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ABSTRACT

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CAI CENTER

TECH MEMO

INCIDENTAL AND RELEVANT LEARNING WITH INSTRUCTIONAL OBJECTIVES

Philippe C. Duchastel

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Duncan N. Hansen
Director
CAI Center

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ABSTRACT

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INCIDENTAL AND RELEVANT LEARNING WITH INSTRUCTIONAL OBJECTIVES[1]

Philippe C. Duchastel
Florida State University

Much research has been done and is presently being conducted on the effects of instructional objectives in learning. One aspect of that research has addressed the question as to whether providing students with advance knowledge of the instructional objectives for a unit of instruction will facilitate their learning of that unit. A review of the results obtained in this area has recently been completed (Duchastel & Merrill, 1972), and points to the great variability involved in the conclusions drawn from these research efforts.

Although a number of studies have failed to support the hypothesis that students provided with objectives will achieve more than subjects unaware of the objectives, a sufficient number of investigations have confirmed the hypothesis to come to an affirmative opinion on the question. Indeed, if the hypothesis was not founded, the number of studies reporting significant differences would be merely 5%, i.e., the chosen Type I error level.

Accepting this view, it would now seem appropriate to view the issue on a more basic level and investigate various reasons why objectives could possibly be helpful to students. The present study addresses one aspect of this issue, namely, that objectives facilitate student learning by providing direction for that learning.

[1]The author gratefully acknowledges the cooperation of Drs. B. Brown, D. Hansen, B. Kibler, F. J. King, and P. Merrill, who reviewed a draft copy of the present paper.

This directive function of objectives can be viewed within the general framework of the theory evolving around the use of orienting stimuli (Rothkopf, 1970). Basically, orienting stimuli are thought to elicit inspection behaviors which in turn determine what is learned. Orienting stimuli should, therefore, focus the student's attention on the important aspects of the content (whatever is so defined as important) and minimize his attention on the incidental or illustrative parts of the learning material. This focusing effect should increase performance on test items referenced to the important aspects of the material and decrease performance on those items which are referenced to the incidental aspects.

Research on Orienting Stimuli

The general perspective within which this research body should be viewed is presented by Rothkopf (1970, 1971), and the main conclusions drawn from the research with orienting questions are summarized by Frase (1970). The main finding from this research effort was that inserting questions in reading material enhanced performance on question-relevant items in the posttest. Performance on nonrelevant items (those not referenced to inserted questions) was generally improved through the use of questions placed after the learning passage, but not through the use of pre-questions. In some cases (Frase, 1968; Patrick, 1968; Frase, Patrick & Schumer, 1970), pre-questions actually depressed incidental learning. Presumably then, questions which are placed before the material focus the student's attention on question-relevant material and not on the incidental material.

Orienting stimuli have also been investigated through the use of typographical cuing. Hershberger and Terry (1965) found that simple typographical cuing, distinguishing core from enrichment content, enhanced the ratio of important to unimportant content learned without affecting the total amount learned.

With respect to instructional objectives, a few studies have been conducted in which the selective learning hypothesis has been investigated. In the first of these (Olson, 1971), fifteen behavioral objectives were written for each of four units of written instruction. Subjects in the behavioral objective group, however, received only 10 of each set of 15 objectives. When tested over all 15 objectives, no significant difference was found between performance on questions related to the explicit objectives and performance on the implicit objectives. These results, however, must be viewed with some reserve, since even on the 10 objectives provided them, the subjects in this group performed no better than those not provided with these objectives. In this study, therefore, objectives had no effect whatsoever.

A second study is that of Morse & Tillman (1972) who investigated the incidental-relevant hypothesis and the effect of training students on the use of behavioral objectives. Half of the 52 subjects received 3 of the 6 objectives for the unit of instruction. The other half received no objectives. Overall, the subjects receiving the partial list of objectives performed significantly better on test items referenced to these objectives than on items not related to these objectives. The subjects receiving no objectives performed equally well on either set of items. Incidental learning for the group with objectives was not adversely affected.

In a third study, Rothkopf & Kaplan (1972) also contrasted the effects of objectives on intentional and incidental learning. The experimental groups provided with objectives performed better on intentional than on incidental learning. However, they also performed better on incidental learning than a control group not provided with objectives and simply told to learn "everything" in the unit.

The preceding two studies have found that objectives, while enhancing relevant learning, do not, however, depress incidental learning. This finding is somewhat unexpected and in conflict with results obtained with the use of pre-questions. One possible explanation for [illegible] findings is that the subjects used in the two studies may not have been familiar enough with the role of objectives to fully use them in focusing their learning. It has been pointed out by a number of researchers (cf. especially Tiemann, 1968) 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. This consideration would seem to be especially crucial in the issue we are presently dealing with. If a student thinks that his instructor might test him on all the material and not just the material delimited by the objectives, he is likely to not focus his attention on the objectives as much as he would otherwise.

Rothkopf and Kaplan, in the study cited above, used subjects which were presumably not familiar with instructional objectives. Morse and Tillman, on the other hand, attempted to train a subset of their subjects in using behavioral objectives. Their results, however, fail to show any practical effect derived from the training: subjects with no training actually outperformed subjects with training.

It would seem, therefore, that the ideal subjects to use in research on objectives are students who have had practical experience with objectives and criterion-referenced testing in their academic courses. The purpose of the present research effort was to investigate the incidental/relevant learning hypothesis with such a group. It was expected that not only would objectives enhance relevant learning, but also decrease incidental learning. Furthermore, because of this sophistication of the subjects with the practical functions of objectives, it was expected that the effects on relevant learning would be larger than those found in the studies reported above.

Specifically, the main hypotheses which were investigated in this study are as follows:

1. Students provided with a partial list of objectives will perform better than subjects without objectives on test items referenced to those objectives (relevant learning).
2. Students provided with a partial list of objectives will perform less well than those without objectives on test items not referenced to the objectives (incidental learning).

METHOD

Subjects

A total of 58 college students participated in the study. These students were volunteers from a communication course at FSU and received course credit for their participation.[2] The course in question is a mastery course organized around a set of established objectives provided

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[2]The author is grateful to Dr. Bob Kibler, M. Ron Basset, and M. Tom Porter who made the course available for research purposes and offered many suggestions for the study.

to the students and in which each unit test is directly referenced to the unit objectives. The pro s conducted after the students had taken four unit t as o have assurance that the students were fully aware, during the experiment, of the role played by objectives in learning. The students had also had a lecture at the beginning of the course explaining to them how to proceed through the course using the objectives.

Materials

The instructional materials consisted of a slightly modified reading passage taken from a text entitled The Mushroom Handbook written by L. Krieger (Second Edition, 1967). The passage, which was 10 pages long (approximately 2400 words), was taken from the section entitled "Conditions Under Which Mushrooms Grow and Thrive," and deals with such aspects of development as food and temperature requirements, parasitism, fairy-rings, etc. These materials were selected mainly because of their presumed unfamiliarity to the typical undergraduate student and because they seemed quite typical of much of the course material found at the college level.

The instructional objectives used in this study number 24 and were developed from an examination of the passage. All objectives state what the student must be able to do (e.g. state, define, etc.), but do not contain conditions nor criteria of performance, as these were considered irrelevant here. All of the objectives are very specific and relate to the knowledge category of Bloom's taxonomy of objectives (Bloom, 1956). The full list of objectives is reproduced in Appendix A.

The posttest was developed so as to reflect directly the instructional objectives. One item was written for each objective, for a total of 24 items on the full test. All items are of a constructed response format which tap recall and not merely recognition. The full test is reproduced in Appendix B.

The objectives, text, and posttest items were reviewed by three graduate students in the Department of Educational Research and Testing in order to assure that each objective was clearly stated and that each posttest item was directly referenced to its appropriate objective. Minor revisions in wording resulted from this review.

Experimental Design

The experimental design of the study comprises two groups of subjects. The first group received half of the objectives (HO group); the second group no objectives (NO group). The design is illustrated in Figure 1.

Half of Objectives	No Objectives

Figure 1.--Design of the study.

Procedure

Subjects were randomly assigned to the two treatment groups. One-half of the objectives had been randomly selected from the full list of objectives for presentation to the HO group.

The subjects were handed an instructional package containing general directions, the objectives (for the appropriate group), and the learning passage. The subjects had a maximum of 30 minutes in which to study the passage. Durin[illegible] learning task, the subjects were permitted to review any section [illegible] the text at their discretion. At the completion of the task, each subject indicated in the space provided the total number of minutes he took to study the materials. He then individually exchanged his instructional package for the posttest and additional, nonrelated, reading material to keep him occupied until all subjects had completed the experiment. The directions given to the subjects appear in Appendix C.

RESULTS

The data collected in this study consist of posttest scores and study latencies. The posttest scores were partitioned into two subscores: the first of these was referenced to the partial list of objectives received by the HO group (relevant learning for that group); the second subscore was referenced to the set of objectives not received by the HO group (incidental learning for that group).

KR-20 reliability indices for each group are presented in Table 1. It is recognized that the use of instructional objectives and the implications thereof for a criterion-referenced approach would lead to the use of a criterion-based technique such as the one proposed by Livingston (1972). Unfortunately, because there was only one test item per objective and because no percentage-type criterion was utilized, such a technique could not be used.

TABLE 1.--KR-20 Reliability Indices by Group and by Scale

Scale \ Group	HO Group (29 Subjects)	NO Group (29 Subjects)	Groups Combined (58 Subjects)
Subscore 1 (12 items)	.71	.45	.68
Subscore 2 (12 items)	.57	.45	.64
Total score (24 items)	.61	.62	.58

The means and standard deviations for each of the two subscores and the total score are presented below (Table 2). For the HO group, subscore 1 represents relevant learning and subscore 2 incidental learning.

TABLE 2.--Posttest Means and Standard Deviations by Group and by Scale

Scale \ Group		HO Group	NO Group	Groups Combined
Subscore 1 (Max. 12)	$\bar{M}$	7.4	5.1	6.3
	SD	2.7	2.1	2.6
Subscore 2 (Max. 12)	$\bar{M}$	3.2	5.6	4.4
	SD	1.9	1.9	2.3
Total Score (Max. 24)	$\bar{M}$	10.6	10.8	10.7
	SD	3.2	3.3	3.3

The means and standard deviations for the time (in minutes) each group spent studying the instructional text are presented in Table 3. These figures represent the combined time involved in reading the directions, reading and referring back to the objectives (HO group only), and studying the text.

TABLE 3.--Means and Standard Deviations for Time (in minutes)

Time \ Group	HO Group	NO Group	Groups Combined
$\bar{M}$	20.0	18.5	19.3
SD	4.8	4.5	4.6

Finally, the intercorrelations between posttest scores as well as between posttest scores and study time are presented below in Table 4.

TABLE 4.--Correlation Matrix for Total Score, Subscores, and Time. (Experimental group - top right triangle; control group - lower left triangle)

	Total Score	Subscore 1	Subscore 2	Time
Total Score		.80	.56	.26
Subscore 1	.86		-.05	
Subscore 2	.83	.44		
Time	.25			

Inferential Statistics

Statistical contrasts using analysis of variance were made between the HO group and the NO group. These were made independently for each of the subscores, for the total score and for study time. The results of these analyses are presented below in Table 5. In all cases, the independent variable is group membership (half of objectives vs no objectives). The proportion of variance accounted for by this variable on the two subscores was calculated as R^2. The power of these analyses for a medium population effect size (calculated at $\alpha = .05$, two-tailed) was .46. That this figure is rather low adds to the reliability of the main results, since the expression of a true difference as a significant result (as is the case here) is less probable in these circumstances.

TABLE 5.--ANOVA Results for each Subscore, the Total Score and Study Time

Dependent Variable	F	P	Accounted Variance	df
Subscore 1	12.4	< .05	18%	1/56
Subscore 2	23.3	< .05	29%	1/56
Total Score	< 1	> .05		1/56
Time	1.5	> .05		1/56

The above table indicates a significant effect for the availability of objectives on both subscore 1 and subscore 2. From Table 2, it can be seen that the HO group performed better than the NO group on subscore 1, indicating that relevant learning was enhanced by the availability of objectives. Indeed the difference of 2.3 points between the groups accounted for 18% of this subscore's variance. Incidental learning, on the other hand, was depressed as evidenced by the means of 3.2 and 5.6 for the HO and NO groups, respectively. The difference of 2.4 between the groups accounted for 29% of subscore 2 variance.

The differences between the two groups with respect to total score and time were not significant at the chosen α level (.05).

DISCUSSION

The results just provided confirm the hypotheses elaborated for this research. That objectives have a focusing effect on learning seems to be supported by the fact that, while the two groups did not appreciably differ either in total posttest score nor in study time, they did differ on each of the two subscores. The subjects who received half of the instructional objectives attained more of those objectives than their counterparts not provided with objectives. They furthermore attained fewer of the non-presented objectives than their counterparts without objectives. It can be implied from these results that they used the objectives provided them in order to focus their learning on the relevant material (as perceived through their list of objectives) and to pay less attention to the incidental material (those parts of the material not referenced to their objectives). The subjects not provided with any objectives, on the other hand, engaged their learning equally on all parts of the material.

The correlations obtained in this study further support this conclusion. Subscales 1 and 2 were correlated .44 for the NO group but only -.05 for the HO group. Furthermore, for the NO group, the correlations between the subscales and the total scale were about equal (.86 and .83); for the HO group, on the other hand, subscale 1 (relevant learning) correlated .80 with the total scale, whereas subscale 2 (incidental learning) correlated only .56. It seems likely therefore that relevant learning contributes more heavily to the HO group's total score than does incidental learning.

The results obtained in this study are in agreement with previous research (Rothkopf & Kaplan, 1972; Morse & Tillman, 1972) only with respect to relevant learning. In all three studies, objectives served to increase relevant learning. With respect to incidental learning, however, the present results conflict sharply with the previous results. Morse and Tillman (1972) found no significant difference on incidental learning between a group with half of the objectives and a group without. They concluded that objectives did not adversely affect incidental learning. Rothkopf and Kaplan (1972), on the other hand, found that objectives not only facilitated relevant learning, but also incidental learning.

As expressed in the introduction, these differences could stem directly from the fact that each of the three studies is actually dealing with a different population. In the Rothkopf and Kaplan (1972) report, no mention is made about the familiarity of the subjects with respect to the role of objectives in learning. It must be presumed that their subjects had little previous experience with objectives. Morse and Tillman (1972), on the other hand, trained a subset of their subjects on the use of objectives, but without apparent effect. In the present study, the participating subjects had practical experience in using objectives in one of their academic courses, an experience which the subjects in the other two studies presumably did not share. We are therefore dealing with three distinct student populations: one having little familiarity with objectives and no experience with them; one familiar with objectives but lacking experience with them; and one with direct previous experience with objectives. The results obtained in each of the three studies should therefore be generalized only to their appropriate population.

A further distinction between the studies is the type of learning which was involved in each. While the present study, as well as the Rothkopf and Kaplan (1972) study, used objectives subsumed mainly under the knowledge category of learning (Bloom, 1956), the Morse and Tillman (1972) objectives related to higher levels of learning (mainly Bloom's category entitled Analysis).

Time

With respect to time, no hypothesis had been advanced in the present research. While the group receiving half of the objectives spent slightly more time studying the passage, the difference was not great (approximately 7% more time).

The correlations between time and performance were also low (about .25) and identical across groups. Carver (1970) strongly argued that the results obtained in orienting stimuli research were generally confounded by time, since the subjects receiving orienting stimuli usually spent slightly more time studying the material. This criticism however, does not have any implication for the results of the present study, since what is being investigated is not an overall effect on performance but rather a differential effect on performance. Both groups, in fact, performed equally well on the total score. Furthermore, with respect to time, it is questionable whether the laboratory studies dealing with orienting stimuli (including the present one) are representative of the situation involved in a regular academic setting. It could easily be expected that the effect of objectives on study time over an academic semester would be quite different from the effects obtained in laboratory studies of short duration.

Conclusion

The present research is seen as supportive of the hypothesis that objectives facilitate learning by focusing the learning effort on relevant material and detracting attention from incidental material. The results obtained however, are directly generalizable only to the knowledge category of learning and should be replicated with other types of learning.

Furthermore, the objectives utilized in this study are very specific objectives, which would be found in typical classroom situations only infrequently. It would be useful, therefore, to replicate these results in an academic setting more representative of the regular academic situation.

It should be noted also that the results were obtained in a situation in which objectives were developed from an existing text. One could expect different results in a situation in which objectives were developed first and then instructional materials were developed around the objectives. Indeed, much less incidental material would be present in such a case.

The present study once again points to the requirement for researchers in the field of instructional objectives to insure that their subjects are familiar with objectives and actually use them, if their results are to be generalizable to an appropriate population. This factor was considered to be the main reason for not finding expected results in a previous research effort in which the author participated (Tobias & Duchastel, 1972). It probably also affected many of the results reported by other researchers (Duchastel & Merrill, 1972).

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APPENDIX A

LEARNING OBJECTIVES

After completing this unit, the student will be expected to

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state in which specific respect fungi resemble animals.

define saprophytism.

state what is special about the specie 'Lentinus lepideus.'

state what is special about 'Polystictus versicolor.'

state which mushroom (common name) is the worst enemy of the oak tree.

state which fungus causes a reduction in the output of wheat.

define mycorrhiza.

name and define the two kinds of mycorrhizas.

give two examples of plants which form a cooperative symbiosis with fungi.

state what the limits of temperature are for growing mushrooms.

state in which seasons the majority of mushrooms grow.

state what protects certain mushrooms from the cold.

state how fungi protect themselves against the heat during early development in torrid climates.

state the effects of extreme cold and heat on mushroom growth.

state the effects of amount of water on mushroom growth.

state the light requirements for mushroom growth.

state what peculiarity is evident in 'Pilobolus crystallinus.'

state the name for a plant's response to gravity.

state two causes for fairy rings as hypothesized by early scientists.

state the extremes in time and dimension observed in fairy rings.

characterize the three types of fairy rings.

state which insects cultivate fungi.

state at least four animals which eat mushrooms.

state how animals help in the dissemination of mushrooms.

APPENDIX B

POSTTEST

1. In which respect do fungi resemble animals?

2. Define saprophytism.

3. What is special about the specie 'Lentinus lepidens?'

4. What is special about the specie 'Polystictus versicolor?'

5. Which mushroom (common name) is the worst enemy of the oak tree?

6. Which fungus greatly affects the national output of wheat?

7. Define mycorrhiza.

8. Name and define the two kinds of mycorrhizas.

9. Give two examples of plants which form a cooperative symbiosis with fungi.

10. What are the limits of temperature for growing mushrooms?

11. In which seasons do the majority of mushrooms grow?

12. What protects certain mushrooms from the cold?

13. How do fungi protect themselves against the heat during early development in torrid climates?

14. a. What effect does extreme cold have on mushroom growth?

    b. What about extreme heat?

15. What effect does amount of water have on mushroom growth?

16. What are the light requirements for mushroom growth?

17. What peculiarity is evident in the specie 'Pilobolus crystallinus' with respect to light?

18. What is the name for a plant's response to gravity?

19. Early scientists had hypothesized a number of causes for fairy rings. Give two of these.

20. a. What is the greatest diameter observed in fairy rings?

b. What age (how old) have certain fairy rings been known to attain?

21. What are the three types of fairy rings?

22. Which insects cultivate fungi as food for themselves?

23. Name at least four animals which eat mushrooms.

24. How do animals help in the dissemination of mushrooms?

APPENDIX C

NAME ______________________________ NUMBER ________________

DIRECTIONS

Your participation in this study will enable educational researchers to study one aspect of how people learn from textual materials. The short text selected for you to study is an instructional chapter on how mushrooms grow and thrive. We believe you will find it quite interesting. Once you have finished studying, you will be given a constructed response posttest to measure your learning.

The posttest will consist of questions requesting factual recall. Therefore, try to learn everything in the text.

You will have a maximum of 30 minutes in which to study the text. Study at a comfortable rate and review any parts of the text you feel are necessary. Once you feel you have mastered the objectives, raise your hand and the experimenter will exchange your learning materials for the posttest. Before you do so, however, write in the space provided below the exact time as indicated on the clock at the side of the room. Since not all students in this experiment will be receiving the same materials, don't worry if some finish before you do; study at your own rate. Good luck!!

After you have finished studying these materials, indicate here the exact time (for example, 7:22) ______:______

NAME ______________________________ NUMBER ______________

DIRECTIONS

On the next few pages are 24 posttest items. Answer each item in the space provided below it. Try answering all items.

After completing the posttest, turn it face down on your desk. The experimenter will then pick it up. Since other students may still be studying or taking the posttest, we have provided additional reading material for you to browse through if you wish. You may leave the room only when all students have completed the posttest.

START THE POSTTEST

NAME ______________________________ NUMBER ______________

DIRECTIONS

Your participation in this study will enable educational researchers to study one aspect of how people learn from textual materials. The short text selected for you to study is an instructional chapter on how mushrooms grow and thrive. We believe you will find it quite interesting. Once you have finished studying, you will be given a constructed response posttest to measure your learning.

On the next page, you will find the behavioral objectives for the text. As you well know, behavioral objectives indicate to you what you will be expected to do after studying the materials. Refer to them as often as you need to while studying the text. A good strategy is to compare your learning with the objectives as you progress through the text. On the posttest, you will be expected to do what is indicated in the objectives.

You will have a maximum of 30 minutes in which to study the text. Study at a comfortable rate and review any parts of the text you feel are necessary. Once you feel you have mastered the objectives, raise your hand and the experimenter will exchange your learning materials for the posttest. Before you do so, however, write in the space provided below the exact time as indicated on the clock at the side of the room. Since not all students in this experiment will be receiving the same materials, don't worry if some finish before you do; study at your own rate. Good luck!!

After you have finished studying these materials, indicate here the exact time (for example, 7:22) ____:_____.

LEARNING OBJECTIVES

After completing this unit, you will be expected to

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state in which specific respect fungi resemble animals.

define saprophytism.

state which mushroom (mmon name) is the worst enemy of the oak tree.

define mycorrhiza.

give two examples of plants which form a cooperative symbiosis with fungi.

state how fungi protect themselves against the heat during early development in torrid climates.

state the effects of amount of water on mushroom growth.

state what peculiarity is evident in 'Pilobolus crystallinus' with respect to light.

state the name for a plant's response to gravity.

state two causes for fairy rings as hypothesized by early scientists,

state the extremes in time and dimension observed in fairy rings.

state at least four animals which eat mushrooms.

NAME ______________________________ NAME ______________

DIRECTIONS

On the next few pages are 24 posttest items. Answer each item in the space provided below it.

The items which cover the objectives for the text are imbedded among other items not referenced to the objectives. It is important that you try to answer all items, whether or not they are related to the objectives. Try answering all items.

After completing the posttest, turn it face down on your desk. The experimenter will then pick it up. Since other students may still be studying or taking the posttest, we have provided additional reading material for you to browse through if you wish. You may leave the room only when all students have completed the posttest.

START THE POSTTEST