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Although the study of learning theory can produce principles applicable to the design of instruction, virtually no instructional materials in existence today have deliberately been prepared on the basis of such principles. Terms used in four different learning theories--motivation, (Neal Miller); stimulus control (Skinner); distinctive conditions and cumulative learning (Gagne); and subsumption (Ausubel)--suggest specific principles of learning. A general principle emerging from modern learning studies is that learning is an individual matter, in which essential idiosyncratic elements must be supplied by the learner himself. In applying these principles to the choice and use of media, an analysis of the events of instruction is required. These involve gaining and controlling attention; stimulating recall; guiding or cueing the learning; providing feedback; arranging for remembering; and assessing the final outcomes. No single medium is likely to be best fitted to perform all of these various functions. An arrangement involving combinations of media may hold the key to effective instruction and efficient media use, particularly where the individual establishes a large part of the learning conditions for himself. (PM)

Media and the Learning Process.

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(Presentation to the First General Session,
DAVI Conference, Houston, Texas, March 25, 1968)

I am most pleased and honored to have the opportunity of addressing this First General Session of your convention.

Audio and visual media are used in the schools, in industry, and by many other organizations of our society, to facilitate the process of learning. If we were living in that simpler age of long ago, all of the knowledge required by an effective adult person could perhaps be transmitted by word of mouth. But of course we have progressed beyond this point many, many years ago, and now depend upon several varieties of media to present, communicate, and store the essential knowledge we need in our very complex modern world. The variety of media available, the many forms they take, and the many combinations of them that are possible, make it a puzzling question as to which medium or media will be most helpful to learning in any given situation.

There are two general ways to seek an answer to the question of which media will best promote learning. One is to look at the outcomes of studies which have been performed to test media effectiveness in a variety of learning situations. A number of modern reviews of this evidence are available, including some which are critical and penetrating. From these kinds of

summaries there are a good many promising suggestions about how media can work best in presenting particular school subjects. It would be largely repetitious to try to do such a job over again for my present audience.

I shall, then, choose the second approach to this question of the relation of media to learning. This is a matter of considering our knowledge of learning as a process, particularly as embodied in systematic studies of learning. What principles are applicable to the design of audio and visual media, and to their effective employment in promoting learning? Are there any such principles that are generally applicable, and not specific to the subject being taught, whether it be history or mathematics?

The design of effective instruction has two areas of knowledge to call upon. Instruction needs to be arranged so that it will bring about the kind of change in a student called learning, and this requires a consideration of learning theory. In attempting to bring about such a change, the act of instruction is a matter of stimulating the student in certain ways--and here one has a choice of media to work with. Putting ideas together from these two domains of knowledge can yield some techniques and procedures of instruction which should make the process of learning an optimally effective one.

Suggestions from Learning Theory

What specific suggestions about instruction can be derived from learning theory? I believe there are four different learning theorists who have presented ideas of major importance to the design of instruction. There are Neal Miller, Skinner, Gagné, and Ausubel. I intend only to mention these ideas briefly here, before going on to elaborate on their implications. It

will be apparent that the suggestions of these theorists vary in their specificity, and I have ordered them along this dimension. Miller's ideas are the most general, applying to a great variety of learning situations. The specificity of suggestions increases progressively through the theory of Ausubel, who attempts to deal in a highly concentrated manner with the problem of acquiring meaningful, organized knowledge.

N. E. Miller. Miller's views regarding the implications of learning theory for instruction are presented in a volume of the Audio-Visual Communication Review, entitled Graphic Communication and the Crisis in Education (1957). The four principles he describes are suggested by the words: motivation, cue, response, reward. It is Miller's contention that an effective sequence of instruction, in any medium, must include provision for these four conditions.

First, motivation: the student must want something.

Second, there must be a cue: the student must notice something.

Third, response: the student must do something.

Fourth, reward: the student must get something he wants.

Obviously, these four principles described by Miller are considered to have highly general applicability to the design of instruction. They are relevant to the learning of all kinds of students, and presumably to all kinds of learning tasks. These principles may be put to work regardless of whether one is considering the task of a first-grader in learning to print letters, or to the task of a graduate student in understanding a scholarly article on Roman architecture.

The generality of these principles is also the key to their limitations in practical usefulness. To the skilled teacher or designer of instruction, they seem obvious, and such a person would likely aver that he always uses

such principles. Most instruction, in fact, could probably be shown to incorporate these four principles in some degree.

Skinner. The views of Skinner on instruction are contained in a variety of articles. At the most general level, it may be said that no great disagreement can be found with the principles of Miller. Skinner's analysis of instruction assumes that motivation must be present, that the student must make a response, and that this response needs to be "reinforced" (which is not necessarily the same as rewarded). The increased specificity of Skinner's suggestions center around the principle of stimulus control, or the ways in which reinforcement may be used to establish both more precise and more elaborate learnings by manipulation of the stimuli impinging on the learner.

Several relatively specific ways of controlling the learning process by suitable sequencing of stimuli and reinforcement are suggested by Skinner's theory, such as shaping, chaining, discrimination.

Gagné. The ideas of this theorist regarding the learning process are contained in a book entitled The Conditions of Learning (1965). The first principle deserving emphasis is that of distinctive conditions for different kinds of learning. I distinguish seven major kinds of mental processing which are called learning, each of which has a different set of conditions for its optimal occurrence. Although all types of learning may require certain general conditions for their establishment, the specific conditions for establishment of concepts, principles, and rules are in addition to these. Furthermore, they are distinguishable for each type: learning complex principles through problem solving demands a different set of conditions than does learning a new concept like "cell," or "nucleus," or DNA.

The second principle of importance for instruction may be called cumulative learning. This is the principle that the learning of any new

capability builds upon prior learning.

Ausubel. Ausubel insists, first of all, that school learning is meaningful learning, and that this process is distinctly different from what is usually called rote learning. Thus he comes to grips directly and specifically with the learning of facts and principles, and is not particularly concerned with other forms of learning such as motor and verbal chains. In this theory, the most important principle is called subsumption. Meaningful learning takes place, according to this theory, when a new idea is subsumed into a related structure of already existing knowledge. The result of this process is the acquisition of a set of new meanings.

These principles of Ausubel add up to a pretty strong specification of how instructional materials should be organized and presented for most effective learning. While one finds only very general guidance for the construction of programs of instruction, texts, or educational films by following such principles as Miller's, it is evident that Ausubel's principles are pretty specific. They tell an instructional designer what to do first, what sequence of ideas to follow, what to do to insure remembering, and what kind of outcome to expect. Note that I do not maintain that Ausubel's theory is entirely correct--only a good deal more experimentation will determine that. But his ideas lead to very concrete suggestions about how to conduct instruction.

Here then we have four theories of learning, each of which has something to say about how to design instruction. Virtually no instructional materials, texts, or films in existence today have deliberately been prepared on the basis of these principles. Today's instruction simply does not reflect these principles, but appears instead to be based upon an older set of principles derived from quite different considerations. Could instructional

materials be designed to take these principles into account? I see no reason why this could not be done. But it would be an expensive undertaking, even to design a single course this way.

Learning and the Individual

There is an even broader theme than any which has been specifically defined by learning theories. Perhaps it may become the most general principle of all. It may be said, surely, that the great majority of modern studies of learning, of a variety of types, provide an accumulating body of evidence for this principle: Learning and remembering require the imposition of an active intellectual process by the learner on the material presented to his senses. One simply cannot account for learning by specifying only what is presented and the level of "intelligence" of the learner. Apparently, some specific sort of processing is always contributed by the learner himself. This kind of processing is given various names, in various experimental settings.

The implication of these studies of learning is quite clear. So far as theories of the learning process are concerned, the learning of any set of materials depends importantly upon individual contributions from the learner himself. Learning is an individual matter. In a fundamental sense, it is determined by what the learner does, and not by what the material does or what the teacher does. One can even go a step farther, in drawing implications for education. If one is concerned about how to make learning efficient, the focus of emphasis must be the student. The design of efficient conditions for learning demands that learning be conceived as an individual matter.

Instruction and the Individual Learner

It is possible, then, to bring to bear upon the design of instruction some principles of learning theory. These principles range from those which are quite generally applicable to all forms of learning to those which apply specifically to the learning of concepts and principles of the sort which characterize the bulk of knowledge taught in the schools. In addition, modern studies of learning suggest the clear implication that some idiosyncratic processing of information is done by the learner. This provides a fundamental reason for viewing learning as an individual process, and strongly suggests that individualized instruction represents the route of efficient learning. If arrangements for individual learning are not deliberately made by the system, they presumably will be made by the learner himself. In doing this, he will presumably use whatever media are available, although some may be better adapted for some purposes than are others.

It seems evident to me that learning theories, some more than others, provide an identification of variables in the learning situation that could be employed for instructional planning with the use of various media. However, I think that an answer to the questions of which media to use and how to use them for instruction must also be sought by means of a more detailed analysis of the events of instruction than has customarily been undertaken. So I should like to turn attention for a few moments to the procedures of instruction.

The function of media is generally agreed to be communication. It is also true that communication is involved in an essential way in instruction. But communication is probably too broad a term to apply to all of the things that are happening when learning takes place during the course of instruction. In a strict sense of the term, communication is only a part of the

story.

What are the events of instruction that must take place in order for learning to occur? What appear to be the most important events are the following:

1. Gaining and maintaining attention. Obviously, in order for learning to occur, attention must be attracted in the first place, and then maintained. Many of the stimulation conditions that attract attention have been known for a long time, including such things as change, novelty, appeal to dominant interests. Concerning the maintenance of attention, we know somewhat less. Presumably, maintaining attention is a matter of achieving a mental set, related to one or more individual goals, which makes the learner return again and again to the task at hand. Manipulating external stimuli is probably ineffective over the long pull, and one must instead seek ways of reinforcing the motivational state of the learner.

2. Insuring recall of previously acquired knowledge is another important function of instruction. When the learner undertakes to learn something new, he must first be reminded of what he already knows which is relevant to that learning.

3. Guiding the learning is done in instruction by verbal or pictorial material that provides "cues" or "hints" to new principles, usually without stating them fully in verbal form. In part, the "organizers" mentioned by Ausubel perform this instructional function. In part, it is done by questions. The skilled self-learner, of course, provides his own questions.

4. Providing feedback to the learner on his accomplishments is another function of instruction. One of the surest ways, it seems to me, is be defining the objectives of instruction clearly to the learner, so that he will become aware immediately when he has attained each specific

goal. Again, the skilled learner may usually do this himself. Textbooks and other media often seem to neglect badly this essential instructional function.

5. Establishing conditions for remembering and transfer of learning would surely be counted as one of the essential functions of instruction. For purposes of transfer, there needs to be a carefully designed series of problems to which application of the newly learned principle is made. For remembering, there needs to be provision for spaced review, which has often been shown to be an effective technique.

6. Finally, there should be mentioned still another instructional function, often neglected. This is the assessment of outcomes. The outcomes of learning and remembering need to be assessed frequently.

There are, then, these six major functions that take place in instruction. It may be noted that learning theory does not, in and of itself, say exactly how these are to be put together in the great variety of specific instances to which they are applicable. What learning theory tells us is that when certain of these conditions are present, learning will occur, and when certain ones are not present, learning is improbable. Beyond such theory there must of course be both technology and artisty, whether this be exhibited by the textbook writer, the film-maker, or the master teacher. And to a considerable extent, at least, we should expect effective techniques of self-instruction to be present in the young adult.

What Can Media Accomplish?

It can readily be seen that most media of communication can readily perform most of these instructional functions. They can be performed by pictures, by printed language, by auditory language, or by a combination of

media. No single medium possesses properties which are uniquely adapted to perform one or a combination of instructional functions. Instead, they all perform some of these functions well, and some not so well. The arrangement of instructional conditions is still the key to effective instruction, regardless of the medium or media employed.

One key to the question of which media is to be found by considering the learning task, that is, the objectives of the learning. A properly defined set of objectives provides information on the nature of stimuli to which the learner is expected to respond, after he has learned. Consider a few examples:

1. An objective in a course in physics might be, "demonstrating Ohm's Law." If one expects the student to show how resistance in an electric circuit varies with the current and voltage, there would seem to be considerable justification for using actual objects and events as the medium for instruction. In other words, one might set up instruction in a laboratory. If the student has sufficient prior acquaintance with such actual objects and events, a pictorial presentation may perform the same functions.

2. An objective in a course in English might be, "editing composed written paragraphs for correctness of structure and optimal clarity of expression." Obviously, what has to be presented here initially are incorrect and non-optimal paragraphs. Printed language has to be the medium. However, it may be of considerable importance in such an instance to arrange for frequent and prompt feedback to the learner as he makes his corrections. Thus one might choose to have a teacher convey this feedback in the presence of printed language given in a text or projected on a screen.

3. In a foreign language course, an objective might be, "making appropriate responses containing personal biographical information to questions

asked by a specaker in the foreign language." Here again, the medium required is quite evident--it is auditory language. The learner must be presented with these questions in an auditory form, and the printed form will not be an adequate substitute.

I believe you can see that similar questions could be asked and commented upon regarding other functions embodied in the events of instruction.

What kind of medium, or combination of media, is to be used to guide the learner in his learning--by questions, by prompting, by hints which will best enable him to discover what he wants to know?

What kind of feedback must be provided to the learner, to inform him whether he is on the right track, and whether his discoveries are correct?

How shall media be used to probe or test his performance, once he has achieved some new learning?

What use can be made of media to insure remembering of essential points?

And, of course, a most important question--how can media be used to insure the transfer of his knowledge to new situations? The possibilities of presenting a variety of situations in which a newly learned principle can be applied would seem to be one of the great advantages of both visual and auditory media, perhaps not yet exploited as fully as it ought to be.

Consideration of these examples, and others like them, leads to the following generalizations concerning the use of media for instruction. There seem to me to be more or less self-evident principles with which one must begin to think about media. They are not "the answers," but merely the bases for further investigation of the uses of media.

1. First, no single medium is likely to have properties that make it best for all purposes. There is, so far as we know, no special magic in any particular medium.

2. Second, the most important single criterion for a choice of medium is often the nature of the learning task itself--that is, the objective of the instruction. If the learner is going to respond to real objects, these need to be used at some point in instruction. If he is going to respond to auditory language, then this form of communication needs to be used at some point in his instruction. However, it should be noted that this criterion doesn't solve the whole problem, by any means. The reason is that for many objectives, one medium is as appropriate to the task as another. For example, the principle relating the sides and hypotenuse of a right triangle can be presented in printed words, in mathematical symbols, or in diagrammatic pictures. Or, the events leading up to the Boston Massacre can be described in a printed text or shown in dramatized pictorial form. In these instances, nothing in the instructional objective itself provides a clue as to which medium will be best.

3. Third, when one considers the six functions of instruction (controlling attention, stimulating recall, etc.) previously mentioned, it is evident that any given medium may perform one of these functions best at a given time during a period of instruction, while another medium may perform an instructional function best at another time. That is to say, the precise answer to the question of "which medium" is not to be found by matching courses with media, or even topics with media, but rather in matching <u>specific instructional functions</u> with media. Within a given topic, for example, attention might best be maintained by the introduction of pictures, whereas guiding learning might best be accomplished by printed verbal instructions, and feedback might be best performed by auditory language. When one chooses a particular medium for a whole course, or even for the development of an entire topic, one is usually making a judgment that such a medium will

be best suited "on the average" for the various instructional functions it must perform.

4. Finally, there is another suggestion to be derived from these considerations about the instructional functions of media. It may be that the most striking effects of instructional planning are to be sought in various combinations of media, where each may perform a particular function best. Any given medium might be used alternately with others over relatively short periods of instructional time.

Consider, for example, an instructional situation in which the student reads from a printed text and responds to it by writing problem answers. When the occasion demands, pictures or diagrams are presented to perform the functions of stimulating recall and guiding the learning. Now, as the student works along in this fashion, every so often, when a new subtopic is to be introduced, or special emphasis is to be given, a taped auditory message is introduced, having the primary purpose of controlling attention. Frequent questions are included in the printed text for self-assessment, and feedback is also provided in an auditory form. What would be the effectiveness of this kind of combination of media?

I do not know the answer to this question, and there is no research to provide it. Yet this is the kind of instructional arrangement, only roughly described in this example, which may hold the key to effective instruction, particularly the sort of instruction which depends upon the individual to do a large part of the establishment of learning conditions for himself. Obviously, a good deal of testing of practical alternatives is needed before we can feel confident about the outcome of such plans for instruction.

Summary

I have been led to consider first how learning theory relates to the practical events of instruction. There is little doubt that this relationship can be demonstrated. Depending upon which learning theory one chooses, the suggestions for practical application to instruction are more or less specific. And running through all theories is the theme that learning is, after all, an individual matter, in which essential idiosyncratic elements must be supplied by the learner himself.

As a practical matter, the events of instruction encompass more processes than are included in learning theories themselves. Instruction involves gaining and controlling attention, stimulating recall, guiding the learning, providing feedback, arranging for remembering, and assessing outcomes. It is these functions that are performed by various media of instruction. One should not expect, I think, to find that a single medium is best fitted to do all of these things. Instead, it seems likely that carefully designed combinations of media may be required to achieve the kind of instruction that is most effective, and which at the same time exploits the properties of various media to fullest advantage.