

and educational philosophy. One of the beliefs most commonly shared by scientists is that application of rational thought will lead to human progress. This theme has been a *leitmotif* in our conference. This is very natural, for, as research scientists and psychologists, this is a necessary part of our value system—necessary in order that we engage ourselves in research effectively. As we have talked about learning by discovery, we have implied that this method of learning will necessarily lead people to rational decisions and better lives. Is this, however, any more of a panacea than any other educational method? Educational statistics show higher percentages of age groups in high-school and college. More people than ever before are being exposed to education. Good, bad, or indifferent, I suspect that increased education increases rationality, the ability to be critical, and the ability to learn by discovery. I wonder, however, if this education is inclining people to build a better society. Do people make the right choices? As Kagan asked, Have we made the value commitments that lead students to the right choices? Do they learn about the good and the beautiful and things of enduring value, or do they discover things of less worth? No education is value-free, and a commitment to rational discovery as a method of learning may ignore issues that we cannot afford to turn aside.

Chapter XV

The Problem of Discovery: Conference in Retrospect

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THE CONTROVERSY OVER LEARNING BY DISCOVERY EXISTS SIMULTANEOUSLY at a number of levels. These levels include those of classroom instruction, curriculum development, psychological studies of learning, and research strategy. Hence, in order to deal with this issue in some meaningful fashion, it becomes necessary to distinguish among these levels of discourse and to specify at which level we are operating at any given moment.

At the level of classroom instruction, the question to be studied is, As I teach Johnny, should I give him a wide variety of examples and expect him to infer the underlying rule, or should I tell him what the rule is while he applies it to examples?

At the level of curriculum development, the question involves something like the following: To what extent ought the order of subjects into which the students inquire be determined by us, and to what extent should this order be determined by the students themselves?

At the level of psychological investigations of learning, the question becomes, What is the transfer value of statements of principles given to a subject, as contrasted with individually-derived principles?

At the level of research strategy, the issue takes on a very different, yet parallel form: What is the most fruitful way to investigate the nature of instruction?

It is the purpose of this chapter to reexamine the contributions of the conference members within the framework just described. One of the difficulties is that the participants tended to shift back and forth among levels. We will thus distinguish among the levels of discourse implicitly or explicitly utilized by contributors, and will examine the extent to which consensus or disagreement resulted. We will also attempt to outline the important questions, as we see them, remaining at

each of these levels. Thus, though this chapter is, in fact, a view of the conference in retrospect, it might also be seen as a prospectus for further dialogues.

THE LEVEL OF CLASSROOM INSTRUCTION

When we explore the meaning of the learning-by-discovery issue for classroom teachers, we need to ask what the statements on this question will lead teachers to do. Sentences which are worded in the form of clear specific suggestions are likely to elicit greater uniformity in teacher practice than statements where the referents are unclear. However, since teachers relate to their pupils in a highly complex fashion, even phrases which have vague denotations may have profound and varied effects on teaching styles. Instructions such as Help the child to discover the solutions by himself, might lead some teachers to undertake a most productive lesson; conversely, this same statement might lead other teachers, with the best of intentions, to let many pupils flounder entirely too long.

When the assertion was made at the conference that research studies had not yet produced evidence to support the hypothesis of learning by discovery, concern was expressed that the publication of this statement could have ill effects on teacher behavior. It was hinted that some teachers might go back to a learning-by-rote approach to teaching if it were implied that learning by discovery had been discredited. While no one at the conference perceived the issue in terms of this dichotomy, the importance of examining the kind of statements made to teachers cannot be ignored.

One way of posing the issue, therefore, is in terms of teacher behavior: How much and what kind of guidance should the teacher provide? Attempts to offer answers to this question have usually been expressed at a common-sense level, such as that found in the following selections from *Theory and Practice of Teaching*:

It is always a very difficult question for the teacher to settle, 'How far shall I help the pupil and how far shall the pupil be required to help himself?' . . . That the pupil should be taught mainly to depend on his own resources . . . is the teaching of common sense. Whatever is learned, should be so thoroughly learned, that the next and higher step may be comparatively easy. And the teacher should always inquire, when he is about to dismiss one subject, whether the class understands it so well that they can go on to the next. He may, indeed, sometimes give a word of suggestion during the preparation of a lesson, and by a

seasonable hint, save the scholar the needless loss of much time. But it is a very greater evil if the pupils acquire the habit of running to the teacher as soon as a slight difficulty presents itself, to request him to remove it. . . . The inquirer should never be frowned upon; this will diminish his self-reliance without enlightening him; for whatever is done for a scholar without his having studied closely upon it himself, makes but a feeble impression upon him, and is soon forgotten. The true way is, neither to discourage inquiry nor answer the question. Converse with the scholar a little as to the principles involved in the question; refer him to principles which he has before learned, or has now lost sight of; perhaps call his attention to some rule or explanation before given to the class; go just so far as to enlighten him a little and put him on the scent, then leave him to achieve the victory himself (Page, 1885).

This excerpt, first written in 1847, dramatizes how little what is said to the average classroom teacher has changed over the past century. The quotation might easily have been taken from an article written for teachers today.

How did the conference deal with this problem of specifying the nature and amount of guidance to be supplied by the classroom teacher? There was general agreement among the conference participants that the degree of guidance by the teacher varies from time to time along a continuum, with almost complete direction of what the pupil must do at one extreme to practically no direction at the other. This was illustrated in both of the examples of teaching presented by Cronbach and Davis. We may here add a third illustration. A teacher introduces a group of students to a totally new subject-matter area, for example, surveying, simply by arranging a wide variety of materials such as instruments, maps, and so forth, across the classroom. There is no overt guidance here from the teacher in the form of clear-cut distinctions between correct and incorrect student responses. Hence, there is little probability of behavior that could be called 'error' on the part of the students.

Subsequently, the teacher might shift to a second phase wherein she provides almost full guidance for the students. They are given very careful practice in using the surveying instruments and in recording their observations. After they have acquired some of the basic skills, the teacher might demonstrate how certain kinds of problems are handled in surveying flat land. When the students have understood some of these possible applications, she then poses the question of surveying other types of terrain. Students would be expected to arrive at a number

of possible solutions to these general questions with little guidance from the teacher.

As the class progresses, the teacher may thus provide sometimes more and sometimes less guidance, depending on her objectives and the performance of the students. Here, in a period of a few days, a teacher may have manifested behavior that ranged from little guidance to full guidance and it would seem patently absurd in this context to ask the question of which degree of guidance was best. This question can only be asked in terms of the specific situation in which a decision about guidance must be made. Clearly, it is more relevant to ask, specifically, Given the subject matter, the kind of students in the class, the objectives to be attained, and what the students have previously learned, what kind and how much guidance is best?

The conference brought out the distinction between what the teacher might do during a given lesson when she, for example, is helping the students to induce a rule, and what she might do during the days and weeks and months prior to that event to prepare the students to profit from this learning experience. The period of preparation, for Hawkins, would involve experiences of exploration during which a student learned the lay of the land for the subject to be mastered. It would require teacher planning, selection, and arrangement of materials, so that related objects could be seen together and compared by the learner. This form of guidance does differ from guided instruction with respect to the scope of sequential decisions left to the students and to the student's perception of the extent to which he is being directed. For example, the student makes his own decisions on such questions as, What should I look at first?

While this period of antecedent criss-crossing of a field may be considered as undirected by the teacher, it depends upon careful teacher planning and is as profound in its effects as directed instruction. For example, the teacher should thoughtfully arrange the materials in a classroom so that the exploration is likely to be most profitable. What the student will look at first may be determined, for example, by placing the object to be noted in an eye-catching location. While the student is clearly making his own decisions in these explorations, the range of alternatives available to him has been somewhat constrained and directed by the teacher's preparation of the situation.

In his paper, Bruner suggested six ways in which teachers may prepare pupils for discovery. He would include such devices as having pupils learn strategies and heuristics for attacking problems, teaching them to select and use information, helping them make full use of their

own self-cues, and cultivating appropriate motives. So prepared, children would not have to resort to blind trial-and-error in order to discover. Teachers' guidance would also involve helping children locate and master the essential information they need; no one suggests that children should discover all facts anew.

Is it possible to prepare a student to learn by discovery, using a direct program of guidance? A sequence of learning activities, based on an hierarchical analysis of the task, might be highly effective by assuring competency in the prerequisite abilities for the inductive experience. Gagné reported one study to support such a possibility but the evidence still is fragmentary.

What can be said about the particular lesson in which a teacher expects her pupils to learn inductively? The guidance she provides at this point can take many different forms. She may set the stage for the desired behavior by posing a problem, revealing a paradox, or directing the learner's attention to a problem-filled situation. She may need to supply broad general instructions to direct the learner's attention somewhat more appropriately. She will, presumably, have structured the environment so that the student will obtain relevant information as a consequence of his own efforts. She may even provide general hints or indirect clues affording further guidance; but she does not, of course, provide the solution directly. It is thus clear that there are many dimensions along which the amount of guidance may be considered.

The conference also examined the dilemma of meeting individual differences when the inductive teaching method is used with a group. If the questions are posed for group discussion, the most competent pupils in the class are likely to make all of the discoveries. It was pointed out that in such a class situation there is heightened activity on the part of all members because of competition, demand for social approval, and so forth. A critical question involves what is learned by that large portion of the class which does not participate actively but simply listens to the few discoverers. Is their learning indistinguishable from that of students who have been taught the same material didactically? Is there some additional advantage to having been a participant, albeit vicariously, in an inductive learning experience? These are pivotal questions in the learning-by-discovery controversy which appear quite amenable to empirical study.

How can the teacher tell whether she has provided the right amount and kind of guidance during a lesson? One alternative is to ask herself, Has the student discovered? and proceed to get evidence as to whether or not the act of discovery has occurred. On the other

hand, she may turn her attention directly to the outcomes of the experience and ask whether students demonstrate new abilities and values without reference to the hidden act of discovery. In either case, she must ultimately see if the learner is now able to deal effectively with a broader class of problems as a consequence of her instruction. The teacher may or may not find it helpful to use the language of discovery for this purpose.

Whether one chooses to talk about the effects of guidance in terms of an inferred internal act or its observable consequences is a reflection of one's point-of-view about instructional goals. In the former case, it is assumed that the inferred, covert event of 'discovery' is to be sought, in and of itself, as a major objective. In the second case, the observable outcomes are the primary criteria; less attention is paid to the intervening events. Which way is best? This question is a reflection of the issue of 'process' versus 'product,' and will be examined in the following section.

In any event, two conclusions for classroom instruction are clear: (1) There is no useful way of posing a broad question regarding how much and what kind of guidance the teacher should supply. The question should always be formulated for a specific context including the type of subject, the maturity of the pupils, prior learning experiences and so on. (2) Regardless of which way of talking about learning by discovery is adopted, no single teaching method is likely to accomplish the wide range of cognitive and affective objectives discussed at the conference.

THE LEVEL OF CURRICULUM DEVELOPMENT

At the level of curriculum, two kinds of decisions are made. One deals with the 'oughts' of education: What objectives do we choose as the goals of our teaching? The other decision reflects the general organization and patterning of subject areas and topics, 'scope and sequence,' in the language of the curriculum-writers: How do we organize a subject matter and identify the order in which it is taught?

At the conference, the questions which dealt with the identification of goals for education took two forms: (1) What is the role of the psychologist in making value judgments which influence the activity of educational institutions? (2) What form is most appropriate for the statement of educational objectives?

The first of these two questions created more consternation than possibly any other raised at the conference. It was generally agreed that psychology is a science which deals with the description, prediction,

and, ultimately, control of human behavior. Does this then provide the psychologist with uniquely relevant insights concerning the most fruitful directions in which to modify that behavior? Participants seemed to divide into three camps. Some felt that, as scientists of human behavior, they are obliged to extrapolate their understanding into objectives for education. Others felt that, considerations of psychology aside, they have this obligation as individual private citizens who happen to be psychologists. A third group reflected the position that psychologists must actively avoid involving themselves in such controversies, because of the necessity for continually emphasizing that science deals with the description of nature and not with the manner in which it ought to be modified. This was a deep-seated disagreement for which no hint of resolution was forthcoming at the conference.

On the second question, the form in which objectives must be stated, discussions were somewhat more fruitful. Concerning the topic, the arguments pivoted around the question of whether statements of educational objectives ought to be made in operational terms which identify in detail the behaviors to be acquired. On those occasions when clear-cut descriptions of desired behaviors have been employed, psychologists have often been successful in producing the desired outcomes. Yet, to some participants, the notion of discovery in learning connoted the very antithesis of such behavioral control. Discovery implies diversity; teaching for specified objectives suggests conformity to a model. Discovery implies novelty and unpredictability; instruction for predetermined goals suggests imitation and constraint. At times, these participants seemed to be defining themselves out of business. They implied that true discovery behavior cannot be defined *a priori*, or it is not discovery. Their goal was to 'open up' the pupil, and they maintained that attempts to define this outcome behaviorally constrain the young scholar. Yet, the dual function of stated objectives is to suggest courses of action on the one hand, and, on the other, to provide a set of standards for evaluating the consequences of action. If one's goal statements are not specific and subject to subsequent evaluation, how do they differ from a vague poetic set of pious pronouncements?

As we read between the lines of controversy, one possible interpretation emerges. A good deal of what semanticists call 'bypassing' was occurring in these dialogues. Participants disagreed to a great extent because they were focusing on different aspects of learning behavior. Those favoring goal-directed teaching were concerned with 'what' questions—What is to be learned, and What methods are most appropriate to that end? Those favoring open-ended teaching were also concerned

with what is to be learned, but they give a higher priority to the question, of How is it to be learned? In many ways, the old distinction between process and product in psychology is reflected in these disagreements. At present, and for the foreseeable future, psychologists can make far more precise and communicable statements about product variables and their control than they can about the more ephemeral range of intervening process variables. We simply lack a reliable language for discussing processes, and the ambiguity of the term discovery as a process-referent is a case in point. Does open-endedness deny the importance of clear-cut objectives? We doubt it. On the other hand, does goal-directedness imply that openness and autonomy are unacceptable human goals? Probably not. The emphasis is simply upon the present inaccessibility of such constructs to scientific explication and investigation.

Those supporting open-ended teaching correctly insist that psychologists attend to the multi-level complexity of the learning process, i.e., that the child who learns a new concept is simultaneously, if incidentally, learning ways to understand future concepts, ideas about the stability or tentativeness of concepts in general, as well as some perceptions about himself as a conceiver. Yet, in focusing upon these important processes, they too often ignore or pay too little attention to the specific learning task from which the others are derived. We not only wish students to discover as an end in itself; we wish them to discover something which will contribute to their further growth, and thus serve as a basis for new learning.

Participants favoring goal-directed teaching were accused of saying, If you can't measure it, don't try to teach it. It appears likely that some participants, while rejecting such a statement, in practice reflect the narrowness implied by the comment; they give little attention to broadening the range of outcomes measured in education. While progress in bringing 'fuzzy' goals within the purview of measurement will not alter the basic issue, at the practical level it can alter the importance given to it.

We may now move briefly to the questions of scope and sequence in the curriculum. By overemphasis upon the process of discovery, one group of participants tended to denigrate the engineering of learning, i.e., the careful planning of sequences of activities through which students will attain desired objectives. Hawkins called attention to Tolman's finding that rats presumably benefit from unreinforced and, hence, undirected, exploration. In contrast, those who speak in terms of the careful planning or programming of learning sequences seem to

ignore the possible educative consequences of relatively unguided exploratory activity.

We would direct both groups to the wisdom of Dewey's *Experience and Education*. The first position reflects the folly of Progressive Education (as distinct from progressive) which sacrificed necessary experience to momentary experiencing. The second position resembles Traditional Education (again in Dewey's sense) which used the subject-matter to be learned as the starting point and too often treated the pupil as a learning machine.

The different emphases on process and product may be seen in another light. Those who favored stressing the act of discovery did not regard such events necessarily to be beyond the scope of evaluation in terms of outcomes. They objected to the premature application of external criteria to such a method. This point of view essentially was saying, Let us focus our attention on how to teach children to discover more effectively as a way of learning; later on we can find out the relationship between this process of learning and overall outcomes. To some extent, but probably not entirely, the disagreement reflected a difference in strategy, rather than a fundamental divergence in value systems.

Another way in which the curriculum problem has been posed is whether the activities of students studying a subject matter ought to parallel the activities of the practitioners of the discipline themselves or whether the learning of a subject content, e.g., physics, demands a structure quite different from that of the discipline qua object of inquiry. The implication is that the activity of scientists is discovery, in contrast to the traditional activity of students, reception learning. This, however, is much too facile, and resembles a verbalism more than a viable distinction.

Quite clearly, scientists do not spend all their time discovering. They exhibit a broad range of activities, from hypothesis-generation and model-building to listening to lectures and reading journal articles reporting someone else's research. Hence, justification of curriculum development which stresses inductive teaching on the grounds that induction is the *sine qua non* of scientific behavior is a half-truth, at best. Scientists do discover, it is true. That they also engage in a wealth of additional activities is also true. That many of these are didactic or receptive in nature is apparent. It is further clear that whether a scientist induces, deduces, plays hunches, or looks up answers in trade books, is contingent not upon the values of those processes in themselves, but on what he intends to accomplish in a given situation. If one wishes to emphasize the analogy of the scientist to the student, one

cannot ignore that in science, decisions about means are dictated by goals.

What then can be said about the issue of learning by discovery and the area of curriculum development? First, unless some consensus can be reached about the statement of objectives, there is little reason to continue dialogues regarding methods of teaching. The question of the superiority of one curriculum method over another is moot if the objectives of each are stated in mutually incompatible terms. One approach would be the extension of present efforts in educational measurement to develop procedures which assess far more complex behaviors than has been done up to now. We need more adequate measures of the kinds of outcomes in Cronbach's list, such as 'creative urge,' and 'openness.' As long as our present objective criteria are deemed utterly inadequate, debate concerning the general question of process versus product will remain clouded.

Second, process and product variables are not inexorably labeled as such, but are definable only in terms of the other variables to which they are referred. Thus, problem-solving can be a process variable in one context and a product variable in another.

Third, the activities of scientists vary too greatly from day to day and man to man to be used as the model justifying any single curricular strategy based on discovery.

Fourth, a curriculum refers to the organization and sequence of a subject matter in which statements about that subject, methods of teaching, and the activities of the learners are intricately interrelated to form a single entity. Research at this level, as distinct from the level of specific acts of instruction or general psychological processes, should include the study of the consequences of the curriculum as a whole. The effects of a particular segment of a curriculum may be quite different *in vivo* than they are when studied in isolation from the rest of that curriculum. If research is to be relevant to curriculum development and evaluation, the research must be conducted at the same level of abstraction as are the decision-alternatives which confront the curriculum workers. This does not exclude the possibility of using such overall evaluation in a diagnostic sense, to throw light, for example, on those aspects of the curriculum which need improvement. But the issue of learning by discovery will not be adequately assessed until we can obtain a broad evaluative base to assess the effectiveness of the curriculum.

THE LEVEL OF PSYCHOLOGICAL INVESTIGATIONS OF LEARNING

One of the major questions posed for this conference was the following: What conclusions can be drawn from the research evidence to date regarding the effectiveness of the method of learning by discovery?

Examination of both the exhaustive reviews of the literature and deliberations of the conference lead to an inescapable conclusion: The question as stated is not amenable to research solutions because the implied experimental treatment, the discovery method, is far too ambiguous and imprecise to be used meaningfully in an experimental investigation. Where investigators have spelled out learning by discovery in terms of a set of educational procedures, the results have been equivocal. For example, there is no evidence that supports the proposition that having students encounter a series of examples of a generalization and then requiring them to induce the rule is superior to teaching the rule first and asking the students to apply it to a wide variety of examples.

Wittrock's review indicated that research has not yet done justice to the magnitude and complexity of the problem. One basic difficulty is that of precise description of procedures. Studies purportedly designed to assess this question have used the same term to apply to a wide variety of instructional activities. In some experiments the name 'rote learning' is applied to a treatment which other investigations call 'discovery.' Unfortunately, not enough information is supplied to enable the reader to identify the precise procedures under either label.

Instead of debating whether or not to call a treatment by the label 'discovery,' we should insist that published reports include a clear description of the events which comprise the treatment or lesson, as well as a few typical examples of each of the instructional procedures being contrasted. In some studies, a complete record might be made available in the form of a program, a tapescript, a film, or a typed record which would be available on request. When such details are available to experimenters, reanalysis and replication of studies is possible. For example, the conference members generally agreed that the filmed demonstration lesson shown by Davis was excellent group teaching, even though the interpretations of what was happening in those filmed lessons differed widely.

A fundamental question from which much of this disagreement derived was related to the nature and the role of unobservable mediating events in learning. The participants who treated discovery as an internal event considered it to be different from the processes that characterize reception or didactic learning. How can one know when such

a covert act of discovery has occurred? This hidden event is always an inference based on several kinds of evidence, among which the following are minimal criteria:

1) Although the learner may have access to a good deal of information prior to solving a problem, the identification of the solutions themselves must never be part of the information he is given.

2) The learner must be able to generalize the solution to other situations. If no such transfer is evident, the successful first solution is considered an accident and not a discovery.

There were four different approaches represented at the conference, differing with respect to the value of internal events, the use of the word 'discovery' to apply to these events, and the importance of the act of discovery as a goal.

The first group of participants discarded the whole issue of covert mediational mechanisms as having no practical relevance. They maintained the researcher should focus directly on the relationship between the environmental changes a teacher introduces (the input variable) and what a student consequently learns to do (the output variable); the language of mediation is excess baggage.

Most of the participants in the conference, however, took the position that a discussion of mediating mechanisms is necessary for any fruitful investigation of learning by discovery. Of this number, a second group felt that the mediating mechanisms of language play a central role in the educational process. In his reflections on the conference, Kendler regretted that greater attention had not been given to a discussion of language. He felt that investigators should study the ways in which students can be helped to incorporate new experiences into preexisting linguistic structures so as to produce optimal learning in subsequent situations. Thus, the second group recognized the value of talking about internal events, but felt that this could be done more efficiently if the centrality of language for these mediating processes were emphasized.

A third group, represented by Gagné, used the term, 'discovery', in an exceedingly broad sense. Gagné maintained that a learner is discovering if he is engaged in any process involving search and selection. This would include the acquisition of many motor skills (such as learning to hit a golf ball), simple verbal learning (such as paired-associates, for which appropriate mediators might be found), as well as more complex verbal learning (such as concept formation, or the derivation of rules for solving various classes of problems).

A fourth group of participants limited the use of the word dis-

covery to cognitive areas of learning. Some members of this group saw the critical process as one wherein the student by himself sought a match between models he had stored in his own head and objects, sets of objects, or events experienced about him. This process could be seen as operating at different levels of discovery. Finding a stored model to fit the problem event exactly, e.g., seeing that all words in an anagram task were coded by being written backwards, was an example of a little-d discovery. On the other hand, big-D discoveries were involved in cases where the stored models themselves had to be restructured or recombined in order to make a fit, as might be the case when a student constructs a general principle under which he can subsume and integrate a series of isolated rules previously learned in a somewhat mechanical fashion.

For this last group, the internal process of search and selection, this act of discovery, was seen as the essence of what the student is learning. Bruner, for example, was more concerned with devising procedures to foster this act of discovery than he was with evaluating the valuable consequences of the act itself. Such evaluation, he felt, could come later. It is this emphasis on the act of discovery, per se, which distinguishes the fourth group from the other three. For the rest of the participants, regardless of how they differed concerning the value of talking about mediating mechanisms, there was greater interest in measurable progress with respect to educational outcomes.

The conference gave some attention to the frameworks within which research on this topic might proceed. There was disagreement, however, regarding the usefulness of psychological theory as a basis for deriving questions and launching new studies. Several participants felt that psychological concepts and tools were ill-suited for the complexities of classroom endeavors, and Hawkins suggested that the practitioner's common-sense way of talking might be more valuable than scientific language. On the other hand, as we noted earlier, Kendler and others emphasized that more precise terms are exactly what we need.

A large number of promising suggestions for future research were presented during the conference. The previous papers have described in detail these proposed directions. In particular, both the critical reviews of Wittrock and Cronbach offered specific as well as general suggestions for the improvement of research investigations concerning this problem. Cronbach, for example, advocated focusing on a narrow problem under limited circumstances with a well-defined population rather than attempting definitive tests of the overall hypothesis of

learning by discovery. Other suggestions involved important features of experimental design such as the use of multiple criteria as dependent variables, the handling of the problem of time differences in instructional treatments, and the disposition of subjects who fail to discover. Research studies were generally criticized for failing to pose questions relevant to education. It was suggested that investigators should pay greater attention to tasks growing out of classroom learning situations.

Participants suggested other possible approaches to this research area such as the application of information theory, mathematical models, and computer simulation. Research in education might also be seen as an engineering task, involving, tryout, revision, and evaluation, until an adequate educational program has been developed.

Another promising approach, with implications for the issues of the conference, is the development of computer-based instruction. Because of the flexibility continuously afforded during instruction, the use of such a research program permits the presentation of task and guidance in almost any way desired. It is possible, therefore, to study, under controlled situations, a wide diversity of sequences to answer questions involving instructional decisions concerning the amount and kind of help teachers should offer.

At the level of psychological investigations of learning, the discussions of the conference reflected an underlying parallel between statements made about the process of education and pronouncements by the same individuals about the process of scientific inquiry. It appeared that often the image of what constitutes the most fruitful approach to teaching was a reflection of the same participants' position concerning the best kind of research strategy for scientific investigation. Quite clearly, adjective pairs such as controlled-open, precise-global and logical-intuitive are equally applicable within the domains of both research and instruction. Hence, the two questions of, How should the teaching of a given subject be conducted? and How should research on teaching be conducted? were inexorably interwoven.

Those who took the position that the best kind of teaching opened up the child and insisted that the demand for operational statements of objectives was instructionally constricting, took a similar position with reference to the practice of research. They advocated the discarding, or at least the temporary suspension, of the classical hypothesis testing model of experimental psychology and recommended in its place a more general exploratory approach to the problems. They have usually found their research approaches most fruitful when applied

to forms of human behavior that are difficult to identify reliably and measure accurately, and their formulations concerning education have tended to reflect the degree of precision that is typical of their objects of research.

In contrast, those who maintained that the best instruction occurs when objectives are carefully specified also felt that systematic experimental studies with precisely stated goals and procedures showed the most promise leading to knowledge about teaching. Those with this goal-directed research orientation have been most successful in dealing with situations where the individual parameters can be reliably identified and systematically varied. Hence, in studying educational problems, they too have been drawn to those situations which best fit their own model. As Dewey observed repeatedly, the processes of education and of scientific inquiry are remarkably similar. It should be no surprise that men are found to hold parallel positions about the 'best' form of each activity. It is to a consideration of these strategies of inquiry that we now turn.

THE LEVEL OF RESEARCH STRATEGY

There is an oft-related story of the drunk who was crawling on his hands and knees under a lamppost when he was accosted by a policeman. The policeman asked the drunk what he was doing. "Looking for my wallet," was the drunk's reply. The policeman offered to help him find his wallet and asked him where he had lost it. The drunk thought for a moment and answered "About half a block down, in the alley." The policeman asked, with a mixture of curiosity and sarcasm, "Why in the world don't you look for your wallet where you lost it?" The drunk quickly responded, "It's much too dark to look for it there."

Controversies over research strategies reflect much of this drunk's dilemma. Do we look where the visibility is good, but where the probability of finding what we seek is low; or do we venture forth into the dark where the answers frequently lie, but probably in some form so obscured by their surroundings that they will not be visible to us?

The problem of strategy may be posed in the following fashion: Is it better to begin a research program by asking highly limited questions in an area where precise answers are possible, and then gradually extend the scope of inquiry so that ultimately precise answers are possible to broad questions? Or is it better to start by posing general questions which, although loosely formulated, deal with a large section of the field, and subsequently to attempt to increase the precision of the statements made?

It is unfortunate that precision and generality, both important research goals, are usually incompatible. If a line of research deals with a series of closely related but precise experiments, inevitably the scope must be restricted. The experimenter's findings, although precise, may well be irrelevant with respect to many interesting problems. Hopefully, of course, the researcher will gradually, in a small-step program of development, extend his sphere of precise description and control to include more and more general questions.

On the other hand, a research strategy which deals broadly and comprehensively with issues in a field may produce statements which appear to be relevant to important issues; however, these generalizations are so lacking in definition that they are of no greater value than the gross over-extrapolations obtained under the first strategy. Here the need is to make the vague formulations more precise so that statements made about a large class of phenomena are more meaningful.

Thus, the dilemma remains. The strategy of beginning with narrowly focused and well controlled studies may not yield the expected base for broadening the scope. Yet, the findings of the global approach may be so inadequate to cope with the problems posed that the researcher finds himself able to state only tenuous formulations which he offers hopefully to others as a general guide.

But there is another alternative. Cronbach has suggested that perhaps an intermediate strategy is desirable. First, the tasks used for the experiments would represent the mastery of some phase of the subjects actually being taught in the school. Second, the duration of the instructional treatment would be long enough to produce cumulative learnings, without becoming so long as to be unwieldy and undefinable; experiments lasting two to twenty weeks might provide an appropriate compromise. As has been previously suggested (Keislar and Mace, 1965), generalizing from a two-month experiment to a two-year curriculum may involve over-extrapolation but at least it seems more reasonable than to base one's judgment on data collected from a 50 minute laboratory session on the same problem.

Third, with an experimental treatment a few weeks in length, it is possible to use standardized instruction, carefully prepared lessons which are manageable in terms of time and money. Under such controlled conditions, the problems of teacher variability and adequate monitoring of instructional events are minimized. Fourth, where instructional treatments last for many weeks, the total testing time can be increased to permit the assessment of a wide diversity of outcomes which may take several sessions for testing alone.

It is always satisfying to recommend a golden mean as the solution to a confrontation of opposites. The middle way has time and again demonstrated its durability in a wide range of circumstances and over a broad array of controversies. There is yet another form of middle way, which can be identified by using Schwab's (1960) term, the "grand strategy."

Since different approaches to research in themselves can highlight only parts of a total object of inquiry, a possibility could be, in Schwab's words, "that some particular order of different strategies, constituting a grand strategy, may be better than all other orders." That is, instead of committing himself to a single orientation, whether polar or intermediate in our framework, the investigator would shift among strategies as he reformulated his questions and refocused his inquiry. Thus, for example, it is not uncommon for psychologists to combine correlational, descriptive, and experimental designs into the same program of research. Similarly, the investigator might pose his research questions in a sequence of different ways, very much like the teacher who utilizes different instructional procedures.

The grand strategy is probably best reflected in the history of psychological studies of learning. Individual investigations, growing out of contrasting or conflicting orientations, reflect a long-term dialectic of strategies. As one set of approaches has asserted its superiority for dealing with some psychological issue, some other group has inevitably proposed an alternative to it. Frequently, these confrontations have fostered productive restatements of important issues. Yet, the resulting rhetoric of claim and counter-claim has too often led to an unfortunate overemphasis upon differences in theory, leading to research involving the examination of otherwise trivial problems. The advantage of a grand strategy for an individual worker is that he may be able to retain the flexibility of alternating among strategies while avoiding the pitfalls of conflict among them.¹

However, such a broad approach may require the coordinated efforts of a group of specialists; few individual investigators are likely to possess the temperament and the diversity of high-level skills required. The currently rapid growth of centers of research in education

¹ The authors of this chapter are fully aware that the positing of these intermediate and grand strategies does not exhaust the range of alternatives available. As participants in the conference themselves, they can lay no greater claim to omniscience than any other participants. It was, in fact, with some amusement that they simultaneously recognized that the two solution strategies outlined above represented extensions of their respective research styles.

may foster the development of research programs which reflect such grand strategies. Yet, the frequent emphasis upon *interdisciplinary* research in these settings, though clearly not objectionable in themselves, may obscure an important alternative. There is great value in gathering together members of the same discipline who reflect highly contrasting investigatory styles, thus constituting an *intradisciplinary* research approach. In this way, the development of centers of research may encourage a continuing dialogue among advocates of various strategies and thus permit a fruitful restatement of a question in the early stages of a research enterprise before conflicting points of view become vested interests.

THE STATE OF THE ISSUE

This volume has attempted, from many vantage points, to deal with a major issue in education and psychology. We have described the past history of the issue and its present status. What lies ahead for the controversy over learning by discovery?

John Dewey (1910a), in his essay on "The Influence of Darwinism on Philosophy," wrote:

. . . the conviction persists—though history shows it to be a hallucination— that all the questions that the human mind has asked are questions that can be answered in terms of the alternatives that the questions themselves present. But in fact, intellectual progress usually occurs through sheer abandonment of questions together with both of the alternatives they assume—an abandonment that results from their decreasing vitality and a change of urgent interest. We do not solve them: We get over them. Old questions are solved by disappearing, evaporating, while new questions corresponding to the changed attitude of endeavor and preference take their place.

Dewey maintained that controversies are resolved through redefinition and reformulation, rather than through victory of one side over another. We have seen in this volume a recurrent call for this very kind of reformulation of the present issue. Throughout the history of psychology, similar issues have arisen and, though not resolved in the same terms in which they were set, have nevertheless disappeared. Such questions have included nature versus nurture, insight versus trial-and-error and imageless versus image-full thinking; in not too many years, we will probably add to that list such burning questions as incremental versus all-or-none learning and learning by discovery versus guided learning.

Dewey has observed that "old ideas give way slowly, for they are more than abstract logical forms and categories. They are habits, predispositions, deeply engrained attitudes of aversion and preference." This is particularly true of the terms in which we couch those compelling controversies of which this volume is characteristic. These terms have become part of the 'familiar furniture of the mind,' and the resolution of the issue lies not in the moving of this furniture about, but in refurbishing with new terms, and perhaps, coming up with new oppositions.

It is the hope of the authors of this chapter that a highlighting of the terms of the controversy will hasten the process of reformulation rather than impede it.