# Discovery As An Aspect of Learning

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In the past few years, the word, "discovery," has aroused a great deal of excitement in educational and psychological circles. Nevertheless, there still is little, if any, general agreement as to the meaning of discovery, how it can be used, how it comes about, and its importance as an aspect of learning. The issue is clouded by numerous terms which are used to refer to discovery, e.g., discovery method, incidental method, nonverbal awareness, inductive method, inquiry, problem solving, and open-ended investigation. In addition to confusion caused by these terms, a review of current literature leaves the reader in a state of bewilderment due to the subjective claims for and against discovery as a method of learning. From the present state of affairs, it is evident that discovery is in dire need of clarification and further research before any real agreement can be reached pertaining to its importance as an aspect of learning.

The purpose of this article is threefold. First, historical antecedents of discovery are identified. Emphasis is placed on the fact that discovery is not a new idea. Secondly, discovery is defined as an aspect of learning. The definition is presented to illustrate that discovery learning and discovery teaching are related but distinct entities. Thirdly, advantages claimed for and against discovery are presented. In essence, the central purpose is to provide a view of discovery learning and to point out the much needed research in this area.

## Historical Antecedents

Learning by discovery is certainly not a phenomenon unique to the Twentieth Century. It is a fundamental form of learning as old as man himself. If this were not the case, man would not have evolved socio-culturally. He would be totally dependent as a learner and a thinker. All data, inferences, conclusions, and generalizations would have to be drawn for him. Obviously, man is capable of intellectual discovery, and the use of discovery as a means of learning can be traced back a considerable distance into the history of man.

Discovery as a motivating force was known by ancient Greeks. Socrates roamed Greece asking questions in such a way that students were able to generalize for themselves. He believed that once a man was stirred by the teacher, he was able to see new meaning in life. Man was guided by curiosity and took pleasure in intellectual inquiry.

The use of discovery was revealed in the teachings of Jesus. He taught by parables which were stories of concrete experiences with deeper meanings or generalizations. From these parables, his students or followers were challenged to intellectualize or discover the meanings for themselves.

Discovery was well known to Rousseau. In his writings concerning the education of Emile, he stated that the teacher should present problems to the pupil and allow him to solve them. He further stated that (Boyd, 1962):

> Whatever he [the child] knows, he should know because he has grasped it himself. Do not teach him science; let him discover it. If ever you substitute authority for reason in his mind, he will stop reasoning, and become the victim of other people's opinions.

Pestalozzi (Mayer, 1960) believed that abstraction

was possible only after concrete ideas had been mastered. This conveys an idea of discovery and is similar to ideas used by the new mathematics programs presently being introduced into American public schools.

In 1904 Boode (Taba, 1963) developed conceptions of discovery learning which were remarkably congruent with present ideas. Boode's ideas were as follows: (1) Help the learner get at generalizations through concrete experiences; (2) Encourage the child to withhold verbalization of a generalization until it is operationally understood; (3) Strengthen the child's ability to infer by placing emphasis on process rather than on content; and (4) Define the process of learning as an active organization and reorganization of mental schemata.

Dewey's writings (Dewey, 1933) reveal his interest in discovery. He stated that information became knowledge only as it was understood. Understanding or comprehension resulted when various parts of the information were grouped in relation to one another. Therefore, understanding was dependent upon arranging or rearranging of information gained through concrete experiences.

Learning by discovery was a foundation stone for the Progressive Education Movement. It was the basis for the child-centered approach to instruction. Emphasis on discovery resulted from dissatisfaction with the "traditional" methods of teaching prior to the movement.

Bagley, although a critic of progressive education, was a proponent of discovery learning. His position was revealed in the following quotation (Johnson, 1966).

> The pupil is not to be told but led to see ... Whatever the pupil gains, whatever thought connections he works out, must be gained with the consciousness that he, is the active agent—that he is, in a sense at least, the discoverer.

During the 1959 Woods Hole Conference (Bruner, 1961), discovery was a frequently mentioned term. In writing about the ideas generated during the conference, Bruner stated that discovery was a possible ingredient in developing attitudes about the orderliness of nature and a belief that the order can be identified.

Discovery, or one of its synonyms, permeated each of the "new curricula" in science, mathematics, and social studies during the 1960's. In these programs, the child was supposed to become an active participant and discover concepts, principles, and generalizations for himself.

In the 1964 meeting of the Conference of Cognitive Studies and Curriculum at Cornell University (Ripple and Rockcastle, 1964), Piaget was quoted as being an advocate of discovery learning. Good pedagogy presented situations to the child in which he himself experiments. The child should be allowed to try out things to see what happens, answer his own questions, manipulate things and symbols, and to compare his answers with those of other children. Children must be allowed to do their own learning by discovery.

The historical antecedents reveal that learning by discovery is not a new and unique idea formulated in the Twentieth Century. What is new is the current emphasis being placed on discovery learning and the conditions in which discovery may flourish.

## Definition

Although discovery learning is as old as mankind, and men have historically encouraged this type of learning, disagreements exist as to its meaning. One reason for disagreement is that learning itself is not properly understood or defined to suit all persons. This is a bugaboo in dealing with any ideas concerning learning, and its solution is not clearly in sight. A second reason, one which could be eliminated with a minimum of cooperation and effort, is that discovery is used indiscriminately to refer to discovery learning and/or discovery teaching. The following statement by Glaser illustrates this point (Shulman and Keislar, 1966).

> . . . learning by discovery is defined usually as teaching an association, a concept, or rule which involves "discovery" of the association, concept, or rule.

Discovery learning is some intellectual process within the learner; however, literature on the subject often views it as manipulative, i.e., something that teachers do.

Discovery learning, as perceived by this writer, pertains largely to the cognitive aspect of learning, and it is the result of an individual's intellectual effort. It involves an inductive sequence which need not be verbalized. Discovery does not necessarily begin with a concept or principle, although this might be a possibility. It begins rather with elements of a concept or principle, which seen together in a particular arrangement, results in a concept or principle. Discovery might begin with concepts and principles, but in this situation, these concepts and principles become the elements which are arranged by the learner into sort of a "grand" principle. The learner may be exposed to the elements either in the concrete or abstract.

Often only a single piece of information, together with what is already known, makes discovery possible, but discovery does not have to be dependent on new information. It may consist of a recombination of elements already existing in the mind of the discoverer. Once the discoverer has these elements at his disposal, he arranges or rearranges them mentally into an organized scheme, resulting

in some new understanding which is greater than the individual pieces.

Discovery is not restricted to what has previously been known to mankind. The discovery is simply new to the person who has formulated the organization of the information. The discoverer, in rearranging, is enabled to reach new insights for himself.

In summary, discovery learning is an inductive process in which the learner develops his own organizing scheme for some cognitive activity. It is an intervening process in the learner which results in some behavioral change—verbal and/or operational.

## Claims For and Against

Research concerning the value of discovery learning has resulted in inconsistent and contradictory findings (Tanner, 1968). For this reason, claims for and against discovery are almost entirely subjective. Nevertheless, a general summary of the advantages stated for and against discovery learning follows to provide some indication of the importance for further investigation.

The advantages claimed for discovery are as follows:

- Discovery is indispensable for teaching the scientific method and effective problem solving skills.
- Various cognitive and motivational factors involved in discovery learning undoubtedly enhance learning, retention, and transferability.
- Abstract conceptions and propositions are forms of empty verbalism unless the learner discovers them directly out of his own concrete, expirical experience.
- Successful discovery enhances intellectual excitement and motivation for sustained problem solving and critical thinking.
- The act of discovery is exciting and pleasurable.
- Through the process of discovery, there is a shift from extrinsic to intrinsic rewards.
- Discovery creates a sense of power in the learner. It creates a sense of potency in the learner as well as an increasing faith in the regularity of the universe.
- Discovery creates a greater skepticism towards any explanatory system as a final and ultimate truth.
- The result of discovery is a greater depth of understanding of concepts and principles.
- It results in the child seeing himself as a curious person and as an autonomous inquirer.
- Discovery results in an increased ability to learn and to recall related materials.

In addition to contradictions of the advantages, disadvantages claimed against discovery are as follows:

- The most satisfying discoveries are relationships which are not obvious. Therefore, the probability exists that students will not discover. Errors, blind alleys, and lack of discovery may result in frustration and negative emotional effects on the part of students.
- Actual discovery is not always necessary before meaningfulness is possible.
- Most of what anyone really knows consists of insights discovered by others and communicated to him in a meaningful fashion.
- Learning by discovery is too time consuming. If secondary school and university students were obliged to discover for themselves every concept and principle in the syllabus, they would never get beyond the rudiments of a discipline.

## Conclusion

Why should there be such controversy concerning advantages claimed for and against discovery? One reason resides in the aforementioned fact that discovery has not been properly defined. Discovery, or one of its synonyms, has been used indiscriminately to refer both to learning and to teaching. Other reasons are as follows:

1. Many researchers have not stated what research shows but have presented a theoretical discussion based on subjective evaluation.
2. In the discovery research, significant variables have not been controlled, and questionable statistical analyses have been used.
3. Artificial situations have been conjured up rather than studying discovery in the "wild."
4. Questionable activities have been involved; i.e., activities studied have not always involved discovery learning.
5. Short term experiments have been used, neglecting the fact that considerable time is required for behavioral changes.
6. Questionable evaluation devices have been used.

Does the existing controversy mean that discovery learning should not be encouraged until it is properly defined and that conclusive evidence is available as to its value? It certainly does not. In the absence of conclusive research on what discovery learning is and what learning is best, ". . . a people must turn to the wise old men for advice" (Cartwright, 1964). The wise old men of education realize that man has and always will learn by discovery. However, in the interim, a number of things can and should be accomplished. Teachers, administrators, curriculum developers, and researchers should become more cognizant of problems which result from imprecise language. This awareness should be reinforced by publishers and readers demanding more precise language. If each writer would report how he was using discovery, replication and comparison would become possible. A careful, large scale program of evaluation concerning discovery should be initiated utilizing more effective research designs. In addition, caution should be exercised before wholesale adoption of some program involving discovery. Just being vogue or trying to

obtain funds, in themselves, are not suitable criteria for becoming proponents of discovery learning and teaching.

The ambiguities, disagreements, and imprecisions concerning discovery are not presented as evidence for a return to methods which are exclusively expository, didactive, or authoritative. They are identified so that a greater sensitivity to the problem will be realized. It is imperative that the controversy be thoroughly investigated if discovery is to have its rightful place in teaching-learning situations.

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Suddenly, the team of Armacost and Klinge ended in February 1959 when Armacost was killed in an automobile accident. Then began for me the isolated responsibility of editorship. In a sense the present termination of tenure signifies a ten-year period (1959-69), but in another sense it is appropriate to call it fifteen years (1954-69).

During all this time, several events of national significance occurred. In the fall of 1957, Sputnik went off into space. In 1957 NSF summer institutes came into full swing after a trial period of two summers. Soon, BSCS came into being. And when 1959 arrived, activity in science education was considerable.

Much of this was reflected in the history of NABT. There was a great membership increase, dues were increased, new programs launched, and the journal itself was expanded.

Thus, the editing of the journal was no static operation. Beyond the routine work of simply getting out each issue, there was considerable discussion, planning, and change. All was done in the context of an assessment of the readership. It was changing rapidly; the organization was changing; and the growing sophistication of the journal's readership necessitated change in the journal, but more importantly, there was constant attention to anticipating the changes which were to come when "their time had arrived."

In these fifteen years the big changes were in format (cover, internal organization, and in 1969, the size), increase in pagination and issues, topical organization of each issue, the use of color, special issues, and a change in the balance of types of articles published. Each change involved long discussions, planning, and financing. None was done without these steps. And so to accomplish change, conception had to be started long before parturition. Hopefully, the final product of each gestation was not too late nor too early for the readership. And primarily, changes were those which we believed the readership wanted.

An old departed and beloved Hoosier politician was responsible for a now oft-quoted story. When approached by one of his constituents for a favor, the politician recounted all the past favors he had given to the man. Then there was the famous rejoinder from the man to the politician, "Yes, but what have you done for me lately?" Let me then not recount past triumphs or even exhume old frustrations, but let me address myself to the future.

Insofar as the editor of this journal is concerned, I would offer the gratuitous advice to my successor that the principle of attention to the readership is still warranted. To repeat, it is not easy to assess, but it must be done and cannot be delegated to others. To accomplish the task of encouraging readers to read, continuous attention must be given the format. There is no one answer to this problem, and like the old story, the solution changes each year to this persistent and fundamental problem.

But what of the future? I see NABT with more than one journal if the membership is to be served and if the membership assumes a wide spectrum. My belief is that the secondary school biology teacher is of prime importance, but the ranks of the junior college and undergraduate biology teacher offer a great potential for membership growth. Secondly, the need for other publications beyond periodicals is now apparent. I am grateful to the NABT leadership for allowing me now to pursue this task. Thirdly, I am convinced that our educational system will undergo substantial changes in the near future. Thus, what biology teachers do will change and our past efforts, such as BSCS, will not be enough. These changes will involve methodology, objectives, and emphases. This implies changes in training and outlook of teachers. Our journal must anticipate these changes and hopefully reflect them in what is published. It will be no easy task. Finally, I see for ABT an increasingly important role as a professional journal, a model for other disciplines, narrow enough

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