David P. Ausubel

Indications and contributions in an approach to . . .

Learning by Discovery

AMONG the repertoire of accepted pedagogic techniques available to teachers, learning by discovery enjoys a proper and established place. For certain purposes and under certain conditions, this procedure has a defensible rationale and undoubted advantages. Hence the issue is not whether it should or should not be used in the classroom, but rather for what purposes and under what conditions.

Typically, however, both the proponents and opponents of learning by discovery tend to take an all-or-none position regarding its usefulness. Advocates of a subject-matter-oriented approach, for example, traditionally tend to de-emphasize the importance of psychological, developmental, and pedagogic factors that affect the meaningfulness of academic materials. They tend to assume that meaningfulness inheres in the logic of subject matter itself, irrespective of how it is presented and irrespective of the developmental status of the learner. Hence, from their standpoint, if an academically competent teacher presents subject matter logically to intellectually normal students, meaningful learning outcomes can always be taken for granted. It is hardly surprising, then, that they regard learning by discovery as inefficient and inadvisable under any circumstances, on the grounds that the learner is, by definition, insufficiently competent in any subject-matter field to learn effectively by himself.

On the other hand, as in the case of many other pedagogic devices, enthusiastic advocates of learning by discovery are prone unwarrantedly to extrapolate the advantages of this technique to all age levels, to all levels of subject-matter sophistication, to all kinds of educational objectives, and to all types of learning tasks. They tend to assume that all problem-solving and discovery experience is inherently and necessarily meaningful, and that all expository verbal teaching necessarily leads to rotely memorized glib verbalisms. They commonly assert that regardless of cognitive maturity or subject-matter sophistication, knowledge can only be meaningfully acquired if students have current or recently prior concrete-empirical experience with the actual realities to which new ideas refer, if they acquire subverbal insight into these ideas and apply them in problem-solving situations *before* verbalizing them, and if they discover these insights autonomously.

David P. Ausubel ***is Professor of Education, Bureau of Educational Research, University of Illinois, Urbana.***

They insist, further, that problem solving and discovery methods must be the *chief* means of transmitting subject-matter content, even if considerations of time-cost render these methods less efficient than expository techniques—both because the resulting knowledge is invariably more meaningful, and because "more basic than the attainment of concepts is the ability to inquire and discover them autonomously" (p. 168).[1]

For these reasons it might be useful to define in some detail the psychological and educational indications and contraindications for discovery methods of teaching. What can learning by discovery reasonably hope to accomplish? When is its use feasible and unfeasible? For what age levels and degrees of subject-matter sophistication is it suitable?

Meaningfulness

Meaningfulness is perhaps the central issue underlying the learning by discovery controversy. However, reactionary critics of public education tend to regard this issue as merely a smokescreen for adulterating the curriculum with "soft" subject matter. "Give the prospective teacher sound academic training," they say, "and he will automatically be able to present subject matter meaningfully to students." Yet actually, subject-matter knowledge per se is only *potentially* meaningful. Such knowledge will only be learned meaningfully if the learning task can be related in nonarbitrary, substantive fashion to what the learner already knows, and if the learner adopts a corresponding learning set to do so.

It follows, therefore, that meaningful learning in students does not necessarily take place just because the teacher is academically knowledgeable. To relate a new abstract-verbal learning task to their existing knowledge in nonarbitrary, substantive fashion, students require an adequate repertoire of abstract terms and symbols based on previous concrete experience. They must also be sufficiently mature from a cognitive standpoint to carry out this operation without the benefit of current or recently prior concrete-empirical props. Furthermore, the new material will not be very meaningful unless they possess an adequate background of organizing, explanatory, and integrative concepts, and unless they can satisfactorily discriminate between new ideas in the learning task and previously learned propositions. Obviously, then, the problem of meaningful instruction can ignore neither the developmental status of the learner nor various substantive and programmatic aspects of presenting subject matter.

Thus it is true that much potentially meaningful knowledge taught by verbal exposition results in rotely memorized verbalisms. We can expect such rote outcomes whenever purely verbal techniques are prematurely used with cognitively immature pupils, when discrete facts are arbitrarily presented without any organizing or explanatory principles, and when new learning tasks are not integrated with previously acquired knowledge.

Contrary to the assertions of some discovery enthusiasts, however, these rote outcomes are not inherent in the expository method per se, but rather in such abuses of this method as fail to satisfy the criteria of meaningfulness. True, to be meaningful, expository teaching must take various developmental and pedagogic considerations into account. But

[1] J. R. Suchman. "Inquiry Training: Building Skills for Autonomous Discovery." *Merrill-Palmer Quarterly of Behavior and Development* 7: 148-69; 1961.

under no circumstances must one discover knowledge *by oneself* before it can be meaningful. Meaningfulness no more inheres in discovery than it does in the internal logic of subject matter.

Both expository *and* problem-solving techniques can be either rote or meaningful depending on the conditions under which learning occurs. Just like expository teaching, laboratory work and problem solving are not genuinely meaningful experiences unless they are built on a foundation of clearly understood concepts and principles, and unless the constituent operations are themselves meaningful. Performing laboratory experiments in cookbook fashion, or mechanically solving "type problems" and manipulating algebraic symbols obviously confers no more genuine understanding than does rote memorization of a teacher's lecture.

Presentation of Subject Matter

Generally speaking, problem-solving or discovery techniques are unnecessary and inappropriate for teaching subject-matter content, except when pupils are in the concrete stage of cognitive development. Even during this latter developmental period, these techniques can only be justified as an auxiliary and occasional means of presenting such content.

During the concrete stage, roughly covering the elementary school years, children are restricted by their dependence on concrete-empirical experience to a semi-abstract, intuitive understanding of abstract propositions. But even during these years, the act of discovery is not indispensable for intuitive (subverbal) understanding and need not constitute a routine part of pedagogic technique. The only essential condition for learning relational ideas during this period is the ready availability of current or recently prior concrete-empirical experience.

Thus, for teaching simple and relatively familiar new ideas, either verbal exposition accompanied by concrete-empirical props, or a semiautonomous type of discovery accelerated by the judicious use of prompts and hints, is adequate enough. When the new ideas to be learned are more difficult and unfamiliar, however, it is quite conceivable that autonomous inductive discovery enhances intuitive understanding. It presumably does this by bringing the student into more *intimate* contact both with the necessary concrete experience and with the actual operations of abstracting and generalizing from empirical data.

During the abstract stage of cognitive development, however, the psychological rationale for using discovery methods to teach subject-matter content is highly questionable. Students now form most new concepts and learn most new propositions by *directly* grasping higher-order relationships between abstractions. To do so meaningfully, they need no longer depend on current or recently prior concrete-empirical experience, and hence are able to by-pass completely the intuitive type of understanding reflective of such dependence. Through proper expository teaching they can proceed directly to a level of abstract understanding that is qualitatively superior to the intuitive level in terms of generality, clarity, precision, and explicitness. At this stage of development, therefore, it seems pointless to enhance intuitive understanding by using discovery techniques.

It is true, of course, that secondary school and older students can also profit sometimes from the use of concrete-empirical props and from discovery methods in learning subject-matter content on an intuitive basis. This is so because even generally mature students still tend to function at a relatively concrete level when confronted with a new subject-matter area in which they are yet totally unsophisticated. But since abstract cognitive functioning in this area is rapidly achieved with the attainment of a minimal degree of subject-matter sophistication, this approach to the teaching of course content need only be employed in the early stages of instruction.

From a practical standpoint, learning by discovery is unfeasible as a primary means of teaching subject-matter content because of the inordinate time-cost involved. It could only be justified on the grounds of psychological necessity or other unusual pedagogic advantages. But since discovery learning is never indispensable for meaningful learning and offers unique educational advantages only under the two special circumstances considered above, the time-cost factor becomes the dominant consideration. If secondary-school and university students were obliged to discover for themselves every fact and principle in the syllabus, simply on a time-cost basis they would not progress much beyond the rudiments of any discipline.

Another disadvantage of using a discovery approach for the transmission of subject-matter content is the fact that children are notoriously subjective in their evaluation of external events, and tend to jump to conclusions, to generalize on the basis of limited experience, and to consider only one aspect of a problem at a time. These tendencies increase further the time-cost of discovery learning in the transmission of knowledge. Moreover, children tend to interpret empirical experience in the light of prevailing folklore conceptions that are at variance with modern scientific theories. Lastly, one might reasonably ask how many students are sufficiently brilliant to discover everything they need to know. Most students of average ability can acquire a meaningful grasp of the theory of evolution and gravitation, but how many students can discover these ideas autonomously?

Discovery methods are primarily useful *not* for transmitting subject-matter content, but for evaluating meaningful learning outcomes and for teaching problem-solving techniques, appreciation of scientific method, and awareness of the sources of knowledge. To ascertain whether students genuinely understand or have merely memorized a given abstract proposition, there are few better methods than to require them to solve problems involving applications of that proposition.

Quite apart from its usefulness in evaluation, however, the enhancement of problem-solving ability as an end in itself is one of the most important objectives of education. Hence it is highly defensible to utilize a certain proportion of classroom time in developing appreciation of and facility in the use of scientific methods of inquiry and of other empirical, inductive and deductive problem-solving procedures. There is no better way of developing effective skills in hypothesis making and testing, "desirable attitudes toward learning and inquiry, toward guessing and hunches, toward the possibility of solving problems on one's own . . . , [and] attitudes about the ultimate orderliness of nature and a conviction that order can be discovered." [2]

[2] J. S. Bruner. *The Process of Education*. Cambridge: Harvard University Press, 1960. p. 20.

This is a far cry from advocating that the enhancement of problem-solving ability is the *major* function of the school. To acquire facility in problem solving and scientific method, it is also unnecessary for learners to rediscover *every* principle in the syllabus. Since problem-solving ability is itself transferable, at least within a given subject-matter field, facility gained in independently formulating and applying one generalization is transferable to other problem areas in the same discipline. Furthermore, overemphasis on developing problem-solving ability would ultimately defeat its own ends. Because of its time-consuming features, this would leave students with insufficient time in which to learn the content of a discipline; and hence, despite their adeptness at problem solving, they would be unable to solve simple problems involving the application of such content. Knowledgeability, in other words, is a necessary although not a sufficient condition for successful problem solving.

One of the more fashionable movements in curriculum theory today is an attempt to enhance the critical thinking ability of pupils apart from any systematic consideration of subject-matter content. An entire course of study is pursued in which pupils perform or consider an unrelated series of experiments in depth, and then concentrate solely on the inquiry process itself rather than on this process as it is related to the acquisition of an organized body of knowledge.[3] A major difficulty with this approach, apart from the fact that it fails to promote the orderly, sequential structure of knowledge, is that critical thinking ability can only be improved within the context of a specific discipline. Countless research studies have confirmed the proposition that grand strategies of inquiry, discovery, or logical analysis are not transferable across disciplinary lines. Also, it hardly seems plausible that a strategy of inquiry, which must necessarily be broad enough to be applicable to a wide range of disciplines and problems, can ever have, at the same time, sufficient particular relevance to be helpful in the solution of the specific problem at hand.

A second significant difficulty with this latter approach is that its proponents tend to confuse the goals of the scientist with the goals of the science student. They assert that these objectives are identical, and hence that students can learn most effectively by enacting the role of junior scientist. Actually, however, the scientist is engaged in a full-time search for new general or applied principles in his field, whereas the student is primarily engaged in an effort to learn the basic subject matter in this field, as well as something of the method and spirit of scientific inquiry.

> Thus, while it makes perfectly good sense for the scientist to work full-time formulating and testing new hypotheses, it is quite indefensible for the student to be doing the same thing. . . . Most of the student's time should be taken up with appropriate expository learning, and the remainder devoted to sampling the flavor and techniques of scientific method. It is the scientist's business to formulate unifying explanatory principles in science. It is the student's business to learn these principles as meaningfully and critically as possible, and then, after his background is adequate, to try to improve on them if he can. If he is ever to discover, he must first learn; and he cannot learn adequately by pretending he is a junior scientist. (p. 39-39)[4]

[3] See, for example, Suchman, *op. cit.*

[4] David P. Ausubel. "Learning by Discovery: Rationale and Mystique." *Bulletin of the National Association of Secondary-School Principals* 45: 18-58; 1961.