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Recent Research on Discovery

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GREAT educators of the past, such as Jean-Jacques Rousseau, Maria Montessori, and John Dewey, advocated teaching through discovery. Today, Jerome Bruner (1966) is the leading spokesman for those who believe that discovery enhances retention and transfer and motivates further learning. This belief has guided revisions of the curriculum (Heath, 1964) and has prompted new strategies for thinking (Taba and Elzey, 1964) and inquiry (Suchman, 1962).

Quite different views are current also. According to David P. Ausubel (1963), most efficient learning, in or out of schools, occurs by the "reception" of material which has been presented in near final form. He suggests ways of organizing subject matter for more effective presentation. B. F. Skinner (1968), a pioneer in the development of teaching machines and programmed instruction, criticizes discovery as a "sink or swim" method which evades the school's responsibility for instruction. He advocates presentations which prompt students' every response while leading them, gradually and in a very logical way, to achieve the objectives set for them.

Another well-known student of learning, Robert M. Gagné (1965), gives a clear statement of the conditions for several types of learning, some of which are prerequisite to others. To learn a principle, for example, the learner must relate two or more concepts that have been previously learned. Concept learning, in turn, requires the prior learning of specific associations. Consequently, effective instruction, according to Gagné, requires the careful sequencing of learning tasks. For each task, he suggests that learners be fully prompted or guided in their attempts to respond correctly. Thus, the need for independent discovery is minimized.

Current research on discovery has been addressed, most often, to questions about the effects of guidance by the teacher or experimenter. A recent volume (Shulman and Keislar, 1966) discusses the disappointing state of much of this research. In spite of the deficiencies and differences among studies, however, a careful analysis suggests that either guided learning or discovery techniques are effective depending on the nature of the task to be learned. Two general hypotheses receive support:

1. Guiding learning—that is, stating or showing the content, principles, or methods which are to be learned—gives better results if the objectives are learning, retention, and application of what is learned.

2. Discovery techniques—that is, allowing the student to discover what is to be learned—are more effective if the objective is the inference and use of new principles or methods.

Guidance and Discovery

The results supporting the guided learning hypothesis suggest matching guidance

to what students are to learn. When rules for a class of problems are to be learned and applied, stating the rules has been more effective than either more guidance, i. e., giving both rules and answers to examples, or less guidance, i. e., giving examples only (e. g., Wittrock, 1963; Guthrie, 1967). When a general method or strategy for finding rules was the objective, explaining that strategy (Roughead and Scandura, 1968) or guidance in finding it (Gagné and Brown, 1961) was more effective than examples of rules only or an opportunity to discover rules.

In general, best results are obtained when the rules or other types of information given learners apply only to the problems for which they are later responsible. Rules which hold for an unnecessarily wide variety of problem situations invariably give less specific direction about what to do in particular situations. Hence, more mistakes are made. On the other hand, if the rules are so specific that they work with only some of the problems given later, learners err in trying to use rules when they do not apply (Wittrock, Keislar, and Stern, 1964).

The discovery hypothesis has been inadequately tested; but, when differences among treatment groups in later ability to infer and use new principles have been found, they favor discovery techniques over the giving of guidance. Guthrie's experiment (1967) is one of the few short-term experiments to report significant differences among experimental groups with respect to the later discovery of rules. College students who were given examples of cryptograms to decipher without rules were found superior to a rule-first group when tested on cryptograms based on different rules. Gagné and Brown (1961) also found discovery groups better than a rule-given group at finding untaught formulas for the sums of number series. Later, using some of the same materials, Roughead and Scandura (1967) reported results for "rule first" and "rule last" groups that suggest that the discovery hypothesis holds, as the wording implies, if there is an opportunity for discovery, even if direct teaching of rules follows.

Worthen (1968) was primarily concerned with the differences between the conditions of the typical experiment and the typical classroom. Regular teachers used his text-like materials on mathematics concepts with fifth- and sixth-grade children every day for six weeks. Contrary to the hypothesis favoring guided learning, his discovery group did better than a group taught concepts by teacher exposition on tests of retention after five and 11 weeks. With many rather than few concepts and with long rather than short learning and retention periods, the guided learning hypothesis may not hold. Under the latter conditions Worthen's tests may have been more like tasks of discovery than of retention and application. Also, in this experiment classroom groups were taught rather than individuals, and several method differences were planned in addition to the central one of whether the concepts or principles were stated before students worked with examples.

White's postulate (1959) that exploration, manipulation, and mastery are intrinsically rewarding is often cited to support the motivational value of discovery. It is an appealing and reasonable notion, but there is little evidence that it is generally true. A major difficulty is the lack of satisfactory measures of motivation for experimental use. Kersh (1964) found that discovery encouraged post-experimental practice in two experiments but not in a third; Worthen (1968) failed to note any effect on measures of attitude; and Craig (1965) showed continued practice to be more closely related to failure to succeed during learning than to discovery *per se*.

The hypothesized and reported differences in the outcomes of guided learning and discovery conditions may be the result of what is practiced and reinforced. A guided learner practices the application of the rules he is given. He doesn't waste time searching for methods of finding rules. Later, if he is asked to solve other problems for which the same rules work, he is probably successful; but if he is tested on problems which require new and different rules, he may stick to the old ones and fail.

A learner who is required to search for

a way to answer correctly, on the other hand, searches because he has no other choice. If he is successful, he is reinforced for this behavior and is apt to repeat it. In addition, he may stumble on a method which will work with other problems he encounters later. He probably will not be as proficient at applying particular rules as he would have been had he practiced that. From a somewhat different point of view, the learner's experience may give a set or predisposition to apply rules he knows or to search for new rules.

Evidence supporting the hypothesized differences in the outcomes of discovery techniques and guided learning is found in studies that differ in many ways; nevertheless, important exceptions to the general results may yet be found with particular types of students, materials, or methods. The great need in future research on discovery is for more comprehensive and systematic investigation of the many possible combinations of these and other variables which may affect the outcomes of classroom instruction.

Comprehensive programs of research with many students and substantial segments of the school curriculum could also begin to answer functional and pragmatic questions about how to combine guidance and discovery techniques. We would not expect to go far wrong by providing both these techniques at every educational level and in every subject, but how should they be synthesized? Is some long-term adaptation of the linear programmed instruction model of gradually withdrawing prompts (guidance) appropriate, or should we teach a common program of substantiated knowledge to all students and provide for frequent discovery branches?

Another plan is suggested by the possibility that discovery experience really does have merit for motivating further learning. In any event, a regular alternation of periods of guided learning and discovery experience is worth a trial. Each discovery experience may motivate students for guided learning which will prepare them for further discovery which will motivate more guided learning and so on. What is most probable, of course, is that no simple strategy will be generally useful under all conditions.

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