test. When you are finished bring all materials to me.

F. Specific Instructions to Receive Group.

Part 1. Prior to the start of the actual experiment and for the next 25 minutes I would like to ask your opinions and reactions to several current events in the news. One topic is the Watergate scandal and the related Congressional impeachment proceedings.

Starter Questions:

What are your views regarding the guilt or innocence of Richard Nixon?

If you feel he's guilty, which is the better method of justice--resignation or Senate impeachment? Why?

If you feel he is innocent, what effect do you think the present impeachment investigation will have on his future political leadership?

Do you feel the House will vote impeachment? Will the Senate convict?

What effects on the nation and/or our system of government would resignation or impeachment have?

What are your views on the role the news media is playing in this situation?

Part 2. It is now time for the main part of the experiment to get underway. In a few minutes each of you will be introduced to a fellow student who has just completed studying some course content. He will have 25 minutes to teach this material to you. Your job is to learn the material as well as you can.

After the 25 minutes are up you will be asked to take a test on the material. The test is comprehensive, that is, it will cover all aspects of the material..from recalling facts to drawing conclusions based on the facts to making evaluations about the material. The test will be part multiple-choice and part short-answer. While you may take notes during the session no notes may be used during the test.

Please feel free to ask questions and discuss with the teacher any points you do not understand or wish to be clarified.

Scratch paper is available should you wish to take notes.

Part 3. Your task during this part of the experiment is to complete this examination of the material you just studied. Please read the directions written on the front page of the test. When you have finished, please look up at me so that I can give you further instructions.

Remember, there are two parts to the test. Do the multiple-choice section first, then the short-answers. Also, please answer every question--even if you must guess! There are no penalties for incorrect responses, therefore, guess whenever you're not sure! This rule is true for the short-answers as well.

Now--please turn to the scoring sheet and let's complete the necessary information. First, legibly print your name in the upper left-hand corner. (pause) Second, complete the name boxes in the upper right-hand corner. (pause) Third, give your student number where indicated. (pause)

Under the column labeled "Day" (the white column), mark 5.

Please now begin the test. When you are finished bring all materials to me.

G. Specific Instructions to Control Group.

Part 1. Your role in this experiment is a particularly important one. Indeed, your group's performance during this phase of the experiment will be a yardstick against which all other groups will be measured. The task may appear difficult and frustrating. However, your full cooperation is vital to the success of this study.

Your task during this part of the experiment is to complete this examination. Please read the directions written on the front page of the test. When you have finished, please look up at me so that I can give you further instructions.

Remember, there are two parts to the test. Do the multiple-choice section first, then the short-answers. Also, please answer every question--even if you must guess! There are no penalties for incorrect responses, therefore, guess whenever you're not sure! This rule is true for the short-answers as well.

Now--please turn to the scoring sheet and let's complete the necessary information. First, legibly print your name in the upper left-hand corner. (pause) Second, complete the name boxes in the upper right-hand corner. (pause) Third, give your student number where indicated. (pause)

Under the column labeled "Day" (the <u>white</u> column), mark <u>6</u>.

Please now begin the test. When you are finished bring all materials to me.

APPENDIX F

APPENDIX F

SUBJECT DEMOGRAPHIC DATA

Distribution of Experiment I Subjects
by Sex and Age (N=82)

Age	Sex	
	Male (N=16)	Female (N=66)
20	—	1
21	—	—
22	—	5
23	1	16
24	1	5
25	5	13
26	1	6
27	1	4
28	—	2
29	1	1
30	1	2
31	—	2
32	—	2
33	1	1
34	—	1
35	2	—
36	1	—
37	—	2
38	1	—
39	—	1
40	—	—
41	—	—
42	—	—
43	—	—
44	—	—
45	—	—
46	—	—
47	—	—
48	—	—
49	—	—
50	—	1
51	—	—
52	—	—
53	—	—
54	—	—
55	—	1

Distribution of Experiment I Subjects
by Sex and Class (N=82)

Class	Sex	
	Male (N=16)	Female (N=66)
Freshman	1	—
Sophomore	—	—
Junior	—	—
Senior	—	1
Specialist	—	4
Masters	13	52
Doctoral	1	2
Other	1	7

Distribution of Years of Teaching Experience
by Experiment I Subjects (N=82)

Years	No. of Ss
0	5
1	21
2	12
3	21
4	7
5	3
6	5
7	3
8	2
9	—
10	—
11	—
12	2
13	—
14	—
15	—
16	—
17	—
18	—
19	—
20	1

Distribution of Experiment II Subjects
by Sex and Age (N = 84)

Age	Sex	
	Male (N=44)	Female (N-40)
16	—	1
17	2	—
18	2	7
19	2	5
20	6	—
21	1	5
22	3	4
23	5	—
24	5	5
25	5	2
26	3	1
27	3	1
28	3	—
29	—	1
30	—	—
31	2	—
32	1	2
33	—	—
34	—	1
35	—	1
36	—	1
37	—	1
38	—	—
39	—	1
40	—	—
41	—	—
42	—	—
43	1	—
44	—	—
45	—	—
46	—	—
47	—	—
48	—	1

Distribution of Experiment II Subjects
by Sex and Class (N=84)

Class*	Sex	
	Male (N=44)	Female (N=40)
Freshman	21	23
Sophomore	21	17
Junior	—	—
Senior	—	—
Other	2	—

*Community College levels.

Distribution of Years of Teaching Experience
by Experiment II Subjects (N=84)

Years	No. of Ss
0	82
1	1
2	1

APPENDIX G

APPENDIX G

EXPERIMENT I TREATMENT CELL MEANS AND STANDARD DEVIATIONS

TABLE 1. -- Experiment I Postest Scores

Groups (N=62)	Materials: Glaciers	Materials: Lisbon
Teach (N=8)	N = 4 M = 33.50 SD = 5.69	N = 4 M = 40.50 SD = 5.20
Anticipate Teach (N=11)	N = 5 M = 32.00 SD = 5.92	N = 6 M = 32.83 SD = 3.76
Study Once (N=13)	N = 6 M = 35.83 SD = 6.37	N = 7 M = 38.43 SD = 3.41
Study Twice (N=9)	N = 3 M = 27.67 SD = 7.51	N = 6 M = 40.17 SD = 1.72
Receive (N=10)	N = 4 M = 29.25 SD = 3.77	N = 6 M = 33.50 SD = 3.94
Control (N=11)	N = 5 M = 23.20 SD = 2.95	N = 6 M = 24.83 SD = 2.32

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

TABLE 2. -- Experiment I Knowledge Subtest Scores

Groups (N=82)	Materials	
	Glaciers	Lisbon
Teach (N=14)	N = 7	N = 7
	M = 9.00	M = 8.86
	SD = 1.15	SD = .69
Anticipate Teach (N=14)	N = 7	N = 7
	M = 9.14	M = 9.00
	SD = 1.46	SD = .82
Study Once (N=14)	N = 7	N = 7
	M = 8.43	M = 8.86
	SD = 1.51	SD = .69
Study Twice (N=14)	N = 7	N = 7
	M = 8.43	M = 9.86
	SD = 1.72	SD = .38
Receive (N=14)	N = 7	N = 7
	M = 8.57	M = 8.14
	SD = .53	SD = 1.07
Control (N=12)	N = 6	N = 6
	M = 5.33	M = 4.00
	SD = 1.37	SD = .89

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

TABLE 3. -- Experiment I Comprehension Subtest Scores

Groups (N=82)	Materials	
	Glaciers	Lisbon
Teach (N=14)	N = 7 M = 5.42 SD = 2.37	N = 7 M = 8.00 SD = 1.91
Anticipate Teach (N=14)	N = 7 M = 4.57 SD = .79	N = 7 M = 7.86 SD = 1.35
Study Once (N=14)	N = 7 M = 5.89 SD = 1.89	N = 7 M = 9.14 SD = .69
Study Twice (N=14)	N = 7 M = 4.86 SD = 2.04	N = 7 M = 8.71 SD = .76
Receive (N=14)	N = 7 M = 5.86 SD = 1.07	N = 7 M = 6.29 SD = 1.70
Control (N=12)	N = 6 M = 3.83 SD = .98	N = 6 M = 5.67 SD = .82

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

TABLE 4. -- Experiment I Application Subtest Scores

Groups (N=82)	Materials: Glaciers	Materials: Lisbon
Teach (N=14)	N = 7 M = 6.43 SD = 1.81	N = 7 M = 6.29 SD = 2.75
Anticipate Teach (N=14)	N = 7 M = 6.57 SD = 1.90	N = 7 M = 5.57 SD = 1.40
Study Once (N=14)	N = 7 M = 6.86 SD = 1.07	N = 7 M = 6.71 SD = 1.89
Study Twice (N=14)	N = 7 M = 7.00 SD = 1.29	N = 7 M = 6.43 SD = 2.30
Receive (N=14)	N = 7 M = 7.14 SD = 1.07	N = 7 M = 7.00 SD = 1.83
Control (N=12)	N = 6 M = 5.50 SD = 1.38	N = 6 M = 3.83 SD = .75

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

TABLE 5. -- Experiment I Analysis Subtest Scores

Groups (N=82)	Materials: Glaciers	Materials: Lisbon
Teach (N=14)	N = 7 M = 5.43 SD = 2.07	N = 7 M = 7.86 SD = 1.77
Anticipate Teach (N=14)	N = 7 M = 5.14 SD = 2.12	N = 7 M = 5.57 SD = 1.40
Study Once (N=14)	N = 7 M = 6.00 SD = 1.41	N = 7 M = 7.29 SD = 1.38
Study Twice (N=14)	N = 7 M = 4.43 SD = 1.99	N = 7 M = 6.57 SD = 1.72
Receive (N=14)	N = 7 M = 3.86 SD = 1.77	N = 7 M = 6.86 SD = 1.35
Control (N=12)	N = 6 M = 3.67 SD = .52	N = 6 M = 5.00 SD = .63

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

TABLE 6. -- Experiment I Synthesis Subtest Scores

Groups (N=82)	Materials	
	Glaciers	Lisbon
Teach (N=14)	N = 7 M = 2.14 SD = 1.95	N = 7 M = 2.71 SD = 1.80
Anticipate Teach (N=14)	N = 7 M = 1.57 SD = 1.62	N = 7 M = 1.71 SD = 1.38
Study Once (N=14)	N = 7 M = 2.57 SD = 1.27	N = 7 M = 2.86 SD = 1.46
Study Twice (N=14)	N = 7 M = 2.43 SD = 1.71	N = 7 M = 3.43 SD = .79
Receive (N=14)	N = 7 M = 1.57 SD = 1.27	N = 7 M = 2.00 SD = .58
Control (N=12)	N = 6 M = 2.00 SD = .89	N = 6 M = 2.33 SD = 1.21

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

TABLE 7. -- Experiment I Evaluation Subtest Scores

Groups (N=62)	Materials	
	Glaciers	Lisbon
Teach (N=8)	N = 4 M = 2.25 SD = 1.71	N = 4 M = 2.75 SD = 1.50
Anticipate Teach (N=11)	N = 5 M = 3.00 SD = 1.41	N = 6 M = 2.33 SD = 1.37
Study Once (N=13)	N = 6 M = 3.00 SD = 1.79	N = 7 M = 3.57 SD = .98
Study Twice (N=9)	N = 3 M = 2.00 SD = 1.73	N = 6 M = 3.83 SD = .75
Receive (N=10)	N = 4. M = 2.75 SD = 1.50	N = 6 M = 2.83 SD = .75
Control (N=11)	N = 5 M = 2.80 SD = 1.10	N = 6 M = 3.83 SD = 1.33

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

APPENDIX H

APPENDIX H

Post-Hoc Comparisons of Groups on the Knowledge Subtest in Experiement I

Contrast	Estimated Contrast Value	95% Confidence Interval
Anticipate Teach - Study Once	.42	1.85, - .99
Teach - Study Twice	.21	1.21, -1.64
Receive - Study Once	.29	1.14, -1.71
Teach - Anticipate Teach	.14	1.28, -1.57
Teach - Control	4.26	2.78, 5.74*
Anticipate Teach - Control	4.40	2.92, 5.89*
Study Once - Control	3.98	2.49, 5.46*
Study Twice - Control	4.48	2.99, 5.96*
Receive - Control	3.69	2.21, 5.17*

*Significant at the .05 level

APPENDIX I

APPENDIX I

Analysis of Variance Test for the Mean Score of Each Group on the Application Subtest in Experiment I

Source	Mean Square	df	F ratio	p value
Materials	7.024	1	2.367	.1285
Groups	9.361	5	3.154	.0127*
Materials x Groups	1.233	5	.416	.8365
Error	2.968	70	-----	-----

*Significant at the .05 level

Marginal Mean Score of Each Group on the Application Subtest in Experiment I

Groups	Mean Score
Teach Group	6.36
Anticipate Teach Group	6.07
Study Once Group	6.79
Study Twice Group	6.71
Receive Group	7.07
Control Group	4.67

Post-Hoc Comparison of Groups on the Application Subtest in Experiment I

Contrast	Estimated Contrast Value	95% Confidence Interval
Anticipate Teach - Study Once	.71	1.51, -2.94
Teach - Study Twice	.36	1.87, -2.59
Receive - Study Once	.29	2.51, -1.94
Teach - Anticipate Teach	.29	2.52, -1.94
Teach - Control	1.69	-.631, 4.01
Anticipate Teach - Control	1.40	-.917, 3.72
Study Once - Control	2.12	-.201, 4.44
Study Twice - Control	2.05	-.274, 4.37
Receive - Control	2.40	.083, 4.72*

*Significant at the .05 level

APPENDIX J

APPENDIX J

Analysis of Variance Test for the Mean Score of Each Group on the Analysis Subtest in Experiment I

Source	Mean Square	df	F ratio	p value
Materials	64.988	1	25.127	.0001*
Groups	10.217	5	3.950	.0033*
Materials x Groups	2.998	5	1.159	.3381
Error	2.586	70	-----	-----

*Significant at the .05 level

Marginal Mean Score of Each Group on the Analysis Subtest in Experiment I

Groups	Mean Score
Teach Group	6.64
Anticipate Teach Group	5.36
Study Once Group	6.64
Study Twice Group	5.50
Receive Group	5.36
Control Group	4.33

Post-Hoc Comparison of Groups on the Analysis Subtest in Experiment I

Contrast	Estimated Contrast Value	95% Confidence Interval	
Anticipate Teach - Study Once	1.29	.80,	- 3.37
Teach - Study Twice	1.14	3.22,	- .94
Receive - Study Once	1.29	.79,	- 3.37
Teach - Anticipate Teach	1.28	3.37,	- .80
Teach - Control	2.31	.14,	4.48*
Anticipate Teach - Control	1.02	-1.14,	3.19
Study Once - Control	2.31	.14,	4.48*
Study Twice - Control	1.17	-1.00,	3.33
Receive - Control	1.02	-1.14,	3.19

*Significant at .05 level

APPENDIX K

APPENDIX K

Analysis of Variance for the Mean Score of Each Group on the Synthesis Subtest in Experiment I

Source	Mean Square	df	F ratio	p value
Materials	4.402	1	2.258	.1375
Groups	3.619	5	1.856	.1132
Materials x Groups	.315	5	.161	.9758
Error	1.949	70	-----	-----

Marginal Mean Score of Each Group on the Synthesis Subtest in Experiment I

Groups	Mean Score
Teach Group	2.43
Anticipate Teach Group	1.64
Study Once Group	2.71
Study Twice Group	2.93
Receive Group	1.79
Control Group	2.17

Analysis of Variance for the Mean Score of
Each Group on the Evaluation Subtest in Experiment I

Source	Mean Square	df	F ratio	p value
Materials	4.199	1	2.424	.1258
Groups	1.346	5	.777	.5710
Materials x Groups	1.695	5	.979	.4401
Error	1.732	70	-----	------

Marginal Mean Score of Each Group
on the Evaluation Subtest in Experiment I

Groups	Mean Score
Teach Group	2.50
Anticipate Teach Group	2.64
Study Once Group	3.31
Study Twice Group	3.22
Receive Group	2.80
Control Group	3.36

APPENDIX L

APPENDIX L

EXPERIMENT II COVARIATE CELL MEANS AND STANDARD DEVIATIONS

TABLE 1.--Experiment II Total Covariate Scores

Groups (N=64)	Materials	
	Glaciers	Lisbon
Teach (N=10)	N = 4 M = 24.50 SD = 5.00	N = 6 M = 25.67 SD = 4.84
Anticipate Teach (N=6)	N = 4 M = 30.00 SD = 4.24	N = 2 M = 26.00 SD = 2.83
Study Once (N=11)	N = 7 M = 25.43 SD = 5.53	N = 4 M = 21.50 SD = 3.42
Study Twice (N=13)	N = 7 M = 27.14 SD = 3.18	N = 6 M = 25.50 SD = 4.76
Receive (N=13)	N = 7 M = 23.43 SD = 6.02	N = 6 M = 25.50 SD = 1.87
Control (N=11)	N = 6 M = 25.50 SD = 3.62	N = 5 M = 25.80 SD = 7.53

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

TABLE 2.--Experiment II Knowledge Subtest Covariate Scores

Groups (N=84)	Materials	
	Glaciers	Lisbon
Teach (N=14)	N = 7 M = 7.14 SD = 2.03	N = 7 M = 6.57 SD = 1.90
Anticipate Teach (N=14)	N = 7 M = 8.42 SD = 1.71	N = 7 M = 6.71 SD = .95
Study Once (N=14)	N = 7 M = 6.57 SD = .78	N = 7 M = 6.14 SD = 1.34
Study Twice (N=14)	N = 7 M = 8.14 SD = .89	N = 7 M = 6.43 SD = 2.22
Receive (N=14)	N = 7 M = 6.57 SD = 1.51	N = 7 M = 7.00 SD = 1.29
Control (N=14)	N = 7 M = 7.57 SD = 1.39	N = 7 M = 7.57 SD = 2.23

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

TABLE 3.--Experiment II Comprehension Subtest Covariate Scores

Groups (N=84)	Materials: Glaciers	Materials: Lisbon
Teach (N=14)	N = 7 M = 6.29 SD = 2.14	N = 7 M = 5.71 SD = 2.21
Anticipate Teach (N=14)	N = 7 M = 7.14 SD = 2.12	N = 7 M = 7.29 SD = 1.70
Study Once (N=14)	N = 7 M = 6.71 SD = 2.29	N = 7 M = 5.86 SD = 2.79
Study Twice (N=14)	N = 7 M = 6.86 SD = 1.77	N = 7 M = 5.86 SD = 1.77
Receive (N=14)	N = 7 M = 6.14 SD = 1.95	N = 7 M = 6.43 SD = 1.90
Control (N=14)	N = 7 M = 6.00 SD = 2.38	N = 7 M = 6.29 SD = 1.98

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

TABLE 4.--Experiment II Application Subtest Covariate Scores

Groups (N=84)	Materials: Glaciers	Materials: Lisbon
Teach (N=14)	N = 7 M = 7.14 SD = 1.34	N = 7 M = 6.43 SD = 2.15
Anticipate Teach (N=14)	N = 7 M = 7.86 SD = 1.21	N = 7 M = 6.29 SD = 1.60
Study Once (N=14)	N = 7 M = 6.71 SD = 1.80	N = 7 M = 5.57 SD = 1.99
Study Twice (N=14)	N = 7 M = 7.00 SD = 2.16	N = 7 M = 7.43 SD = 1.99
Receive (N=14)	N = 7 M = 5.86 SD = 2.61	N = 7 M = 6.43 SD = 1.13
Control (N=14)	N = 7 M = 6.29 SD = 1.38	N = 7 M = 6.71 SD = 1.89

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

TABLE 5.--Experiment II Analysis Subtest Covariate Scores

Groups (N=84)	Materials: Glaciers	Materials: Lisbon
Teach (N=14)	N = 7 M = 4.00 SD = 1.15	N = 7 M = 4.86 SD = 2.12
Anticipate Teach (N=14)	N = 7 M = 4.85 SD = 1.95	N = 7 M = 5.42 SD = 2.64
Study Once (N=14)	N = 7 M = 5.43 SD = 1.51	N = 7 M = 4.00 SD = .57
Study Twice (N=14)	N = 7 M = 5.14 SD = 1.57	N = 7 M = 5.14 SD = 1.35
Receive (N=14)	N = 7 M = 4.86 SD = 1.34	N = 7 M = 4.86 SD = 1.07
Control (N=14)	N = 7 M = 5.43 SD = 1.51	N = 7 M = 5.71 SD = 1.11

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

APPENDIX M

APPENDIX M

EXPERIMENT II TREATMENT CELL MEANS AND STANDARD DEVIATIONS

TABLE 1. -- Experiment II Postest Scores

Groups (N=64)	Materials: Glaciers	Materials: Lisbon
Teach (N=10)	N = 4 M = 28.75 SD = 4.50	N = 6 M = 33.00 SD = 7.13
Anticipate Teach (N=6)	N = 4 M = 30.00 SD = 5.78	N = 2 M = 27.50 SD = 6.36
Study Once (N= 11)	N = 7 M = 26.86 SD = 6.09	N = 4 M = 25.75 SD = 8.66
Study Twice (N=13)	N = 7 M = 29.86 SD = 4.60	N = 6 M = 31.83 SD = 3.60
Receive (N=13)	N = 7 M = 25.86 SD = 8.61	N = 6 M = 27.33 SD = 1.97
Control (N=11)	N = 6 M = 28.00 SD = 2.00	N = 5 M = 22.20 SD = 7.33

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

TABLE 2. -- Experiment II Knowledge Subtest Scores

Groups (N=84)	Materials	
	Glaciers	Lisbon
Teach (N=14)	N = 7 M = 9.29 SD = .76	N = 7 M = 8.14 SD = 1.95
Anticipate Teach (N=14)	N = 7 M = 8.29 SD = 1.25	N = 7 M = 7.71 SD = 1.38
Study Once (N=14)	N = 7 M = 8.29 SD = 2.06	N = 7 M = 7.14 SD = 1.95
Study Twice (N=14)	N = 7 M = 8.29 SD = 1.38	N = 7 M = 8.43 SD = 1.27
Receive (N=14)	N = 7 M = 7.57 SD = 1.27	N = 7 M = 7.57 SD = 1.13
Control (N=14)	N = 7 M = 5.29 SD = 1.70	N = 7 M = 4.14 SD = .38

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

TABLE 3. -- Experiment II Comprehension Subtest Scores

Groups (N=84)	Materials: Glaciers	Materials: Lisbon
Teach (N=14)	N = 7 M = 4.14 SD = 1.21	N = 7 M = 7.57 SD = 1.62
Anticipate Teach (N=14)	N = 7 M = 5.14 SD = 1.68	N = 7 M = 6.42 SD = 1.40
Study Once (N=14)	N = 7 M = 4.43 SD = .98	N = 7 M = 7.00 SD = 1.63
Study Twice (N=14)	N = 7 M = 6.14 SD = 1.35	N = 7 M = 7.71 SD = 1.25
Receive (N=14)	N = 7 M = 4.43 SD = 3.31	N = 7 M = 5.57 SD = .98
Control (N=14)	N = 7 M = 3.71 SD = .95	N = 7 M = 5.71 SD = 2.06

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

TABLE 4. -- Experiment II Application Subtest Scores

Groups (N=84)	Materials: Glaciers	Materials: Lisbon
Teach (N=14)	N = 7 M = 6.43 SD = 1.51	N = 7 M = 5.71 SD = 2.21
Anticipate Teach (N=14)	N = 7 M = 6.29 SD = 1.25	N = 7 M = 5.00 SD = 1.63
Study Once (N=14)	N = 7 M = 6.43 SD = 2.30	N = 7 M = 4.29 SD = 1.98
Study Twice (N=14)	N = 7 M = 7.86 SD = 1.35	N = 7 M = 5.00 SD = 1.00
Receive (N=14)	N = 7 M = 5.57 SD = 1.62	N = 7 M = 5.00 SD = 1.53
Control (N=14)	N = 7 M = 5.14 SD = 2.67	N = 7 M = 3.71 SD = 1.50

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

TABLE 5. -- Experiment II Analysis Subtest Scores

Groups (N=84)	Materials	
	Glaciers	Lisbon
Teach (N=14)	N = 7 M = 4.43 SD = 1.81	N = 7 M = 5.43 SD = 2.37
Anticipate Teach (N=14)	N = 7 M = 5.00 SD = 1.53	N = 7 M = 4.86 SD = 1.21
Study Once (N=14)	N = 7 M = 5.00 SD = 1.53	N = 7 M = 3.86 SD = 2.41
Study Twice (N=14)	N = 7 M = 4.00 SD = 1.00	N = 7 M = 5.14 SD = 1.57
Receive (N=14)	N = 7 M = 4.57 SD = 1.90	N = 7 M = 4.43 SD = 1.81
Control (N=14)	N = 7 M = 4.43 SD = 1.90	N = 7 M = 4.57 SD = 1.81

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

TABLE 6. -- Experiment II Synthesis Subtest Scores

Groups (N=84)	Materials: Glaciers	Materials: Lisbon
Teach (N=14)	N = 7 M = .85 SD = .89	N = 7 M = 1.57 SD = 1.81
Anticipate Teach (N=14)	N = 7 M = 2.00 SD = 1.00	N = 7 M = 1.14 SD = 1.46
Study Once (N=14)	N = 7 M = .86 SD = .89	N = 7 M = 1.71 SD = 1.89
Study Twice (N=14)	N = 7 M = 1.57 SD = .98	N = 7 M = 1.86 SD = 1.21
Receive (N=14)	N = 7 M = 2.29 SD = 2.05	N = 7 M = 2.14 SD = 1.34
Control (N=14)	N = 7 M = 2.57 SD = 1.90	N = 7 M = 1.14 SD = .90

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

TABLE 7. -- Experiment II Evaluation Subtest Scores

Groups (N=64)	Materials	
	Glaciers	Lisbon
Teach (N=10)	N = 4 M = 4.00 SD = 1.83	N = 6 M = 2.00 SD = 2.19
Anticipate Teach (N=6)	N = 4 M = 2.75 SD = 2.06	N = 2 M = 1.00 SD = 1.41
Study Once (N=11)	N = 7 M = 1.86 SD = 1.35	N = 4 M = 2.50 SD = 1.91
Study Twice (N=13)	N = 7 M = 2.00 SD = 1.91	N = 6 M = 3.83 SD = .41
Receive (N=13)	N = 7 M = 1.71 SD = 1.60	N = 6 M = 2.50 SD = 1.52
Control (N=11)	N = 6 M = 3.50 SD = 1.38	N = 5 M = 1.80 SD = 1.30

N - Number of Observations Per Cell
M - Mean
SD - Standard Deviation

APPENDIX N

APPENDIX N

Post-Hoc Comparison of Groups on the Knowledge Subtest in Experiment II

Contrast	Estimated Contrast Value	95% Confidence Interval
Anticipate Teach - Study Once	.16	2.10, -1.77
Teach - Study Twice	.40	2.29, -1.49
Receive - Study Once	.19	1.70, -2.08
Teach - Anticipate Teach	.79	2.69, -1.11
Teach - Control	4.07	2.17, 5.97*
Anticipate Teach - Control	3.29	1.40, 5.16*
Study Once - Control	3.12	1.19, 5.06*
Study Twice - Control	3.67	1.78, 5.56*
Receive - Control	2.94	1.03, 4.84*

*Significant at the .05 level

APPENDIX O

APPENDIX O

Post-Hoc Comparison of Groups on the Comprehension Subtest in Experiment II

Contrast	Estimated Contrast Value	95% Confidence Interval	
Anticipate Teach - Study Once	.13	1.97,	-2.22
Teach - Study Twice	1.00	1.08,	-3.08
Receive - Study Once	.71	1.36,	-2.79
Teach - Anticipate Teach	.33	2.44,	-1.78
Teach - Control	1.17	-.90,	3.25
Anticipate Teach - Control	.84	-1.26,	2.95
Study Once - Control	.97	-1.11,	3.05
Study Twice - Control	2.17	.09,	4.25*
Receive - Control	.26	-1.82,	2.33

*Significant at the .05 level

APPENDIX P

APPENDIX P

Analysis of Covariance for the Mean Score of Each Group on the Application Subtest in Experiment II

Source	Mean Square	df	F ratio	p value
Materials	41.218	1	14.051	.0004*
Groups	5.354	5	1.825	.1190
Materials x Groups	2.934	5	1.000	.4242
Error	2.933	71	------	-----

Correlation Coefficient = .27

*Significant at the .05 level

Marginal Covariate Mean, Postest Mean and Adjusted Postest Mean Score for Each Group on the Application Subtest in Experiment II

Groups	Covariate Mean	Postest Score	Adjusted Postest Mean
Teach Group	6.79	6.07	6.03
Anticipate Teach Group	7.07	5.64	5.52
Study Once Group	6.14	5.36	5.50
Study Twice Group	7.21	6.43	6.27
Receive Group	6.14	5.29	5.40
Control Group	6.50	4.43	4.47

APPENDIX Q

APPENDIX Q

Analysis of Covariance for the Mean Score
of Each Group on the Analysis Subtest in Experiment II

Source	Mean Square	df	F ratio	p value
Materials	.387	1	.122	.7277
Groups	.859	5	.271	.9274
Materials x Groups	1.987	5	.627	.6795
Error	3.168	71	----	-----

Correlation Coefficient = .15

Marginal Covariate Mean, Postest Mean and Adjusted
Postest Mean Score for Each Group on the
Analysis Subtest in Experiment II

Groups	Covariate Mean	Postest Score	Adjusted Postest Mean
Teach Group	4.43	4.93	4.90
Anticipate Teach Group	5.14	4.93	4.97
Study Once Group	4.71	4.93	4.84
Study Twice Group	5.14	4.57	4.63
Receive Group	4.86	4.50	4.54
Control Group	5.57	4.50	4.69

APPENDIX R

APPENDIX R

Analysis of Variance for the Mean Score of
Each Group on the Synthesis Subtest in Experiment II

Source	Mean Square	df	F ratio	p value
Materials	.191	1	.093	.7611
Groups	1.942	5	.951	.4539
Materials x Groups	2.848	5	1.393	.2371
Error	2.044	72	-----	-----

Marginal Mean Score for Each Group
on the Synthesis Subtest in Experiment II

Groups	Mean Score
Teach Group	1.21
Anticipate Teach Group	1.57
Study Once Group	1.29
Study Twice Group	1.71
Receive Group	2.21
Control Group	1.86