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An Investigation of the Role of Quantitative and Qualitative Objectives and Delayed Feedback in Prose Learning

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AN INVESTIGATION OF THE ROLE OF

QUANTITATIVE AND QUALITATIVE OBJECTIVES

AND DELAYED FEEDBACK IN PROSE LEARNING

by

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AN INVESTIGATION OF THE ROLE OF

QUANTITATIVE AND QUALITATIVE OBJECTIVES

AND DELAYED FEEDBACK IN PROSE LEARNING

The overall premise of the present investigation was
that qualitative objectives presented to subjects prior to
reading prose material would enhance learning and that the
addition of quantitative objectives would further enhance
learning. The subjects consisted of all students enrolled
in two classes of a small school of practical nursing
located in Chicago who were randomly assigned to four
treatment groups (quantitative objectives only, qualitative
objectives only, quantitative and qualitative objectives,
and no objectives). Each treatment group was given one type
of a combination of the objectives previously mentioned
along with a prose passage. After reading the prose materi-
al all subjects took a posttest of comprehension. One half
of each group then received feedback immediately on their
test performance and the other half received feedback 24
hours later. It was hypothesized that there was a signif-
icant relationship between type of feedback, (immediate and
delayed) and type of objectives (quantitative only, quali-
tative only, quantitative and qualitative, and no objec-

1

tives) and the degree of relevant and incidental prose
learning assessed by the posttest of retention. Specifi-
cally, it was hypothesized that delaying feedback would
enhance learning prose material when used in conjunction
with quantitative and qualitative objectives. Overall,
the results indicated that the provision of quantitative
and qualitative objectives improved learning of prose
material. That is to say, that those subjects receiving
both quantitative and qualitative objectives scored higher
on a posttest of retention for relevant learning than those
receiving qualitative, quantitative or no objectives. It
is interesting to note that the second highest scorers on
relevant learning were the qualitative objectives only.
group. However, there was no significant difference in
incidental learning. On the other hand, there were signif-
icant differences between types of learning (relevant and
incidental) with the combination of quantitative and qual-
itative objectives and qualitative objectives groups
demonstrating significant differences between relative and
incidental learning. There was also a significant inter-
action effect between type of learning and type of objec-
tive. These results are generally consistent with other
studies which continue to show that instructional objec-
tives are an effective aid to prose learning.

Unfortunately, the exploratory component of the exper-
iment which investigated the effects of feedback on the

retention of prose material revealed no significant differ-
ence between the posttest of retention scores for those
subjects in the delayed versus the immediate feedback sub-
groups. Perhaps this lack of significant findings was due
to the fact that academic material unfamiliar to the sub-
jects was used. Also, completion type questions were used
in the posttest and the subjects could perhaps not fully
process the information. Individual difference variables
such as anxiety, sex, IQ, and achievement may have had an
effect on the outcome of the feedback. Finally, the type of
feedback provided may have been inappropriate for the type
of learning task.

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VITA

The author, Lawrence Allen Biro, is the son of Louis Biro and Cassie (Adamski) Biro. He was born December 4, 1944 in Wyandotte, Michigan.

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He is presently employed by the Columbus-Cuneo-Cabrini Medical Center as Vice President for Human Resource Development.

TABLE OF CONTENTS

TABLE OF CONTENTS CONTINUED

LIST OF TABLES

LIST OF TABLES CONTINUED

LIST OF FIGURES

CONTENTS FOR APPENDICES

INTRODUCTION

A major area of interest to educational psychologists is investigating ways to improve classroom instruction. Educational psychologists who have worked in this area have investigated many different methods of instruction such as computer assisted instruction (Seltzer, 1971; Shurdak, 1967; Suppes, 1968; Suppes & Morningstar, 1969), programmed instructional television (Brown, Brown & Danielson, 1975; Chu & Schramm, 1967; Dublin & Hedley, 1969), and prose learning (Anderson & Myrow, 1971; Frase, 1969a, 1969b, 1972; Jenson & Anderson, 1970; Meyers, Pezdek & Coulson, 1973; Stolurow, 1973). Recently, prose learning has been the object of a great deal of research for several reasons. First, it is still one of the most widely used methods of instruction. Second, it is one of the most interesting and most easily studied methods of instruction because it capitalizes on already existing writing skills. Finally, it is fairly inexpensive and one of the easiest methods to implement in naturalistic educational settings.

Several variables have been investigated in an effort to facilitate learning from prose. For the most part, research has looked at such things as meaningfulness of prose material (Johnson, 1973), organization of the total passage

1

and paragraphs (Frase, 1969a, 1970, 1973; Gagnè & Rothkopf, 1975; Meyers et al., 1973), and use of questions and other ways of directing students' attention to the material to be learned (Ausubel, 1980; Blaney & McKie, 1969; Dalis, 1970; Faw & Waller, 1976; Hartley & Davies, 1976; Kaplan, 1974, 1976; Kaplan & Simmons, 1974; LaPorte & Nath, 1976; Mayer, 1979, 1980; Rothkopf & Kaplan, 1972). This directing, or mediating of student processes, goes beyond merely looking at the structure of instructional material, but also systematically examines the instructions or guidelines the student is given in using the material. One element of this type of research is the investigation of the use of objectives in conjunction with prose material to improve student comprehension. From this research with both quantitative and qualitative objectives, has come the general acceptance of the idea that objectives placed at the beginning of prose material "directs" the student to the relevant material within the passage.

The overall purpose of the present study was to investigate whether quantitative or qualitative objectives, or a combination of both would enhance prose learning and retention. A quantitative objective is an objective which states a goal to be met on a test of comprehension such as: "After you read this material, you should be able to get 18 out of 20 correct on a test". A qualitative objective is an objective that instructs the student to learn certain elements of

the instructional material. For example: "You will be able to list the 13 original colonies". In addition, the present study examined whether performance on retention was better if feedback on the objectives was immediate or delayed. Furthermore, for the purpose of identifying the learning related to objectives, the amount of learning was divided into two types: objective relevant learning and incidental learning. Objective relevant learning is material that is related directly to the stated qualitative objective (those items the student has been directed to learn). Incidental learning is any other material the student may learn but was not directed to do so by the stated qualitative objectives.

Specifically, the present study was designed to test the following informally stated hypotheses. First, will students who are given either quantitative or qualitative objectives or a combination of both learn more from prose material and thus perform better on a posttest of comprehension than those students who do not receive objectives? Second, will students who receive both quantitative and qualitative objectives perform better on a posttest of comprehension than those receiving only one type of objective? Third, will students who receive both quantitative and qualitative objectives exhibit both objective relevant and incidental learning? Fourth, do qualitative objectives facilitate learning by providing direction for that learning? Finally, will retention of material be greater when feedback

on accomplishment of objectives is delayed?

These hypotheses were tested by randomly dividing the subjects into four treatment groups. Each group was given a passage to read with one of the four treatments: (a) quantitative objectives only, (b) qualitative objectives only, (c) qualitative and quantitative objectives or (d) no objectives. The subjects were then given a test of comprehension and their results were compared as to the relative amount of objective relevant learning and inciden- tal learning. Half of each group received immediate feed- back of test results while the other half received results 24 hours later. Seven days later both groups responded to another test of retention.

The potential educational implications for this research are many. First, the original purpose of instructional psychology was to facilitate learning within the formal classroom setting. The identification of which type of objective (quantitative or qualitative) leads to better comprehension of the material should facilitate learning. Instructional materials could then be produced that incorpo- rate the most efficient type of instructional objective. Students would then have another tool that would aid them in their acquisition of the material being presented. In addition, objectives could be used in a way that would allow the student to progress at his own pace since he would know whether or not he had obtained the objective relevant mate-

rial with the necessary scores. There also is the implication of ease and efficiency of instruction. If it is shown that students not only need qualitative goals but also quantitative goals, it would not be difficult or extremely complicated for a teacher to ensure that a student had a concrete quantitative goal to achieve for each block of subject matter he or she had to master. Finally, one could also facilitate retention of learned material if it could be determined when is the optimal time to inform the student of his or her level of comprehension of the material as measured through testing. If retention can be enhanced by delaying this feedback it would be relatively easy to use this method to help the student learn.

Generally, this research project attempted to further explain how students learn from prose material. Previous research has looked at content, organization, and how the prose material is presented to the student. The area to be investigated in the present study is to determine how objectives can best be used to facilitate the presentation of prose material to students to enhance school learning. More specifically, the primary focus of the present study is on what type of objective (quantitative or qualitative) most efficiently directs the student to the relevant material within the passage and thus results in improved performance on a posttest of comprehension. This study also examined whether immediate feedback or delayed feedback of objective

attainment was more effective. Hopefully, this study will yield results that will provide yet another tool that will improve the quality of time the student spends learning in the classroom.

REVIEW OF RELATED LITERATURE

In an effort to improve learning and retention of
prose material, the instructional psychologist has tradition-
ally looked at three elements: the content of the material,
its organization, and its presentation to the learner. How
prose material is presented to the learner has proven to be
a very promising way to improve the quality of instructional
material. This review of the literature focuses on this
third element, the manner in which the material is presented
to the learner, and more specifically on how the instruc-
tional objective, a statement made to the student telling
him what knowledge he is to gain from an instructional
experience, can be used to direct the student to relevant
or important material. First of all, the literature which
discusses research investigating the use of objectives to
enhance school learning is reviewed. This section presents
a general theoretical discussion related to the use of
objectives in school learning situations. The second area
to be presented focuses on relevant and incidental learning.
Finally, the delayed-retention effect (DRE), as it relates
to the use of objectives, is reviewed. In all instances,
both theory and relevant research are systematically
addressed.

Utilizing Objectives to Enhance School Learning and
Retention

The use of objectives in instructional design to
enhance learning evolved from the work of B. F. Skinner.
In his book, The Behavior of Organisms (1938), Skinner
proposed a formulation of behavior that could be applied
systematically to the process of instructional design.
The basic tenet of his approach was that complex behavior,
thinking and problem solving, when properly analyzed, could
be interpretable in terms of a complex interplay of
fundamental learning concepts and principles (Hilgard &
Bower, 1975).

From Skinner's basic theoretical framework, a movement
to develop a technology of instructional design was devel-
oped. One of the first publications, Teaching Machines and
Programmed Learning by Lumsdaine and Glaser, related to the
behavioral investigation of instruction was published in
1960. This book presented a collection of articles dealing
with the application of teaching machines to various learn-
ing situations and the programming of these machines. A
follow-up volume, Teaching Machines and Programmed Learning
II, Data and Directions edited by Glaser (1965), discussed
the theory, technology and implementation of teaching
machines and programmed learning.

More recently, several models have been developed for
the design of instructional material. Anderson and Faust

(1973) identified six steps for the design of instructional material: (1) formulating educational goals as behavioral objectives, (2) analyzing the task implied in each objective into skills and concepts, (3) devising instruction, (4) teaching, (5) evaluating student performance, and (6) revising and reteaching material for students who did not meet the objectives. Popham (1970a) proposed a "goal referenced instructional model" that had four steps: (1) specification of objectives, (2) pre-assessment, (3) instruction, and (4) evaluation. Gilbert (1962a, 1962b) developed a system of program design which he named mathetics. The mathetics program began with a detailed analysis of what was to be taught. This analysis concentrated on student activity, not subject matter coverage. Mager (1962, 1968, 1973), Mager and Beach (1967), and Mager and McCann (1961) contributed a great deal of information on instructional design and instructional objectives. Mager's book, Preparing Instructional Objectives (1962), popularized the writing of behavioral objectives as we know it today. Gagne (1965), in an article in Teaching Machines and Programmed Learning II (1965), pointed out that the use of instructional objectives is extremely important in the behavioral science approach to instructional design. First, the objective revealed the nature of the terminal behavior. This determined final sequencing of the program. The objective also provided information to the instructional

designer as to which behaviors needed to be modified.
Second, objectives specified the past learning behavior and
stipulated the minimum behavior the student must perform.
Third, objectives distinguished the varieties of behavior
which were to be modified by instruction. A terminal
behavior consisted of different classes of behavior such as
discriminations or chains. Each class of behavior carried
a specific set of implications for the conditions of
learning for its establishment. Gilbert (1962a, 1962b),
with the mathetics approach to instructional design,
identified three major categories of behavior for which
differential treatment needs to be prescribed: chains,
multiple discriminations, and generalizations. Evans (1961)
distinguishes two classifications for which learning
techniques can be developed; classes of discrimination and
functional relationship between these classes. Basically,
the reason for defining objectives is to make them known to
the learner so that they can carry out matching procedures
involved in reinforcement. Objectives provide learners with
the capability of programming their own activities.

Popham (1970b) perhaps best summarized the behavioral
technologist's position on instructional objectives in his
article reviewing the use of objectives from 1960-1970.
Popham noted that the interest in objectives by educators
grew because of the enthusiasm of those writing programmed
instruction by insisting that objectives were an integral

part of instructional design. Writers of instructional
material insisted on specificity in objectives. However,
this demand for specificity of objectives has not been
totally accepted. Atkin (1968) and Eisner (1967) have
raised two main objections. First, it takes the flexibility
out of our educational offerings. Second and probably more
serious, objectives draw educators toward more easily
operationalized objectives rather than higher level,
difficult to measure, goals. During the sixties, objectives
have weathered these criticisms rather well and their popu-
larity in use has continued to grow.

Popham (1970b) closed by saying that the seventies
would be a period of refinement in the use of instructional
objectives. In the following sections the research on
objectives is reviewed for the 1970's. Whether objectives
met the expectations set for them by Popham and others or
whether the criticisms and problems identified eventually
reduced the importance of objectives will be systematically
discussed.

The theory which articulates why one must specifically
state what is expected of a student when he is given
material to learn is perhaps best presented by
Ernest Rothkopf (1970) and Richard Anderson (1970). Both
have written articles that explain why it is important to
state objectives. The following is a summation of their
position on presenting instructional materials to the

learner.

Rothkopf (1970) was interested in the basic skills required to acquire knowledge. He refers to these skills as "mathemagenic behaviors". The term derived from two Greek words, <u>mathemain</u>--that which is learned and <u>gignesthia</u> --to be born, or literally, those behaviors that give birth to learning. The point Rothkopf makes is that the knowledge the student acquires from a learning situation will largely be determined by the activities in which the student has engaged. He feels that these activities must be viewed in terms of specified situations and with specified objectives. Rothkopf further points out that in learning from written material there are three components: the content of the instructional material, the organization, and what the student does with the piece of instructional material. If he does not use the instructional material properly, the other two factors will be completely negated. The concept of mathemagenic activities refers to those things the student does to insure that the first two components are used most efficiently.

Rothkopf views specified instructional objectives and specified situations as extremely important because he sees learning as an extremely complex process from which the learning consequences of an instructional sequence are difficult to determine. Any definition of a mathemagenic activity that takes in too many situations is too broad to

be useful. He further states that activities in any specific situation or place can be broken down into four categories that either aid learning (positive), hinder learning (negative), have no effect (neutral), or are unknown. These behaviors can be broken down into the following three classes:

Class I: Orientation. Getting the students into the vicinity of the instructional material and keeping them there. The mathemagenic behaviors in this class would be concerned with eliminating distractions from the instructional setting.

Class II: Object Acquisition. This includes the acquisition of instructional material. Again, the interest would be in controlling the student's activities, devising activities that would allow the student to select the appropriate instructional material and keeping the student interested in it.

Class III: Translation and Processing. This is the process of reading where the student internalizes the material. This can be broken into three parts; translation, sequencing, and processing. These activities can be controlled in two ways. Directly, by observing and controlling eye movements and indirectly, through use of directions and questions to guide the student to certain parts of the learning materials.

The significance of the whole concept of mathemagenic

activities is that, when preparing instructional material, we cannot look at only the written material itself but at the total learning environment. Research looking further into this area is still at the descriptive data collection stage. Most research dealing with prose is based on the propositions set forth in Rothkopf's article and becomes more readily apparent as relevant research is systematically reviewed.

Richard Anderson (1970) has also been very interested in this area of controlling the student mediating process during verbal learning and instruction. His hypothesis is very similar to Rothkopf's and is clearly outlined in an article written by Anderson (1970) which states that the instructor has to control the attention the student places on material during the learning process. Many problems with self-instructional materials are that the authors have failed to direct the attention of the student to important material. This hypothesis has been investigated several times with different types of instructional material including prompting in programmed instruction (Anderson & Faust, 1967; Faust, 1967; Royer, 1969), immediate feedback (Anderson, 1969; Anderson, Faust & Roderick, 1968; Anderson, Kulhavy & Andre, 1971; Brown, 1966), and retro-active inhibition (Kulhavy & Anderson, 1972; More, 1969; Newman, Williams & Hiller, 1974; Sassenrath, 1975; Sassenrath & Yonge, 1968, 1969; Sturges, 1969; Surber &

Anderson, 1975). The present investigation is primarily concerned with how material is presented to the learner.

As previously stated, the hypotheses of both Anderson and Rothkopf and the work of behavioral instructional designers has generated a great deal of research which attempts to examine the process of mediating the student's attention to relevant material. Primary emphasis in the present review of the literature is given to the use of instructional objectives or the use of goals in mediating student attention to relevant instructional material. First, the use and effectiveness of instructional objectives in general will be examined and then, more specifically, studies utilizing objectives with prose material will be presented.

The Use of Objectives in General Educational Settings

The concept of clearly stated instructional objectives has been discussed in the academic community for the last 40 years. As stated previously, the real interest in instructional objectives began in the 1960's. Since then there has been a constant flow of articles advocating the use of instructional objectives. Although, it should be mentioned, there has also been considerable criticism of instructional objectives.

From this commentary have emerged three main instructional functions for objectives: first, they serve as a direction for teaching and curriculum development; second, they provide guidance and evaluation; and third, they

facilitate learning. This review is primarily concerned with the third function: the facilitation of learning.

There are many variables that can be considered when using objectives to facilitate learning. Three of these variables are discussed in a review by Duchastel and Merrill (1973). The first variable to consider is the specificity of the objectives. Researchers generally make a distinction between specific, general, and no objectives. It is important to have an operational definition of what type of objective one is using in trying to influence learning. The second variable is the type of learning one is trying to influence. The two categories of learning most frequently used in research on objectives are knowledge, usually considered as the learning of factual information, and comprehension, mainly considered as the learning of concepts and principles. The third variable of interest focuses on student characteristics. Do objectives work better with certain types of students? How do ability and socio-economic-status of learners affect the utilization of objectives? These three categories of variables must be considered when researching the effectiveness of objectives.

There have been several studies that have attempted to measure the effectiveness of instructional objectives. In this section studies which have dealt with the general effectiveness of objectives and characteristics of the learner are reviewed. Those dealing specifically with the

use of objectives with prose material are reviewed more
comprehensively in the next section.

Gagnè (1965), in his review, cites several studies
that support the effectiveness of objectives. Dressel (1961)
summarized the experience of 13 different institutions of
higher learning with the use of instructional objectives in
various courses. Although quantitative data were not
reported, Dressel observed a consistent interest by faculty
to specify terminal behaviors as a way of improving achieve-
ment testing. French (1956) divided a group of 40 appren-
tice mechanics into two groups. One group received their
instruction on the actual piece of equipment and the other
on a teaching machine which presented specific behavioral
objectives. Those training on the teaching machine were
more proficient with the equipment after seven and one
half days. Briggs and Besnard (1956) also had similar
findings working with air force maintenance training pro-
grams. Those groups receiving objectives were more pro-
ficient at the tasks being taught. Several studies dealing
with variables of programmed instruction also demonstrate
the need for defined objectives (Gagnè, 1962a, 1962b;
Gagnè & Paradise, 1961). These studies with various tasks
of mathematics showed that objectives must be arranged
in a hierarchical format and that accomplishment of subor-
dinate objectives will increase the probability of the
student achieving a higher level objective. Mager and

McCann (1961) trained a group of engineers using three different instructional strategies. With one group the instructor controlled the sequence of the instruction. With the second group, the students were permitted to select content in accordance with an importance and sequence they themselves assigned. The last group received a set of objectives and questions and could instruct themselves in any manner they wished. Through the use of objectives, training time was reduced as much as 65%. The conclusions were that objectives specify for the students what has to be learned. They compare these specifications with what they do know and fill in the knowledge gaps.

McNeil (1967) did a study which emphasized the importance of prior knowledge of behavioral objectives to acquisition. He worked with two groups of students and their student teachers. One group of student teachers was told that their grade depended upon their setting and achieving acceptable behavior objectives. The other group of teachers was told that their grade would depend on good lesson plans. Higher achievers were found in the group working with objectives. McNeil also found that a focus on specific objectives did not restrict the students to learning objective related material only.

Blaney and McKie (1969) conducted a study on the effects of providing behavioral objectives to a group of attendees at a conference. The attendees were divided into

three groups; those who received objectives, those who received a brief introduction, and a control group. They found a significant difference between the objective and introduction group, but no significant difference between either the introduction or objective group and the control group.

There have been studies which have measured the effect of specific and general objectives on learning of material. Tiemann (1968), working with college economics students, divided the class into two groups; those who received specific objectives and those who received general objectives for the course. He found no significant difference on a midterm examination but did find significant difference on a test given later for retention in favor of those given specific behavioral objectives. Other researchers have had similar results with specific objectives. Dalis (1970), working with tenth grade students studying growth and development, found a significant difference between those given specific objectives and vague objectives. Boardman (1970), working with college students in a remedial chemistry class, studied whether giving students listings of behavioral objectives and attendance at laboratory lecture sessions would improve their grades. He found no significant difference. In another study Bishop (1969) investigated the use of objectives in a ninth grade agricultural class. He had two groups, each comprised of 45

subjects. One group received objectives, the other group did not. He found no significant difference between the groups. Finally, studies by Engel (1968) and Lawrence (1970) supported the utilization of behavioral objectives with elementary education majors. Those that received objectives did significantly better on both post and retention tests.

A second group of studies focused on learner character- istics and the effectiveness of objectives. These studies are selectively summarized below. Cook (1969) investigated the use of objectives and outlines of learning hierarchies. His subjects were randomly assigned to four groups; a control group, an objective group, a hierarchy-outline group and an objective-hierarchy group. Subjects were also blocked according to their grade in a previous mathematics course. They were given a performance test immediately after each instructional unit and failed to show a signif- icant difference between groups. However, a significant treatment by ability level interaction indicated that middle ability students profited most from the objective-hierarchy treatment.

Conlon (1970) investigated the effects of ability as measured by the College Aptitude Rating Test on usefulness of instructional objectives. Two seventh grade classes were blocked as to high, medium and low aptitude. The experi- mental group received objectives while the control group did

not. The results indicated that the achievement of those who did receive objectives was not significantly different.

Kueter (1970) investigated the interaction of student personality characteristics and behavioral objectives. Using the School Personality Inventory, subjects were blocked (high, medium, and low) on 14 personality traits. The subjects were then randomly assigned to either objective or non-objective groups. The groups were then shown a film on the monarch butterfly. Those who received objectives scored significantly higher than those without objectives. However, objectives were less effective with those subjects with personality traits of submissiveness, self-control, considerateness, and conscientiousness.

Etter (1969) concentrated on several individual differences related to the effectiveness of objectives. He chose to look at age, sex, socioeconomic-status, learner outcome preference, verbal ability, and life goals. The task was a 135 frame programmed lesson related to the functioning of the stock market. The subjects were placed in either specific, general, or no objective groups. No significant difference was found between groups, but it was found that males with a high socioeconomic background scored higher than others in the specific objective group.

As one can see from the above, the results of using objectives have been mixed. In the first group of studies where the general effectiveness of objectives was examined,

objectives in many cases proved to be effective in enhancing
performance on posttests (Blaney & McKie, 1969; Dalis, 1970;
Engel, 1968; Lawrence, 1970; Tiemann, 1968), while others
did not find objectives to enhance performance on posttests
(Bishop, 1969; Boardman, 1970; Conlon, 1970). It appears
that objectives can facilitate learning in some instances,
but it also appears difficult to consistently generalize
these findings to other situations. However, the findings
related to learner characteristics appear to be more conclu-
sive in that there appears to be a considerable interaction
between ability and the use of objectives. At times this
interaction is not clear, as in the case of ability. Gener-
ally, the studies concerned with personality characteristics
(Conlon, 1970; Kueter, 1970) have indicated that objectives
are only effective with certain individuals under certain
conditions.

Studies have also investigated the effect objectives
have upon student behaviors other than achievement. Tiemann
(1968), in a study of a videotaped college economics course,
reported a more favorable attitude associated with the
presentation of specific objectives. Staley (1978) found
that the inclusion of objectives in a videotaped lecture
improved the attitude of students toward such lectures.
Hass (1977) found opposite results; objectives did not
significantly change the student's attitude toward a
principles of biology course or instruction.

DuBois et al. (1979), in their review on the influence
of objectives, also considered efficiency of instruction.
Mager and McCann (1961) in a study with engineers found that
objectives reduced training time 65%. Duchastel and Merrill
(1973), after reviewing several studies, concluded objec-
tives increased study time. Staley and Wolf (1979) inves-
tigated the use of objectives with prose materials and
concluded that objectives decrease study time. Staley and
Wolf explain the difference between their results and
Duchastel and Merrill's conclusion with the explanation
that objectives influence study time as a function of type
of learning task. If the task contains a great amount of
non objective related material, then objectives will reduce
study time.

Three recent studies have examined the conditions under
which objectives facilitate learning. Royer (1977) found
that adults attending lectures that contained specific
objectives learned more than those attending lectures that
did not have specific objectives. Staley (1978) demon-
strated that the use of objectives facilitates the learning
of memorization objectives, but not the learning of concepts
from lecture. Main (1978) found that learning objectives
facilitated the learning of objective relevant knowledge
from a slide-tape presentation when the objectives were
presented at the beginning of the presentation.

The interest in developing and using the behavioral

approach to instructional design, which included the use
of instructional objectives that began in the 1960's, and
continued into the 1970's. One primary source for articles
on instructional objectives in the late seventies was
Educational Technology Magazine. In 1977 this publication
devoted two full issues comprised of 13 articles on the use
of objectives. The reason for this special interest stated
by Mariam B. Kapfer (1977a), the special issue editor, was
that the use of objectives was at a turning point. Objec-
tives are well developed in education, but, at the same
time, there is a turning away from the use of objectives.
Kapfer cites three problems with objectives. First, how
can behavioral objectives better express outcomes regarding
learning processes? Second, how can objectives better
define the overall aims of education? Third, how can
objectives be designed so that students can identify with
them and be motivated by them? McAshan (1977), in the
summary article of the first issue, concludes that the
instructional objective movement still has a future. Con-
troversy will continue over whether objectives should be
specific or abstract. Competency-based education, that is
prescribing a minimum standard for educational activities
and performance-based education, will become synonymous
with objectives. Several other articles (Dressel, 1977;
Harrow, 1977; Kapfer, 1977; Piper, 1977) deals with the
nature and role of objectives in instructional design and

their application in specific educational settings. Kapfer (1977b) summarizes the material presented in the articles with the following six points: (1) behavioral objectives represent one tool for systematic instructional design and validation; (2) behavioral objectives represent a significant step toward a more scientific approach to teaching and learning; (3) behavioral objectives may be written at a variety of levels to meet different needs; (4) highly specific behavioral objectives may be made meaningful by relating them to some type of variously labeled broader goal; (5) behavioral objectives may either expand or limit a learning environment; and (6) behavioral objectives may be shaped to meeting emerging educational needs. Kapfer closes on a positive note by stating she sees objectives being able to solve a variety of educational problems.

In summary, it appears that there is still no conclusive evidence suggesting that the use of instructional objectives facilitates learning in all situations. However, as Duchastel and Merrill (1973) point out in their review, objectives are sometimes helpful but never harmful. Therefore, if the provision of objectives is relatively inexpensive, they should be made available to the students. It is clear that additional research must be completed in this area. This research must determine what objectives actually do. When the actual function of objectives is better defined then they can be applied more uniformly.

Other Preinstructional Strategies. Other preinstruc-
tional strategies have been researched and reviewed exten-
sively in the literature (Faw & Waller, 1976; Hartley &
Davies, 1976). Hartley and Davies (1976) identified three
preinstructional strategies other than objectives. One
such strategy was pretests which are sets of related ques-
tions that are given prior to instruction that directly
relates to the knowledge, skill or attitude to be acquired.
The research on pretests has been mixed. Several studies
found no difference when pretests were used (Apter, Boorer
& Murgatroyd, 1971; Campbell & Stanley, 1963; Hartley, 1969;
Rothkopf, 1966; Welch & Walberg, 1970). Other studies have
found that pretest questions enhance learning (Berlyne,
1954; Lucas, 1972; Peeck, 1972; Samuels, 1969). Hartley
and Davies (1976) conclude that further analysis would be
necessary to determine the effectiveness of pretest ques-
tions.

Another preinstructional strategy that has been system-
atically researched is the overview. An overview serves to
introduce students to new material by familiarizing them
with the central argument. Hartley and Davies (1976) found
little research on the overview and the results have been
mixed (May & Lumsdaine, 1958; Northrup, 1952; Reynolds,
1966; Rosenshine & Furst, 1971; Weiss & Fine, 1956).

The last preinstructional strategy Hartley and Davies
(1976) identified was the advance organizer. Mayer (1980)

summarizes the concept of advance organizers as developed
by Ausubel (1968). Ausubel defined advance organizers as
"appropriately relevant and inclusive introductory
materials . . . introduced in advance of learning . . . and
presented at a higher level of abstraction, generality,
and inclusiveness" (p. 148). The function of the organizer
was "to provide ideational scaffolding for the stable
incorporation and retention of the more detailed and
differentiated material that follows" (p. 148). This was
accomplished by manipulating "the availability to the
learner of relevant and proximately inclusive subsumers"
(p. 136). Hartley and Davies (1976) stated that advance
organizers are more complex than overviews and serve a
different purpose than pretests or behavioral objectives.
Advance organizers are meant to provide a conceptual frame-
work that the student can use to clarify the task ahead.
Advance organizers are not intended to give the students a
synopsis of the material, but are process oriented. Ausubel
(1969) has identified two broad types of advance organizers.
The expository organizer is used when the material is new
and the comparative organizer is used when the material is
either not new or completely novel. Advance organizers can
be used either in prose form or as visual displays (Weisberg,
1970).

Since the introduction of the concept, a large amount
of research has been generated testing the effectiveness of

the advance organizers. This research has been reviewed extensively (Ausubel, 1980; Barnes & Clawson, 1975; Faw & Waller, 1976; Hartley & Davies, 1976; Lawton & Wanska, 1977; Mayer, 1979, 1980). There is continuing controversy as to the effectiveness of the advance organizer (Anderson, Spiro & Anderson, 1978; Ausubel, 1978, 1980; Barnes & Clawson, 1975; Faw & Waller, 1976; Hartley & Davies, 1976; Lawton & Wanska, 1977; Mayer, 1979). Barnes and Clawson (1975) reviewed 32 studies dealing with advance organizers. They analyzed these studies according to several variables such as length of treatment, ability level of students, subject area, grade level, types of organizers, and level of learning task. Their conclusion was that the efficacy of advance organizers had not been extablished. Of the 32 studies reviewed, 12 reported advance organizers enhanced learning and 20 advance organizers did not enhance learning. When the above discussed variables were analyzed, no clear patterns emerged. Barnes and Clawson (1975) closed their article by listing nine steps that should be taken methodologically in future experiments to insure more accurate studies. Hartley and Davies (1976) and Faw and Waller (1976) with limited reviews, draw the same conclusion as Barnes and Clawson (1975). There is no strong evidence that advance organizers enhance learning and there are methodological problems which must be resolved. Lawton and Wanska (1977) replied to the Barnes and Clawson (1975) evaluation. They

cited several limitations of the Barnes and Clawson review.
First, they did not limit themselves to published articles
and second, some of the articles were misinterpreted.
Lawton and Wanska (1977) concluded by providing their list
of 12 points that need to be considered when constructing
experiments that deal with the effectiveness of advance
organizers.

Ausubel (1978) also published a reply to the Barnes and
Clawson (1975) and Hartley and Davies (1976) critiques.
Ausubel has responded to the general criticism that advance
organizers are a vague concept in that there is exhaustive
and explicit general discussion of the definition, nature,
and effects of an organizer in various publications
(Ausubel, 1960; Ausubel & Fitzgerald, 1961, 1962; Ausubel &
Youssef, 1963; Fitzgerald & Ausubel, 1963). Ausubel stated
that there is a specific description on how to construct
an advance organizer for a particular topic (Ausubel, 1968).
He cited two studies (Lawton, 1977; Lawton & Wanska, 1977)
that show that advance organizers enhance learning. Mayer
(1979) also replied to the criticism of Barnes and Clawson
(1975). Mayer reviewed several theories of why advance
organizers do work. Anderson, Spiro, and Anderson (1978) in
their research, again questioned the usefulness of advance
organizers. Anderson et al. stated that Ausubel's assimila-
tion theory of meaningful learning and retention is too
vague. They also stated advance organizers are a few vaguely

worded sentences intended to facilitate textual learning directly rather than through modifying the learners cognitive structure. Overall, research of advance organizers has been inconclusive. Ausubel (1980) replies that these conclusions are a misrepresentation of published material. Luiten, Ames, and Ackerson (1980) conducted a meta-analysis of the effects of advance organizers on learning and retention. They examined 135 published and unpublished studies, examining influencing variables such as grade level and subject studied. They concluded that advance organizers have a facilitative effect on both learning and retention.

Probably because of the above controversy, advance organizers continue to generate much research. Mayer and Bromage (1980) examined the effects of providing the advance organizer before or after the reading. They found that the group receiving the advance organizer before the reading recalled more conceptual idea units, recalled more material appropriate to posed questions and made more novel inferences. The group receiving the advance organizer after the reading recalled more technical idea units, remembered less question related material and produced vague summaries. Lawton and Wanska (1979) investigated the effect of the type of advance organizer presented to elementary school children. The three types of advance organizers were subject organizers, process organizers, and a combination of both

subject and process organizers. A subject organizer is what
its name implies; it presents an overview of the organiza-
tion of the material. Process organizers present general
ideas of ways subject matter concepts might be arranged in
some sort of hierarchical classification. Subject/process
organizers were the most effective. The second most effec-
tive was the process organizer followed by the subject
organizer and then the control group.

Mayer (1977, 1978, 1979) has completed a great deal of
research that has served to articulate Ausubel's theory of
advance organizers. Mayer (1978) investigated the role of
advance organizers in learning from a text. It was hypoth-
esized by both Ausubel (1968) and Mayer (1975) that advance
organizers may be especially helpful in learning technical,
unfamiliar, or poorly organized material. Advance organ-
izers are helpful because they provide a meaningful con-
text for which new material may be assimilated. Advance
organizers may also serve to encourage an encoding strat-
egy in which the subject attempts to integrate incoming
information with meaningful context. In the study there
were two experiments. In the first experiment subjects
were given a 24 frame text on computer programming. One
half received random order and the other half received
logical order. Random organization students who received
advance organizers performed better on a posttest than
the control group. The opposite was true for those

who received the logical organization. In the second
experiment, subjects read a four paragraph text about
imaginary countries that were organized either by name or
attribute. Low ability subjects who were given an advance
organizer prior to reading performed better on questions
that required integrating subject matter across different
paragraphs. Subjects given advance organizers after
reading performed better on questions that related to one
paragraph. Mayer (1978) concluded that advance organizers
serve as an assimilative context for unfamiliar organization.
A second study by Mayer (1977) also attempted to study the
effectiveness of a preorganizer on encoding and subsequent
performance. With several trials he taught subjects letter
or number chains. Those that learned the pattern or rule
performed better on tests of transfer.

Mayer (1976) also investigated conditions of meaningful
learning for computer programming. The two conditions
investigated were advance organizers and subject control of
frame order. Subjects who were given pretraining performed
better on novel problem solving and worse on routine problem
solving as compared to those receiving post-training or no
training.

Advance organizers have also been used to facilitate
the retention of oral instruction and television
instruction. Alexander, Frankiewicz, and Williams (1979)
worked with fifth, sixth, and seventh graders who received

oral instruction in social studies. The subjects were divided into four treatment groups; advance organizers before and after the presentation, and presentation of the material visually or orally, and a control group receiving no advance organizer. Students were tested after the presentation and two weeks later. Alexander et al. (1979) concluded that nonwritten cognitive organizers facilitated both the learning and the retention of oral instruction. A second study dealt with the effective use of advance organizers with instructional television. Nugent, Tipton, and Brooks (1980) obtained data from 943 students and 54 teachers at the college level. Introductory organizers were tested. Results showed that advance organizers signif-icantly increased student comprehension.

In summary, several preinstructional strategies other than instructional objectives have been researched in the literature (Barnes & Clawson, 1975; Faw & Waller, 1976; Hartley & Davies, 1976). Research with pretest questions and overviews to enhance learning has had mixed results (Faw & Waller, 1976; Hartley & Davies, 1976). Another preinstruction strategy that has been investigated and continues to be investigated is the advance organizer. Several studies have shown the advance organizer to enhance learning from a text (Alexander, Frankiewicz, & Williams, 1979; Ausubel, 1968; Luiten, Ames, & Ackerson, 1980; Mayer, 1975, 1977, 1978, 1980). Others have questioned the

effectiveness of the advance organizer (Anderson, Spiro
& Anderson, 1978; Barnes & Clawson, 1975)

As one can see from the above, there has been a great
amount of research concerning the effectiveness of
preinstructional strategies. By far, most research in
preinstructional strategies has been completed in the area
of instructional objectives and advance organizers. Both
of these areas continue to produce research. The present
research project examines the effect of preinstructional
strategy of instructional objectives when used with prose
material. The reason for selecting instructional objectives
is that neither the research on objectives nor advance
organizers has been conclusive, yet both continue to be
widely used. The present investigation examines objectives
with the additional variable of specification of level of
performance (easy and hard). It is hoped that from the
results of the present study, additional information will
be provided that will indicate whether objectives are
effective, and if so, what form they should take (quantita-
tive, qualitative, or a combination of quantitative and
qualitative).

Facilitating Objectives Related to Prose Learning

The research concerned with the use of instructional
objectives related to prose learning has been much more
extensive and consistent than the research previously cited.
Those concerned with the use of objectives and prose

material have been concerned with both relevant and inciden-
tal information. Relevant material is defined as that
material directly related to the objective and incidental
material being all other material contained in a particular
passage. Furthermore, prose learning research has also
looked at several other variables that influence the effec-
tiveness of material with objectives over material without
objectives. Studies have looked at such things as (a)
specificity of phrasing objectives (Dalis, 1970; Kaplan,
1976a; Rothkopf & Kaplan, 1972), (b) number of objectives
(Kaplan, 1974; LaPorte & Nath, 1976; Rothkopf & Billington,
1975; Rothkopf & Kaplan, 1972), (c) text length (Gagnè &
Rothkopf, 1975; Rothkopf & Kaplan, 1974), (d) location of
objectives (Frase, 1968a; Gagnè & Rothkopf, 1975; Kaplan,
1974, 1976a; Kaplan & Simmons, 1974; Rothkopf & Bisbicos,
1967), and (e) the amount of information contained in the
objective (Dalis, 1970; Kaplan, 1974; Kaplan & Simmons, 1974;
LaPorte & Nath, 1976; Rothkopf & Kaplan, 1972). In this
section several studies will be reviewed that primarily will
look at the effectiveness of instructional objectives and
also the above listed variables that could improve the
effectiveness of using objectives.

Duchastel and Brown (1974) conducted a study to
investigate whether objectives were effective with prose
material as related to performance and whether this was
caused by the fact that objectives provided a direction for

learning. One half of a group of 58 college students re-
ceived objectives for the text and the other half received
none at all. Those that received objectives performed
better than their counterparts on those questions that were
relevant to the stated objectives and less well on those
items not covered by their objectives. These findings are
in conflict with research by Morse and Tillman (1972) and
Rothkopf and Kaplan (1972) who found that objectives enhance
both relevant and incidental learning. Duchastel and Brown
attribute this discrepancy to the fact that the subjects had
experience with an objective-referenced instructional model.

Research conducted by Kaplan and Simmons (1974) was
concerned with the construction of the objective, its place-
ment and the results it would elicit as to relevant and
incidental learning. The findings were that objectives
aided in the acquisition of relevant material, both when the
objectives were presented before or after the text. How-
ever, performance on incidental information was greater when
the objectives appeared at the end of the text. The out-
comes were attributed to different methods used by the
students to process the text information. When objectives
or questions are presented prior to the material, they serve
as orienting stimuli that results in selective attention to
relevant or objective related material. When objectives
appear at the end of the material, the text is read non-
selectively. The objectives are inadequate as a summary or

review.

Kaplan (1974) has also looked at the placement of objectives within the text. Kaplan used three passage lengths with either specific or general objectives. The results showed that both relevant and incidental learning improved with the use of objectives. By dispersing the objectives throughout the material, relevant learning could be improved. Gagnè and Rothkopf (1975) obtained similar results with high school students. One half of a group of 157 students received a reading preceded by a list of objectives. The other half received a reading with objectives dispersed throughout. The objectives that were not dispersed resulted in a substantial elevation of performance on all objectives relevant to the text material. With objectives dispersed throughout the passage improvement was seen on only the first relevant element for each objective. Incidental learning was lower in both groups as compared to the central group which received only generalized instructions.

Closely related to the above study is one by Kaplan and Rothkopf (1974) in which text length and density or amount of objective relevant sentences within each passage were considered. Again, those receiving objectives out performed those in the reference group. It was also found that the amount of objective relevant learning decreased with more objective relevant sentences but was not related to passage

length. Incidental learning decreased with passage length and specifically stated objectives resulted in the learning of more intentional material. Kaplan (1976a), in a later study, also looked at the effects of grouping and response characteristics of instructional objectives when learning from prose. Subjects were given objectives which were either specific or general in nature. For one half of those receiving specific objectives, the objectives were interspersed throughout the text and for the other half the objectives were grouped. Additionally, one half of each group was instructed to overtly respond to each objective. The results showed greater intentional learning with objectives than without objectives. There was no difference between overt and covert responding, but overt responding resulted in less incidental learning than covert responding, particularly when objectives were interspersed. He also found a strong relationship between correct identification of object-relevant text sentences and subsequent text performances. Kaplan (1976b) also examined the relationship between student experience with objectives and the effectiveness of objectives in learning from text material. Four different treatments were used: no objectives, objectives before text, objectives after text, and a combination of before and after text. The findings were that experience with objectives produced greater overall learning and greater intentional rather than incidental learning.

The number of goals as related to the amount of
achievement has been studied by Rothkopf and Billington
(1975). They tested 192 college students and randomly
assigned them to eight groups. Treatment groups were
differentiated by: (a) number of assigned goals, (b)
number of goals achievable for passage, and (c) resemblance
between unachievable goals and certain text segments. It
was found that goal-relevant learning was reduced by
increasing numbers of assigned goals whether or not they
could be achieved. More incidental learning was found for
text segments resembling goals than for dissimilar texts.

Recent research on the use of objectives has addressed
the question of how an objective changes a learner's
behavior when learning from prose. Geiselman (1977) studied
memory from prose as a function of learning strategy and
inspection time. He found that, when subjects were given
specific instructions (generalized goals or objectives)
about what material to study, they studied the material at
a slower pace. Those that were given specific instructions
also spent more time on the material that was not emphasized
as well as the emphasized, but there was no similar increase
in learning. In the second part of the experiment,
Geiselman found that inspection time was necessary for
increased learning to occur. Gagnè, Bing & Bing, (1977)
hypothesized that goals affect the organization of free
recall thus facilitating the solving of problems. Working

with 24 high school students, they found that this was the case; objectives do have an effect on organization.

Rothkopf and Koether (1978) investigated the organization of objective lists and the prose material to which they related in terms of discrepancies between the sequence of the two. Gagnè and Rothkopf (1975) observed that study goals are less effective when the sequence of the list of objectives does not match the sequence of objective relevant material in the passage. In their experiment some of the objectives could not be found from the information in experimental passage. They hypothesized that students stop looking for out-of-order objective relevant material once they find the material is not in the text. The Rothkopf and Koether (1978) study replicated the Gagnè and Rothkopf (1975) study except all objective related material was in the text. The finding was that objective relevant learning was lower when the objectives and the text sequence did not match. Duchastel (1979) studied the role of objectives in relation to the organization of text. The texts were organized in terms of ideational prominence. In a high ideational prominence passage, the target topic is placed high in the content structure of the text. In this experiment, ideational prominence was manipulated and influenced learning on its own, but it was found to lose its affect when relevant objectives were also provided. Objectives and structure were interpreted as providing redundant

orientation in the learning situation.

A quantitative goal may be defined as a goal that specifies numerically what the student is to attain from an instructional experience. For example, "You will be able to spell at least 80% of the spelling words assigned". The 80% is considered a quantitative goal. Quantitative goals can be used in prose learning. The use of quantitative goals had at least part of its beginning in the early work with behavioral instructional design. Gagnè (1965), in his article analyzing the use of instructional objectives, gives two reasons for utilizing a quantitative component to an instructional objective. First, it specifies the postlearning behavior for measurement. There is an observable measurement which will tell the instructor that the student has met the objective. The second reason is that specification of level of attainment can be communicated to the student. The student then carries out the necessary matching procedures to insure that the objective is met. In this sense the quantitative objective is seen as a motivator; something that the student will strive for and thus complete the task. Locke (1968) proposed such a theory of motivation. The basic premise of the theory is that an individual's conscious intentions regulate their actions. Locke (1968) defines a goal as what the individual is consciously trying to do. He further states that hard goals result in a higher level of performance than easy

goals and specific hard goals result in a higher level of performance than do no goals or the general goal of "do your best". In addition, the theory states that a person's goals mediate how performance is affected by monetary incentives, time limits, knowledge of results, participation in decision making, and competition. Locke, Bryan, and Kendall (1968) found, in a series of experiments, that the relationship between goals and incentives is two-fold. Incentives do not affect behavior unless they also affect goals and intentions. Goals and intentions are related to the obtained level of behavior regardless of incentives.

Locke's (1968) propositions have been tried experimentally both in the business and school settings. Latham and Yukl (1975a) reviewed the application of goal setting in the business environment. They examined the following aspects of Locke's theory: (a) the effects of specific goals versus generalized goals or no goals, (b) the effects of goal difficulty on performance, and (c) goals as mediators of performance feedback, monetary incentives and time limits. The first two categories will be reviewed in that they are of an interest in this research. Latham and Yukl (1975a) reviewed ten studies that supported Locke's position on specific goals (Blumenfeld & Leidy, 1969; Burke & Wilcox, 1969; Kolb & Bayatzis, 1971; Latham & Baldes, 1975; Latham & Kinne, 1974; Latham & Yukl, 1975b; Lawrence & Smith, 1955; Ronan, Latham & Kinne, 1973; Sorcher, 1967;

Wexley & Nemeroff, 1975). In terms of goal difficulty,
six studies (Blumenfeld & Leidy, 1969; Carroll & Tosi,
1970; Dachler & Mobley, 1973; Steers, 1975; Zander,
Forward & Albert, 1969; Zander & Newcomb, 1967) have found
that difficult goals lead to greater performance.

Several recent studies have also tested Locke's (1968)
hypothesis. Strang, Lawrence and Fowler (1978) examined
the effects of assigned goal level and knowledge of results
on arithmetic. Female university students either received
or did not receive explicit knowledge of results while
under easy or challenging goal assignments. A control
group received neither a goal assignment or knowledge of
results. Subjects receiving knowledge of results under a
challenging goal assignment significantly increased their
computation speed without losing accuracy. Without know-
ledge of results, goal assignments had no noticable effect
on computational speed and lead to a significant increase
in errors. Dossett, Latham and Mitchell (1979) found the
opposite in terms of knowledge of results. Female clerical
personnel were randomly assigned to participative, assigned,
and do your best goal conditions. With goal difficulty
held constant, there was no significant difference between
the assigned and participative conditions on performance or
goal acceptance. No main or interaction effects were found
for knowledge of results. A final study by Becker (1978)
showed that knowledge of results and difficult goals

improved performance. Eighty families were asked to set a
goal to reduce their residential electrical consumption for
several weeks during the summer. One half received a
difficult goal of reducing their consumption 20% while the
other half received an easy goal of reducing consumption
2%. One half of each of these groups received feedback
three times a week about their consumption. The group
given the hard goal and which received regular feedback
conserved the most energy and were the only group to
significantly conserve more energy than the control group.

Three studies (Gardner & Gardner, 1978; LaPorte &
Nath, 1976; Rosswork, 1977) have applied Locke's (1968)
motivational approach in the academic setting. LaPorte
and Nath (1976) investigated the effect of learning goal
instructions on prose learning. Subjects read and were
tested on two passages. Different goal instructions were
introduced for the second passage. One group received a
hard specific goal (answer 18 out of 20 test questions
correctly) a second group received an easy goal (answer
5 out of 20 test questions correctly) and the third group
received a general goal (do your best). The hard goal group
scored higher on a test of comprehension than the other two
groups. Rosswork (1977) measured the effects of goal
setting and varying magnitudes of incentive. The experi-
mental group consisted of 86 grade school students who were
assigned either a specific difficult goal or nonspecific

general goal. There were four levels of monetary incentive with two levels of ability blocked within each group. Each subject received three trials at a task of learning spelling words. The results were that specific difficult goals lead to higher levels of performance than nonspecific goals across various incentive conditions. Gardner and Gardner (1978) found similar results with retarded children. Goal setting was found preferable over no goal setting in the learning of spelling words.

It should be noted that much of the preinstructional strategy research contained in the Hartley and Davies (1976) and Faw and Waller (1976) reviews presented earlier in this literature review can be applied to prose learning. Many of the studies dealing with prequestions cited in their reviews utilized prose material (Campbell & Stanley, 1963; Hartley, 1969; Peeck, 1970; Rothkopf, 1966; Welch & Walberg, 1970). The same is true for advance organizers. The majority of the research with advance organizers has been completed using prose material. Hartley and Davies cite many of these studies (Ausubel, 1960; Ausubel & Fitzgerald, 1961; Newton & Hickey, 1965; Wagner, 1973). The three Mayer (1975, 1976, 1978) studies also utilized prose material.

There is much research that has examined variables other than objectives and preinstructional strategies to facilitate prose learning. Readability of the prose material and factors that affect readability have been

researched (Fass & Schumacher, 1978; Klare, 1976). Several studies (Royer & Cable, 1975, 1976; Royer & Perkins, 1977; Royer, Perkins & Konold, 1978) have presented evidence that learning of meaningful material can be facilitated by relating the to be learned information to previous known information. Other research (Frase & Schwartz, 1975; Rickards and August, 1975) has shown that if subjects took part in some activity which they generated themselves (such as writing their own questions or underlining phrases) they performed better on future tests of comprehension. Although the above examples are not preinstructional strategies, they are but just a few of the many variables being examined that are attempting to meet the same goal as preinstructional strategies; that is, to improve comprehension of prose material.

After reviewing many of the studies cited above, Melton (1978) concluded that a variety of complex conditions determine whether or not behavioral objectives enhance relevant learning and depress or enhance incidental learning. Those studies that have tried to determine whether or not objectives aid in learning material have over-simplified the problems. Melton feels that we should not direct our efforts at proving whether or not objectives aid learning but rather we should regard objectives as just another tool available to educators. That is to say that research should be directed toward identifying the

conditions under which objectives can be used most effec-
tively.

All in all, the above investigations conclusively
show that instructional objectives enhance learning from
prose material. These studies also show that there are a
great many variables such as specificity of phrasing ob-
jectives, number of objectives, text length, location of
objectives and the amount of information contained in the
objective which can either enhance or detract from this
interaction. Further research is needed to determine the
best combination of variables (type of preinstructional
strategy, text length, location of intentional cues) that
will facilitate learning from prose material.

Intentional (Relevant) and Incidental Learning

For many years experimental psychologists have been
concerned with the question, "Do we learn things inciden-
tally as we go about performing tasks?" They have been
concerned with whether the intent to learn (i.e. being
instructed to learn something) is the critical factor in
learning or if it is the interaction with some other vari-
able (e.g. what the subject attends to) that causes an
individual to learn.

Postman (1964) has identified two types of situations
where incidental learning may take place. They are
identified as Type I or Type II situations. A Type I
situation is when a subject is exposed to the learning

materials under some pretext. For example, he may be shown a list of words and be asked to rate them on some feature. Then he would be asked to recall as many words as possible. Type II is very similar to the type of experiments that have been conducted using instructional objectives. The subject is asked to learn some material, usually through a set of directions, and is then asked questions about material the directions have not told him specifically to learn. For example, the subject may be asked to learn pairs of nonsense syllables which are printed in different colors. Then, later on, he is asked which colors were associated with each syllable. The color was not a part of the instructions, but an intrinsic part of the material. Several experiments have been done to study this interaction.

Most of the research has been conducted with the Type I model. Postman and Adams (1956) varied the orienting task that assured exposure to the materials. There were three groups: (1) an intentional group that was instructed to learn the material; (2) a group that performed the orienting task and also were instructed to learn the material; and (3) the incidental group. Each was given two tasks; a list of 20 nonsense syllables and a list of 30 adjectives. The findings were that on the nonsense syllables the intentional learners scored better on posttests of learning. The second group, which was

instructed to learn the material and perform an orienting
task, did no better than the incidental group who performed
the orienting task only. With the adjectives the inten-
tional learners always performed better than the incidental
learners. Postman, Adams and Phillips (1955) also
conducted experiments with nonsense syllables and found that
there was very little difference in learning between groups
on those nonsense syllables that had low association.
Eagle and Leiter (1964), Breitman (1969), Gleitman and
Gillett (1957), and Mechanic (1964) all found similar
results: that the intention to learn has no direct effect
on learning but it influences it indirectly through the
kinds of learning responses it generates. What becomes
important is the quality of the learning responses rather
than the intent.

There have been fewer experiments conducted that were
concerned with Type II learning. Mechanic (1962a), using
nonsense syllables, found that the meaningfulness of the
incidental items was important in terms of learning. He
found that low meaningful items were easily remembered. The
same finding was also noted by Feldman and Underwood (1957)
and Jantz and Underwood (1958). It should be noted that
the results in Type II situations have not always been in
agreement when verbal and nonverbal situations have been
investigated (Postman, 1964; McLaughlin, 1965; Mechanic,
1962b). Mechanic (1962a) was able to show that this

difference can be attributed to the relative interference be-
tween the incidental and intentional components of the task.

Research continues in this area of intentional and
incidental learning in the 1970's but generally with fewer
studies being published today than in the 1950's and the
1960's. The focus of the reported research is still to
identify the variable or variables that causes learning to
take place. Eagle and Milliken (1974), using affective
ratings of stimulus words, found that intent to learn was
not the critical factor; but the effectiveness of the
operations to learn and the facilitation of affective
ratings is what is critical. Till and Jenkins (1973) also
found that recall was dependent on the nature of the
orienting tasks. A variety of orienting tasks were used.
Wolk and Svoboda (1975) studied the role of orienting tasks
of field dependence/independence. Two groups were used.
One was told to read for content while the other was
instructed to detect typographical errors. In terms of
incidental learning, the group that read for content
experienced more incidental learning and field-dependents
exceeded independents in incidental learning. They also
found that retention of incidental material was substantial
after 21 days. These three studies typify the type of
research being published on intentional and incidental
learning today.

The research reviewed here tends to support the

hypothesis that intent to learn is not sufficient to cause learning. An important factor is the type of response that is generated. Thus, if responses are elicited in some other manner such as orienting tasks, they will also cause learning to take place. Most of the studies related to intentional and incidental learning have been conducted with a Type I model. This model exposes subjects to stimuli but does not tell them precisely what to learn, rather it instructs them to perform some operation such as matching geometric objects. Unfortunately, few experiments have been conducted with the Type II model where subjects are exposed to material and are told to learn parts of it and then tested over all the material. This type of study is very similar to the type of experiment being conducted here. All of this research does have implications for instructional psychologists and generally supports the statements of Rothkopf (1970) and Anderson (1970): "You not only have to tell a subject to learn something, but the material must be presented in such a way that the student can respond to it. The response is the important aspect". More research must be done in the applied area to see how the findings really work in the classroom setting and if they can be applied in generalized learning situations.

The Delay-Retention Effect

The delay-retention effect is a part of the larger

topic, feedback effects. Feedback, in the learning
setting, is usually defined as a means to provide the
learner with an awareness of the appropriateness of his
or her responses. The issue of whether feedback should be
provided immediately has been extensively studied, yet no
firm answer exists. This research has examined the effect
of feedback on psycho-motor and perceptive tasks, standard-
ized test scores, behavior modification, verbal learning,
programmed instruction, role of errors and false feedback.

Annett (1969), in an exhaustive review of the litera-
ture concerning feedback and human behavior, identified
three factors that possibly explained the effect of feed-
back on learning and retention. These three factors are:
(1) reinforcement, (2) incentive, and (3) information.
Annett concluded that feedback may be regarded as infor-
mation about the outcome of a test carried out on the
environment. He further stated that knowledge of results
as an incentive function adds nothing to its properties
as feedback; in a general sense, motivation can be
regarded as feedback in action. The so called incentive
function of knowledge of results seems to involve both
providing the subject with a performance standard to aim
for and information necessary for corrective action. These
conclusions were confirmed in a study by Carels (1975).
He found that feedback provided to the learner enhanced
learning and retention of programmed text materials. He

further found that the beneficial effects of feedback
could more appropriately be explained in terms of the
information it conveys.

In another rather extensive review Geis and Chapman
(1971) cited several studies that examined the effect of
knowledge of results and other possible reinforcers in self-
instructional systems. There is ample evidence that, under
some circumstances, feedback affects performance. However,
with self-instructional material, the results have been
mixed. Several studies have shown that feedback does
enhance learning (Alter & Silverman, 1962; Anderson et al.,
1971; Campeau, 1968; Krumbaltz & Keisler, 1965; Wittrock &
Twelker, 1964). Even more numerous are the studies
questioning the effectiveness of feedback (Becker, 1964;
Feldhusen & Birt, 1962; Hough & Revsin, 1963; Jacobs &
Kulkarni, 1966; Moore & Smith, 1961, 1964; Ripple, 1963;
Swets, Millman, Fletcher & Green, 1962). Geis and Chapman
also reviewed the literature that dealt with delay of
confirmation. Though not entirely consistent, the research
strongly suggests that delaying the presentation of the
reinforcing consequence reduces its effect on the behavior
upon which it has been made contingent. One study by
Evans, Glaser and Homme (1962) using programmed instruction
to teach symbolic logic investigated delay of feedback.
Delays in confirmation seem to have only a little effect
on criterion performance. The authors suggested that, when

the correct response is highly probable, the effect of confirmation may be minimal. A study by Meyer (1960) involved teaching Latin prefixes to eighth graders with a 19 lesson programmed text. One group received immediate feedback while the other group received feedback on their answers 24 hours later. Students in the delayed feedback group produced more errors. Meyer concluded that immediate feedback is preferable over delayed feedback for the acquisition of material. Boersma (1966) using a modification of a symbolic logic program found a significant interaction effect of delay of feedback (i.e. time from response to feedback exposure), and post-feedback delay (i.e. time between end of feedback exposure and presentation of next frame) on program errors, but not on criterion tests. Geis and Chapman (1971) conclude that the evidence is weak that confirmation is a reinforcer. They state further; if there is a trend, it is toward showing no real reinforcing effect of feedback.

The effect of delayed feedback in facilitating the retention of instructional material from prose has been studied for several years. There have been several studies that have indicated that delaying feedback to students of results from examinations is superior to immediate feedback. Kulhavy (1977) in an extensive review cites several of these studies. Sassenrath and Yonge (1968) gave 160 undergraduate college students a 60 question multiple choice test. One

half received feedback immediately, the other half received
feedback 24 hours later. The type of feedback was also
varied: half received both the stem of the question and
the correct responses; others received just the responses.
Also, one half of the group was provided with positive
incentives. The results indicated that on a test of
delayed retention, the groups receiving delayed feedback,
both the stem of the correct response to the question and
positive motivation, scored higher. Several other studies
with similar results have also been reported. Sassenrath
and Yonge (1969) working with college students found no
differences in immediate retention between those receiving
immediate and delayed feedback. On delayed retention those
receiving delayed feedback performed slightly but reliably
higher than those receiving immediate feedback. More (1969)
worked with eighth grade students and investigated the
effects on learner performance of feedback delays ranging
from immediate to four days. Retesting took place either
immediately or three days after feedback. In terms of
acquisition, the immediate feedback group scored signif-
icantly lower than those who received delayed feedback.
Within retention groups the two and a half hour and one day
groups scored significantly higher than those that received
immediate feedback and four days of delay. Sturges (1969)
used multiple choice questions. Subjects received infor-
mation about their test performance either immediately or

24 hours later. Students were tested for retention immediately after receiving information feedback and seven days later. Delay had no effect on tests of immediate retention, but, after seven days, retention was superior for those that received delayed feedback. Finally, Kulhavy and Anderson (1972) tested high school juniors and seniors who completed multiple choice tests on topics in introductory psychology under various conditions of immediate and delayed feedback. On the same test a week later, delayed feedback groups performed significantly better than immediate feedback groups. Those groups that studied the feedback booklet prior to the initial testing performed best of all. It should be noted though that there have been studies which have had contrary findings (Renner, 1964; Taber, Glaser & Schafer, 1956). There are contradicting positions on this issue in the field of psychology.

In an effort to answer the criticisms of the above studies that they were not truly representative of school learning and thus lacked external validity, Surber and Anderson (1975) conducted an additional experiment. To do this they used an environment that approximated the normal classroom. They also used methods and materials that were very similar to those used in the classroom. They used a 550 word passage about army ants. There were four treatment groups; two received instruction prior to the initial test and two received no instruction. One pre-instruction

and one no instruction group received feedback on day two.
All groups took tests on retention on day one and day
seven. There were also two control groups. The results
indicated again that feedback was preferable over no
feedback and that delayed feedback was preferable over
immediate feedback.

Newman, Williams and Hiller (1974) again offered
criticism that the preceding Surber and Anderson (1975)
study was still not truly representative of the normal
instructional setting. Specific errors cited in the Surber
and Anderson study and corrected in the Newman et al. study
were: (a) students were required to answer test questions
without relevant prior instruction, (b) subjects were
carefully deprived of any indication that they were to be
retested, (c) achievement level was not established as
instrumental for any reinforcement such as course grades,
and (d) instructional materials relevant to the test were
not made available to the subjects during the interval
between initial and retention testing. With all these
criticisms taken into account, no overall differences were
noted between those that received immediate feedback and
those that received delayed feedback. The general con-
clusion was that the previous experiments conducted lacked
external validity.

Two theories attempt to explain the beneficial effect
of delayed feedback on delayed retention. The verbal

facilitation theory (Sassenrath, 1975) states that delayed
feedback subjects have more time than immediate feedback
subjects to make use of response produced verbal cues
originating from the stimulus material. When meaningful
verbal material is presented to older children and adults
the verbal cues can help the subject mediate or covertly
rehearse the material during the delayed feedback period.
The second theory developed by James R. Surber and
Richard C. Anderson (1975) is the interference-preservation
hypothesis and states that over the delayed feedback the
initial wrong responses are forgotten more readily and less
proactive interference occurs when learning the correct
response from feedback. Sassenrath (1975) reanalyzed
several of the studies cited in this review using two
ratios: wrong responses on the first test that were changed
to a right response on test two and the change of right
responses on the first test to wrong responses on test two.
Feedback was either immediate or delayed between test one
and test two. Sassenrath found that delayed feedback
produced a higher number of wrong responses that were
corrected on the second test thus supporting the inter-
ference-preservation theory. Immediate feedback did not
produce a higher number of items that were right on both
the first and second tests than did delayed feedback. This
indicated that immediate feedback does not act as a
reinforcer of right answers but rather as information to

change wrong responses to right responses.

Three recent studies had mixed results with delayed
feedback enhancing learning. Phye, Gugliemella and Sola
(1976) conducted an experiment with 320 undergraduates.
There were four experimental groups. One group took a
40 question multiple choice test and one group took a 40
question completion test. One half of each group received
feedback immediately after the test; the rest received
delayed feedback 48 hours later. The delayed feedback
was not superior as predicted by the delayed retention
effect. Also, feedback in the form of correct answer only
was superior to correct answer plus distractors. Sturges
(1978) administered a multiple choice or completion
computer assisted test to a group of college undergraduates.
Subjects either received immediate feedback or delayed
feedback 24 hours later. Delayed feedback was found to
be more effective with the multiple choice test. There was
no significant difference between immediate and delayed
feedback with the completion test. Peeck and Tillma (1978)
had 67 fifth graders study a text and take a test of compre-
hension. One third received feedback after 30 minutes, one
third after 24 hours, and one third received no feedback.
The students were tested a week later. Those students
receiving feedback 24 hours later scored the highest.

The above information indicates that delayed feedback
appears to have effect on the retention of material

presented, but further research needs to be completed to determine its actual effects in the classroom. Also, the interference-preservation theory appears to offer one explanation of these findings.

During the last five years, the effect of feedback on subjects in the school setting has been investigated in terms of several variables other than delay of feedback. Some of the areas researched are the effects of types of feedback on learning various tasks (Barringer & Gholson, 1979; Donohue & Ratliff, 1976; Dwyer & Arnold, 1976; Henderson, 1977), effect of feedback on present and future performance of the student (Clair & Snyder, 1979; Latta, 1978; Saudargas, Madsen, Jr. & Scott, 1977; VanHouten, Hill & Parson, 1975; Van Houten & McKillop, 1977; Woolfold, 1978) and the effect of evaluative feedback in use of feedback to control classroom behavior (Marholin & Steinman, 1977; Walker & Hops, 1976). Let's first look at the effect of feedback on conceptual learning.

The effects of type and combination of feedback upon conceptual learning by children with implications for research in academic learning was extensively reviewed in an article by Barringer and Gholson (1979). Barringer and Gholson define concept formulation as the process of learning to differentiate phenomena of one class from phenomena not found in that class. In learning these discriminations, feedback can be given in several forms:

verbal, the experimenter says correct or wrong following the response; symbolic, which involves a tone or flash when the correct response is provided; and tangible reinforcement such as tokens, candy or money for correct responses. Feedback may be given in several ways: (a) feedback for both correct and wrong answers, (b) feedback for correct answers only, and (c) feedback for incorrect answers only. Barringer and Gholson (1979) after reviewing the literature, concluded that verbal feedback and symbolic feedback produce more rapid acquisition than does tangible feedback (Spence, 1970, 1971; Spence & Dunton, 1967; Spence & Segner, 1967). They also concluded that providing feedback for correct answers only was the least efficient method for teaching children conceptual material (Curry, 1960; Mims & Gholson, 1977; Spence, 1966; Williams, 1972). Feedback which followed wrong answers but not right answers usually resulted in the most efficient learning during acquisition (Curry, 1960; Meyer & Seidman, 1961; Spence, 1966). This detrimental effect of tangible feedback has been attributed to the fact that it distracts the child's attention from the stimulus materials (Miller & Estes, 1961; Penny, 1967; Spence & Dunton, 1967). Barringer and Gholson (1979) closed their review by stating that educators should look closely at the research before instituting feedback systems that use tangible feedback, such as token economy, because the research tends to show them least effective.

These conclusions were supported in a study by Donohue and Ratliff (1976). They investigated the differential effects of a contingent reward (candy), punishment (loss of candy) and knowledge of results with ten year old boys during an acquisition exercise on a laboratory instrument. The level of performance was significantly higher for those who received knowledge of results only with no other reinforcement. Donohue and Ratliff (1976) concluded that knowledge of results serves to focus attention on the relevant aspects of the task. The candy reward served as a distraction.

Recent studies have investigated the role of visual feedback on the acquisition of the task. Dwyer and Arnold (1976) studied the effects of verbal and visual feedback. Subjects were provided with a programmed instruction in one of two forms: (1) providing printed (verbal) reinforcement (2) visual reinforcement. A third group received text like material. Differences were found between the groups for several criterion. Henderson (1977) examined the role of various sources of feedback in developing and maintaining the complex skill of dart throwing. Both visual and auditory feedback were manipulated. Immediate and delayed feedback effectiveness was also measured. When there was a brief delay of visual feedback, accuracy was affected, but with practice the accuracy recovered. When the subjects received no visual feedback, they used subtle

cues. The subject identified the relative location of the dart from the sound of it hitting the target. When even the sound was removed, the subject's consistency remained the same, but accuracy fell. As soon as all feedback cues were restored, accuracy improved. Henderson's conclusions were that delayed feedback was detrimental to performance. She also noted that subjects can improve their competance when no external feedback is available.

A great amount of the research completed during the last five years investigated the effect of feedback on present and future performance of the student (Clair & Snyder, 1979; Latta, 1978; Saudargas et al., 1977; VanHouten, Hill & Parson, 1975; VanHouten & McKillop, 1977; Woolfolk, 1978). All have attempted to identify how feedback can facilitate acquisition of skills and the student's future performance. Clair and Snyder (1979) conducted an experiment with college students to examine the effect of instructor delivered evaluative feedback on a subsequent classroom task. It was hypothesized that the evaluative feedback to students on their past performance would result in changed performance on a subsequent task. This has been referred to as the self-fulfilling prophecy or 'Pygmalion effect' in previous research (Rosenthal, 1971; Rosenthal & Jacobson, 1968). In the Clair and Snyder study, subjects received one of four evaluative feedback conditions on six learning task trials (uniformly positive,

uniformly negative, negative-to-positive, positive-to-negative). The subjects then listened to an audio tape and took a performance test. The subjects' performance was higher for those who received positive reinforcement, followed by negative-to-positive, positive-to-negative, and uniformly negative. Woolfolk (1978) studied student learning and varying conditions of teacher verbal and nonverbal evaluative communication. Two male and two female teachers presented four combinations of feedback to sixth graders. They were (a) verbally and nonverbally positive (b) verbally positive and nonverbally negative (c) verbally negative and nonverbally positive, or (d) verbally and nonverbally negative. Their findings were that negative nonverbal behavior lead to significantly greater performance during the lesson.

Latta (1978) investigated the effects of initial achievement orientation and prior success feedback on the mastery of subsequent difficult and easy tasks. His experimental group consisted of 80 male introductory psychology students; 40 had been identified as high in initial achievement orientation and 40 had been identified as low in initial achievement orientation. Latta administered six trials of a digit-symbol substitution task on which they received either feedback or no feedback. The participants then learned an easy or difficult list of paired-associates with no feedback about performance.

Results indicated success facilitates digit-symbol perform-
ance in general, but slightly more for participants
initially low in achievement orientation. The findings
also showed that success feedback has: (1) no effect on
rate of mastery on a subsequent easy task, (2) a positive
transfer effect on rate of mastery of a subsequent difficult
task for participants initially high in achievement
orientation, and (3) a negative transfer effect on the rate
of mastery of a subsequent difficult task for participants
initially low in achievement orientation.

Three studies (Saudargas et al., 1977; VanHouten et al.,
1975; VanHouten & McKillop, 1975) examined the effect of
a performance feedback system on academic performance.
VanHouten, Hill and Parsons (1975) used timing, feedback,
and public posting of student scores to improve story
writing performance. The use of all these variables
improved the story writing, reading comprehension, and
word meaning exercises of elementary school children.
VanHouten and McKillop (1977) replicated the previous
study with tenth and eleventh grade honor students. The
treatment consisted of the same elements: explicit timing
of the composition period, self scoring and public posting
of the highest scores. The writing rates of all students
improved. Saudargas, Madsen and Scott (1977) investigated
the effects of fixed and variable time feedback, in the
form of home reports on the production rates of elementary

school children. The reports consisted of the amount of work completed, an evaluation of the quality of work and a place for the parent's signature. The reports were either distributed every Friday or on a variable time basis. When the reports were distributed on a variable time basis more assignments were completed.

Feedback has also been used to reduce behaviors that do not contribute to classroom learning. Marholin and Steinman (1977) worked with fifth and sixth grade students who had behavior problems. They found that these problems were reduced when reinforcement was contingent on academic accuracy and rate, rather than for the child working on the task. Walker and Hops (1976) had opposite results. They used three intervention groups. One was reinforced for facilitative or academic performance; one for correct academic performance; and group three for both. No significant differences were found. However, there was significant difference between the experimental and control groups favoring the experimental groups in reading and math achievement and level of appropriate behavior.

In summary, many studies have utilized feedback and other variables to enhance student performance in the classroom. In most of the studies, knowledge of results was only one aspect of the feedback. In almost every study, the feedback was immediate. The present study examines the differential effect of knowledge of results

upon learning and retention of prose material when feedback
is presented immediately and when delayed. Hopefully, the
results of the present investigation taken in combination
with the reported outcomes of the delayed feedback exper-
iments prior to 1975 (Anderson, 1975; Kulhavy & Anderson,
1972; More, 1969; Sassenrath & Yonge, 1968, 1969; Sturges,
1969), and the research completed in the last five years
(Clair & Snyder, 1979; Latta, 1978; Saudargas et al.,
1977; VanHouten, Hill & Parson, 1975; VanHouten & McKillop,
1977; Wolfolk, 1978) will help identify the specific role
of feedback and the conditions under which it should be
provided.

Recapitulation

The concept of attending or drawing attention to
particular instructional material is a well established
principle in education. As one can see from the literature
reviewed above, there has been a great deal of research
concerning the use of instructional objectives. When
objectives are applied to broad and general learning situa-
tions, the results appear mixed (i.e. objectives appear to
work only in some situations). However, the effectiveness
of objectives becomes much more apparent when one deals
with prose material. In every study reviewed, it was
shown that acquisition of objective relevant material is
improved when students are given objectives. It was also
shown in many studies that incidental material, that not

related to the objectives, is also retained through the use of objectives. Taken together, these studies have also shown that performance on achievement tests can be enhanced by the specific way in which the objectives are used. That is to say that objectives are useful when they are: placed in front of the material to be read, made specific to what the instructor intends the student to learn, and provided in a sufficient number to adequately identify the material to be learned.

The results of experiments with intentional and incidental learning are also mixed. The Type I experiments (i.e. exposing the subject to learning materials under some pretext and then measuring their recall) have fairly well established that intent to learn is not in and of itself enough to insure learning. Of more critical importance, is the type of response elicited through the use of orienting activity. Unfortunately, little work has been done with the Type II experiment which is comparable to those experiments dealing with objectives; (i.e. giving the subjects a reason to complete the material then directing them to learn parts of it and testing them over all the material contained in the exercise). The few Type II experiments reported have agreed with the findings that intent is not crucial as reported in the Type I experiments, but too few Type II experiments have been done to draw a valid conclusion. It should also be noted

that most of the research on incidental learning is more
on the basic end of the research continuum while studies
with objectives are more applied. It would appear from the
above discussion that further research must be conducted
to see if the basic research findings are also true in
applied situations.

Generally, the purpose of the present study is to
further investigate the use of objectives in prose learning.
This study focuses specifically on the little researched
area of the use of both quantitative and qualitative objec-
tives. The majority of the experiments have used qualita-
tive objectives, but LaPorte and Nath (1976) had excellent
results with quantitative objectives. The present experi-
ment investigates both intentional, or objective relevant,
and incidental learning. The primary interest in the pres-
ent study is whether or not objectives direct the subject
to relevant material.

METHOD

Statement of Hypotheses

The following null hypotheses were tested:

1. There will be no difference in the learning and/or retention scores in those situations in which quantitative objectives alone, qualitative objectives alone, and a combination of quantitative and qualitative objectives are presented to learners.

2. There will be no difference in learning and/or retention scores in situations using a combination of quantitative and qualitative objectives as opposed to using only one type of objective.

3. There will be no difference in the amount of incidental learning between those subjects receiving both quantitative and qualitative objectives versus those receiving quantitative objectives only or qualitative objectives only.

4. There will be no difference in the amount of direction provided for learning between qualitative and quantitative objectives as assessed by the amount of relevant material learned.

5. There will be no difference between the results on tests of comprehension of written material in those situations in which feedback is delayed versus those situations in which feedback is not delayed.

Subjects

All 64 members of two consecutive annual classes (n = 31, n = 33) of practical nursing students attending a small private school of practical nursing located within the city of Chicago formed the experimental group. All subjects had either a high school diploma or two years of high school and had passed the General Education Development Tests. In addition, all subjects had been required to take a battery of entrance screening examinations on which they had to have a minimum intelligence quotient of 90 on the California Capacity Inventory, a vocabulary grade level of 10.5 and a reading comprehension grade level of 10.5 on the Nelson Denny Reading Inventory. The experimental subjects were randomly assigned to four treatment groups (1-quantitative objectives only, n = 14; 2-qualitative objectives only, n = 15; 3-qualitative and quantitative objectives, n = 16; or 4-no objectives, n = 14). The data was analyzed from only 59 of the experimental subjects because five subjects were not present for both sessions of the experiment. This resulted in experimental groups with unequal numbers.

Procedure

The specific treatment each group (qualitative objectives only; quantitative and qualitative objectives; quantitative objectives only; and no objectives) received is described below:

1. The Qualitative Objectives Only Treatment Group. This

group received ten qualitative objectives with prose reading material. They were directed to read and study the material. At the conclusion of the study period they were given a 20 question completion test. Ten questions covered the objectives given with the prose material. The other ten questions covered incidental (not objective related) material in the passage. After taking the test one half of this group, randomly selected, received immediate feedback of their performance. They were shown the answers and were allowed to correct their test. Twenty-four hours later the other half of the group were shown the answers and were allowed to correct their test. Seven days after the initial test the entire group was retested.

2. The Quantitative and Qualitative Objectives Treatment Group. This group received the same ten qualitative objectives as the first group. They were also given a quantitative objective of 18 out of 20 correct on a posttest of comprehension. They were directed to read and study the material. At the conclusion of the study period they were given a 20 question completion test. Ten questions covered the objectives given with the prose material. The other ten questions covered incidental (not objective related) material in the passage. After taking the test, one half of this group was randomly selected and received immediate feedback of

their performance. They were shown the answers and were allowed to correct their test. Twenty-four hours later the other half of the group were shown the answers and were allowed to correct their test. Seven days after the initial test the entire group was retested.

3. The Quantitative Objectives Treatment Group. The third group received the difficult goal of 18 out of 20 correct on a posttest of comprehension. They were directed to read and study the material. At the conclusion of the study period they were given a 20 question completion test. Ten questions covered the objectives given with the prose material. The other ten questions covered incidental (not objective related material in the passage. After taking the test, one half of this group was randomly selected and received immediate feedback of their performance. They were shown the answers and were allowed to correct their test. Twenty-four hours later the other half of the group was shown the answers and were allowed to correct their test. Seven days after the initial test the entire group was retested.

4. The No Objectives Group. This group received neither quantitative nor qualitative objectives. They were given the written material and instructed to read and study it. At the conclusion of the study period they

were given the same 20 question completion test all other groups had received. After taking the test, one half of this group was randomly selected and received immediate feedback of their performance. They were shown the answers and were allowed to correct their test. Twenty-four hours later the other half of the group was shown the answers and were allowed to correct their test. Seven days after the initial test the entire group was retested.

All subjects had 30 minutes in which to read and study the material during the initial study period. Since the average person reportedly reads 250 words per minute, as measured by the Nelson-Denny Reading Test (Brown, 1976), the experimental passage was constructed to include 2,400 words so that each subject had approximately ten minutes for reading and 20 minutes for studying. It should be noted that the subjects were free to control their time. When they felt confident that they had studied enough, they indicated the time required for completion on the cover sheet and exchanged the reading materials for a posttest.

Materials

The instructional materials consisted of a passage entitled "Conditions Under Which Mushrooms Grow and Thrive" from a text entitled The Mushroom Handbook by Kruger (1967) pages 32-51 (see Appendix B). The passage was ten pages long and contained approximately 2,400 words. It dealt with

such aspects of development as food, temperature require-
ments, parasitism, etc. This selection was chosen because
the subjects would probably be unfamiliar with the material.
This material also approximated undergraduate college-level
material which all the subjects should have been able to
comprehend. Twenty objectives (see Appendix D) were pre-
pared from the passage. These objectives were very specific
requiring the subjects to recall information from one or two
sentences of the text. They basically fell into Bloom's
(1956) classification of knowledge objectives. An example
of an objective is as follows: After completing this unit
you will be able to (a) give two examples of plants which
form cooperative symbiosis with fungi (b) state the name for
a plant's response to gravity.

The posttest (see Appendix C) was developed so as to
directly reflect the objectives. One item was written for
each of the objectives. Since each subject received only
half of the objectives, those questions relating to the
objectives the subjects received were defined as objective
relevant and the remaining ten questions served as the
incidental material. An example of questions that were
related to the sample objectives above is as follows: (a)
Give two examples of plants which form a cooperative symbi-
osis with fungi (b) What is the name for a plant's response
to gravity? All questions were written in the recall rather
than the recognition format.

The objectives, test, and posttest were reviewed by at least two other educational specialists who were familiar with objectives and construction of instructional materials. Also, three members of the faculty of Loyola University of Chicago double checked the material for face validity and accuracy. Both the educational specialists and the faculty groups reviewed each objective to see that it was clearly stated and each posttest item was directly referenced to its appropriate objective.

RESULTS

Treatment Group Comparisons

Overall, a 2 X 4 factorial analysis of variance design
with unequal ns was used to evaluate amount of material
learned with each of the treatments (quantitative objectives
only, qualitative objectives only, quantitative and qualita-
tive objectives, and no objectives). Two factors were
employed in the analysis. One was the type of objective or
combination of objectives received by the subject. These
were quantitative objectives, qualitative objectives,
combination of both quantitative and qualitative objectives
and no objectives (control).

The second factor employed in the analysis was the type
of learning: relevant, incidental, and total (the sum of
the two). The dependent variable was number of correct
responses on a test of 20 questions (see Appendix C). Ten
questions were related to objective relevant material and
ten questions were not (i.e. incidental material). Type of
learning (quantitative objective only, qualitative objective
only, quantitative and qualitative objectives, and no objec-
tive) was considered a replication factor (both the relevant
score and incidental score are considered a part of the
total score). As pointed out on page 71, the unequal n was

the result of subjects not being present for the entire experiment. The Bio-Med statistical computer package was utilized to compute the univariate tests. In addition, a one-way analysis of variance was calculated for relevant and incidental learning independently across type of objective. The SAS statistical package was used to calculate the one-way analysis of variance results.

Table I depicts the mean scores for objective relevant, incidental, and total learning for each treatment group on the posttest. The two-way analysis of variance using repeated measures revealed a significant difference for type of learning, F (1, 55) = 16.76, p = .0001. A Newman-Keuls Test (Kirk, 1968, p. 91) at the .01 alpha level revealed a significant difference between relevant and incidental learning for the qualitative objectives only and a combination of quantitative and qualitative objectives groups. There was significant interaction, F (3, 55) = 7.35, p = .0003 between type of objective X type of learning (see Table II). A graphic representation of the significant interaction depicted in Figure I shows that those groups receiving qualitative objectives only or a combination of qualitative and quantitative objectives recalled more objective relevant material than incidental material. While those receiving quantitative objectives only or no objectives recalled approximately the same amount of both objective relevant and incidental material. A one-way analysis

Table I

Mean Number Correct for Type of Learning

in Each of the Four Treatment Groups

| | | Type of Learning | | |
| | | Relevant | Incidental | |
Treatment Group	n	Relevant	Incidental	Total
Quantitative Objective	14	3.64	3.64	7.28
Qualitative Objective	15	5.67	3.47	9.14
Quantitative & Qualitative Objective	16	6.25	3.44	9.69
No Objective	14	4.00	4.07	8.07

Note. Total Incidental Score = 10

Total Relevant Score = 10

Total = 20

Table II

Summary Table Analysis of Variance with Repeated

Measures for an Objective X Type of Learning

Factorial Design on Posttest Recall

Source of Variation	Sums of Squares	Degrees of Freedom	Mean Squares	F Ratio
Type of Objective	23.41	3	7.80	.99
Type of Feedback	36.64	1	36.64	16.76 *
Objectives X Feedback	48.21	3	16.07	7.35 **
Within Cell	120.26	55	2.18	

* p .0001

** p .0003
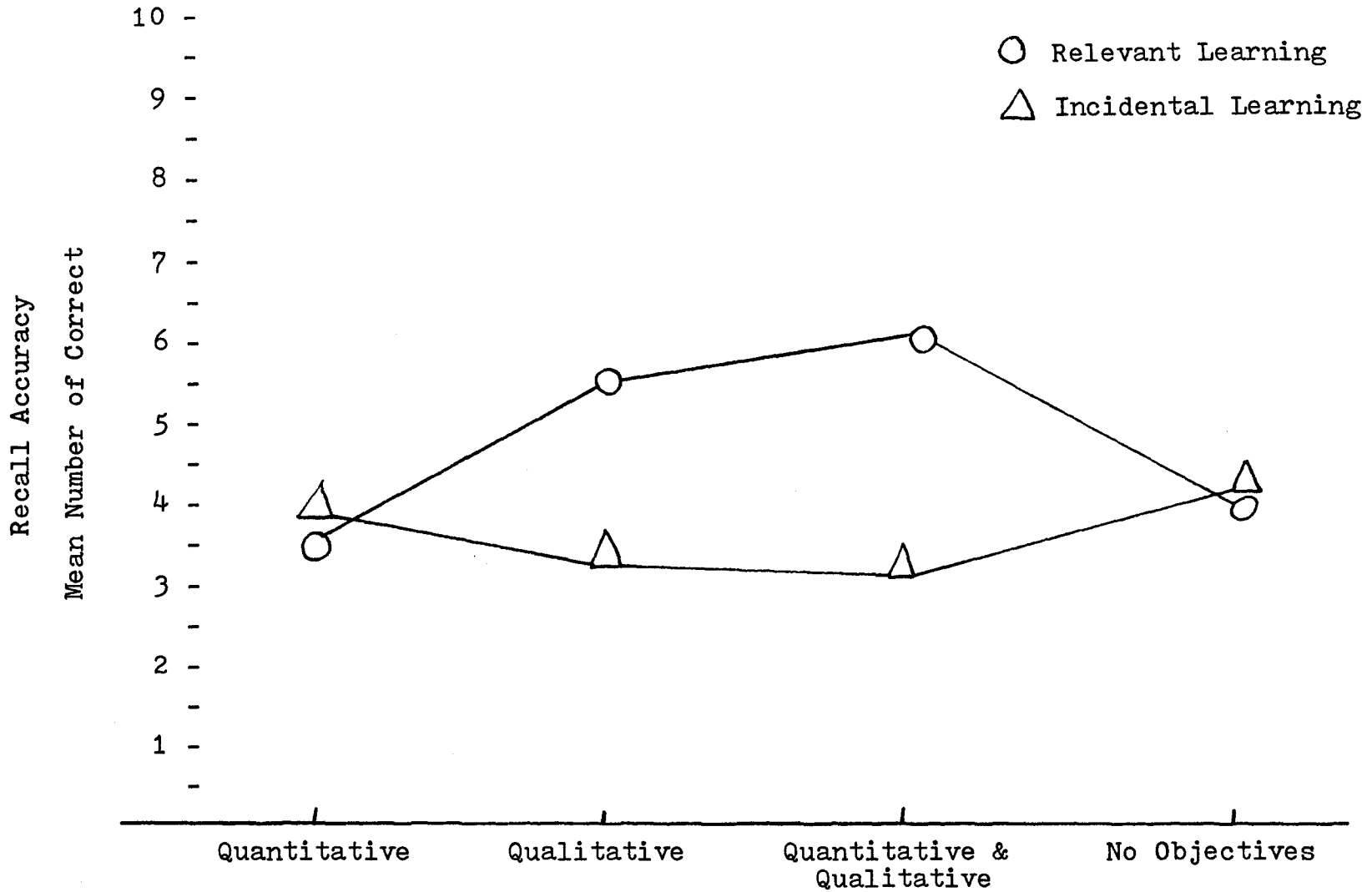
Figure I   The Interaction of Mean Number Correct for Relevant and Incidental Learning
            on the Posttest

of variance was calculated independently for both objective
and incidental relevant learning. A significant difference
was found for relevant learning F (3, 55) = 5.20, p = .003
(see Tables III and IV). A Newman-Keuls Test revealed a
significant difference at the .01 alpha level between those
subjects receiving a combination of qualitative and quanti-
tative objectives and those subjects receiving no objec-
tives. In addition, a Newman-Keuls Test at the .05 alpha
level of significance revealed a difference between the
performance of subjects in the combination of objectives
treatment group versus the quantitative objectives only
treatment group. There also was a .05 alpha level of sig-
nificant difference found between the performance of
subjects in the qualitative objective only treatment group,
the quantitative objective only treatment group, and no
objectives treatment group. However, no significant differ-
ence was found for incidental material between the quantita-
tive objectives only treatment group, qualitative objectives
only treatment group, quantitative and qualitative objec-
tives treatment group, and no objectives treatment group.
These results must be interpreted in light of the inter-
action found in the initial two-way analysis of variance
previously reported and depicted in Tables I and II and
Figure I.

The results partially reject null hypothesis one (there
will be no difference in the learning and/or retention

Table III

Summary Table of Analysis of Variance for

Relevant Learning by Type of Objective

Source of Variation	Sums of Squares	Degrees of Freedom	Mean Squares	F Ratio
Type of Objective	71.30	3	23.8	5.20 *
Within Cell	251.55	55	4.57	
Total	322.85	58		

* p   .003

Table IV

Summary Table of Analysis of Variance for

Incidental Learning by Type of Objective

Source of Variation	Sums of Squares	Degrees of Freedom	Mean Squares	F Ratio
Type of Objective	3.71	3	1.237	.22
Error	307.81	55	5.596	
Total	311.52	58		

scores in those situations in which quantitative objectives alone, qualitative objectives alone, and a combination of quantitative and qualitative objectives are presented to learners). In terms of relevant learning, the quantitative and qualitative objectives group scored the highest followed by the qualitative objective only group. The no objectives group with the quantitative objectives only group scored the lowest. The difference was significant between the posttest scores of subjects in the quantitative and qualitative objective group and the quantitative only and no objectives groups. There was also a significant difference in posttest scores between the qualitative only group, the quantitative only group, and the no objectives group. Therefore, subjects who received qualitative objectives or both quantitative and qualitative objectives were apparently affected in their learning of prose material. However, it appears that quantitative objectives alone do not have an affect on prose learning. The second hypothesis (there will be no difference in learning and/or retention scores in situations using a combination of quantitative and qualitative objectives as opposed to using only one type of objective) was also partially rejected with the above data. For relevant learning, both a combination of quantitative and qualitative objectives was significantly better than quantitative objectives or no objectives. However, there was no significant difference between the posttest scores in the

combination of quantitative and qualitative objective group versus the qualitative only group. Again, these results may be interpreted by the fact that significant differences were found in the one-way analysis of variance but not in the two-way analysis and there was a significant interaction between type of objectives and the type of learning.

The fact that there was a significant difference between objective relevant and incidental learning scores for both the combination of quantitative and qualitative objective group and the qualitative objective group rejects both null hypothesis three (there will be no difference in the amount of incidental learning between those subjects receiving both quantitative and qualitative objectives versus those receiving quantitative objectives only or qualitative objectives only) and null hypothesis four (there will be no difference in the amount of direction provided for learning between qualitative and quantitative objectives as assessed by the amount of relevant material learned). When given a combination of quantitative and qualitative objectives or qualitative objectives only, relevant learning becomes significantly higher. Thus, it appears that qualitative objectives do direct subjects to the objective relevant material in the text. This is also supported by the interaction between type of learning and type of objective as noted previously. When qualitative objectives are

provided, either alone or in combination with quantitative objectives, relevant learning is greater than incidental learning; without qualitative objectives, relevant and incidental learning is basically the same.

An Exploratory Investigation of the Delay-Retention Effect

A total of six 2 X 4 factorial analyses of variance with unequal ns were used to analyze the data gathered in the second phase of the experiment (examining the effect of informational feedback with objectives).

Table V depicts the mean total scores on the seven day test for those receiving immediate or delayed feedback by type of objective. No significant difference was found between type of feedback or type of objective. In addition, there was no significant interaction (see Table VI).

Tables VII and VIII depict the means for relevant and incidental learning for immediate and delayed feedback by type of objective on the seven day posttest. No significant difference was found between either type of feedback or type of objective for both relevant and incidental learning. Once again, there was no significant interaction (see Tables IX and X).

A 2 X 4 factorial analysis of variance was also used to analyze the gain scores between the posttest and the seven day test. Table XI depicts the results for the total scores. No significant difference was found between type of feedback or type of objective, nor was there any

Table V

Mean Total Scores on Seven Day Test

by Type of Objective

| | Feedback | |
Group	Immediate	Delay
Quantitative Only	9.14	7.14
Qualitative Only	8.12	9.28
Quantitative and Qualitative	9.00	9.50
No Objectives	9.57	7.57

Note.   Maximum Score = 10

Table VI

Summary Table of Factorial Analysis of Variance

for Type of Objective X Feedback Group

on a Total Seven Day Recall Test (Number Correct)

Source of Variation	Sums of Squares	Degrees of Freedom	Mean Squares	F Ratio
Type of Objective	9.40	3	3.13	.33
Type of Feedback	3.98	1	3.98	.42
Objective X Feedback	30.04	3	10.01	1.05
Within Cell	485.4	51	9.5	

Table VII

Mean Relevant Learning Scores on Seven Day Test

by Type of Objective

| | Feedback | |
Group	Immediate	Delay
Quantitative Only	4.57	3.71
Qualitative Only	4.37	5.14
Quantitative and Qualitative	5.25	5.87
No Objectives	4.86	3.57

Note. Maximum Score = 10

Table VIII

Mean Incidental Learning Scores on Seven Day Test

by Type of Objective

Group	Feedback	
	Immediate	Delay
Quantitative Only	4.57	3.43
Qualitative Only	3.75	4.14
Quantitative and Qualitative	3.87	3.62
No Objectives	4.71	4.00

Note. Maximum Score = 10

Table IX

Summary Table of Factorial Analysis of Variance

for Type of Objective X Feedback Group

on a Seven Day Recall Relevant Learning Test (Number Correct)

Source of Variation	Sums of Squares	Degrees of Freedom	Mean Squares	F Ratio
Type of Objective	19.57	3	6.52	1.95
Type of Feedback	.314	1	.314	.09
Objectives X Feedback	11.8	3	3.93	1.17
Within Cell	170.82	51	3.34	

Table X

Summary Table of Factorial Analysis of Variance

for Type of Objective X Feedback Group

on a Seven Day Recall Incidental Learning Test (Number Correct)

Source of Variation	Sums of Squares	Degrees of Freedom	Mean Squares	F Ratio
Type of Objective	2.85	3	.95	.28
Type of Feedback	2.44	1	2.44	.72
Objective X Feedback	4.74	3	1.58	.47
Within Cell	171.96	51	3.37	

Table XI

Mean Difference Between Day Seven and Day One

Total Scores by Objective

Group	Feedback[a]	
	Immediate	Delay
Quantitative Only	.72	1.00
Qualitative Only	(1.24)	.42
Quantitative and Qualitative	(.62)	(.25)
No Objectives	1.29	(.28)

[a]Numbers in parenthesis indicate a decline in test scores between Day 7 and Day 1.

significant interaction (see Table XII). Tables XIII and XIV show the results for relevant and incidental data. For both variables, no significant difference was found between type of feedback or type of objective, nor was there any significant interaction (see Tables XV and XVI).

The above results failed to reject null hypothesis five (there will be no difference between the results on tests of comprehension of written material in those situations in which feedback is delayed versus those situations in which feedback is not delayed). Therefore, when the information on the correctness of answers on the posttest of recall was delayed, prose learning was not enhanced.

Table XII

Summary Table of Factorial Analysis of Variance for

Type of Objective X Feedback Group of Changes Between

Day Seven and Day One for Both a Relevant

and Incidental Learning Test (Number Correct)

Source of Variation	Sums of Squares	Degrees of Freedom	Mean Squares	F Ratio
Type of Objective	22.08	3	7.36	.74
Type of Feedback	1.35	1	1.35	.14
Objectives X Feedback	19.00	3	6.33	.64
Within Cell	517.75	51	9.96	

Table XIII

Mean Difference Between Day Seven and Day One

Relevant Learning Scores by Objective

Group	Feedback[a]	
	Immediate	Delay
Quantitative Only	.14	.85
Qualitative Only	(1.38)	(.43)
Quantitative and Qualitative	(.87)	(.5)
No Objectives	.43	.00

[a]Numbers in parenthesis indicate a decline in test scores between Day 7 and Day 1.

Table XIV

Mean Difference Between Day Seven and Day One

Incidental Learning Scores by Objective

Group	Feedback[a]	
	Immediate	Delay
Quantitative Only	.57	.14
Qualitative Only	.13	.86
Quantitative and Qualitative	.37	.25
No Objectives	.85	(.28)

[a]Number in parentheses indicate a decline in test scores between Day 7 and Day 1.

Table XV

Summary Table of Factorial Analysis of Variance for

Type of Objective X Feedback Group⁻ on Changes Between

Day Seven and Day One Relevant Learning Test (Number Correct)

Source of Variation	Sums of Squares	Degrees of Freedom	Mean Squares	F Ratio
Type of Objective	23.85	3	7.95	2.36
Type of Feedback	3.75	1	3.75	1.11
Objectives X Feedback	3.54	3	1.18	.35
Within Cell	175.03	51	3.36	

Table XVI

Summary Table of Factorial Analysis of Variance for

Type of Objective X Feedback Group on Changes Between

Day Seven and Day One Incidental Learning Test (Number Correct)

Source of Variation	Sums of Squares	Degrees of Freedom	Mean Squares	F Ratio
Type of Objective	.289	3	.096	.02
Type of Feedback	.817	1	.817	.14
Objective X Feedback	6.56	3	2.19	.64
Within Cell	209.88	51	4.03	

DISCUSSION

Discussion of the Effects of Objectives on Prose Learning

Table I (see page 79) summarizes the effect of different types of objectives on relevant and incidental learning. For relevant learning, a combination of qualitative and quantitative objectives and qualitative objectives only were significantly more effective than the quantitative objectives only and no objectives treatments (hypothesis one). The finding that qualitative objectives alone or in combination with other information facilitate the retention of objective relevant material is consistent with several other studies (Blaney & McKie, 1969; Dalis, 1970; Duchastel & Brown, 1974; Frase, 1968b; Frase, Patrick & Schumer, 1970; McNeil, 1967; Patrick, 1968; Rothkopf & Kaplan, 1972, 1974).

The basic explanation for these results can be described within the general framework of the use of orienting stimuli (Rothkopf, 1970). Essentially, orienting stimuli are thought to elicit inspection behaviors which in-turn determine what is going to be learned by the subject. The qualitative objectives presented in the present study supposedly focused the subjects' attention on the important aspects of the reading material. This focused attention

apparently led to increased performance on the posttest of comprehension.

One alternative explanation as to why objectives are generally effective is presented by Gagnè (1978) using the ACT model of human memory developed by Anderson (1976). The ACT model proposes that human cognition is made up of two systems; a propositional network and a set of productions. The propositional network is a set of nodes connected by links. The nodes generally represent ideas and the links represent some sort of relationship between those ideas. A production represents procedural knowledge. The formal structure of a production is that of a condition followed by an action. Using the ACT model the effectiveness of qualitative objectives can be interpreted in two ways. First, as material is entered into the memory it is encoded to form the links and nodes discussed above. With objectives, subjects apparently altered their attending and encoding productions. That is to say, that when reading objectives the subject established a set of productions that say, "If x matches an objective, incorporate x into the propositioned network; if x does not match, don't incorporate x". Alternatively, or simultaneously, the learner could set up from the objectives a set of rehearsal productions by encoding all of the objectives and then, after reading, posing questions based on the encoded objectives. Answering these questions would strengthen the pathway used to the

extent that self-questions matched retention test questions, thus long-term recall should be improved. A third facilitative role for objectives may be that of providing an alternate pathway for to be remembered material. This is especially true when the objective is general rather than specific.

The present study indicates that a combination of quantitative and qualitative objectives is superior to quantitative objectives only and no objectives in facilitating the learning of objective relevant material from prose (hypothesis two). Frase (1975a) has proposed that the information learned from prose is a function of the reader's internal learning goals and the constraints of the prose material upon the reader's intentions. Changes in learning behaviors were conceptualized by Frase as resulting from changes in the reader's goals of learning. One method by which a reader's goals may be influenced is by externally presenting learning goals. The simplest explanation as to why subjects perform differently depending on the goal is that goals affect the amount of time spent reading the passage. However, the effectiveness of quantitative objectives to increase prose learning must be evaluated in light of the fact that there was no significant difference between those groups receiving both quantitative and qualitative objectives and those receiving qualitative objectives only. Also, those subjects receiving quantita-

tive objectives only scored the lowest on relevant learning. These findings are not consistent with other research (Frase, 1975a; Kaplan & Rothkopf, 1974; LaPorte & Nath, 1976; Locke, 1966; Rothkopf & Billington, 1975; Rothkopf & Kaplan, 1972) which show that goal instructions do produce changes in learning behaviors. These discrepant results may be explained in many ways.

First, the studies listed above compared groups that received goal statements that were actually qualitative in nature with groups that received no goal statements and found superior performance for those receiving goal statements. In addition, the studies cited above did not use quantitative objectives. The present study would also support the effectiveness of qualitative objectives. Another consideration is the actual construction of the experiment. Results of previous experiments involving quantitative objectives only have been somewhat different. Locke (1966) did not use prose material. He had subjects study and recall lists of words after they had been given a hard or easy goal of the number of words to recall. One study (LaPorte & Nath, 1976) was located in the literature search which dealt with quantitative objectives only. In this study three separate groups were provided with a quantitative learning objective; hard, medium, and easy. Generally, LaPorte and Nath found that students performed at the objective set for them. In contrast, in the present

study only two levels of quantitative learning objectives
were provided; hard, 80% correct and easy, no specified
level of performance. There also was a combination of a
hard quantitative and qualitative objective. The last,
a combination of both was found to be superior. Addition-
ally, LaPorte and Nath also repeated the exercise while
subjects in the present study were given instructions and
had only one trial. Overall, these differences in proce-
dure between the LaPorte and Nath study and the present
study may have affected the outcome. The results with hard
and easy quantitative objectives in the present study
were reversed, with those receiving no quantitative objec-
tive scoring higher than those receiving the hard quanti-
tative objective.

Another possible factor to consider when using
objectives is the subject's lack of knowledge of the
material and the use of quantitative objectives. Duchastel
and Brown (1974) found when they studied college students
learning from instructional objectives that knowledge of
the use and function of instructional objectives helped
students acquire more information and thus perform better
on posttests of recall. The lack of knowledge about the
process may have caused those who received the quantifiable
objective not to recognize their purpose and importance,
thus not internalizing them. Gagnè (1978) in her review
of long-term retention from prose learning gives a similar

explanation using Anderson's (1976) ACT memory model and elaboration hypothesis. Anderson's elaboration hypothesis states that the greater the knowledge of a prior topic, the more elaboration will take place and therefore, the greater the long-term retention. Anderson defines elaboration as the internal construction of links between ideas that had not been explicitly linked within the prose material. This is substantiated by two studies by Johnson (1973, 1974). He found college students recalled more information on immediate and seven day tests after reading prose which they had rated high as to meaningfulness and comprehensibility than on that information they had rated low on these dimensions. It seems reasonable to assume that meaningfulness and comprehensibility are correlated with prior knowledge and therefore this data provides evidence for the hypothesis that prior familiarity with material has a positive effect on long-term retention. In the present study, the subjects in the quantitative only and those in the control group which received no objectives had little prior knowledge and no specific stimulus; such as an objective to guide them, in the processing of the material. Thus, the necessary internal constructions could not be made. This is further illustrated by the fact that after the subjects had taken the test and been given feedback, their scores increased. Apparently, the test material and feedback provided the necessary stimulus

to retain the material.

Further possible explanations of the lack of effectiveness of quantitative objectives from Gagnè's (1978) review are self-confidence and ability. Gagnè points out that the ACT model assumes that sometimes people give up the attempt to recall information. This may be related to how much in the past they have been reinforced for being persistent in completing a task. This assumption has been supported by Hiller (1974) who found that self-confidence correlated with both immediate and two-week recall information from a difficult passage. Although no specific information is available about the self-confidence of subjects in this study, it is possible that the self-confidence factor could have played a part in the scores obtained by those in the quantitative objective only group and this may have depressed the scores of many of the subjects. Practical nurse training is primarily a skill acquisition program rather than a highly intellectual program. This type of experimental exercise may actually have threatened some subjects. Ability is another factor which Gagnè discusses. After summarizing several studies (Allen, 1970; Martinez, 1973; Sanders, 1973), Gagnè concludes that verbal ability has been found to be related to long-term retention and to interact with other variables in determining the amount of long-term retention. For this to be an explanation in this study, one must then

look at the power of qualitative objectives to compensate for ability. As pointed out previously, all subjects in the present experiment passed an initial screening examination for aptitude and academic achievement that required them to have average academic ability. They were assigned to treatment groups randomly, yet those receiving qualitative objectives supposedly performed better on the test because objectives provided direction to the learner as to what material was to be learned. However, it should be noted that there are other possible explanations available in the literature.

There was a significant difference between the amount of relevant learning and incidental learning for both groups that received qualitative objectives only and a combination of qualitative and quantitative objectives (hypothesis three and hypothesis four). Generally, the results obtained in this study are in agreement with previous research (Duchastel & Brown, 1974; Frase, 1968b; Frase, Patrick & Schumer, 1970; Morse & Tillman, 1972; Patrick, 1968; Rothkopf & Kaplan 1972) in that objectives facilitate student learning by providing direction for learning. However, the effect of objectives on incidental learning has not been clearly identified. Although research has shown that prequestions depressed incidental learning, in the present study there was no significant difference between groups on the incidental learning

questions. Rothkopf and Kaplan (1972) contrasted the effects of objectives on relevant and incidental learning and found that experimental groups that were provided with objectives performed better in relevant learning situations than in incidental learning situations. However, they also performed better in incidental learning situations than a control group who were told to learn everything. Duchastel and Brown (1974) found significant differences between the amount of incidental material learned between a group receiving objectives and a group not receiving objectives. The group not receiving objectives learned more incidental material.

The present study also supports the findings which show that there is no significant difference in incidental learning between groups receiving and not receiving objectives (Duchastel & Brown, 1974; Morse & Tillman, 1972). One reason for this result is that the subjects did not have experience with objectives and criterion-referenced testing in their academic courses. Tiemann (1968) points out that the possible effects of objectives may not be detected in research in which the subjects have not fully accepted the idea that the posttest which they will be taking is directly referenced to the objectives presented to them. If the student thinks the instructor is going to test him or her on all the material, he or she may not pay attention to objectives as much as he or she should.

Duchastel and Brown's (1974) research supports this hypothesis. Using subjects who were familiar with objectives, the one group of subjects that received objectives learned less incidental material than the group that received no objectives.

Passage length and density of objectives could also be examined as a possible contributing cause of the lack of incidental learning. The passage used in the present experiment was 2,400 words. In studies using passages up to 1,500 words, Kaplan and Rothkopf (1972, 1974) found that the amount of relevant and incidental learning decreased with the length of passage. The number of sentences relating to the stated objectives was small, less than 1%. Duchastel (1972) found that the learning of incidental information was interfered with when the number of sentences in the passage relating to the objectives was small. Studies by Kaplan and Rothkopf (1972, 1974) reported no difference between relevant and incidental learning when subjects received objectives and 13 to 85% of the sentences in the prose material related to the objectives. Apparently, increased numbers of objectives forced the subject to inspect the material more thoroughly. The present study had approximately 5% of the sentences relating to the stated objectives. Because of this, the subjects in the present study may have searched the passage without closely inspecting the incidental material.

The significant interaction found between type of learning and type of objective is consistent with other research (Frase, 1968b; Frase, Patrick & Schumer, 1970; Kaplan, 1974; Kaplan & Rothkopf, 1974; Kaplan & Simmons, 1974; Morse & Tillman, 1972; Patrick, 1968; Rothkopf & Kaplan, 1972). That is to say that when subjects are provided with qualitative objectives they will be directed to the specific material they are to learn and they will score higher on a test of relevant learning and lower on incidental learning items. When not provided with qualitative objectives, learning will be evenly distributed between relevant and incidental learning since the student does not have the stimulus that will focus him or her toward specific material.

Discussion of the Delay Retention Effect

This experiment failed to reject the null hypothesis that there is no significant difference in retention of prose material when delayed feedback is provided as opposed to immediate feedback. This failure to reject the hypothesis must be evaluated in light of the limitations of the present study.

At least seven studies have reported superior retention with a delay of 24 to 48 hours prior to presenting feedback (English & Kinzer, 1966; Kulhavy & Anderson, 1972; More, 1969; Phye & Baller, 1968; Sassenrath & Yonge, 1968; Sturges, 1969, 1972). The experimental conditions under

which this delay-retention effect was found were basically
the same in the following ways: (a) the learning task was
academic material, (b) the initial test and informative
feedback were presented in multiple-choice format, (c)
there was only one presentation of informative feedback, and
(d) the retention test consisted of the same items as the
initial test.

It is important to point out that the present experi-
ment met some, but not all of the criteria listed above.
The criteria that were not met are discussed below to
determine the differences that may have produced the
differing outcome. First, let us dispose of two criteria
that were the same in the present experiment and those
previously mentioned. There was only one presentation of
information feedback for each group. Second, the seven-
day test consisted of the same items as the initial test.
One variation that distinguishes the present experiment
from others is the type of study material. The present
study used a prose passage which was academic material
while several other experiments have merely used a series of
multiple choice questions (Kulhavy & Anderson, 1972;
Sassenrath & Yonge, 1968; Sturges, 1969). Generally, the
results of those studies using multiple choice questions
have shown a positive relation between delay of feedback
and retention of material. Some other studies have used
prose material (Sturges, 1978; Surber & Anderson, 1975)

and have also had positive outcomes, while others (Newman, Williams & Hiller, 1974) found no significant difference between immediate and delayed feedback. Also, the material used in the present experiment was probably unfamiliar to the subjects and this was not the case in the experiments mentioned above. Therefore, the type of stimulus material could be a possible factor influencing the outcome. It can be assumed that all subjects had to search through unfamiliar material and half of the subjects had to locate responses to specific objectives. This searching for material would have proceeded at a much slower pace than the 240 words per minute average reading rate of the group. The 240 words per minute average reading rate is the rate predicated on reading material not searching for answers (Brown, 1976). It should also be noted that subjects were free to control their own time so there was no way of actually knowing if students used the entire time for study. In other studies (Sturges, 1978), the subjects' time was more closely controlled to insure that the subject was attending to the material. In either case the subject may not have conducted the deeper processing and made full use of the information supplied at feedback.

Another difference between previous studies and the present study is the type of question used for testing retention of material learned. The present study used completion type questions. The previously mentioned seven

studies that found significant results for delayed feedback and retention used multiple choice questions for testing. A few studies have found that the type of test item does make a difference. Sassenrath, Yonge and Schnable (1968) found that immediate feedback facilitated retention of multiple choice questions but not completion questions. Sturges (1969) varied the form of informative feedback. Feedback was received in either the form of a multiple choice question with a stem and the four alternate responses with the correct one underlined or the stem with only the correct response. Seven-day retention was superior with 24 hour delay information feedback when the feedback was presented with the stem and four alternative answers. Sturges (1978) used completion questions in a delay feedback experiment utilizing the computer and found no significant difference between immediate and delayed feedback. In the present experiment, completion questions were used and feedback was presented as a question with the correct answer. Using this format may have prevented the subjects from fully processing the material at the point of information feedback. Sturges points out that it is not what happens during the delay period that is important, but what happens immediately following the information feedback and this reaction depends, at least in part, on the information provided at the time of feedback. Also important according to Sturges, is that for

delayed information feedback to be effective, the subject
must have knowledge of alternative responses, more specifi-
cally, of incorrect alternatives. This conclusion is
based on the concepts developed by Craik and Tulving (1975).
The basic propositions of Craik and Tulving's research is
that information stored in the long-term or episodic memory
is the result of operations carried out on the information
by the cognitive system. How long information remains in
the episodic memory depends on the depth of processing it
received in the cognitive system. Depth of processing is
best defined as stimulus elaboration. In the present study
stimulus elaboration would have been greater when subjects
were given the alternate or incorrect responses such as in
a multiple choice question. Less stimulus elaboration
would take place with a completion question when the
subject was given only the answer and no incorrect re-
sponses. With the use of completion test items as in the
present study, there were no alternative answers available
to the subjects. This was especially true for those re-
ceiving no qualitative objectives. These results were re-
versed for those receiving immediate feedback who scored
higher on the seven day test. Those groups receiving qual-
itative objectives had results similar to those that
Sturges (1978) had reported. Delayed feedback was superior
over immediate feedback in terms of retention on the seven
day test but it was not significantly higher.

The findings of this study do not agree with a large
group of studies which strongly suggests that delaying the
presentation of the reinforcing consequence reduces its
effect on the behavior upon which it has been made con-
tingent. Most of this literature has involved infrahumans,
although there is a fairly large collection of studies
dealing with retarded children (Renner, 1964). Both Geis
and Chapman (1971) and Annett (1969) note that the evidence
that delaying feedback affects the performance of humans
is less solid than the evidence of such effects with lower
organisms. In an effort to explain these varying findings
concerning delay of results research, Geis and Chapman (1971)
suggested that the organismic variables such as anxiety,
sex, IQ, age, and achievement may have an affect on the
usefulness of feedback. The present study did not take
into account any of the above variables and this may be
a possible thrust for future research. There is research
which has demonstrated a relationship between achievement,
anxiety, and poor performance in females (Campeau, 1968;
Carels, 1975; Devi, 1969; Suchett-Kaye, 1972; Walsh, 1971).
O'Neil (1972) also found a relationship between high
anxiety and poor performance on computer assisted materials.
Higher levels of anxiety were associated with more difficult
learning materials and high anxiety students were found to
make more errors in the more difficult portions of the
learning tasks. In the present study, the experimental

group consisted of 57 females and 2 males. No measure of
anxiety was taken prior to the experimental sessions. The
variables of intelligence, age, and achievement motivation,
cited by Geis and Chapman (1971) were not controlled in
the present study. Geis and Chapman could find little
research that attempted to control or manipulate the
variables mentioned above. There is also some research
suggesting that various instructional methods are best
utilized by those subjects with certain personality traits
(Blitz & Smith, 1973; Conroy, 1971; Hashell, 1971; Truog,
1977). However, there does not appear to be any correla-
tion between personality traits and affective feedback.
Group differences may also be considered. Most previous
studies utilized either college undergraduates (Sassenrath
& Yonge, 1968, 1969; Sturges, 1968, 1969) or high school
students (Surber & Anderson, 1975). College graduates
and high school students may possess many of the variables
discussed above that possibly enhance feedback effects.
The thrust of future research could be to identify feed-
back procedures that can be generalized for a large popu-
lation.

In addition, the type of feedback may have been
inappropriate for the type of learning. Geis and Chapman
(1971) stated that there may be a relationship between the
type of task and the effectiveness of feedback. They
concluded that feedback may be more reinforcing when one

is executing a complex motor coordination than when one
is merely recognizing a correct item in a choice situation.
Kulhavy (1976) also states that feedback will not be very
effective when the material is very difficult and the
learners spend most of their time guessing at the answers
and then trying to associate the feedback with the question.
The feedback process for the present experiment was very
simple. The students compared their test with an answer
sheet and were asked to write the correct answer. Whether
the subjects found the feedback inappropriate for the task,
as Geis and Chapman suggest, or that the material was too
difficult, as Kulhavy suggests, are important considera-
tions worthy of attention. Controls for both of these
variables should be built into future experiments.

Suggestions for Future Research

Research concerned with the relationship between the
use of objectives and prose learning still has many chal-
lenging areas that require further research. One of these
areas is the relationship between quantitative and qual-
itative objectives. The present study is one of the first
studies to use a combination of a specific quantitative
objective and a specific qualitative objective. Previous
studies (Kaplan & Rothkopf, 1974; Rothkopf & Billington,
1975; Rothkopf & Kaplan, 1972) have used varying degrees of
specificity or varying levels of quantitative performance
(LaPorte & Nath, 1976). The next phase of this research

could investigate this relationship by using the same qual-
itative objectives and varying the level of the quantitative
objective. This research would allow one to identify the
specific effect the quantitative objective has on prose
learning when used in conjunction with qualitative objec-
tives.

A second area which needs further investigation is
the relationship of relevant and incidental learning in
the use of objectives. To date, the results have been
mixed as to whether objectives reduce or increase inciden-
tal learning (Duchastel & Brown, 1974; Frase, 1968b;
Rothkopf & Kaplan, 1972). The key variable in these studies
appears to be the number of objectives for length of passage
or density of objectives. Further studies need to be com-
pleted that vary the density of objectives. Emphasis
should be placed on using a few objectives with a long
passage and then increasing the density while holding the
passage length constant. This type of experiment will bet-
ter define the role of number of objectives in enhancing
incidental learning. Another issue that should be addressed
in terms of relevant and incidental learning is the subject's
knowledge about the use of objectives. Some have contended
(Duchastel & Brown, 1974) that if the subject is familiar
with objectives, relevant learning will be enhanced and
incidental learning depressed. Research needs to be
completed that will relate students' knowledge of the use

of objectives with the amount of prose learning the subject
exhibits when objectives are used. If it is determined
that knowledge of how to use objectives does make a differ-
ence in the amount of learning, then instructional materi-
als could be developed that instruct students in the use of
instructional objectives prior to utilizing them.

Another area for future research is that of verifying
the information processing models that have attempted to
explain why objectives are effective in enhancing prose
learning. Models and their explanation of how objectives
work are very interesting. Yet, to date very little, if
any, research has been completed to specifically verify
these models. Experiments should be developed that would
systematically test these models and their propositions.
Once these models have been identified and verified,
instructional objectives and instructional material could
be organized to compliment the model and thus facilitate
learning.

Future research dealing with the effect of feedback
when used in conjunction with different types of objectives
needs to focus on the specific form the feedback should
take. There are several studies (Sturges, 1969, 1972, 1978)
that indicate that for delayed feedback to be effective,
it must provide for sufficient depth of processing by the
subject. Further experiments need to be designed that will
match one type of objective with different levels of

processing. The desired outcome of such research is to identify the best combination of objectives and the level of processing to maximize the effectiveness of prose learning through the use of delayed feedback, objectives and the appropriate form of feedback.

The effect of gender on this type of task requires further study. Carels (1975) found significant sex differences in a study dealing with false feedback. His results were consistent with those obtained by Marx, Witter and Muller (1972) who found that males were superior in multiple choice learning and that females were slower learners. A study by Palmer (1972) has also shown that females react differently to frustration; specifically, that males are generally more accepting of overt reactions to frustration. Several students in the experimental group indicated that the experiment was "hard". Interpretation of this discussion about group factors becomes more difficult to explain because of the significant difference found in the first part of the experiment as opposed to the second. One must ask the important question as to why these were influences in the second part of the study but not in the first.

Future research should also place emphasis on conducting experiments in a more natural situation such as the classroom. The present study was conducted with students who were enrolled in a technical nursing training

program. Students enrolled in such a technical program may have possessed certain characteristics (IQ, aptitude, academic achievement) that affected the outcome of the experiment. Future experiments should select subjects randomly from a larger population. This would reduce the chance of subjects with high or low motivation from being concentrated in the experimental group. It should be noted though, that randomization will not totally solve the problem of motivation. It still is not known whether the subjects selected are motivated to perform the task presented to them. As one can see by the several potential research areas discussed above, the use of preinstructional strategies, such as instructional objectives, remains a viable area of research. The results of future research will hopefully provide data related to at least two areas of instructional psychology. First, additional information on how to construct and utilize instructional objectives to make them most effective in enhancing prose learning will be provided. Second, future research will help identify the type of individual who benefits most from the use of instructional objectives. Together these results will enhance the quality of time spent in classroom learning activities.

SUMMARY

The overall premise of the present investigation was
that qualitative objectives presented to subjects prior to
reading prose material would enhance learning and that the
addition of quantitative objectives would further enhance
learning. The subjects consisted of all students enrolled
in two classes of a small school of practical nursing
located in Chicago who were randomly assigned to four
treatment groups (quantitative objectives only, qualitative
objectives only, quantitative and qualitative objectives,
and no objectives). Each treatment group was given one type
of a combination of the objectives previously mentioned
along with a prose passage. After reading the prose materi-
al all subjects took a posttest of comprehension. One half
of each group then received feedback immediately on their
test performance and the other half received feedback 24
hours later. It was hypothesized that there was a signif-
icant relationship between type of feedback, (immediate and
delayed) and type of objectives (quantitative only, quali-
tative only, quantitative and qualitative, and no objec-
tives) and the degree of relevant and incidental prose
learning assessed by the posttest of retention. Specifi-
cally, it was hypothesized that delaying feedback would

123

enhance learning prose material when used in conjunction with quantitative and qualitative objectives. Overall, the results indicated that the provision of quantitative and qualitative objectives improved learning of prose material. That is to say, that those subjects receiving both quantitative and qualitative objectives scored higher on a posttest of retention for relevant learning than those receiving qualitative, quantitative or no objectives. It is interesting to note that the second highest scorers on relevant learning were the qualitative objectives only group. However, there was no significant difference in incidental learning. On the other hand, there were significant differences between types of learning (relevant and incidental) with the combination of quantitative and qualitative objectives and qualitative objectives groups demonstrating significant differences between relative and incidental learning. There was also a significant interaction effect between type of learning and type of objective. These results are generally consistent with other studies which continue to show that instructional objectives are an effective aid to prose learning.

Unfortunately, the exploratory component of the experiment which investigated the effects of feedback on the retention of prose material revealed no significant difference between the posttest of retention scores for those subjects in the delayed versus the immediate feedback sub-

groups. Perhaps this lack of significant findings was due to the fact that academic material unfamiliar to the subjects was used. Also, completion type questions were used in the posttest and the subjects could perhaps not fully process the information. Individual difference variables such as anxiety, sex, IQ, and achievement may have had an effect on the outcome of the feedback. Finally, the type of feedback provided may have been inappropriate for the type of learning task.

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126

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APPENDIX A

Student Study Exercises

Time _____

Study Exercise - A

Qualitative Objectives Only

Directions: This is an exercise to see how well you learn

from written material. You will have a maximum of twenty

minutes to read and study the material and at the end of

the session you will be tested over what you have read.

Below are the objectives for the material. When you have

completed studying, mark the time on the top of the page,

turn in your material and obtain the test. After completing

this unit of study you will be able to:

1. State which substance mushrooms lack which other plants
    have to produce food.

2. State the name for a mushroom that lives off of dead
    plants.

3. Define parasitism.

4. State the species of fungus that feeds on wheat.

5. Name one kind of mushroom that is found under or near
    green plants.

6. State the scientific term for mushroom roots-hairs.

7. State the seasons of the year when mushrooms grow best.

8. State what is the effect of extreme heat on a mushroom.

9. State how much water a mushroom must have to grow.

10. State the name for a fungus living outside a root of
a plant.

Time _____

Study Exercise - B

Quantitative Objectives Only

Directions: This is an exercise to see how well you learn
from written material. You will have a maximum of twenty
minutes to read and study the material. When you complete
your studying, mark the time at the top of the page and
turn in your material and obtain the test. On this test
you will be expected to get 18 out of 20 correct on it.

Time _____

Study Exercise - C

Qualitative and Quantitative Objectives

Directions: This is an exercise to see how well you learn
from written material. You will have a maximum of twenty
minutes to read and study the material and at the end of
the session you will be tested over what you have read.
Below are the objectives for the material. You are
expected to get 18 out of 20 correct on a test over the
material. When you have completed studying, mark the time
on the top of the page, turn in your material and obtain
the test. After completing this unit of study you will
be able to:

1. State which substance mushrooms lack which other
    plants have to produce food.

2. State the name for a mushroom that lives off of dead
    plants.

3. Define parasitism.

4. State the species of fungus that feeds on wheat.

5. Name one kind of mushroom that is found under or near
    green plants.

6. State the scientific term for mushroom roots-hairs.

7. State the seasons of the year when mushrooms grow best.

8. State what is the effect of extreme heat on a mushroom.

9. State how much water a mushroom must have to grow.

10. State the name for a fungus living outside a root of a plant.

Time _____

Study Exercise - D
No Objectives

Directions: This is an exercise to see how well you learn from written material. You will have a maximum of twenty minutes to read and study the material. After you have completed studying, mark the time on the top of the page, turn in your material and obtain the test.

APPENDIX B

CONDITIONS UNDER WHICH MUSHROOMS GROW AND THRIVE

FOOD REQUIRED

Unable, because of the lack of chlorophyll, to manufacture for themselves out of the carbon dioxide of the air, out of water, and out of certain mineral salts the food they require, fungi, in order to grow and thrive, attack the higher, green plants that alone possess this power. In this respect they resemble animals. Like these, they must have starch, sugar, and other substances. Such fungi as are parasitic invade living tissues (see Parasitism, p. 33); others, the saprophytic kinds, are content with dead remains (see Saprophytism, p. 32).

SAPROPHYTISM

With few exceptions all fleshy mushrooms are saprophytes, that is, they settle upon and disintegrate plants already dead. A walk in the woods in the autumn will show them at work. Great tree trunks, lying prostrate, will be found covered with species belonging to a variety of genera (plate 1). Species of *Collybia, Mycena, Omphalia, Pluteus, Pholiota, Armillaria, Tricholoma, Flammula, Hypholoma, Boletus, Clavaria, Hydnum* and *Thelephora* find nutriment here. Scattered over the débris of the forest floor—on and amongst thoroughly rotted wood, branches, twigs and leaves—are troops of fungi, ranging from gorgeously colored and stately Amanitas to ever-so-tiny species of *Marasmius*. One of the latter genus, *M. rotula*, is always a pleasure to behold (figure 106). Upon a black stem, as fine as horsehair, is poised a delicately fluted cap, on the underside of which are gills so

curiously attached to a collar around the stem that one is reminded of the workmanship of an extraordinarily skilled mechanic. Russulas, of a red so deep and transparent that a Titian or a Rubens would find himself outdone, stud the pathway as one wanders about regarding the wealth of fungus forms. It fills one with wonder that this scavenger work of disposing of vegetable trash is done to the accompaniment of so much unseen or unregarded beauty. Man, if he would, could take a lesson here.

One saprophytic species, *Lentinus lepideus* (figure 57e), specializes in the destruction of railroad ties. Very appropriately, it has been called "the train wrecker." Railroad men have, however, taken steps to combat this enemy of the unsuspecting passenger by impregnating the wood with preservative materials that prevent the development of destructive mycelia.

Polystictus versicolor, a common polypore growing in dense, shelving masses on standing tree trunks, may be parasitic as well as saprophytic. Its velvety Jacob's-coat-of-many-colors, marked with conspicuous zones, ought to recall it to the forest rambler (figure 44).

PARASITISM

Whereas the saprophytic, scavenger activities of mushrooms are necessary and welcome in nature's colossal laboratory, the parasitic, life-destroying activities, though equally necessary, are not so welcome, at least to man, in so far as plants of economic value are concerned. But destruction alternating with reproduction (construction) are the two great and eternal principles of the organic world as well as of the rest of the universe. The little,

"hopeful" acorn of the White Oak, as it germinates, is not aware of the existence of a host of fungus species already lying in wait to kill and destroy the mighty tree of which it is the humble beginning (Farlow and Seymour, 1888; Saccardo, 1882–'26, vol. 13; Seymour, '29). By far the worst of the oak's enemies is the Root-rot, caused by the Honey Mushroom, *Armillaria mellea* (figure 69), a species equipped with an insatiable hunger for woody tissues, including those of our prized fruit trees.

Where are our chestnut trees that represented two hundred million dollars worth of lumber? With few isolated exceptions one and all fell prey to a fungus of insignificant size, introduced into our country from Asia. All that remains now of those magnificent trees are gray skeletons, naked and desolate.

The ravages of the Wheat Rust are so enormous that our annual output of this precious cereal is considerably reduced (p. 105). For the entire world the toll levied on our economic plants by parasitic fungi is almost beyond computation. Plant breeders and students of plant diseases, by their incessant activities, attempt to hold these ravages in check.

MYCORRHIZAS OR MUSHROOM ROOTS

Collectors and students have long known that certain kinds of mushrooms are constantly found under or near trees and other green plants. *Boletus laricinus* and *B. elegans*, for example, are always found under larches; *Boletus granulatus* (plate 9) and *B. luteus* (figure 70), under pines. Others do not limit themselves to specific trees, but occur either in coniferous or deciduous woods, or in both, while ubiquitous and omnivorous kinds, like

the detested *Armillaria mellea* (figure 69), grow wherever there is wood to be devoured.

Some forty years ago, a German mycologist (Frank, 1885), after examining into the nature of this association between mushrooms and higher plants, found that the mycelia of the species studied form mantles of fine hairs or "mushroom roots" (hyphae) on the roots of their "hosts." He also stated that the relationship between the two plants is not one of parasitism, but rather one of mutual interdependence. These mushroom root-hairs he called mycorrhizas (p. 34); the relationship between the plants concerned, symbiosis (p. 36).

The question as to whether there is a perfect equilibrium in the life processes, working for the preservation of both fungus and flowering plant, is still a matter of controversy.

Mycologists distinguish between two kinds of mycorrhizas, one kind living on the outside of the roots (ectotrophic), the other within (endotrophic). It is conceded that the latter are beneficial to the invaded plants; indeed, certain orchids are absolutely dependent upon their assistance, as will be learned further on. The former are held to be mildly parasitic, at least by one school of workers.

The following mushrooms have been found to form ectotrophic mycorrhizas on the roots of trees:

Amanita muscaria, on Birch, Larch, Pine and Spruce.
Boletus badius, on Pine.
Boletus edulis, on Birch.
Boletus elbensis, on Tamarack.
Boletus granulatus, on Pine.
Boletus scaber, on Birch and Poplar; var. *fuscus,* on Birch.

Boletus versipellis, on Birch and Poplar.
Cantharellus floccosus, on Fir.
Cortinarius camphoratus, on Larch.
Hygrophorus russula, on Beech.
Lactarius deliciosus, on Pine and Spruce.
Lactarius piperatus, on Beech and Oak.
Russula emetica, on Oak.
Russula fragilis, on Pine.
Scleroderma vulgare, on White Oak.
Tricholoma flavobrunneum, on Birch.
Tricholoma terreum, on Pine and Beech.
Tricholoma transmutans, on Oak.

Consultation of the list of mushroom species under Habitats (p. 50) will offer further suggestions to the student interested in possible mycorrhiza associations (Hatch and Doak, '33; Hatch & Hatch, '33; Henry, '32; Kauffman, '06; Kelly, '32; Mason, '30; Masui, '27; McDougall, '14; Melin, '30; Mimura, '33; Rayner, '22).

SYMBIOSIS

Coöperation is the present-day watchword among enlightened individuals, corporations and societies, and, apparently, among nations. Competition, sooner or later, means the end of one or more, or perhaps of all competitors. Some plants learned to coöperate many eons ago. In considering the mycorrhizas, or mushroom roots, it was learned that orchids and certain fungus mycelia are dependent one upon the other. This is particularly true of a Japanese orchid, *Gastrodia elata,* which produces no flowers on the offsets of its tuberous rhizomes unless these have been infected by mycorrhizas produced by the rhizomorphs (cord-like strands of mycelium) of that

arch tree-enemy, *Armillaria mellea* (Ramsbottom, '23). Frank's term, symbiosis, aptly describes this coöperative effort in plants, being derived from two Greek words meaning, "living together." Another well-known instance of symbiosis—the coöperation of fungi and algae in the lichens—was mentioned in the introduction.

TEMPERATURE REQUIREMENTS; SEASONAL OCCURRENCE

Every mushroom grower knows that temperature is one of the chief factors in the successful production of a crop. In fact the limits are very narrow, between 50 and 60 degrees Fahrenheit (see Growing Mushrooms, p. 121).

In the case of wild mushrooms there is a greater tolerance for both high and low temperatures. In the coolness of early spring—rarely in late autumn—we get morels, Pezizas and other Ascomycetes. Some, such as Boleti, occur in the hot summer months. (Is it possible that their capacity to endure the direct rays of the sun in midsummer is due to the unusually thick flesh of the caps?) The great majority of mushrooms grow in late summer and autumn. A sure sign of the approach of the latter season is the appearance of troops of Cortinarii. At the end of autumn and until well into the frosty days of November certain species of *Hygrophorus* of the Limacium group still hold their own. But these Hygrophori, especially *H. fuligineus* (for descriptions of species, consult the index), are well protected against cold by the thick slime which completely envelops the plants. One fleshy species, *Collybia velutipes,* grows in winter, the velvety coat of its stem and the glutinous exterior of the cap keeping out the nipping cold of December and January days (Graham, '26).

So much for mushrooms of temperate regions. In regions of a torrid or semi-torrid climate, like the hot inner valleys of California, fungi keep well under ground until their structural parts are fully formed and the spores are ready for dissemination. In *Podaxon* (figure 60b), for example, the cap, after having been perfected deep under the surface of the hot soil, is pushed up by a tough, almost wood-like, stem. In the tropics fungi of a tender, fleshy nature are rare, or they appear at high altitudes in the mountains. Extreme cold has an inhibitive effect upon fungous growth, though Buller ('24) finds that *Schizophyllum commune* is not killed by the lowest temperatures. Extreme heat, on the other hand, long enough applied, will kill the life-plasm.

Photo by C. E. Cummings. Courtesy Buffalo Society of Natural Sciences

Figure 7 *Mitrula phalloides* as one finds it in its natural surroundings, in cold, boggy places in the Adirondacks

SEASONAL OCCURRENCE OF FLESHY FUNGI

	Dec.–Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
Amanita					.....	.....	.....	.....	
Amanitopsis				.....	.....				
Armillaria					.....	.....	.....	.....	.....
Boletus				.....	.....	.....	.....	.....	
Calvatia									
Cantharellus				.....	.....				
Clavaria				.....	.....				
Clitocybe			.....	.....					
Clitopilus									
Collybia				.....	.....				
Collybia velutipes	.....	.....	.....	.....	.....	.....	.....	.....	.....
Coprinus		.....	.....						
Cortinarius					.....	.....	.....	.....	.....
Crepidotus					.....	.....			
Entoloma					.....	.....			
Flammula					.....	.....			
Galera				.....	.....	.....			
Hebeloma					.....	.....	.....		
Helvella		.....	.....						
Hydnum					.....	.....	.....	.....	
Hygrophorus puniceus, virgineus, etc.				.....	.....				
Hygrophorus fuliginues, etc.			•						
Hypholoma incertum, etc.				.....	.....				
Hypholoma perplexum, etc.				.....	.....				
Inocybe				.....	.....				
Laccaria				.....	.....	.....			
Lentinus				.....	.....	.....			
Lepiota				.....	.....	.....			
Lycoperdon				.....	.....	.....			
Marasmius				.....	.....				
Morchella		.....	.....						.....
Mycena				.....	.....	.....			
Naucoria				.....	.....	.....			
Omphalia				.....	.....	.....			
Panaeolus				.....	.....	.....			
Panus	.....	.....							
Peziza		.....							
Phallus				.....	.....	.....			
Pholiota				.....	.....	.....			.....
Pleurotus				.....	.....	.....			
Pluteus				.....	.....	.....			
Psathyrella				.....	.....	.....			
Psilocybe				.....	.....	.....			
Schizophyllum	.....	.....	.....	.....	.....	.....	.....	.....	.....
Stropharia				.....	.....	.....			
Tricholoma				.....	.....	.....			.....
Volvaria					.....	.....	.....	.....	.....

WATER; MOISTURE CONDITIONS

As with all organisms, mushrooms must have water. The very low, almost alga-like, Phycomycetes actually live in water and in the juices of potatoes, fruits, etc. But ordinarily, mushrooms grow when the water supply is just sufficient for growth. Too much or too little effectually prevents or stops it (see Growing Mushrooms, p. 128). Every hunter of the common Meadow Mushroom knows that it is useless to look for this delicacy during a time of drought. He also knows that, given a favorable season of moderate rain and heat, it is equally useless to seek specimens in low, wet places, as, almost invariably, they are to be found on more or less elevated ground in meadows.

An old Italian investigator, and a modern one (Farlow), found that small *Coprinus* species sometimes grow in water, and certain Ascomycetes (species of *Vibrissea* [figure 49a] and *Mitrula* [figures 7, 47d]) grow on water-soaked sticks and leaves that have long lain in the cold water of mountain brooks and swamps.

LIGHT; PHOTOTROPISM

Though mushrooms as a class, unlike green plants, are relatively independent of light, there are some species that are unable to form caps and hymenial surfaces in its absence. A certain species of *Lentinus* (figure 57e), when growing in the dark, produces no caps but only oddly-formed stems; other species fruit freely in cellars, mines and caves (figure 29). As will be seen by consulting the list of species cited under Habitats (p. 50), some grow in the open, others in the more or less dense shade of woods and forests. One small dung-inhabiting

fungus, *Pilobolus crystallinus,* is provided with a tiny, transparent bladder that functions as an eye. At the terminal end of the bladder is a black spore-case that is shot off with considerable force, but the shooting does not begin until the longitudinal axis of the bladder is in perfect alignment with the source of light (figure 8). Since this interesting little species grows on horse-dung, anyone can verify this phenomenon (Allen and Jolivette, '14; Buller, '21).

GRAVITY

If a large gill-mushroom in perfect condition—say, an *Amanita*—be left lying on a table in the horizontal position over night, it will be found by the next morning to have changed its shape. The straight stem will be curved, the upper end having assumed an approximately vertical position. The cap, which was left with its margin touching the table, will have resumed the horizontal position (figure 9). The cause of this spectacular phenomenon is gravity. Every plant must adapt its structures to the steady pull of this force. Just as the engineer, in constructing a bridge, must design its parts in such a manner that it will not be pulled down by the earth's attractive force, so a mushroom that similarly essays to construct parts above the earth's surface must arrange those parts so that the entire structure will not topple over. The problem with a gill-mushroom of the type of *Amanita,* in which a perfectly circular disk, the cap, is to be elevated above the soil in the horizontal position, is to have the straight, columnar stem attached to the exact center of the cap. Now, when such a specimen is laid on its side, the straight stem no longer serves this purpose. In order to bring the cap back again to the horizontal position, the
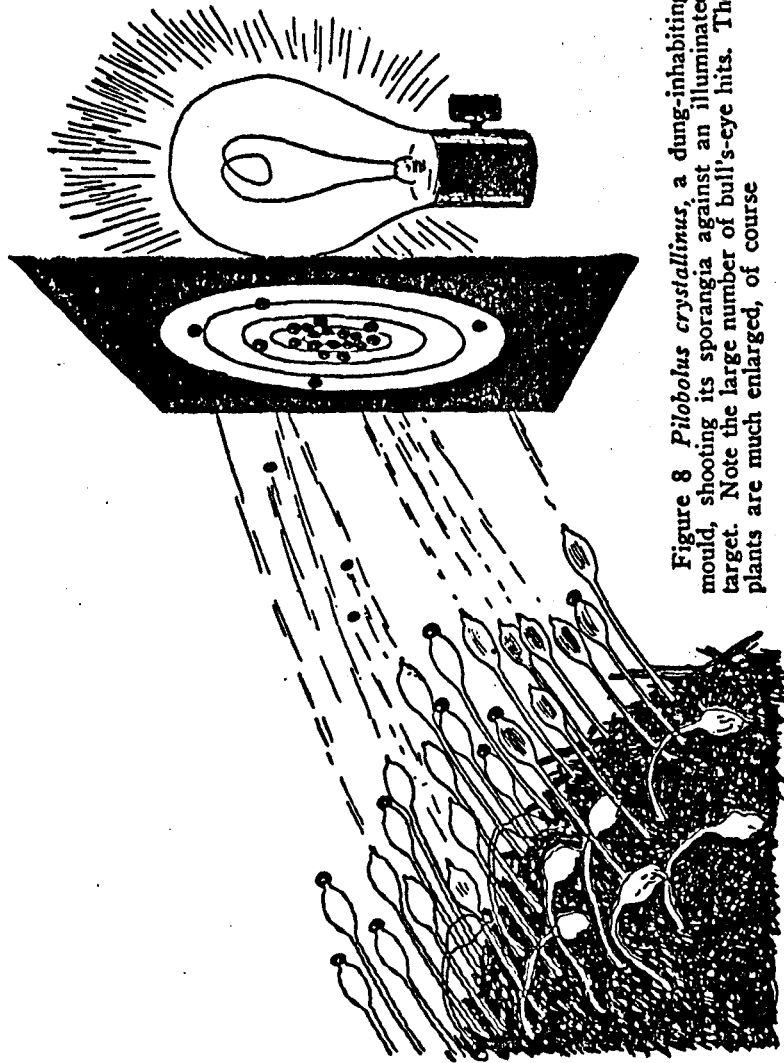
stimulus of gravity reasserts itself by curving the stem sufficiently to accomplish this.

The gills exhibit a like response to this force. In order that the spores may fall without coming in contact with the gill-sides on which they were produced, the gills hang down from the underside of the cap in the absolutely perpendicular position (figure 20a; Buller, '09, '22, '24). They do this so long as the specimen remains erect. When it is laid on its side, the gills, to regain the closest approximation to the vertical, fall over sidewise, those to the right falling to the right, those to the left falling to

Figure 8 *Pilobolus crystallinus*, a dung-inhabiting mould, shooting its sporangia against an illuminated target. Note the large number of bull's-eye hits. The plants are much enlarged, of course
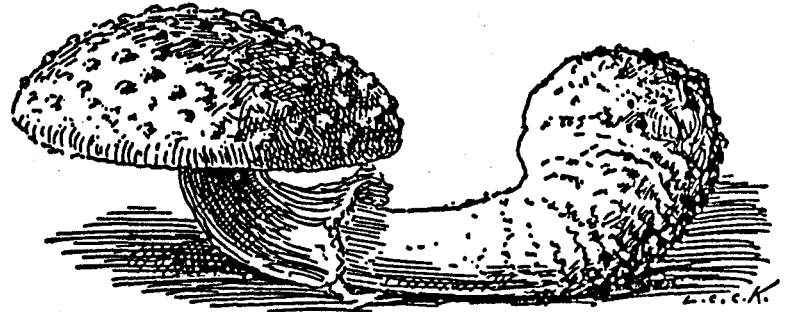

Figure 9 A specimen of *Amanita muscaria* that has lain in the horizontal position over night. Note the effect of gravity in causing the stem to bend so that the cap will again be horizontal

the left. In viewing the gills of a cap that has lain undisturbed on its margin for a few hours, it will be seen that the uppermost gills have parted from each other, whereas those lowermost are closely pressed together to form what appears like the crest of a wave. Artists, who wish to give their mushroom pictures a natural appearance, will do well to heed these truths.

The phenomenon of a plant's response to the earth's pull is called *geotropism,* that is, turning towards the earth. Botanists distinguish between two kinds of geotropism, viz., *positive geotropism,* which draws tissues or organs such as roots and gills toward the earth, and its negation, *negative geotropism,* which causes plant-parts, such as the plumules of seeds and the stems of mushrooms, to grow upwards and away from the earth.

FAIRY-RINGS

Some mushrooms have the habit of growing in circles called fairy-rings. Among these are such well-known New York species as *Psalliota arvensis* (plate 29), *P. campestris* (plate 29), *Amanita caesarea* (plate 2), *A. muscaria* (plate 3), *A. phalloides, Calvatia cyathiformis* (figure 73), *C. gigantea* (figure 74), *Cantharellus cibarius* (plate 11), *Clitocybe infundibuliformis, Clitopilus orcella, Cortinarius armillatus* (plate 16), *Hebeloma crustuliniforme, Hydnum repandum* (plate 19), *Hygrophorus virgineus, Lactarius piperatus* (figure 98), *L. torminosus, Lepiota procera* (plate 25), *Lycoperdon gemmatum* (figure 102), *Marasmius oreades* (figure 105) *Morchella esculenta* (figure 50b), *Paxillus involutus, Pluteus cervinus, Psalliota placomyces* (figures 121, 122), *Tricholoma equestre, T. panaeolum, T. personatum, T. terreum,* etc., etc.

Quite a formidable list, but best known are the rings formed by *Marasmius oreades* (figures 10, 11).

To be seen almost anywhere where there are extensive areas of grass, these rings have attracted the attention of man from earliest times. In the absence of a scientific explanation of the phenomenon, the imagination was

Figure 10 Fairy-ring formed by *Marasmius oreades*
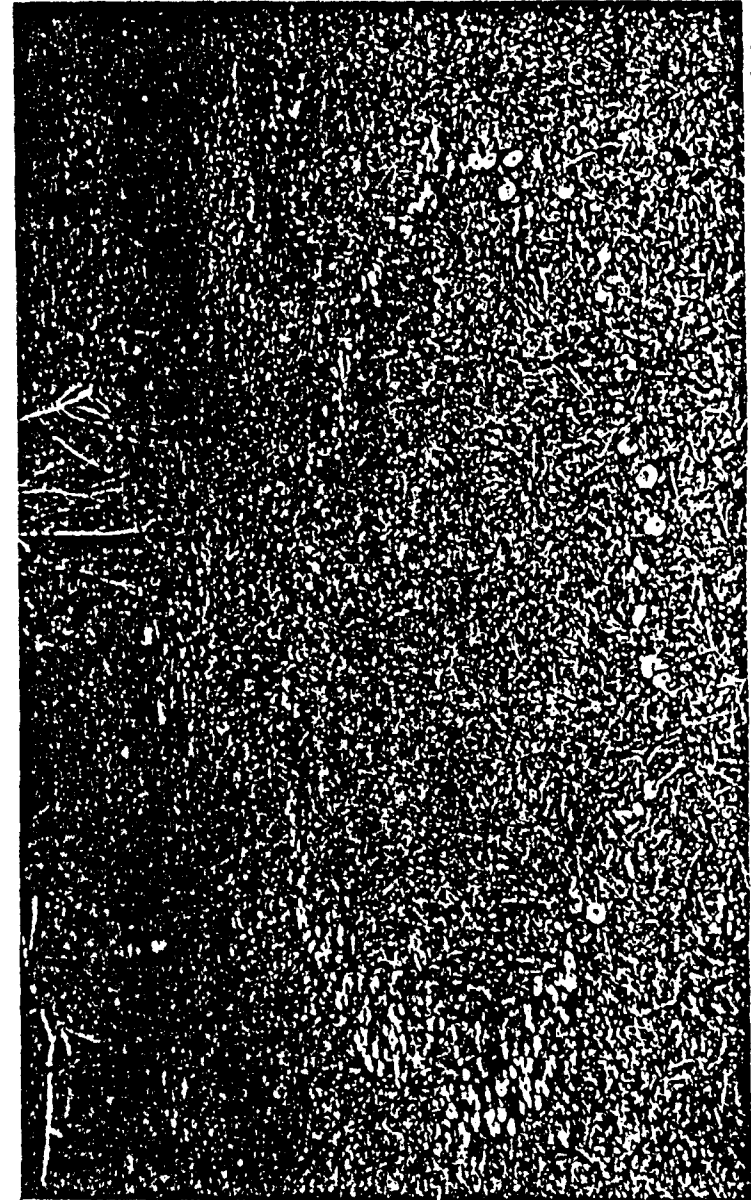
Courtesy U. S. Department of Agriculture

175

drawn upon. Fairies were supposed to step "the light fantastic" on misty, moonlit nights, whirling around in circles as they danced, thus wearing down the grass. Gnomes and hobgoblins buried their treasure within the confines of such rings. Dragons, resting momentarily from the labor of scaring simple folk out of their wits, breathed living fire, thus scorching the greensward about them. Even "old Nick," when not at his usual devilish work, sometimes churned butter in such places, and so forth, endlessly. Later, seeking more natural causes, the then "scientists" thought that the rings marked the spots where thunderbolts had struck in the open, where a whirl-wind had passed, where ants or moles had been active, or where haystacks had stood. It was not until the latter part of the eighteenth century that an English botanist (Withering, 1796) hit upon the real cause, the afore-mentioned mushroom, *Marasmius oreades* (Ramsbottom, '27; Rolfe, '25).

A fairy-ring is in reality a grass disease. Beginning from a point of infection, where spores of this fungus have started the growth of a mycelium, it spreads steadily outward (unless interrupted by lack of food), sometimes attaining a diameter of great dimensions (300 to 800 feet; this in the case of another species). In Colorado, rings, or segments of rings, have been found that must have taken anywhere from 250 to 600 years to form. The rate of advance of a ring varies ac-cording to conditions, the minimum being three inches in a year, the maximum about thirteen. The effect of fairy-ring mycelia on grass has been recently studied (Shantz and Piemeisel, '17). The initial stimulation experienced by the grass through the liberation of nitro-

genous materials is shown in figure 11 at *d*. The grass becomes very tall and dark green. Following this zone is a bare one (at *c*) in which, owing to the packing of the mycelium, the ground is rendered impervious to water. Lacking this essential, the vegetation languishes. In the third, innermost zone (at *b*), the mycelium having here died off, water again becomes available and growth is luxuriantly resumed, even the bare zone being eventually recovered. At *e* and at *a*, normal grass before and after the attack, respectively. The active mycelium is shown at *f*.

Figure 11 Cross-section of a fairy ring produced by *Marasmius oreades*. *a*, center of ring; *d*, grass in central portion; *b*, inner stimulated zone; *c*, bare zone showing fruit-bodies of the *Maras-mius*; *d*, outer stimulated zone; *e*, normal grass outside of ring; *f*, the mycelium. Adapted from Shantz and Piemeisel ('17) who reproduce Molliard's figure

Three types of fairy-rings are known, the one just described, another in which the verdure is stimulated without the production of a bare zone, and a third in which no effect is visible.

The mycelia of fairy-rings are excellent illustrations of the perennial type of mycelium as opposed to that formed anew each year .

ANIMAL EATERS OF MUSHROOMS

Man is inclined to rate himself rather highly, especially in the realm of gastronomics, but, "there are others", creatures quite as selective, when it comes to "tickling the palate".

To begin near the bottom of the scale of animal life, the common slug does not pass by a mushroom that happens to stand in its slimy path; it halts and gormandizes until there is nothing left of the plant but a complete wreck, sometimes much to the disgust of the student who may have wanted the specimen for his scientific collections. Buller ('22) tells of the wonderful "smeller" these lowly animals have for a certain fungus.

Insects, too, are no despisers of a mushroom diet. Indeed, the larvae of some kinds may be regarded as among the happiest creatures on earth, for the mother, in depositing her eggs, seeks out especially tasty mushrooms that will serve as a food-bed for her progeny (Johannsen, '09–'12; Weiss, '22).

Certain large tropical ants, the termites, even go so far as to cultivate little, mycelial bodies as food for themselves. The "compost" is made of green leaves which are brought in by hosts of these intrepid mushroom growers. During a recent visit to Cuba, the writer saw a long procession of "bibijaguas"—*Atta insularis,* a termite peculiar to the island—advancing, Indian fashion, toward their nest, each individual holding a leaf-fragment aloft, like an umbrella, from which habit they get their popular name, "umbrella-ants".

The original observations on these mushroom-cultivating ants were made on Brazilian species of *Acromyrmex* and *Atta* (Forel, '28; Möller, 1893).

Advancing up the line of animal life, the tortoise occasionally stops in its leisurely peregrinations to take more than a look at the mushroom it meets. A friend of the writer once surprised this animal "red-handed" at the business of devouring an *Amanita!* He did not actually see it eating, but there was the *Amanita* with fresh evidences of having been picked at, and there was the tortoise, its beak still retaining tell-tale fragments of the meal! A jury would hang a man on evidence so conclusive.

But the prime mushroom eaters, short of discriminating humans, are the red squirrels (Buller, '20; Cram, '24; Hatt, '29). Specimens of Boleti are frequently found, their caps showing distinct signs of having been nibbled at by these rodents. When satiated, they store specimens in the forked branches of trees for future use (figure 12).

Figure 12 Red squirrel storing mushrooms in the forks of a tree branch. After W. E. Cram ('24)

They seem to prefer the substantial Boleti, but other kinds are also eaten. According to one observer (Metcalf, '25),

even the poisonous Fly Agaric, *Amanita muscaria* (plate 3) is not despised. To the forester it is not news that deer and cattle are also fond of mushrooms.

Animals, in eating mushrooms, unconsciously aid in the distribution of the various kinds eaten, for in devouring the fungi they also take within themselves the spores which are later scattered far and wide in the excreta (see Spore Dissemination, pp. 23, 85).

HABITATS; WHERE MUSHROOMS GROW

General remarks. To say where mushrooms—and fungi generally—do not grow would be easier than to give even a few of their numberless habitats. That they grow everywhere except in fire and in boiling water would be a statement approximating the truth. The lower forms, bacteria and the ferment-producers, being omnipresent, fill the air with their tiny cells and spores that are ever ready to pounce upon both living and dead plants and animals. Sticky culture-plates, carried into the upper atmosphere by airplanes and there exposed, have caught up spores of the rust of wheat. The larger fungi, or mushrooms, occur on all substances that offer nourishment.

In a general way it may, therefore, be said that the places where their food plants grow, are also the places of their occurrence. Some grow only in the open, while others require sheltered, shady ground. Some grow under or on certain kinds of trees, while others are to be found in mixed woods. Many may be sought only on dung, while others prefer association with mosses, lichens and ferns. In a few cases they even parasitize each other (Graham, '27, '28).

The appended tabulation, in which a large number of

the species of fleshy mushrooms are classified according to their habitats and hosts, should prove useful to the beginner who, finding himself in any one of the situations where the plants or plant associations indicated grow, would like to know what mushrooms he is apt to encounter. The principal omissions in the list consist of species that occur either generally in woods the character of which is not specifically indicated in the literature, or of species that are too rare to be taken note of in this general account.

KINDS OF MUSHROOMS GROWING MORE OR LESS IN THE OPEN

On Mossy Rocks and in Rocky Soil

Hebeloma pascuense	*Pholiota duroides*
Lycoperdon calyptriforme	*Psilocybe fuscofolia*

In Gravelly Soil

Amanita spreta	*Inocybe subtomentosa*
Entoloma scabrinellum	*Tricholoma infantile*
Hebeloma velatum	

In Sand or Sandy Soil

Amanita spreta	*Inocybe maritimoide*
Boletus cyanescens	*Inocybe serotina*
Boletus scaber	*Inocybe subfulva*
Boletus subluteus	*Laccaria laccata*
Boletus versipellis	*Laccaria trullisata*
Cortinarius tricolor	*Lactarius chelidonium*
Gyromitra esculenta	*Lepiota arenicola*
Hebeloma colvini	*Naucoria arenaria*
Hebeloma excedens	*Naucoria lenticeps*
Hebeloma gregarium	*Polysaccum pisocarpium*
Hebeloma parvifructum	*Psalliota halophila*
Hebeloma sordidulum	*Psilocybe arenulina*
Hygrophorus immutabilis	*Tricholoma equestre*

In Clayey Soil

Clavaria argillacea	*Inocybe rigidipes*
Eccilia housei	*Inocybe unicolor*
Helvella infula	

APPENDIX C

APPENDIX C

POSTTEST

Directions: Below is a quiz over the material you just studied.

1. Name the substance mushrooms lack which other plants
    have to produce food.

2. What is the name for a mushroom that lives off of dead
    plants?

3. What fungi specializes in the distruction of railroad
    ties?

4. What is parasitism?

5. What species of fungus eats woody tissue?

6. What species of fungus feeds on wheat?

7. Name one kind of mushroom that is found under or near
    trees and green plants.

8. What is the scientific term for mushroom roots-hairs?

9. What is symbiosis?

10. Give two examples of plants that form cooperative symbiosis with fungus.

11. At what temperature do mushrooms grow best?

12. What seasons of the year do mushrooms grow best?

13. How do mushrooms respond to excessively hot climates?

14. What species of mushrooms will grow in extreme cold?

15. What is the effect of extreme heat on a mushroom?

16. How much water must a mushroom have to grow?

17. How much light is needed to grow mushrooms?

18. Name a plant's response to gravity.

19. What is the name for a fungus living outside a root of a plant?

20. What is the name of the species of mushroom that grows in water?

APPENDIX D

Appendix D

Objectives - Mushroom

1. State which substance mushrooms lack which other plants have to produce food.

2. State the name for a mushroom that lives off of dead plants.

3. Name the fungi that specializes in the distruction of railroad ties.

4. Define parasitism.

5. State the species of fungus which eats woody tissue.

6. State the species of fungus that feeds on wheat.

7. Name one kind of mushroom that is found under or near green plants.

8. State the scientific term for mushroom roots-hairs.

9. Define symbiosis.

10. State two examples of plants that form cooperative symbiosis with fungus.

11. State the temperature at which mushrooms grow best.

12. State the seasons of the year when mushrooms grow best.

13. State how some mushrooms respond to excessively hot climates.

14. State the species of mushroom that will grow in extreme cold.

15. State what is the effect of extreme heat on a mushroom.

16. State how much water a mushroom must have to grow.

17. State how much light is needed to grow mushrooms.

18. State the name for a plant's response to gravity.

19. State the name for a fungus living outside a root of a plant.

20. Name the species that grows in water.

APPROVAL SHEET

The dissertation submitted by Lawrence A. Biro has been
read and approved by the following Committee:

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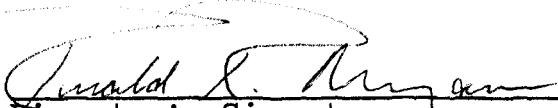> Associate Professor, Educational Foundations, Loyola
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The final copies have been examined by the director of
the dissertation and the signature which appears below
verifies the fact that any necessary changes have been
incorporated and that the dissertation is now given
final approval by the Committee with reference to content
and form.

The dissertation is therefore accepted in partial fulfill-
ment of the requirements for the degree of Doctor of
Education.

_12/5/80_ _____

Date Director's Signature