Improving Instruction Through Instructional Design

Gary R. McKenzie

Teachers can improve student learning by using test-like questions and other systematic procedures derived from learning theory and research.

The highly individualized, child-centered, process-oriented approach to education is based on an attractive philosophy, but it does not pay off very well for students and teachers in real life. Dozens of studies show that students learn more in content-oriented classes where teachers use direct methods of presentation addressed to groups.[1] Furthermore, the trend in research suggests that child-centered, process-oriented classes *increase* anxiety,[2] *lower* children's self concepts,[3] and produce more negative pupil ratings of the teacher.[4]

The reasons are not hard to understand. Child-centered philosophy is premised on the assumption that the teacher will be able to diagnose and prescribe on the basis of readiness. Readiness is a mental state that cannot be observed, is poorly understood even by experts, and is accessible to classroom teachers only in the form of current knowledge. Progressive philosophy implies that what the child learns is determined not by the teacher but by the child's stage of mental development and unknowable gestalt. The teacher cannot intervene in learning directly but can only guess at the sort of experience the student needs on the basis of inadequate tests. This philosophy, implying an unnecessarily indirect role, handicaps teachers instead of equipping them to present new information effectively.

Individualization Causes Frustration

When teachers individualize, the number of lessons, activities, and experiences that must be prepared for each day is multiplied, and the teacher has less time to do a good job planning, mediating, presenting, and assisting every student with each lesson. What is gained in personalization is lost in clarity and thoroughness of instruction. Teachers are forced to depend on games, learning centers, and problem-solving projects, many of which do not provide sufficient information or evidence to allow students to learn or even complete the activity.[5] Students who have not already mastered all the ideas and skills necessary for the independent work become frustrated and fail, and students who can do the work independently must know the material and are only reviewing.

Repeated frustration and failure reduce self concepts and in-

[1] See for example, R. S. Soar, *Follow-Through Classroom Process Measurement and Pupil Growth (1970-71): Final Report* (Gainesville, Fla.: University of Florida, 1973); J. E. Brophy and C. M. Evertson, *Process-Product Correlations in the Texas Teacher Education Study: Final Report* (Austin, Tex.: The University of Texas, 1974); J. A. Stallings and D. Kaskowitz, *Follow Through Classroom Observation Evaluation, 1972-3* (Menlo Park, Calif.: Stanford Research Institute, 1974); D. Wright, "The Affective and Cognitive Consequences of Open Education," *American Educational Research Journal* 12 (Spring 1975): 447-68; D. Solomon and A. J. Kendall, *Final Report: Individual Characteristics and Children's Performance in Varied Educational Settings* (Chicago: Spenser Foundation, 1976); *Impact of Educational Innovation on Student Performance: Project Methods and Findings for Three Cohorts: Executive Summary* (Palo Alto, Calif.: American Institutes for Research, 1976); N. Bennett, *Teaching Styles and Pupil Progress* (London: Open Books, 1976). Also see summaries of additional research in B. S. Bloom, *Human Characteristics and School Learning* (New York: McGraw-Hill, 1976); B. V. Rosenshine, "Academic Engaged Minutes, Content Covered, and Direct Instruction," paper presented at the annual meeting of the American Educational Research Association, New York, April 1977.

[2] Wright, "Consequences"; Bennett, *Teaching Styles.*

[3] Stallings and Kaskowitz, *Classroom Observation*; R. Van Horn, "Effects of Four Types of Teaching Models on Student Self-Concept, Academic Ability, and Attitude Toward the Teacher," *American Educational Research Journal* 13 (Winter 1976): 285-91.

[4] The Bennett study to the contrary, see Van Horn, "Effects of Four Types."

[5] G. R. McKenzie, "The Fallacy of Excluded Instruction: A Common Error in the Logic of Progressive Teaching," paper presented at the annual meeting of the Southwestern Educational Research Association, Austin, Texas, January 1978.

crease anxiety.[6] When students are given an objective but not enough information to achieve it easily, they quit trying to learn.[7] Of course the progressive teacher tries to help, but it is physically impossible to explain 25 ideas to 25 students one at a time, assist individuals when they begin to get frustrated, and keep all the students engaged in learning activities. Elementary children end up doing dot-to-dot tasks, coloring turkeys, or drawing pictures a substantial part of the time. The indirect role makes teaching impossibly complex.

There is a more practical and effective alternative which, though less charming, corresponds far better with classroom realities. Called instructional design, it assumes that the student must learn through personal mental activity, but it also recognizes that teachers are responsible for making sure that students learn. It equips teachers with specific procedures for presenting information clearly and thoroughly and for making sure students pay attention and think appropriately.

Start With the Curriculum

In real life, most classroom teachers do not start with the individual student in planning. They start with the curriculum — an outline of goals, ideas, understandings, and skills which taxpayers, parents, administrators, other teachers, and students expect them to communicate — and they try to figure out the most effective way of communicating that curriculum to students. Instructional design starts from the same practical point,[8] which makes it relatively easy to apply in classroom lesson planning. It is largely a content-oriented approach; it does not depend upon natural readiness of students for success but equips teachers to teach necessary background material within the lesson.

Instructional design begins with the premise that whatever else a lesson must do, it must provide the information and evidence necessary to demonstrate the idea to be learned, to show exactly what it means, and to prove it is true. Although different students may require more or less evidence and practice, *the essence of what must be presented is determined by the content to be learned and can be presumed to be the same for anyone.* Thus a careful task analysis of a lesson objective can define a sufficient set of inputs to enable any student to learn that objective.

Second, instructional designers suppose that most of the content of any school curriculum can be classified into a few categories of objectives according to the logical requirements implicit in each type of learning. These categories are *associations* (stimulus response pairs to be memorized like B-bu, 2-two, Columbus-1492, or that big chunk of land south of Europe is called Africa); *concepts* (abstract ideas for classifying — the essence of all word meanings — including the idea of two, democracy, rectangle, reptile, custom, desert, noun, haiku, on, equal, atom, and so on); *principles and generalizations,* (ideas that state relationships among variables, such as $A=S^2$, heat causes expansion, two vowels together usually take the long sound of the first vowel, and so on); and *skills* (step-by-step procedures or algorithms that can be followed to produce a desired outcome, such as finding a word in a dictionary, computing a sum with counting

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[6] See, for example, A. D. Calvin, M. Scriven, J. J. Gallagher, C. Hanley, J. V. McConnell, and F. J. McGuigan, *Psychology* (Boston: Allyn and Bacon, Inc., 1961), p. 410-20.

[7] E. D. Gagné and E. Z. Rothkopf, "Text Organization and Learning Goals," *Journal of Educational Psychology* 67 (June 1975): 445-50; E. Z. Rothkopf and M. E. Koether, "Instructional Effects of Discrepancies in Content and Organization Between Study Goals and Information Sources," *Journal of Educational Psychology* 70 (February 1978): 67-71.

[8] Many instructional designers are actually employed by industry rather than universities, where they are given goals and required to develop effective training programs. If the programs don't produce real results, the designer is unemployed.

sticks, calculating surface miles from map scale, reducing fractions, making a bow knot, mixing orange paint from primary colors, measuring volume, and so on). Task analyses performed on different objectives within each category tend to be very similar in the nature and sequence of inputs required. The task of learning one association is pretty much like the task of learning any other association. Most concepts are fairly similar in what their learning requires.

To the extent that the logical requirements are essentially the same for teaching any objective within each of these categories, a teacher equipped with an effective strategy for teaching some associations should be able to use that strategy for teaching most associations. A strategy for teaching some concepts should work for teaching most concepts, and the general procedure for teaching some generalizations should work for teaching others. While the steps will not be the same for different skills, the procedure for identifying steps, organizing, demonstrating, and proving different skills should be quite similar. In effect, four basic strategies should equip teachers to teach most content to most students.

Concept Learning

The conditions necessary — the basic guidelines for what must go into each of these kinds of lessons — have been rather thoroughly described.[9] In concept learning, for example, it is recommended that the definition of the term be presented in the following form:

A *(concept term)*
is a kind of *(state domain or superset)* which has the following characteristics:

1. (Critical attribute 1).
2. (Critical attribute 2).
3. (Critical attribute 3).

This form of definition is easier to understand, remember, and use than typical dictionary definitions.[10] It is absolutely necessary to show examples of the concept which represent the entire range and variety examples can take.[11] For example, if *mammal* is illustrated only with female cows, goats, and dogs, pupils will predictably undergeneralize and misclassify males, people, and whales as nonmammals.

It is also logically necessary to provide carefully selected nonexamples to ensure that pupils realize all critical attributes are necessary, and to prevent overgeneralization.[12] Thus a hairy-looking, air-breathing vertebrate which does not nurse its young should be used to prove that mammaries/nursing is a necessary characteristic of mammals even if a mythical creature has to be made up. Finally, if students are to learn to use the concept in classifying new items, then unlabeled new items should be presented for them to classify by applying the definition, and feedback is necessary to confirm or correct their responses.[13] This pro-

[9] See R. Gagné, *The Conditions of Learning* (New York: Macmillan, 1970) for a general overview.

[10] S. Markle, "They Teach Concepts, Don't They?" *Educational Researcher* 4 (June 1975): 5-10; D. M. Merrill and R. Tennyson, *Concept Learning: An Instructional Design Guide* (Englewood Cliffs, N.J.: Educational Technology Publications, Inc., 1976).

[11] Markle, *Educational Researcher;* Merrill and Tennyson, *Concept Learning.*

[12] Merrill and Tennyson, *Concept Learning.*

[13] G. R. McKenzie and R. Dueck, "Effects of Testlike Events on Mathemagenic Behavior in Inductive Concept Learning," paper presented at annual meeting of the American Educational Research Association, San Francisco, Calif., April 1976.

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cedure is so thorough that it will build the necessary "readiness" into the lesson and thus make it possible for any reasonably normal person to learn.

The logical structure of the content determines what must be presented during the lesson to enable a student to learn and thus informs the teacher of what input is needed. In addition, however, since learning takes place in the student and results from his/her mental activities, the student must be active. Furthermore, not just any activity will produce the learning the teacher wants. The student must actively attend to the necessary details, and process those details in specific ways that will lead to understanding and ability to use the information taught.[14] Recombining Dewey's ideas, "The teacher . . . has not only the right but the duty to suggest lines of activity . . . so that pupils will make the responses that cannot help having learning as their consequence." [15] Instructional design procedures go far beyond merely suggesting a project. They elicit very specific details of study behavior.

Extensive research in the use of prompts and cues provides some devices to ensure that students notice and think about key ideas and details. Merrill [16] suggests use of exploded diagrams to highlight critical attributes, juxtaposing an example and nonexample matched on all attributes but one, and use of verbal cues to inform students that — in concept learning, for instance — an important rule or a mere example is about to be stated.

Test-Like Questions

In addition, Rothkopf has produced some true breakthroughs by the use of test-like questions. When a lesson has particular objectives, it is effective to tell students exactly what the objectives are so the students know what to attend to.[17] Further, if final test questions are provided before the presentation, students will study extremely efficiently — and ignore incidental information. Extensive research demonstrates that questions used as test-like events (that is, interspersed throughout a presentation with every student required to respond to every question) elicit, focus, and sustain intensive study behaviors and increase achievement.[18] When such questions are inserted into oral classroom presentations and every student is asked to make a response to every question, attention and behavior problems are dramatically reduced. The teacher ensures that all students notice and think appropriately about each point, and that they review and practice it. The teacher can immediately detect any misunderstanding and correct it before going on to the next stage of the lesson.[19] This use of test-like events serves the same intent as oral questioning, but it is much more precise (questions are planned to elicit particular thoughts), efficient (every student responds to every question), and effective (it reduces inattentive behavior by half and produces higher achievement on transfer tasks).[20]

Like the content outline of the presentation, the nature of the test events is determined by the lesson objective. A test event is prepared to require each student to apply each step or key point to make an overt response immediately after the point is presented. In order to apply the idea, the student must attend, understand, and practice using the point. Instructional design models of learning make the proper location and content of the questions quite obvious.

[14] E. Z. Rothkopf, "The Concept of Mathemagenic Activity," *Review of Educational Research* 40 (June 1970): 325-37.

[15] J. Dewey, "Progressive Education and the Science of Education," *Progressive Education* 5 (July-September 1928): 203-4.

[16] D. Merrill, "Instructional Strategies," paper presented at the annual meeting of the American Educational Research Association, San Francisco, Calif., April 1976.

[17] Gagné and Rothkopf, "Text Organization."

[18] See summaries in Rothkopf, "The Concept"; H. W. Faw and T. G. Waller, "Mathemagenic Behaviors and Efficiency in Learning from Prose Materials: Review, Critique, and Recommendations," *Review of Educational Research* 46 (Fall 1976): 691-720.

[19] G. R. McKenzie, "Quizzes: Tools or Tyrants?" *Instructional Science* 2 (Fall 1975): 281-94.

[20] G. R. McKenzie and Mixon Henry, "Effects of Test-Like Events on On-Task Behavior, and Test Anxiety, and Achievement in a Classroom Rule Using Task," *Journal of Educational Psychology*, 71 (August 1979): 370-74; G. McKenzie, "Effects of Questions and Test Events on On-Task Behavior and Achievement in a Classroom Concept Learning Task," *Journal of Educational Research* 72 (July-August 1979): 348-51.

The trick in convenient classroom use appears to be a matter of figuring out what students can *do* physically to indicate a response, since unison oral answers are difficult to interpret. Particularly useful (cheap, quick, and effective) ideas are to present a case or example and ask, "If you think this case has all the characteristics, raise your hand" or "If you predict the same outcome in a new case like this, raise your hand." In association lessons the teacher can distribute duplicated maps, time lines, or symbols with a variety of responses possible, and then say, "Point to the product of 3 x 4," "Point to the location of Texas on your map," or — using the reading text — "Point to the sentence that tells why Jack went to town." In skill lessons, one can distribute a set of materials to be used in performing the skill. After each step is demonstrated, have each student repeat the step with a second example as the teacher checks comprehension. For instance, in teaching use of a map index, one might distribute highway maps, demonstrate how to find Luckenbach in the index, and ask students to use the skill to find Turkey, Texas, in the index and point to the term. The teacher might then demonstrate how to find Luckenbach using coordinates, after which the students would use the same procedure to point to Turkey.

Recipes For Planning

These principles can be stated and used as recipes for planning most association, skill, concept, and generalization lessons. In concept lessons, for example:

1. Establish set by informing pupils they are to learn how to tell if something is an ______. Perhaps display mixed unlabeled cases as a preview of the test and explain the task.

2. Inform pupils that the definition to be stated should be understood and remembered as a check list.

3. State the definition in the form Markle suggested.

4. Provide an example, pointing out each attribute, stating "This is an example because it has ______, ______, and ______."

5. Provide other examples duplicated for pupils and have them point to the first attribute, the second, and so on.

6. Provide matched example/nonexample pairs and demonstrate that each example has all attributes, while items with missing attributes are nonexamples.

7. Present a case which has not been discussed and ask pupils to use the definition to decide if it is or is not an example of the concept. Ask why or why not. Provide feedback. Repeat until errors are eliminated.

This procedure is extremely versatile and effective. It has been used to teach new concepts to graduate students and to two-year-olds, to bilingual and to Anglo children. Special education teachers report that it is effective with slow and with accelerated students.

Equally specific but transferrable procedures can be described for teaching associations, principles, generalizations, and algorithms or skills.

A Systematic Approach

In summary, instructional design provides a highly systematic, content-oriented, teacher-controlled theory of instruction which helps ensure that sufficient information is presented to enable students to learn. It is an extremely useful approach to instruction and may be necessary even in connection with discovery activities—to ensure that pupils have learned the information they will need to solve discovery problems on their own.

Admittedly, instructional design is more technical than looking up an activity in an idea file, and it is not easy to use at first. Once the basic lesson is designed and test events are planned, student characteristics must be considered: illiterate children must have examples presented in other than written form; blind students can't learn from photographic prints; and slow learners will probably require more examples and more practice than others. Still, these problems are relatively easy to detect and deal with when the teacher knows exactly what the content demands. The time saved by not having to make up a creative approach from scratch and in not having to plan ten ways to present the same idea compensate. Once the pattern for each type of lesson is understood, planning time may actually be reduced.

If students learn more and faster, and if Gagné is correct that the ability to reason and solve problems is learned largely as a set of relatively specific principles, ideas, and skills, then instructional design may provide the most direct, rewarding, and nonfrustrating approach available for teaching students to think and solve problems. At the very least it gives teachers an effective means to teach content and meet the demands of basic education in a minimum of class time; it may save enough time to allow for creative experiences as well. EL

Gary R. McKenzie is Associate Professor of Curriculum and Instruction, University of Texas, Austin.