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About this issue...

Five noteworthy articles mark the beginning of JD's third volume:

- A tactical perspective of a direct attempt to improve organizational and individual readiness for instructional innovation and change.
- A powerful argument to explain why faculty members prefer the lecture method as their instructional strategy and a method of instruction that meets PSI needs for both the lecturer and the learner.
- Results of a study that was designed to test whether materials employing "good" instructional strategies produce better learning.
- The second of our four—(rather than three) as promised) part series on cost-effectiveness analysis, and
- A model for actually applying the aptitude-treatment-interaction approach to the design of instruction.

The Book Review department reviews the 20-volume Instructional Design Library, one of the most extensive ID publication efforts yet undertaken, and two curriculum related books that might help clarify the differences between curriculum development and instructional development.

Finally, we introduce the ID Project Abstracts department, which is designed to provide brief descriptions of ongoing and recently completed ID projects, indicate where more detailed information may be obtained, and thus establish a communication link between developers.

FLASH! We have just received word that, beginning with the next issue, JD will have a column from the ERIC Clearinghouse on Information Resources. It will summarize selected ERIC documents related to instructional development.
Improving Readiness for Change and Innovation: A Case Study

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This is a case study of an effort to improve the effectiveness of an instructional development program in a health professions school by modifying the level of organizational readiness and individual faculty readiness for instructional innovation and change. It is a tactical example of an attempt to alter the setting in a specific educational institution.

The Literature on "Readiness for Change" in Education

The relationships among organizational readiness, individual faculty readiness, and instructional development have been noted and discussed frequently in the literature of instructional development.

Abend and Sachs (1978), in the lead chapter of a recent book on the state of the art in instructional development, define "readiness for instructional innovation" as "that critical combination of characteristics prerequisite to the adoption of an innovation which changes instructional content or process" (p. 5). Other authors, although not referring to "readiness" directly, discuss the issue in somewhat different terms. Durso (1978), for example, synthesizes from his review of the literature, 16 "guiding principles" for implementing instructional development programs in higher education. Spitzer (1977) creates a fictitious "survival manual for instructional developers" and offers the following as one of the manual's major concepts: "We must take the pulse of the institution and recognize whether it is ready for our exciting ideas. Good ideas in an immature organization can be extremely threatening." Dwyer (1976) focuses specifically on the assessment of readiness for change and lists a number of common-sense guidelines for the process of readiness assessment and constructive follow-up. DeBlois and Adler (1973) suggest that a "conservative" program for instructional development services can be developed as an "ascending ladder of faculty readiness," with the bottom rung labeled "awareness activities"; the second, "faculty support activities"; and the top, "institutional development activities."

For the most part, the authors cited and others (e.g., Caetano, 1978; Craig, 1976; Lawson, 1978; Lee, 1972; and Purdy, 1975), have been concerned with the context in which instructional development takes place and have provided mostly strategic views of faculty readiness, organizational readiness and the approaches to improving them. In contrast, the present discussion offers a tactical perspective of a direct attempt to improve organizational and individual faculty readiness for instructional innovation and change. Specifi- cally, the change method involved a highly structured, 2-day workshop that engaged faculty in problem-solving activities related to curriculum management.

The Institutional Setting

The change effort took place in a state-supported dental school having a near 80-year history as a free-standing institution and a national reputation for producing graduates who are highly competent in clinical skills. In 1975, along with the nearby schools of medicine and nursing, the school of dentistry became part of a new university health sciences center. Only 2 years earlier, the school of dentistry had established a new Division of Educational Resources and appointed the author as its first Director of Instructional Development, and the school's only professional "educator." During the period 1974 to 1976, the author's efforts as Director of Instructional Development included: assessing institutional needs; setting divisional goals; developing proposals; writing grants; obtaining resources; negotiating with the other schools of the health sciences center for resource sharing (e.g., media production and classroom audio-visual services, previously unavailable); making on-site presentations on instructional product development; conducting evening faculty seminars on teaching methods; having individual faculty consultations; and working on such committees as admissions, curriculum, and teaching-learning.

For many, if not most, of the school of dentistry faculty, both the new university affiliation and the appointment of an in-house education specialist were considered imposed changes to be ac-

Author's Note:
The author wishes to acknowledge Dr. Alison McPherson, Director of the NIAP Medical Technology Program and Associate Professor, Thomas Jefferson University, Philadelphia, for her valuable counsel and encouragement during the period that the activities described in this paper were conducted. Dr. McPherson was formerly Associate Director of the Office of Medical Education, University of Oregon Health Sciences Center.

The workshop activities described in this paper were previously presented at the 1977 Health Sciences Communications annual conference in Indianapolis, Indiana.
cepted with a "wait-and-see" attitude. Resistance to change among faculty in higher education is nearly pandemic; dental educators are among the most stolid opponents of change. There seem to be several reasons for this. As Oaks, Fox, and Valter (1977) have stated in an article about unionization in dental schools, the reasons for the general passivity exhibited by dental faculty in several schools toward negotiations of any sort were their "competing loyalties," "professional commitments and the pervasive, if declining insulation from much of what occurs elsewhere in universities" (p. 662). Oaks and his colleagues have noted further that:

Many [dentists and physicians] chose the profession in part because they disliked collective action, preferring to work alone. The values and personality traits that sustain commitment to medicine and dentistry often conflict with those that enable people to enjoy or even accept life in complicated organizations. (p. 662)

Nalbone and Terek (1978) have characterized dental faculty as follows:

Dental faculty, many of whom are part-time and have practices outside of the institution, see themselves first as health-care practitioners and only secondly as educators. Even as educators their interests focus heavily on problems of patient care, the basics of supplies, space and other resources and the struggle to gain more student contact time. . . . Moreover, the administration's effectiveness in exercising power is somewhat eroded when cooperation on organizational matters is needed because dental faculty always have the option to return to full-time professional practice (p. 62).

Not all dental school faculty are dentists, of course, but the clinical faculty typically are the dominant element and set the tone for individualistic behavior and factionalism that is counter-productive to cooperative change efforts. It should be pointed out, however, that it is not uncommon in dental schools for faculty to have heavy commitments to student contact and often little more than one-half day per week of unscheduled time for preparation. In the subject school, the noon lunch-hour is typically the only time that committees can hold meetings and reliably expect a quorum.

There is another important point that makes dental school faculties different from those of regular university arts and sciences institutions, and perhaps somewhat more wary of change: the usual dental school curriculum consists of a set of specific courses presented only once each year and arranged so that an entire class of students goes through the same instruction as a group in lock-step fashion. Any call for change in the curriculum by any group or individual is typically perceived by other faculty as a threat simply because even a minor change in one area of instruction may necessitate a drastic change in how other courses are to be taught. The last attempt at major curriculum revision at the subject school of dentistry took a full 7 years to implement.

The Tactic for Increasing Readiness for Change: Create a Visible Sign

It was the view of the Director of Instructional Development that the most effective changes to improve instruction, given the limitations on resources, could best be accomplished by working closely with the school administration, other key decision-makers such as committee chairpersons, and influential faculty who were more inclined toward progressive educational ideas. After 2 years of effort, from the time the school's instructional development program was initiated, however, it became clear that significant change toward instructional improvement would be extremely slow in coming unless a requisite change could be effected in the readiness among the faculty as individuals and concurrently as a body. Moreover, because previous change efforts had not produced an image of readiness that was recognized, some visible sign of readiness had to be created.

Had been engaged in day-long, structured, individual career-planning, and departmental goal-setting exercises in which they generally participated in a positive and productive manner. With this precedent established, a set of highly structured and conceptually complex activities were designed in consultation with members of the teaching committee for the retreat in the fall of 1976.

With the overall goal of increasing the readiness for change among individual faculty and the faculty as an organization, the retreat program was planned. Its specific goals were to:

- Increase faculty awareness of interrelated curriculum problems;
- Improve the likelihood of faculty acceptance of proposals for comprehensive change; and
- Prepare faculty to give relevant input to proposals for change.

The assumption, at this time, was that the faculty were unprepared for change because of a lack of awareness of the relationships among—or even the existence of—certain problems involving their curriculum and the management of their individual instructional efforts. This situation was not unique to the school of dentistry inasmuch as Spitzer's (1977) survey of 60 ID personnel at various universities and colleges indicates that "a frequent reason for the ineffectiveness of ID programs is a lack of understanding and acknowledgement of institutional and instructional needs" (p. 18).

DeBlois and Adler (1973), as has been noted, propose that "awareness activities" comprise the first step in increasing faculty readiness. Havelock (1973) also refers to "awareness" as the first phase in the process of an individu-

"Resistance to change among faculty in higher education is nearly pandemic..."
"cognitive maps" are individually specific and are constantly being reinforced by individual experiences. A major goal of the retreat for the school of dentistry, therefore, was to supplant those personal cognitive maps with a common one that focused on the interrelatedness of curriculum problems.

The second goal was set with the recognition that incremental changes, say by mini-grants to faculty for instructional improvement, would have little long-term impact; that given the ex-

member in mind. As viewed by the faculty, the goals of the retreat were to provide faculty with a means for:

- Identifying and defining educational problems, using a curriculum evaluation model as a conceptual framework;
- Developing alternative solutions to educational problems, using a systematic problem-solving approach; and
- Developing alternative solutions to educational problems, using interdepartmental teams.

"After 2 years of effort, from the time the school's instructional development program was initiated, however, it became clear that significant change toward instructional improvement would be extremely slow in coming unless a requisite change could be effected in the readiness among faculty as individuals and concurrently as a body."

From the Director’s view, a faculty member who participated in the retreat experiences aimed at these announced goals would:

- Acquire an increased awareness of curriculum issues as interrelated problems;
- Be more able to offer input to proposals for change, having been exposed personally to a variety of possible problem solutions that might relate to a given proposal; and
- Be more likely to accept a change proposal that was based on possible and familiar solutions generated by himself or his peers rather than by the administration or an education specialist (Gropp- per, 1977).

The rationale was that the announced goals would establish enabling conditions for the more comprehensive, unstated goals aimed at increasing organizational and faculty readiness for change.

Restating the Goals from the Faculty’s Viewpoint

Because the three goals, particularly the second goal, might have appeared to be too much for the direct benefit of the school’s administration or the change agent, alternate goal statements were formulated with the view of the faculty planned and arranged to facilitate an optimal outcome.

Introduction by respected faculty—to establish faculty ownership of the retreat's goals and the program format, two senior faculty who were members of the Teaching-Learning Committee were enlisted to give opening addresses and to reiterate the announced goals.

Welcome address by the Dean—to establish the support of the school administration, the Dean was enlisted to challenge the faculty to approach the program activities not simply as exercises, but as the initial steps toward solving real problems that the school faced. (According to Durzo, 1978, who cites a number of other authors who are in agreement, “administrative encouragement and support of innovation” is the first necessary principle for instructional development.)

Overview presentation by the Director—to familiarize the faculty with the complex set of materials, the Director gave a presentation linking practical and familiar problems to the theory underlying the problem-solving processes and the group activities that were to follow. To establish a mood of enjoyment for the activities, colorful slides in a cartoon style with humorous remarks were used to illustrate the theoretical concepts and to introduce locally appreciated issues as examples.

Problem-solving activities—following the Director’s presentation and a brief period for questions, the faculty engaged in the planned, structured activities; first for a 1½-hour session and subsequently for a 2-hour session the following morning.

Handout materials for the activities consisted of a restatement of the retreat goals and the material shown in Figures 1, 2 and 3. Figure 1 duplicates the procedural instructions for the activities. As has been noted, the process was highly structured and required participants to adhere closely to the instructions. This was done to assure that each group proceeded in a consistent manner that would enable each individual to participate actively, minimize the amount of time needed to grasp the requirements of the task, and provide a means of monitoring each group's progress. The method used is similar to what Van de Ven and Delbecq (1974) have called the "nominal group technique." Each individual always takes a turn at presenting an idea or response and the group votes on a solution after a limited
General Instructions

1. Form Groups: Your assigned group is identified on the upper right-hand corner of this page.
2. Choose Leaders: Group members elect a Team Leader, responsible for keeping efforts aimed at the given task, and a Secretary who will record group decisions.
3. Select Priority Issue: Your group has been assigned to work on questions associated with the Track identified in the upper right-hand corner of this page. The following page lists the questions for each Track. Without discussion, each Group member submits his/her choice of the question for the Group to consider first. Tally the votes to determine the Group’s priority. Revote if necessary with a show of hands.

Problem-solving Instructions

Identify Problem

1. Once the priority question has been selected, each person, on his/her own, converts the question into a problem. Use the space under the first two blocks of the curriculum problem-solving worksheet. Refer to the curriculum model to characterize the problem.

Characterize/Define Problem

2. The Team Leader requests each person in turn to state what he or she wrote down to complete the above steps. As each person issues his or her report the Secretary records the responses for reference. No comment or discussion should be made until everyone has had his or her response entered.

Generate Alternative Solutions

3. After all responses have been recorded, the Team Leader initiates a discussion to restate the information in a single version acceptable to the group.

Select Favored Action

4. With the problem clearly defined and characterized for all members of the group, each person alone completes the third block on the worksheet.

Implement

5. The Team Leader requests responses from each person in turn, and the Secretary records them without comment from the group.

Evaluate and Recycle

6. The Team Leader opens the discussion to further generate alternative solutions.

7. After all possible solutions have been proposed the Team Leader moves the discussion toward assessing each alternative and selecting one favored action.

8. After a favored action is selected the group should discuss it in greater detail. (Optional)

9. The group may then decide to initiate the implement phase by suggesting the persons who should carry out the solution. In this workshop, this step may be done as a group discussion.

10. In this workshop the Evaluation/Recycle phase should be used to consider a new question or to discuss the problem-solving process itself.

Summary

At the end of the session(s) the group should prepare a summary report which:
1. Presents in a series of brief statements each problem considered by the group.
2. Describes the favored solution to each problem.
3. Outlines any other suggestions the group wishes to present to the faculty.

Each group will have an opportunity to present its summary to the faculty.

FIGURE 1. Workshop procedures/instructions to participants.

period of discussion. Time limitations for steps were not imposed, but groups were encouraged to establish a pace aimed at closure for at least one problem solution per session.

Figure 2 shows a list of “20 Questions” arranged into three “tracks,” one of which each faculty group was pre-assigned and from which each group would select a question as a basis for defining a problem, developing alternative solutions and selecting a preferred approach. Each question had been generated originally from responses to a survey conducted among faculty earlier in
FIGURE 2. List of questions from which problems were defined.

the year. An effort was made to characterize each question with a suggestive and easily remembered “catch phrase” that did not have the ring of educational jargon (although this was not always accomplished) (Gropper, 1977). “Basic Science Blues,” for example, referred to the issue of making the physical science courses more meaningful in terms of the knowledge needed for clinical practice. Note that the questions did not constitute problems in themselves, but had implications for problems that might be identified and defined. These questions were intended as advanced organizers to suggest possible relationships among issues and to avoid wheel-spinning on trivial or entirely philosophical matters.

A problem was to be defined (a) by using one of the questions as a point of reference and (b) by characterizing the problem in terms of a “curriculum description cube,” which had been elaborated earlier in the slide presentation and
was also included in each handout packet. The cube, shown here as Figure 3, is a system matrix having substantive (resource), structural (decision-level), and process dimensions. The matrix was incorporated into the overall procedure through the use of a worksheet that arranged the problem-solving process into successive but interdependent steps following a systems approach. Figure 4 shows a sample worksheet with an example problem worked out, although somewhat superficially. The sample work sheet and a blank worksheet were provided to each faculty member in the handout packet.

The problem-solving model was custom-designed for the retreat. However, other models were valuable references. A decision-making process developed by Wallis and Stager (1975) and a training-oriented model for educational settings developed by Jung, Pino, and Emery (1973) proved to be useful guides. Most valuable was McPherson’s (1975) instructional systems improvement model with which the model shown in Figure 4 is nearly isomorphic.

FIGURE 4. Problem-solving worksheet (with example problem).

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Outcome, Evaluation, Follow-up, and Observations in the Aftermath

All 14 faculty groups successfully completed the problem-solving process for a minimum of two problems each, although some groups were more proficient at documentation than others. An open discussion period at the end of the retreat revealed that among groups that dealt with the same issues, problems were defined and characterized in a fairly consistent manner, but final solution choices were quite diverse. The wealth of ideas generated included a number of problem definitions and innovative solutions that, if introduced by an education specialist, might previously have been viewed as radical, but having come from the faculty itself, received general approval when discussed in the open session.

Using a brief questionnaire provided at the close of the retreat, faculty rated the problem-solving sessions as valuable experiences. This seemed to concur with the general aura of enthusiasm maintained throughout the workshop period. However, out of the nearly 100 participants, only two persons documented their interest in contributing to follow-up work on any specific problem after the retreat.

Because the retreat program was not designed with research in mind, there are no baseline data except perceptions of the need for an improved climate for change. In the 3 years following the retreat, however, a number of significant developments have occurred within the school suggesting that the retreat successfully affected the organizational and individual faculty readiness for innovation and change. For example, although there is little evidence that faculty are actively using a systematic approach to problem-solving with considerable input from faculty. Perhaps most important, the Curriculum Council, working from a system plan proposed by the Director, has begun a long-term effort to develop curriculum management procedures involving continuous evaluation and iterative phases for course improvement.

Although these changes might have occurred without the retreat program, it appears that the retreat experience's impact was catalytic for the changes that followed, that the faculty's collective 'cognitive map' of the instructional system was reoriented, and that instructional development efforts in general have been successful.

Recommendations for Application in Other Settings

The basic design of this effort to effect an improvement in the organizational and individual faculty readiness for change and innovation is seen as readily adaptable to other higher education institutions. The only major modifications needed would be to customize, for the specific institutional setting, the questions (Figure 2) from which problems would be defined and to increase the amount of time provided for the problem-solving procedures. A final recommendation would be to provide follow-up incentives for faculty so that the impetus generated from the workshop activities could be sustained.

It is hoped that this article will stimulate further discussion regarding the issue of readiness for change and direct methods for improving readiness in higher education institutions. This case study should be viewed as one fairly successful attempt, to infuse enthusiasm for innovation and instructional development into a typically conservative instructional atmosphere. Through compilation of many such efforts, more effective guidelines for accomplishing certain instructional development goals, to bring about an open, innovative problem-solving atmosphere, may be derived.

References


Lecturing Is a Personalized System of Instruction—for the Lecturer

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Editor's Note

PSI is an instructional strategy not an example of the instructional development process—so why is JID publishing an article about it?

Fisher's article differs from the technique/media articles we summarily reject. It offers insights into the opposition to designed instruction and suggests a strategy to manage that opposition.

Instructional developers are often at a loss to explain why lecturing is the favored method among so many instructors. Fisher discusses, in terms of psychological motivation, why she believes instructors cling so tenaciously to the lecture method, despite its deficiencies—she is interested in the real reasons for resistance to change, not the ones instructors overtly cite. Unless an instructional developer is aware of these primary motivational factors and is prepared to deal with them, no instructional strategy, no matter how good it is, will succeed.

Fisher combines two old techniques—lecturing and PSI—and develops a new approach that offers the developer yet another option in instructional strategy selection.

The author is indebted to W. Anderson and S. Williams for their assistance in preparing this manuscript. Some of the work described here has been supported in part by National Science Foundation Comprehensive Assistance to Undergraduate Science Education Grant #E4477.

PSI for Students—The Keller Plan

In 1968, Fred Keller described the now well known personalized system of instruction (PSI or Keller Plan) and the five features that distinguish this approach from most conventional instruction: (a) the go-at-your-own-pace feature, (b) the unit-perfection requirement for advance, (c) the use of lectures and demonstrations as vehicles of motivation, (d) the related stress upon the written word in teacher-student communication, and (e) the use of proctors for repeated testing, immediate scoring, and tutoring. Keller hypothesized that the reinforcement contingencies included in PSI would enhance student learning. To date, this hypothesis has been substantiated. Reviews of many evaluative research studies on Keller teaching conclude that final examination performance in Keller sections always equals, and usually significantly exceeds, performance in lecture sections (Kulik, Kulik, & Carmichael, 1974; Taveggia, 1976). Further, students consistently rate the plan more favorably than teaching by lecture; they also report feeling that they learn more in Keller sections. These findings are particularly striking when one considers how few significant differences in student achievement have been found with previously known (traditional) teaching methods (Dubin & Taveggia, 1969).

The Keller Plan thus has seemingly well documented superiority for students over the lecture method of learning. It is the subject of much research and enjoys considerable popularity as...
an innovative teaching method. Yet it has not succeeded in becoming the dominant or even a major mode of college and university teaching. On the contrary, Kulik et al. (1974) reported 877 psychology courses taught by the Keller method in the United States in 1972, a modest fraction of total psychology courses. Similarly, a 1975 survey of a nine-campus university found the Keller Plan used in just 36 courses (Susskind, 1975)—less than 1.0 percent of all courses taught in the system. Even if these reports underestimate PSI use by a factor of 2, which is unlikely, the frequency of PSI instruction is impressively small.

In contrast, a study of the University of California at Davis found that a method used at least 75 percent of the time in more than 70 percent of all classes surveyed (Wallick, Note 3; Venturino, Note 2). This figure is similar to, or perhaps greater than, that reported by faculty in 28 southern and midwestern colleges and universities almost 30 years ago, where lecturing accounted for 58 percent of all class time (Umstattd, 1964). If lecturing is decreasing in frequency as more alternative teaching methods become available, as might be expected, the trend seems almost imperceptible.

Why does the lecture, an invention of the Middle Ages, continue to prevail? Many have pondered this question and a variety of answers have been suggested (Paulsen, 1902; Smithers, 1970; McLeish, 1976). For me, the most persuasive response is the one suggested by the title of this paper—that lecturing is a personalized system of instruction, for the lecturer.

PSI for Faculty—The Lecture Method

The reaction of faculty members to the lecture method of instruction is almost universally favorable. Compared to other teaching methods, lecturing seems to produce a greater sense of understanding of the course content, generate a greater feeling of achievement, and provide a greater recognition of the faculty member as a person and eminent authority.

Among the important features of the lecture method are:

- The stress upon the spoken word in teacher-student communication with its associated spontaneity, flexibility, simplicity, and familiarity;
- The immediate feedback provided by the live audience and the appreciation that is demonstrated when the intellectual and/or dramatic performance is well done;
- The marked enhancement of the personal-social aspect of the educational process wherein the lecturer can project his or her personality and philosophy to the students and serve as a role model for them;
- The emphasis on the teacher as knowledgeable authority and the self-confidence that results from identification with this role;
- The motivation that lecturing provides for keeping current in the literature, with the consequent reinforcement of the lecturer's scholarly endeavors; and
- The use of teaching assistants to free instructors from the tedious aspects of lecture teaching so the latter may concentrate on the intellectually satisfying activities of preparing lectures and the psychologically satisfying activities of delivering them.

In addition to the intrinsic psychological rewards, external contingencies also operate to make lecturing the method of choice for most university professors. Peers, for example, recognize lecturing as appropriate, desirable, and comprehensible behavior, and the reward system in many institutions is biased in favor of teachers who use the lecture method. Also, teaching by lecture is generally less time-consuming than teaching with alternative methods such as the Keller Plan, especially at the outset. More importantly, a greater proportion of the time invested in a lecture course seems to be on a relatively high intellectual plane (reading, thinking, synthesizing), while individualized instruction seems to demand the expenditure of relatively large amounts of time on comparatively uninteresting tasks. Because of its emphasis on the written word and on self-pacing, individualized methods usually entail significantly greater time commitments to tasks such as proofreading, planning, organizing, and managing.

The satisfactions associated with lecture teaching contrast markedly with the PSI experience, which offers relatively little reinforcement for most instructors. PSI is designed to move ahead at various paces set by the students, not the teacher. The professor becomes an invisible behind-the-scenes organizer who arranges things so students can productively "do their own thing." He or she plays the role of facilitator rather than knowledgeable authority and may experience a concomitant loss (or lack of enhancement) of self-image and self-confidence. In PSI, the instructor can interact with some students on a one-to-one basis, but there is relatively little opportunity to project one's persona to the class as a whole. Stress upon the printed word, while it may enhance precision, constrains spontaneity and flexibility. It also discourages continuous updating, because it is more difficult to modify print materials than oral presentations. Even the teaching assistants and tutors in PSI courses, rather than relieving instructors from tedium, often add to their burdens because of the requirements for special training, coordination, and supervision. And for all of the effort that PSI requires, the instructor receives little recognition and no immediate feedback. The evidence seems strong that the Keller Plan is good for students and lecturing is good for faculty.

PSI for All—the Combination Method of Instruction

To resolve this dilemma, a new instructional method is proposed which incorporates the empirically documented strengths of both approaches. Dubbed the combination method of instruction (CMI), it is intended to significantly enhance student learning and personal-social development while at the same time providing intellectual stimulation and personal satisfaction to the instructor. It should be a valuable method from the institutional viewpoint.
as well because it is conducive to continuous updating of the knowledge framework and it recognizes the importance of the discovery and ordering of knowledge as well as its transmission.

The reader will recognize that CMI, or some variations of it, has been used in university teaching for many years. But these variations are often just thought of as compromises, either by the lecturer who feels he or she should do something to innovate or by the instructor of an individualized course who is unable to maintain a full-blown individualized approach. The combination method of instruction is not generally recognized as a valuable, perhaps even an ideal, strategy in its own right. Yet there is every reason to believe that, when applied systematically, CMI will produce levels of student achievement and retention as high as those now obtained with PSI and instructor satisfaction as great as that associated with the lecture method.

Six features characterize the combination method of instruction:
1. Substantive oral presentations (lectures) given frequently by the instructor to the class;
2. Frequent individualized testing with immediate feedback on test results;
3. Emphasis on higher order learning skills;
4. Unit perfection requirement or mastery grading (for some topics);
5. Normative grading (for other topics); and
6. Carefully structured learning materials to provide precise and definitive sources of information which students can study independently and each at his or her own pace.

It may be useful to examine the theoretical and empirical bases for the elements of the combination method of instruction.

Theoretical and Empirical Bases

The Lecture

More than 100 studies demonstrate that, on the average, students learn no more with the lecture method of instruction than they do through discussion, supervised independent study, or even unsupervised independent study (Dublin & Taveggia, 1969). Reviews of the literature conclude that students learn significantly less with lectures than when taught by the personalized system of instruction (Kulik et al., 1974; Taveggia, 1976) or various auotutorial methods (Fisher & MacWhinney, 1976). Students also appear to retain significantly less from a lecture course than from a PSI course (Kulik & Jaksa, 1977). Yet college and university professors continue to prefer the lecture method. Why?

It seems that lectures are not dinosaurs of past ages, but rather a highly evolved and successful species in the pedagogical sphere. The process of preparing lectures seems to provide continual intellectual stimulation to faculty members and prompt them to continuously reassess and rethink the knowledge structures of their fields. A recent survey (Fisher & Cohen, Note 1), for example, found lecturers significantly more inclined than instructors of individualized courses to report that their instructional method helps them keep current in the literature, integrate new knowledge, and develop new research ideas. Thus, the lecture method of teaching may stimulate faculty to greater creativity, insight, and/or research productivity rather than other instructional methods. Two well known adages, "teaching (lecturing) and research go hand in hand" and "the best researchers are the best teachers (lecturers)," reflect the popular view that university teaching is an adjunct to or extension of the processes of research and scholarship. Likewise, faculty members generally opt for teaching assignments which are closely related to their fields of expertise and which will rein-

fessors derive more satisfaction from teaching than from any of their other responsibilities (Ladd & Lipset, 1976). Students also tend to enjoy the psychological benefits associated with witnessing a live performance and interacting with a role model, and they generally appreciate the fact that information is presented from a here and now perspective (see, for example, Dubin & Hedley, 1969).

Furthermore, lecturing is generally cost-effective and conserves instructor time as well. More importantly, as suggested previously, a greater proportion of the time invested in a lecture course seems to be on a relatively high intellectual plane. Faculty members indicate that lecturing stimulates them to engage in more reading, thinking, writing, and rethinking than individualized instruction does (Fisher & Cohen, Note 1). If this is so, the institution as well as the individual has a stake in preserving the lecture method. Students are, after all, transients in academia. Faculty are the pillars of the organization and the determinants of its quality. Development of new ideas and fresh perspectives seems to be an arduous process which generally requires a lot of thinking and rethinking. The learning gains which individualized instruction can contribute to current students may be counterbalanced by learning losses for future students if the intellectual vigor of the faculty declines. That is, while students may generally learn more of whatever is taught in a PSI course, the quality of what is taught may sometimes be higher

"It seems that lectures are not dinosaurs of past ages, but rather a highly evolved and successful species in the pedagogical sphere."

Frequent Testing and Immediate Feedback

Theoretically, frequent testing with immediate feedback stimulates a continuous rate of learning (rather than cramming) by students and provides guidance so that things are learned in productive rather than unproductive ways (Skinner, 1954). The process provides a steady stream of reinforcement contingencies to reduce the chances of a

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... the repeated study-test-feedback loop provides students an opportunity to assess their learning progress and to keep themselves on the right track, making continuous fine-tuning adjustments as they go along.

Mastery Grading for Core Topics

Mastery learning theory asserts that under appropriate instructional conditions virtually all students can learn well (Block & Anderson, 1975; Anderson & Block, 1976). That is, teachers can teach in such a way that most students can master most of what is taught. Further, as a result of these successful learning experiences, students theoretically develop positive attitudes toward learning and therefore enjoy increasingly strong intrinsic motivation to continue learning. The concept of mastery is not new; its origins can be traced to such early educational philosophers as John Locke (Bloom, 1974).

In mastery teaching, the instructor determines a minimum acceptable level of performance on unit tests (usually 80 percent to 100 percent) and requires that students who fail to achieve this level retest and retake quizzes until they obtain an acceptable score. There is no penalty for unacceptable quiz scores.

Mastery teaching produces significant learning gains among students. A review of 97 studies of achievement with mastery and nonmastery conditions found that mastery students scored higher 89 percent of the time and significantly higher 61 percent of the time; likewise, in 27 comparisons of retention scores, mastery students almost always scored higher than nonmastery students and significantly higher 63 percent of the time (Block & Burns, 1976).

Yet mastery seems to generate greater skepticism among college and university faculty than any of the other components of PSI. The nature of the controversy has been succinctly summarized by Block and Burns (1976):

Critics of mastery learning assert that mastery approaches to instruction are rigid, mechanistic, training strategies ... that they can only give
students the simple skills required to survive in a closed society . . . and that they do not appreciate the complexities of school learning . . . Adherents of mastery approaches to instruction maintain that they are flexible, humanistic, educational strategies . . .; that they can provide students with the complex skills needed to prosper in an increasingly open society . . .; and that they do take into account the realities of classroom life . . . (p. 3).

One way to resolve the conflict is to combine mastery and normative grading in a single course, not an uncommon practice. Mastery grading may be used for those topics which the instructor feels are core elements; that is, those which, in the instructor's opinion, all students should master before going on to more advanced topics.

Normative Grading for Advanced Topics

It seems desirable at times to encourage students to "reach" or "stretch" as high as their own intellectual limits will allow, rather than to minimum acceptable levels set by the instructor. Normative grading has been successfully used for this purpose for years. The value of competition as a means of achieving excellence has been repeatedly documented, not only in academia but in sports, social systems, and many other areas. Competition in civil service examinations, for example, has been credited with creating a stable society in China for two millennia (Ebel, 1972). Competition is also an integral part of the American free-enterprise system. As a consequence, competition in school is valued not only as a means of identifying the brightest and most capable students, but also as important preparation for life in the "real world."

Normative grading also avoids problems of grade inflation which may result when mastery grading is used by itself. Further, it isn't always possible or appropriate for an instructor of a college-level course to define precisely the limits of a knowledge or skill set that students are to acquire (a necessary condition for virtually random access. Students can study these materials at their convenience, at their own pace, and as often as they wish. Keller (1968) proposed sole reliance on printed materials for information transfer. The traditional lecture method offers substantive information to students in two modes, auditory (lectures) and print (text). The audio-autotutorial approach (Postlethwait, 1965) adds two more communication channels, visual images in tape/slide programs and interactive work with demonstration materials. As mentioned previously, audio-autotutorial methods have proven to be more effective than the lecture method in promoting student learning (Fisher & MacWhinney, 1976). One is reminded of the proverb, "I hear and I forget, I see and I remember, I do and I understand." Presumably, the greater the range of media employed, the greater the likelihood that a student's individual learning style will be optimized. More important than the quantity of the material selected, however, is its quality and appropriateness for the learning task.

Elements Excluded

Some features of PSI are not emphasized in CMI because available evidence suggests that they do not contribute significantly to gains in student learning. These include: motivational lectures, self-paced, and proctor-grading. That is, student achievement remains about the same whether motivational (as opposed to substantive) lectures are included or omitted (Calhoun, 1976), whether progress is self-paced or instructor-paced (Robin & Graham, 1974; Semb, Conyers, Spencer, & Sanchez-Sosa, 1975; Calhoun, 1976), and whether quizzes are self-graded or proctor-graded (McMichael & Corey, 1969; Born, Gledhill, & Davis, 1972; Blackburn, Semb, & Hopkins, 1975; Calhoun, 1976). Some instructor-pacing seems preferable because self-pacing leads to problems of procrastination, higher drop-out rates, and failure to finish the course (Robin & Graham, 1974; Semb et al., 1975).

Prototypes

The combination method of instruction has been and is being developed in a number of large enrollment science classes at the University of California—Davis. Use of a computer system to generate and score unique quizzes makes the frequent testing both feasible and cost-effective in a large class setting. Discussion of quiz results by the student and teaching assistant serves both to personalize the feedback and to allow it to take on greater depth, while still keeping the cost relatively low.

Once appropriate computer programs are developed they can be shared by many different courses (providing the necessary flexibility is built into them), making program development cost-effective.

Typically, a professor and a part-time graduate student can produce a bank of reasonably high quality items in 6 months to a year, while continuing their other activities. We have found that professors can and are willing to share a single item bank for several different but similar lecture courses.

Maintenance of an item bank is less
problematic than might be anticipated. Students are excellent critics who call attention immediately to any item that seems wrong, outdated, or irrelevant to a particular course. This, in combination with item analyses generated by the computer, makes pruning and refining of the item bank a relatively simple task. Teaching assistants and faculty add some new items each quarter.

We find that students like frequent quizzes. They report feeling that they learn more and feel less anxious about their progress. They seem especially to appreciate being able to take quizzes at times of their choosing.

This new PSI/lecture hybrid bears remarkable resemblance to a centuries-old tradition, the University of Oxford tutorial. The tutorial system includes: lectures; a weekly paper by the student which is presented orally to the tutor/professor; immediate feedback from and discussion with the tutor; emphasis on higher order skills including reading, writing, and elocution as well as content skills; and extensive use of structured learning materials (books). The method of grading is somewhat analogous to a mastery/normal combination.

While few universities enjoy Oxford's student-teacher ratio, or may hope to even in the future as student numbers decline, the advantages of including at least some student exposition, oral defense, and reading of original sources in the combination method of instruction (or other methods) are not to be overlooked.

Summary

The personalized system of instruction is designed to provide psychological reinforcement for the enhancement of student learning and satisfaction. It has proven to be one of the most effective instructional methods yet devised for college teaching. Unfortunately, it is not as satisfying a method for many instructors and it may at times introduce a time lag into the processes of transmitting knowledge.

The traditional lecture method has evolved in such a way that it maximizes intellectual stimulation and personal-social satisfaction for the instructor. It is hypothesized that the continuous impetus for reading, thinking, and synthesizing knowledge provided by this method is indirectly beneficial to institutions of higher learning and the world at large through its enhancement of research and scholarship. The lecture method is accepted by students and is as effective as discussion or independent study. It is, however, less effective than PSI and other individualized approaches in promoting student learning and retention.

The evidence seems strong that the Keller Plan is good for students and lecturing is good for faculty. CMI resolves this dilemma. It is expected to produce levels of student achievement as high as those now obtained with PSI and instructor satisfaction as great as that associated with the lecture method. CMI consists of six elements: (a) substantive lectures, (b) frequent tests with immediate feedback, (c) emphasis on higher order skills, (d) mastery grading (for some units), (e) normative grading (for other units), and (f) carefully structured learning materials. With CMI, instructors find ongoing intellectual stimulation in the processes of preparing and delivering lectures and creating challenging test questions. Student learning and motivation are enhanced through the incorporation of frequent testing, immediate feedback, and mastery grading—i.e., those elements of PSI that have proven most potent. Normative grading is included for some units to encourage students to stretch as high as their intellectual limits will allow, rather than to some predetermined level. CMI is similar to PSI in its reliance upon carefully structured learning materials for independent, self-paced study; it is similar to the lecture method in that these learning materials are not the sole source of substantive information.

This, at least, is the theory. Considerable research will be required to determine if it is empirical fact. While it seems clear that frequent testing, immediate feedback, and mastery grading are potent components of PSI, will they be equally potent in another context? Why do most college teachers shy away from PSI? If it is because of the intellectual stimulation associated with lecturing, as proposed here, CMI may provide a suitable avenue for achieving higher levels of student learning and satisfaction on a widespread basis. If, on the other hand, it is simply adherence to tradition or aversion to change, then CMI is no more likely to be widely accepted than PSI has been. More research is needed on instructor attitudes and satisfactions as well as on institutional expectations, because these more than anything else determine the acceptance (or rejection) of new instructional methods.

Reference Notes


References


Block, J. H. & Burns, R. B. Mastery learning. In Shulman, L. S. (Ed.),
“More research is needed on instructor attitudes and satisfactions as well as on institutional expectations, because these more than anything else determine the acceptance (or rejection) of new instructional methods.”
The Relationship of Test Performance to ISDP Rating in Organic Chemistry Texts

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Introduction

The Chemistry Department at Brigham Young University (BYU) has used two different textbooks for the beginning organic chemistry course. The two textbooks are *Introduction to Organic Chemistry* by Streitwieser and Heilbronn (1976) and *Organic Chemistry* by Morrison and Boyd (1973). The two different textbooks were used to determine the most appropriate textbook for the organic chemistry course.

For the evaluation of students' performance, a national standardized organic chemistry test was used. Students' scores on the test represented student competency in this area. Therefore, this study used Form 1974 American Chemical Security (ACS) Cooperative Exam in organic chemistry, prepared by the Examination Committee of the Division of Chemical Education of the American Chemical Society through its Organic Chemistry Subcommittee. The test has 70 multiple-choice items.

Prior to this study the Chemistry Department at BYU had selected a textbook based upon student performance (ACS organic chemistry test) and intuition; however, no empirical study such as the one described in this article had been conducted to assist with the selection process. Therefore, this study was designed to find out which textbook is "better" from an instructional science perspective and to provide data bearing on the Chemistry Department's textbook selection decision.

Merrill, Olsen, and Coldeway (1976) have developed an analytic tool to evaluate instructional materials. This tool is called the Instructional Strategy Diagnostic Profile (ISDP). The ISDP is an instrument to judge the consistency and adequacy of a content/task objective, presentation, and evaluation.

"... this study was designed to find out which textbook is 'better' from an instructional science perspective. . . ."

Overview of the Instructional Strategy Diagnostic Profile

The ISDP is an analytic tool, in the form of a set of prescriptions, that facilitates the evaluation and revision of existing instruction and the design of new instruction. The ISDP is designed to evaluate instructional materials on two main criteria: consistency and adequacy. Consistency must be determined before adequacy can be assessed.

The consistency criterion is met if the instructional objectives, test items, and the instructional presentation are consistent. Determining consistency is accomplished in two steps. First, the instructional objectives and test items are classified on two dimensions: (a) the performance, or task level, required of the student and (b) the type of instructional content. These two dimensions are combined to form a task/content classification matrix, which is used to classify objectives, test items, and instructional presentation. This matrix is illustrated in Figure 1. If an objective and its corresponding test item can be classified in the same cell of the matrix, they are considered to be consistent. The second step involves rating the consistency between instruction and objective/test items. The ISDP requires that different components of instructional presentation, called primary presentation forms, be present for different combinations of task level and content type. If the combination of primary presentation forms required for the task level and content type of each objective/test item is present, then the instruction is consistent with the objective/test items.

Once it has been determined that instructional materials are consistent, the adequacy criterion is assessed. This is done by determining whether or not the instructional presentation adequately communicates the "to-be-learned" information. Variables that are hypothesized as affecting instructional ade-
## Task/Content Classification Matrix

As shown in Figure 1, the task dimension of the task/content classification matrix is comprised of several levels, the broadest of which consists of the strategies Use and Remember. Use is defined as the act of applying a general relationship to a specific situation where it has not been previously applied, and Remember, as the act of bringing to mind something that has been previously encountered. Thus, a use item (or objective) would require the student to respond by applying a generality to a newly encountered example; that is, one that has not been previously displayed to the student as part of the instructional presentation. A remember test item (or objective) would require the student to respond by recognizing or recalling a generality or example that has been previously encountered. Generality is defined as a statement of definition or relationship that can be applied to more than one specific object or event; and example, as a specific object or event or its representation that does or could exist in the real world.

The use level cannot be divided into sublevels—it always requires newly encountered examples. The reason for this is obvious—it an example had been previously encountered, the test item or objective would be classified at the remember level. The remember level, however, can be divided into sublevels, either paraphrase or verbatim. Paraphrase means equivalent in meaning but expressed in other words; verbatim, word-for-word or exactly the same. Thus, a paraphrase generality means that synonyms have been substituted for the substantive words (nouns, verbs, and modifiers) of the original statements; and paraphrase example means that the same object or event is presented but that the form or representation used to exhibit this object or event has been modified. A verbatim generality/example requires the student to recognize or restate the same words that were used previously to present the generality/example. All paraphrase and verbatim generalities and examples have been previously encountered by the student.

As shown in Figure 1, the content dimension of the matrix involves four mutually exclusive content categories: facts, concepts, procedures, and principles. Except for facts, for which there can be no generalities, all types can be tested at any of the task levels. These categories are defined as follows:

- **A fact** is a one-to-one association of a symbol and a specific object or event.
- A **concept** is a class of objects, events, or symbols that (a) share critical attributes, (b) can be referenced by a name or symbol, and (c) have discriminatingly different individual members.
- A **procedure** is a series of steps required to produce an example of an outcome class. Each step may involve the temporal or spatial ordering of specific objects, events, or symbols or a branching decision, based either on a fact or the classification of an example of a concept. A procedure is often characterized as “how to do something.”
- A **principle** is a predictive relationship between specific examples of a concept, or among a set of related concepts, which explains why an example of a particular class is produced as a result of a particular manipulation.

Further information concerning these content categories is provided in Merrill (Note 1), which was designed to teach users how to classify test items and objectives according to the ISDP task/content classification matrix. It should be noted that some of the variables.
identified as affecting instructional adequacy are not applicable to all content types and task levels.)

Primary Presentation Forms
The ISDP defines the instructional presentation form or display as the fundamental unit of instructional strategy. As indicated previously, the instructional presentation forms must meet consistency and adequacy requirements.

Four primary presentation forms or displays, which represent the various ways that information can be presented, have been defined (Merrill, Note 1):

1. Tell via generality (TG)—A display that presents a definition of a concept, an algorithm that describes a procedure, or a proposition that expresses a principle.
2. Tell via example (Teg)—A display that illustrates how a generality applies to a specific example.
3. Question via generality (QG)—Not used in this research study.
4. Question via example (Qeg)—A display that presents an example and requires the student to respond to the example or it presents a name or generality and requires the student to respond by providing an example.

Hypotheses
The hypotheses of this study are:

1. There is a significant difference between ISDP ratings for the two texts.
2. There is a significant difference on test performance between students using the two different texts.
3. There is a significant linear relationship between ISDP ratings and test performance of the two texts.
4. There is a significant difference between the text selected by the Chemistry Department and the text with the lower ISDP rating and lower performance.

Methods
Subjects
Four undergraduate organic chemistry classes at BYU were selected for this study. Two of the classes used Introduction to Organic Chemistry (by Streitwieser and Heathcock) and two of the classes used the Organic Chemistry text (by Morrison and Boyd).

Materials
The materials of this study consist of two organic chemistry texts used at BYU: Introduction to Organic Chemistry and Organic Chemistry mentioned in the preceding paragraph.

Design
Student posttest scores were obtained on the National Standard Organic Chemistry test, the 1974 ACS Cooperative Exam in organic chemistry. A discrimination analysis was conducted on each item of the test comparing test item scores for those students who used the Introduction to Organic Chemistry text with test item scores for those students who used Organic Chemistry. A discrimination index was arrived at using the following formula: D = (number of incorrect responses for each textbook)/(total number of respondents). Specific test items were selected for analysis if they had a percentage difference greater than 11 percent between the discrimination indices. A list of 18 items of the total possible 70 items of the posttest were selected for analysis. (The test items were numbers 2, 13, 17, 18, 27, 29, 33, 40, 43, 48, 54, 56, 57, 62, 66, 68, and 69 of the Form 1974 ACS Cooperative Exam in organic chemistry.)

An ISDP was determined for each posttest item. A systematic procedure was followed for the determination of each item's profile. The following is the step-by-step procedure used:

Step 1. Task level of item was determined.
Step 2. Content type of item was determined.
Step 3. The correct ISDP form was selected for the item dependent upon the task/content of the item. (See Figures 2 to 5.)
Step 4. Both texts were surveyed for location of presentation of information relevant to test item.
Step 5. Presentation-test consistency was determined (i.e., presence or absence and number of prescribed components for each test item).
Step 6. Presentation adequacy was determined (i.e., degree to which presentation components meet ISDP criteria).

When all of the selection posttest items were profiled according to the ISDP, a cumulative rating of overall text consistency and overall text adequacy was computed for each item.

Statistical analyses were conducted on the data to address the stated hypotheses of the study. The following are the specific analyses conducted:

1. A t test to compare ISDP consistency and adequacy cumulative ratings of the two texts.
2. A t test to compare posttest scores of the students using the two texts.
3. A linear regression of ISDP cumulative ratings on posttest scores.
4. Another comparison was made be-

... we suggest that the present materials be reassessed using the complexity of performance task measure...."
FIGURE 2. Sample ISDP form: UGeg component consistency.
### Presentation Adequacy for Use Generality Example

<table>
<thead>
<tr>
<th>UGeg Adequacy Questions</th>
<th>PROFILES</th>
<th>INDEX</th>
<th>PROBLEMS</th>
<th>PROFILES</th>
<th>INDEX</th>
<th>PROBLEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. TG (Tell via Generality)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consistency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Is there at least one TG display?  
  (If there are no TGs, go to the TG section.) |          |       |          |          |       |          |
| Isolation                 |          |       |          |          |       |          |
| Is each TG separate?      |          |       |          |          |       |          |
| Is each TG identified?    |          |       |          |          |       |          |
| Is one of the TG's an alternate representation?  
  Is a mnemonic included? |          |       |          |          |       |          |
| **TG INDEX**              |          | **3=**|          |          |       |          |
| **II. Teg (Tell via Example)** |          |       |          |          |       |          |
| Consistency               |          |       |          |          |       |          |
| Is there at least one Teg display?  
  (If there are no Tegs, go to the Teg section.) |          |       |          |          |       |          |
| Isolation                 |          |       |          |          |       |          |
| Are the Teg's generated?  |          |       |          |          |       |          |
| Are the Teg's identified? |          |       |          |          |       |          |
| Help                      |          |       |          |          |       |          |
| Are the Teg's accompanied by help?  
  Does at least one Teg use a simplified or presentation? |          |       |          |          |       |          |
| Matching                  |          |       |          |          |       |          |
| Are most Teg's matched?   |          |       |          |          |       |          |
| Sampling                  |          |       |          |          |       |          |
| Do Teg's represent a range of difficulties?  
  Are Teg's divergent on variable attributes? |          |       |          |          |       |          |
| **Teg INDEX**             |          | **5=**|          |          |       |          |
| **III. Qeg (Question via Example)** |          |       |          |          |       |          |
| Consistency               |          |       |          |          |       |          |
| Is there at least one Qeg display?  
  (If there are no Qegs, go to the Qeg section.) |          |       |          |          |       |          |
| Isolation                 |          |       |          |          |       |          |
| Are the Qeg's generated?  |          |       |          |          |       |          |
| Are the Qeg's identified? |          |       |          |          |       |          |
| Help                      |          |       |          |          |       |          |
| Are the Qeg's accompanied by help?  
  Do the feedback displays include help? |          |       |          |          |       |          |
| Matching                  |          |       |          |          |       |          |
| Are the Qeg's randomly sequenced on working difficulty, etc.? |          |       |          |          |       |          |
| Sampling                  |          |       |          |          |       |          |
| Do the Qeg's represent a range of difficulties?  
  Are the Qeg's divergent on variable attributes? |          |       |          |          |       |          |
| **Qeg INDEX**             |          |       |          |          |       |          |
| **OVERALL INDEX**         |          | **13=**|          |          |       |          |

**FIGURE 3.** Sample ISDP form: Presentation adequacy for use generality example.
FIGURE 4. Sample ISDP form: Rpeg component consistency.

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FIGURE 5. Sample ISOP form: Presentation adequacy for *remember paraphrase* example.
### Table 1. ISDP ratings on the 18 selected test items

<table>
<thead>
<tr>
<th>ACS test item</th>
<th>Morrison &amp; Boyd Text ISDP index</th>
<th>Streitwieser &amp; Heathcock Text ISDP Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TG</td>
<td>Teg</td>
</tr>
<tr>
<td>2</td>
<td>1.00</td>
<td>.40</td>
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<tr>
<td>13</td>
<td>.67</td>
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<td>17</td>
<td>.33</td>
<td>.80</td>
</tr>
<tr>
<td>18*</td>
<td></td>
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</tr>
<tr>
<td>27</td>
<td>.67</td>
<td>.80</td>
</tr>
<tr>
<td>29</td>
<td>.67</td>
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<td>33</td>
<td>.33</td>
<td>.80</td>
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<tr>
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<tr>
<td>43</td>
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<tr>
<td>48</td>
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<td>0</td>
</tr>
<tr>
<td>54</td>
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<td>.60</td>
</tr>
<tr>
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<td>.67</td>
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<td>.80</td>
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<tr>
<td>69</td>
<td>.33</td>
<td>.60</td>
</tr>
</tbody>
</table>

*Note. For the Morrison & Boyd text, \( \bar{x} = 3.882 \) and SD = .0432. For the Streitwieser & Heathcock text, \( \bar{x} = 2.135 \) and SD = .0888. TG = tell via generality. Teg = tell via example. Qeg = question via example. OI = overall index.

*Item number 18 has no ISDP ratings reported because no presentation could be found in either text on the content of the item.

### Table 2. ACS organic chemistry test performance

<table>
<thead>
<tr>
<th></th>
<th>Morrison &amp; Boyd Text</th>
<th>Streitwieser &amp; Heathcock Text</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Winter 1978</td>
<td>Winter 1977</td>
</tr>
<tr>
<td>Teacher 1</td>
<td>( \bar{x} = 46.0 )</td>
<td>( \bar{x} = 46.42 )</td>
</tr>
<tr>
<td></td>
<td>SD = 1.04</td>
<td>SD = 1.46</td>
</tr>
<tr>
<td></td>
<td>( n = 77 )</td>
<td>( n = 52 )</td>
</tr>
</tbody>
</table>

|                      | Winter 1978          | Winter 1977                   |
| Teacher 2            | \( \bar{x} = 47.5 \) | \( \bar{x} = 43.4 \)         |
|                      | SD = 1.12            | SD = 1.36                     |
|                      | \( n = 74 \)         | \( n = 49 \)                  |

*Note. \( t = 1.374, p < .10 \). For the Morrison & Boyd text, mean = 46.66 and SD = .760. For the Streitwieser & Heathcock text, mean = 44.96 and SD = 1.00.

p < .005); the respective means are .3882 and .2135.* (See Table 1.)

Hypothesis 2 stated: "There is a significant difference on test performance between students using the two different texts." The results of this study show partial support for the above hypothesis. Students using the Morrison and Boyd text (1973) had higher test performance than the students using the Streitwieser and Heathcock text (1976) on the 70-item posttest (\( t = 1.3745, p < .10 \)); the means respectively are 46.66 and 44.96. (See Table 2.) Also noted were marginal differences between the two groups on the 18 selected items (\( t = 1.52, p < .10 \)); the means respectively are 61.25 and 55.08. (See Table 3.)

Hypothesis 3 stated: "There is a significant linear relationship between ISDP ratings and test performance of the two texts." The above hypothesis was not supported by the results of the study (\( t = -0.007, p > .10 \)). The regression equation was \( y = 59.99 - 0.822x \). See Figure 6 for a plot of the data.

Hypothesis 4 stated: "There is a significant difference between the text selected by the Chemistry Department and the text with the lower ISDP rating and lower performance." The Chemistry Department selected the Morrison and Boyd text. The results of this study tend to support the above hypothesis. Students given the Morrison and Boyd text outperformed over the students given the Streitwieser and Heathcock text and the Morrison and Boyd text had higher ISDP ratings than the Streitwieser and Heathcock text.

### Discussion

The Morrison and Boyd text (1973) received higher ISDP ratings than the Streitwieser and Heathcock text (1976), and although student performance was only marginally significant, it was in the expected direction. That is, the text with the higher ISDP ratings, the Morrison and Boyd text, also produced higher student performance. Other available data similar to the data of this study were analyzed. A separate analysis was conducted on this data because the authors felt that the subject populations were characteristically different. The results of this analysis fully support the second hypothesis (\( t = 2.337, p < .025 \)), with the results in the expected direction. The Morrison and Boyd text group outperformed the Streitwieser and Heathcock group. The respective means were 46.26 and 43.44.

Although a linear relationship between posttest performance and ISDP rating was hypothesized, this particular research study found no such relationship. Merrill, in previous research (Note 2), has found that with similar content a linear relationship may not exist. In particular, the subject matter Merrill investigated contained test items of considerable complexity that the ISDP rating form possibly could not handle. The ISDP forms are designed to index one-to-one correspondence; however, certain subject areas do not follow a one-to-one correspondence between presentation and test items. Merrill has found a course in physics to be in this category (Note 2). Several of the items in the Organic Chemistry Exam were of

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*The ISDP ratings are based upon 0.00 to 1.00 scale.
the same type as described by Merrill.

Apparently the approach taken in this study can be helpful in textbook selection. The text that had higher ISDP rating and higher posttest student performance was also the text selected by the Chemistry Department.

Recommendations

Because a linear relationship was not found with this data and because the authors feel that the ISDP form may be limited to one-to-one correspondence type materials, it is recommended that further analysis be conducted on those test items from this study which are one-to-one correspondence types. The expectation is that the analysis will find a significant linear relationship for those items which have a one-to-one correspondence. Such research would be helpful in predicting student performance based on one-to-one correspondence type materials ISDP ratings.

On the other hand, Wood, Richards, and Merrill (1976) have conducted research investigating complex objectives or test items similar to those found in this study using ISDP rating forms. Wood used a complexity of performance task measure defined as the number and type of task/content relations inherent in individual test items. His findings indicate that a high correlation exists between student performance ratings and ISDP ratings of the presentation materials.) Therefore, we suggest that the present materials be reassessed using the complexity of performance task measure employed by Wood in his study. The expectation is that the more complex the task/content relations are the higher the probability of incorrect manipulation of one or more task/content. Such research would enable developers to isolate on those test items where problems arise to do the following: (a) identify items that should be simplified or broken down to smaller components of evaluation, if possible, (b) conduct "rear-end" analysis for diagnostic purposes, and (c) provide information as to what needs to be taught and included in the instructional materials.

The authors recommend other instructional materials be likewise studied, especially when material selection decisions are to be made. Also, research on textbook effects (i.e., supplemental materials, specific emphasis, laboratory experiences, etc.), which were not controlled in this present study need to be addressed.

The authors suggest that all instructional materials be rated according to the ISDP and that areas of low ratings receive development through a joint contribution from content experts and ISDP experts.
FIGURE 6. Plot of the correlation of the ISDP ratings and test performance.

Reference Notes


2. Merrill, M. D. Personal communication, April 1979.


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A Model for Applying Cost-Effectiveness Analysis to Decisions Involving the Use of Instructional Technology

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EDITOR'S NOTE
This is the second in a series of articles on the use of cost-effectiveness analysis to evaluate instructional programs. The first article appeared in the last issue of JID (Doughty, 1979) and provided an overview of conceptual and practical criteria for judging and designing cost-effectiveness studies. In the present article, Lent provides a detailed model of the methods of cost-effectiveness analysis as used to inform decisions about instructional development efforts, and other applications of educational technology. A companion article in the next issue of JID will go into further detail on the techniques of cost analysis appropriate to this context. Finally, the concluding article of this series will present an applied case study of cost-effectiveness analysis in an instructional development context that demonstrates many of the features, methods, and problems of such studies as described in the earlier articles.

Overview
As a result of difficulties encountered in attempts to apply the classical techniques of cost-effectiveness (CE) analysis to decisions facing instructional developers and educational technologists, it is apparent that those techniques require a certain degree of interpretation and adaptation if they are to be useful in this context. The following presentation describes a general model for applying CE analysis to decision situations involving instructional technology. A brief introduction to the nature of CE analysis is followed by a review of the history and problems encountered in its use within education. Finally, a six-phase model is presented for applying the methods of CE analysis to instructional technology.

Nature of Cost-Effectiveness Analysis
Determining the cost-effectiveness of something (such as an application of instructional technology) is a specialized kind of evaluation activity designed to help developers make informed decisions about the relative worth of alternative means to a given goal. Although definitions differ, cost-effectiveness can generally be defined as the relationship between something's inputs (costs) and outcomes (effectiveness) relative to the particular goal being served and the alternative means of achieving it. Cost-effectiveness is a relative quality of something that can be judged only in comparison to the similar property of another thing (Carpenter, 1970). One alternative is judged as more cost-effective than another if, for example, it is more effective in reaching the goal for a given level of cost or if it reaches a fixed level of effectiveness for the lesser cost (Quade, 1975).

Quade (1971) groups cost-effectiveness analysis with cost-benefit analysis, policy analysis, operations research and other management sciences as sharing the common purpose of aiding decision-making. Cost-effectiveness analysis is distinctive because it is designed to compare alternative approaches to a given goal. The cost of the alternative under consideration can generally be represented in monetary units. Effectiveness is usually not estimated in dollars, but rather is measured on a scale chosen to reflect the nature of the particular goal (e.g., achievement test scores). Thus, while CE analysis is a particularly flexible technique, it is only suitable for choosing among competing approaches to the same goal. When choices have to be made between competing goals as well as alternative activities, effectiveness must be measured in the same units as costs in order to make a meaningful comparison. Under these circumstances, the more specialized economic tool of cost-benefit analysis (comparing costs and benefits on identical scales of estimated monetary value) is more appropriate (Quade, 1971).

The nature and purposes of CE analysis make it particularly well suited for many of the decisions facing education in general and instructional technology in particular. Carpenter and Haggart (1972), and Doughty (1973, pp. 15-16) among others have suggested the variety of decisions to serve. It may be used to choose among alternative programs for achieving the same educational outcome, or to determine whether a single program is becoming more or less effective or expensive over time as a result of changes in the educational environment. The ability of cost-effectiveness analysis to assist in these kinds of decisions could impact upon the future use of instructional technology as an innovative or alternative approach to efforts at meeting educational goals under constrained budgets.

Growth of Cost-Effectiveness Analysis in Education and Instructional Technology
Over the last 10 years, increasing attention has been given to the potential
role of CE analysis in decisions regarding the design and conduct of instructional programs. For example, from 1956 to 1967 the Office of Education Research Reports listed four publications related to analysis activities. But in 1968, the new Education Resources Information Center listed 22 references under the specific descriptor "cost-effectiveness" and by the 1970's this number had grown to almost 100 references per year. Unfortunately, most of this attention appears to have been more rhetorical than practical. Reviews of this literature by such authors as Caffarella (1973), Vadhavanapich (1976), and most recently Levin (1978) have found that relatively few studies are actually being conducted or at least reported. Furthermore, careful consideration of the few reported studies suggests that CE analyses frequently suffer from serious methodological defects which threaten the validity and utility of their findings (Caffarella, 1975; Carnoy and Levin, 1975; Lent, Note 1; Rogers, 1976).

One explanation for this state of affairs is that the methods of CE analysis may be ill-suited to the kinds of variables present in any study of instructional programs. Dating back to some of the first attempts to conduct CE analyses in educational settings, various writers (e.g., Cogan, 1971; Grayson, 1972; Mushkin and Cleveland, 1968) began noting particular difficulties in applying the methods of CE analysis to meet the demands of their studies. Generally, these difficulties were seen to reflect the rather complicated and poorly defined nature of the variables involved in educational contexts as compared to the military, business, and engineering settings within which the analysis techniques were originally developed (Quade, 1975). In a detailed critique of the problems facing CE analyses of instructional technology, Levin (1971) concluded that the inadequate nature of our current understanding of the educational process virtually precluded any hope of meeting the basic requirements for the conduct of CE analysis.

In spite of this rather gloomy prognosis, the efforts of a number of analysts suggest that ways can be found to adapt CE analysis to serve educational decisions. The example studies and methodological suggestions of Carnoy (1976), Carpenter, Chesler, Dordick, and Haggart (1970), Dougherty and Stakenas (1973), Haggart (1978), Jamison, Kees, and Wells (1978), Karanowski (1968), Mayo, McAnany, and Kees (1975), Roid (1974), Lent (1977), and Temkin (1974) all provide evidence that the means can be found to successfully employ cost-effectiveness analysis in complicated decision situations. Furthermore, the experience gained from even relatively unsuccessful studies can suggest methodological adaptations useful in future studies (Lent, Note 2).

It is not the intent of this article (nor is there the space) to document the precise nature of the methodological problems and possible modifications required to successfully conduct CE analyses of instructional technology. A good introduction to many of these points has already been provided by Doughty (1979). Instead, the remainder of this presentation is devoted to the explication of a general model for applying the methods of CE analysis to decisions involving the use of instructional technology. This model has been derived from the suggestions in the existing literature and an extensive comparative analysis of the methods employed in reported CE studies of instructional technology. It also reflects the author's own experience and that of several of his colleagues in conducting this kind of study in a variety of educational settings. Certain aspects of the model were developed with the assistance of Temkin, Doughty, Beilby, and Stace in preparing a training session on this subject for the American Educational Research Association.

A General Model for Applying Cost-Effectiveness Analysis to Instructional Technology

A six-phase model for the conduct of cost-effectiveness analysis is described below and illustrated in Figure 1. The model is broken into phases by areas of methodological decisions and activities involved in completing a study. Overall, the process of conducting a CE analysis is seen to be only loosely linear with some phases occurring simultaneously. Within each phase, a variety of decisions and activities must be completed and, again, these often may be completed almost simultaneously or in different orders.

Several assumptions underlie the development of this model. First, it has been designed to be used by the instructional developer or educational technologist involved in the project that is to be the subject of the study. It is assumed that such a person would be familiar with the concepts and techniques of educational evaluation, but is also likely to require occasional assistance with specific aspects of research design, instrumentation or cost analysis. That is, it is this author's opinion that CE analyses

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**FIGURE 1.** A general model for applying cost-effectiveness analyses to decisions involving the use of instructional technology.
should not be the exclusive domain of someone with a specialized background in the tools of economic analysis any more than they should require the presence of a specialist in statistical analysis. The methods of CE analysis are necessarily eclectic and the person best suited to conduct them is typically the person most familiar with the context. Finally, this model assumes that CE analyses are conducted to provide information for decision-making. The emphasis in the necessary and desirable in the final study (Gephart, 1971); the program variables which the decision-makers believe are important; the information they seek and will find credible; and the process and timing of the decisions which the analysis will ultimately serve. In short, the following questions must be addressed:

- Who are the decision-makers?
- With what aspects of the instructional program are they concerned?

"Cost-effectiveness is a relative quality of something that can be judged only in comparison to the similar property of another thing."

design of such studies, therefore, should be on creating a valid and readily interpretable study that reflects the characteristics of the specific decision situation for which it was conducted.

A description of each phase of the model and the activities which comprise them follows. (It should again be noted that a companion article in this series focuses exclusively on the methods of cost analysis and thus that aspect of the model is not treated as fully here as it otherwise might have been.)

Phase I: Prepare for the Study
Cost-effectiveness analyses may or may not begin with the realization that the decision situation calls for a comparison of the costs and outcomes of alternative instructional programs or media. Often, the issue or decision at hand is viewed in some other way and only later is the necessity of a cost-effectiveness comparison realized (e.g., Lent, 1977). However, no matter when in the course of the investigation the decision to employ CE analysis is reached, a number of specific decisions must be made and information collected in order to begin the study.

Identify decision-maker(s) and audience(s). One of the first concerns in planning any CE analysis must be to ensure a clear understanding of the nature of the decision-makers who will be the primary users of the study's findings. The design, conduct, and reporting of the CE analysis will differ according to the level of decision-making (the higher the level of responsibility or decision-making, the lower the amount of detail necessary and desirable in the final study, Gephart, 1971); the program variables which the decision-makers believe are important; the information they seek and will find credible; and the process and timing of the decisions which the analysis will ultimately serve. In short, the following questions must be addressed:

- What information do they want?
- How and when will they reach their decisions?

In addition to the formal decision structure, the interests of a number of other groups or individuals may have an important influence on the conduct of the study. For example, a university's decision to introduce television-based courses cannot be made without consideration for the attitudes of the faculty and students who will be involved in those courses. Answers to the following questions will help to establish the role and importance of various audiences for the study's findings.

- What groups or individuals are directly or indirectly affected by the program?
- What information would they be interested in?
- How will they influence the judgment or priorities of the decision-makers?

Determine study purposes. Cost-effectiveness analyses can be conducted to serve a variety of widely differing purposes and it is important to establish from the outset the specific framework within which the study is to be conducted. On the most general level, CE analyses can be conducted to describe the performance of existing instructional programs or to predict the performance of future programs. Perhaps most frequently, CE analyses are conducted to compare the performance of an existing program with that of a potential future program (which is typically a comparison of a traditional and innovative, instructional technology-based program).

The specific type or function of decision-making to be served can also have an impact on the design of the CE analysis (Doughty, 1973). First, analysis may serve a control function when the decision-maker is concerned with managing and monitoring the flow of resources and level of output. Analysis activities may also support the function of planning for predicted changes in the resources or outcomes of activities. A third function is that of evaluation where the emphasis is on comparing the desired versus the actual costs and outcomes of an activity. Finally, analyses may be conducted to serve a development function in order to assist in the generation, design, and implementation of new activities.

Finally, at the most immediate and pragmatic level, the purpose of the CE analysis can be defined in terms of the specific, individual questions posed by the decision-makers to be addressed through the study. These questions may reflect a variety of different aspects and issues surrounding the subject of the study and decision situation. At least in theory, complete cost-effectiveness analyses should address each variable that plays a significant role in the final decision. The following list suggests some of the dimensions of an instructional activity about which information might be requested.

- Costs—direct and indirect, budgetary and nonbudgetary, capital and operating
- Outcomes—direct and indirect
- Relative effectiveness in achieving a goal
- Relative efficiency in achieving a goal
- Impact of changes on existing system/subsystems
- Political and organizational implications
- Consideration of intangible impacts

Plan study management. The final element in preparing to conduct a CE study is a consideration of the resources available for the study and the overall timelines and operating characteristics to be followed in conducting the study. The analyst must determine the budget available for the full study and then allocate that budget across the study's various activities. At this point it often becomes necessary to consider the deci-
Identify the goal(s) of the system under study. By definition, CE analysis involves a comparison of alternative means to a given end. The process of identifying and defining possible alternative means must therefore be based upon a clear understanding of the goal(s) to be served. This requires careful consideration of the system within which the alternatives are to function and the surrounding environment or suprasystem within which that system resides.

Identify any constraints upon the way in which the system's goal(s) are achieved. In addition to understanding the nature of the goals, it is necessary to identify any constraints or requirements for achieving those goals (Kazanowski, 1968). Knowledge of constraints and requirements can then be used to establish the parameters of feasible alternatives. Typical constraints might include the scope of available resources and any untenable side effects that are likely to render to many approaches to the goal's achievement. The analyst should review identified constraints carefully to ensure that they are necessary and realistic and not simply the result of tradition and unexamined assumptions.

Identify a range of existing or potential alternative means for achieving the goal(s). Working from the information on the system's goal and its constraints, along with an understanding of the decision-maker's information needs, it is now possible for the analyst to begin identifying or further defining the various alternative approaches to the goal. It should be noted that this step is to be completed even under those circumstances in which the alternatives seem fairly clear to the decision-maker. Often, an additional alternative can be considered within the CE analysis for little extra cost or effort and with great benefits for the eventual utility of the study.

The outcome of this step is the selection of the particular alternatives to be compared within the CE analysis. Three specific activities are required at this point.

The first activity is designed to stimulate creative thinking regarding the range of possible alternatives. Rather than focusing immediately on specific alternatives, the analyst should identify

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Phase II: Identify Alternatives

The second major phase of methodological activity in conducting a CE analysis involves identifying the alternatives to be compared within the study. The utility of the study's findings will ultimately depend in large part upon the nature of the alternatives chosen for comparison. Frequently, however, the nature of the alternatives under consideration by the decision-maker has not been fully established prior to the study's beginning. Furthermore, the analyst may want to introduce additional alternatives that may either outperform the original alternatives or provide an important source of extra data for comparison against those original alternatives. (For an example of this situation see Lent, 1977.)

Identifying and defining the alternatives for study then becomes one of the most creative and important activities of the whole study. Four sequential steps for completing these activities are described below. While the completion of these steps is primarily the responsibility of the analyst, the decision-maker should be involved throughout.

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A Cost-Effectiveness Analysis Model

Phase I: Prepare for the study.
- Identify decision-maker(s) and audience(s).
- Determine study purposes.
- Plan study management.

Phase II: Identify alternatives.
- Identify the goal(s) of the system under study.
- Identify any constraints upon the way in which the system's goal(s) are achieved.
- Identify a range of existing or potential alternative means for achieving the goal(s).
- Describe the selected alternatives.

Phase III: Design cost-effectiveness.
- Define criteria.
- Design analytical model.

Phase IV: Determine costs.

Phase V: Determine outcomes.

Phase VI: Assemble findings.
- Assemble cost and outcome information.
- Analyze information and prepare recommendations.
- Consider uncertainties and test assumptions.
as many alternative approaches or classes of alternative approaches as possible. Answers to the following questions may suggest some of these alternatives.

- What is the current approach to the goal? Could it continue in the future? What was its predecessor? What would be the exact opposite approach?
- On what performance dimensions do the most critical differences among alternatives lie? Could alternatives be identified which represent the extreme points on each of these dimensions?
- How will the comparison of alternatives serve the information needs of the decision-makers? In what ways could additional alternatives provide a more complete picture of the trade-offs involved in the choice of a specific approach?

Examples of CE studies exist which illustrate the identification of alternatives in each of the ways suggested by these sets of questions (e.g., Carpenter et al., 1970; Lent, 1977; Mayo et al., 1975). When the subject involves the use of instructional technology, further alternatives can sometimes be identified by considering separately the two ways in which instructional technology can improve the cost-effectiveness of an educational activity: by improving instructional effectiveness and thereby bettering the rate of return on invested resources, or by reducing costs while maintaining a constant level of instructional effectiveness.

Once a range of possible alternatives has been identified, the next activity is to review these alternatives for possible inclusion within the study. The following questions should be addressed in the process of this review.

- Are the alternatives feasible within the constraints set for the goal's achievement?
- Do they represent critical competitors (or are some of them only "straw men")?
- Can they be designed to show their best sides within the present study?

The concluding activity of this step is to make the final selection of the alternatives to be compared within the CE analysis. This selection should be completed in consultation with the decision-maker and is likely to involve some consideration for the number of alternatives that can be realistically investigated with the resources available for the study. Cost-effectiveness analyses rarely involve more than four alternatives.

Describe the selected alternatives. The final step of Phase II requires that the analyst create a careful description of how each of the alternatives is functioning or would function in achieving the goal within the system under study. Several of the specific techniques used to describe the operation of alternatives at this stage include: model building, experimental design, input-output analysis, futures invention, and case studies. Whatever technique is used, the important point is that the functional characteristics of each alternative are fully understood before proceeding with the study.

Phase III: Design Cost-Effectiveness Comparison

The purpose of this phase of the analysis is to design the specific form of the cost-effectiveness comparison itself. There are two major components to be considered: criteria and the analytical model.

Define criteria. A criterion is a particular property or characteristic of something which is chosen for making a decision or judgment about that thing. In a CE study, at least two criteria must be employed to judge the relative desirability of the alternative means to the goal. One of these criteria must reflect the resources consumed in attempting to achieve the goal while the other highlights the defining element of the goal's effective achievement. Most CE analyses, however, employ more than two criteria in structuring their comparison. Typically one or two cost criteria are identified along with up to five or more effectiveness variables. Additional criteria are sometimes specified which have little to do with either the cost or effectiveness of the goal's achievements. Such criteria are apt to reflect secondary or tertiary impacts of the alternatives or certain feasibility requirements in their operation (Lent, Note 1, Chapter 4). Some of the criteria employed in CE analyses of instructional technology have included: cost per student, cost per viewing, student achievement and attitudes, production of graduates, efficiency, and faculty receptivity.

Criteria should be selected on the basis of their relevance to the decision-maker. That is, they should reflect the specific dimensions of system performance which the decision-maker will consider, even intuitively, in making a final choice between or judgment of the alternatives. Criteria can be identified in part by reviewing the information needs and study purposes identified in Phase I. Additional criteria may be suggested by the process of choosing alternatives for the comparison. But the best way to define criteria is through direct interview with the decision-maker(s).

Design analytical model. The second component to be considered in structuring the CE comparison is the analytical model. This model provides the framework upon which the performance of the alternatives on the various cost and effectiveness criteria are to be compared. Two of the most common forms of analysis models in CE studies of instructional technology are ratio and matrix models. The ratio model produces a relatively direct and simple comparison of cost per unit output by alternative. The matrix model compares the alternative across an array of criteria with the performance of the alternatives reported in the naturally occurring units of each criterion. While the ratio approach virtually awards a cost-effectiveness "score" to each alternative, the matrix model leaves the final judgment of relative cost-effectiveness to the decision-maker.

Analytical models can range from simple to complex. They can rely upon physical or conceptual, and quantitative or qualitative techniques in their design. A good model will focus on the most relevant variables in the CE comparison and clearly communicate the results of the analysis. Traditional approaches to CE analysis have also emphasized the role of the analytical model in fixing certain variables and thereby simplifying the comparison. However, in educational settings, very few reported studies have been able to meaningfully fix
either the cost or the effectiveness sides of the analysis. (But they usually do control time as a variable.)

Phase IV: Determine Costs

The cost and effectiveness sides of the investigations represent almost separate substudies within the overall CE analysis and are treated here as such. The cost study begins with careful consideration of the nature of the resources required by the alternatives and the kind of cost reports the decision-maker will find most meaningful. Cost analyses of instructional technology may categorize costs technically (by the nature of the specific objects or services being employed), economically (by the variable or invariable nature of the costs in an operating system), or by an accountability classification (which distinguishes between capital and operational expenditures), or a financial classification (which classifies costs by contributor and distinguishes between direct and indirect costs). A thorough cost analysis will employ several of these classifications as relevant to the decision-maker (UNESCO, 1977).

The overall approach to the cost investigation itself is based upon the lifecycle costing concept in which the costs of an activity are identified over the design, investment, and operation period of its existence. (A companion paper in range of evaluation methods in investigating the alternatives. Specific consideration of such methods is beyond the scope of this article.

Phase VI: Assemble Findings

The concluding phase in the conduct of CE analyses involves the synthesis of the cost and outcome sides of the study and the subsequent analysis of this information on an alternative-by-alternative basis. Three steps must be completed in sequence.

Assemble cost and outcome information. At this point it is time to apply information gathered through the separate cost and outcome studies to the analysis model. Depending on the nature of this model's design, it is sometimes necessary to transform the data as originally obtained into a form that will fit the model. For example, ratio models require that the numerator and denominator reflect a common meaningful cost per unit of output and thus a wealth of evaluative information must be reduced to a single statement like cost-per-student contact hour, or cost-per-unit gain or an achievement test. No matter what kind of analysis model is used, it is important to report as much of the data (and assumptions employed in gathering it) as possible. Cost-effectiveness analyses will frequently uncover some data may need to be summarized within and between alternatives, and it is here that a good analysis model is most helpful. Findings from this comparative analysis, noting important similarities and differences between alternatives, should be reported in support of various decision alternatives and recommendations.

Consider uncertainties and test assumptions. The final step in the process of cost-effectiveness analysis is to review the design and conduct of the study to identify areas of particular weakness in its findings. This involves identifying those criteria and data with large uncertainty factors and conducting some form of sensitivity analysis to estimate how the findings would change if the study's assumptions were violated or errors made in the study's design or procedures (Quade, 1976). Sensitivity analyses are particularly important in predictive CE comparisons where much of the study has been based upon predictive models and estimation. The final report of the analysis should contain a section which specifically treats the likelihood of errors or changes in the findings and their impact on any conclusions drawn from the study.

Concluding Remarks

A six-phase model has been presented for the application of cost-effectiveness analysis to decisions involving the use of instructional technology. As described here, the model's activities imply a reasonably elaborate analysis effort: a more complicated effort may be required for some studies. The distinguishing characteristic of a good study is not its size or expense but its foundation in proper design decisions. Furthermore, in no case should the cost of conducting the CE analysis exceed the cost of choosing the wrong alternative.

Some mention also should be made as to the role of the instructional developer or educational technologist in the design and conduct of CE studies. The role of analyst and decision-maker, yet in practice such distinctions often disappear. Cost-effectiveness studies may be conducted with a team of cost analysts, evaluators, and instructional developers working to serve multiple decision-makers and other audiences for the findings. In other situations, however, the instructional de-

"... the process of conducting a CE analysis is seen to be only loosely linear with some phases occurring simultaneously."

this series by Bellby will elaborate the specific methods of costing the use of instructional technology.)

Phase V: Determine Outcomes

Determining the outcomes of the operation of the alternatives, or the effectiveness side of the analysis, involves the conduct of an appropriate evaluation study. Each of the noncost criteria should be the focus of a specific substudy to determine the performance of the alternatives on that criterion. The design of these studies will vary with the nature of the criteria, the resources available for the investigation, and the alternatives chosen for comparison. Effectiveness analyses of instructional technology are apt to employ a full important differences between the alternatives that were not suggested by the original set of criteria and these differences should be portrayed even if they do not fit neatly into the analysis model. The challenge facing the analyst here is the preparation of a clear report that portrays the results in an understandable and accessible manner.

Analyze information and prepare recommendations. The second step in developing the study's findings is to analyze the results across alternatives. Each alternative's performance is compared and contrasted across the variables or criteria important to the final decision. To accomplish this, various amounts of quantitative and qualitative
"... the conduct of CE analyses of instructional technology may be as much an art as a science."

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Applying the ATI Concept in an Operational Environment

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Overview

In the more than a decade since Cronbach (1967) made his recommendation that instructional methods be adapted to student differences, much has been written about the aptitude-treat-interaction (ATI) methodology, ordinal and disordinal interactions, and the search for meaningful hypotheses involved with ATI research (e.g., Berliner & Cahan, 1973; Bracht, 1970; Hunt, 1975; Parkhurst, 1975; Rhetts, 1974; Tobias, 1976). An attempt is made in this article to synthesize the authors' experiences and the relevant literature in the area of ATI research into a working model for applying the ATI concept in an operational instructional environment. This model attempts to set forth a framework for designing, evaluating, and implementing alternative instructional modules that can benefit individual learners, instructors, and the instructional environment as a whole.

By way of review, an aptitude variable can be any personological or organismic variable upon which individuals differ (e.g., IQ, anxiety, dogmatism, level of prior experience or achievement, etc.). A treatment is any instructional strategy or combination of instructional strategies that structure information in particular ways that are matched to specific student needs or characteristics. As generally defined, an aptitude-treatment-interaction exists when, as a result of a given treatment, individuals at one end of an aptitude variable continuum perform at one level on a criterion measure. Individuals at the other end of the aptitude variable continuum perform at a significantly different level on the criterion measure and the reverse performance patterns hold true for a second treatment. (Expanded discussions of the ATI concept can be found in Cronbach and Snow, 1977; Snow, 1977; and Snow and Solomon, 1968.)

The literature is filled with ATI plots (varying greatly in degree of angularity) of different treatment groups against a variety of both aptitude and criterion measures. Little if anything, however, has been written proposing ways to incorporate the ATI concept into a decision-making instructional environment. Two common criticisms of the ATI approach are that findings resulting from ATI research (a) lack a design strategy that demonstrates a need to develop alternative modules in the first place and (b) do not include guidelines for selecting particular student characteristic/treatment matches. The proposed working model addresses these issues and is based on the premise that the ATI concept is best applied, not in isolation, but as an integral part of the dynamic decision-making instructional environment. (A more detailed treatment of the proposed model, including the theoretical and empirical rationale for model procedures and evaluation data from an application of the model, can be found in McCombs and McDaniel, Notes 1, 2, and 3.)

Five aspects of applying the ATI concept in an operational instructional environment will be presented: (a) implementation methodology (the overall steps in the process); (b) aptitude and outcome variable categories (procedures for selecting appropriate independent and dependent variables); (c) data
analysis procedures (approaches used in the design and evaluation of alternative modules); (d) alternative module design and development guidelines (design suggestions for instructional designers); and (e) module assignment guidelines (procedures for identifying and assigning treatments to particular students).

Implementation Methodology

The assumption underlying the implementation of the proposed model is that for most of us, the time and expense involved in alternative module development is not worth taking unless the existing instructional treatment or module causes large or alarming student failure rates or excessive variations in the criterion variable. That is, if all students are reaching criterion or achieving mastery (passing grades) in an acceptable time frame with a given existing module, why use resources searching for ATTs or developing alternative modules? It is only when grades, time-to-completion, or some other dependent variable of interest or importance varies excessively with a given module or otherwise indicates that the needs of all students are not adequately being met by a single module, that educators should be concerned about developing alternative modules. Only then does it seem justifiable to allocate resources for alternative module development in an operational instructional environment.

The methodology proposed by the model involves six main steps, as shown in Figure 1:

Step 1: (Point "A") Establish main track modules. Establish a single or main track of instruction; that is, develop a "best guess" approach or strategy for teaching instructional concepts (grouped into modules) for the entire unit or course being taught.

Step 2: (Point "B") Establish student

![Diagram](image.png)

**FIGURE 1.** A working model for designing, evaluating, and implementing alternative instructional modules.
characteristics data pool. Establish a data pool of student characteristic variables of interest and importance. These variables must be ones that are expected to be closely associated with performance on the criterion measure(s) and can easily be assessed by available measures.

Step 3: (Point "C") Assess main track module performance. Examine the dependent variable(s) of interest, usually score and/or completion times, with regard to student failure rates or amount of variance in student performance on the main track of instruction. Identify those main track modules with unacceptable failure rates or excessive variance in the dependent variable(s).

Step 4: (Points "D" and "E") Analyze predictor/criterion variable relationships. Analyze predictor/criterion variable data and, based on significant predictor/criterion relationships, design and develop alternative modules for the selected unacceptable main track modules.

Step 5: (Points "F," "G," and "H") Evaluate alternative module(s). Implement alternative module(s) and evaluate their effectiveness in meeting the needs of the students for whom they were designed. That is, examine the performance of students randomly assigned to main track and alternative modules via an ATI regression analysis approach, using the aptitude variable(s) in the treatment design set. Assess evaluation results and make decisions as to the relative effectiveness of the alternative module(s) versus main track modules.

Step 6: (Points "I" and "J") Individualize the assignment of alternative module(s). For those alternative modules that demonstrated satisfactory performance in meeting differential student needs, devise assignment rules for manual (e.g., per decision tables) or computer-based (adaptive decision model) selection of student/module matches. Continue to monitor and evaluate the performance of alternative module(s).

Aptitude and Outcome Variable Categories

Once the main track modules have been developed (Step 1) serious consideration must be given to the selection of variables to be entered into the student characteristics data pool (Step 2). At least the following four categories of aptitude (independent) variables are suggested for consideration (see Point "B" in Figure 1): (a) cognitive; (b) achievement motivation; (c) personality/anxiety; and (d) derived.

Cognitive

This category includes general mental ability measures (e.g., IQ or general aptitude measures), specific aspects of general mental ability (e.g., perceptual or logical reasoning measures), or specific information processing measures (e.g., short- and long-term memory measures, measures of analogical reasoning components) for which a strong rationale could be built that the variable or variables are related to performance on the dependent variable(s) of interest. A number of potentially relevant cognitive variables have been identified by Cattell (1971), Guilford (1967), and Sternberg (1977, 1978).

Achievement Motivation

This element of the data pool is important in determining the degree to which an individual's motivation to succeed is related to the task at hand. The concern here, then, is with measuring specific task-related achievement motivation for the dependent variable of interest (e.g., motivation to obtain high grades on a particular unit or course of instruction). For an excellent discussion of factors to consider in the selection of this type of variable, see deCharmes and Muir (1978).

"Little if anything . . . has been written proposing ways to incorporate the ATI concept into a decision-making instructional environment."

Personality/anxiety

According to Cronbach and Snow (1977), analysis of what they call achievement-treatment-interactions via levels of anxiety is a potentially useful concept that has emerged from analyzing many ATI studies. The optimal level between various levels of trait and state anxiety and trait and state curiosity as predictors for differing kinds of performance tasks has yet to be widely studied; however, among those who have written on this topic are Lehtissey-McCombs (Note 4); Lehtissey-McCombs, O'Neil, and Hansen (1971); McCombs and McDaniel (Notes 1, 2, and 3); and Spielberger (1972).

Derived

A fourth category of independent variables that deserves attention in more sophisticated instructional environments is a category of variables that can be referred to as within-course or derived variables. For example, using time on one or several previous modules (or some other variable whose value is not determined until after the start of an instructional unit) to predict time or score (or some other dependent variable of interest) on subsequent modules would be a form of adaptation which uses the derived category of aptitude variables. This derived set of variables can often only be studied in computer-based instructional systems where dynamic data collection and decision-making are possible. Tobias (1976) presents a good argument and supporting data for using derived variables, such as level or prior achievement, in ATI research.

Finally, outcome (dependent) variables must also be selected. The selection of these variables is usually dictated by the type of instructional context. In conventional settings, grades or achievement test scores are typical dependent variables; in more innovative self-paced or computer-based settings, time-to-criterion, criterion test scores, and a number of attempts to mastery are representative dependent variables.

In the choice of appropriate dependent variables, the important consideration is to select the variables most critical to the effectiveness of the instructional system (i.e., those variables which best indicate student mastery of instructional objectives).

Data Analysis Procedures

There are three basic stages in the data analysis procedures: (a) identifying the main track modules with excessive failure rates or large variabilities in the dependent variables (Figure 1, Point
(a) identifying a predictor set that is most predictive of dependent variable values for the candidate main track modules (Figure 1, Points "D" and "E"); and (c) using ATI regression methodology to evaluate alternative module effectiveness and determine predictor score ranges to be used in individualizing alternative module assignments (Figure 1, Points "F" through "J").

Identifying Candidate Main Track Modules

This step in the data analysis procedure entails the computation of some relatively simple descriptive statistics on the performance of all main track modules. For example, if criterion test scores or other measures of student achievement are available, one useful statistic is the percentage of students who fail to reach criterion or fail to obtain a passing score on main track modules. This statistic is then used in making the determination of which main track module(s) have unacceptable failure rates. Failure rate values considered to be unacceptable will, of course, depend on the nature of the course, the criticality of mastering particular instructional objectives, and a variety of other considerations. Typically, failure rates in excess of 20 percent are considered unacceptable.

A second category of descriptive statistics that is useful in identifying candidate main track modules in need of some type of alternative module(s) is the variability or standard deviation of the dependent measures of interest. Whether one is interested in test scores or some combination of test scores and completion times for the main track modules, the concern is with identifying those main track modules for which the standard deviations are large relative to the mean score, indicating an unusually large range of student scores. Although there are sophisticated statistical techniques for determining what constitutes large or significant variability, the emphasis here is on a simple procedure that relies mainly on human judgment. That is, each educator must make some judgment about what is acceptable performance variability. If the dependent variable of interest is test scores, the amount of variability considered to be excessive will depend on the passing score criterion: the higher the passing score, the smaller the standard deviation should be to be in the acceptable range. If the dependent variable of interest is completion times, standard deviations which are more than one third of the mean are generally considered large. Where large variability in main track module performance does not exist, it makes good sense to continue using that module or make minor revisions and repeat the analysis process.

Determining Aptitude Predictors

Once a main track module has been identified as a candidate for some type of alternative module(s), the task of determining the best aptitude predictors of student performance on that candidate module begins. This task has the purpose of identifying a small set of easily understood student characteristic variables that can account for a practically significant amount of variance in the dependent variable(s) and, thus, provide clues as to the kind of student characteristic/treatment matches that are likely to be effective for each candidate module.

The analysis procedure suggested here is to use stepwise multiple regression to isolate, from the previously defined student characteristic data pool, that subset of variables most predictive of student performance. This subset of variables then becomes the design variable set for determining appropriate instructional strategies to incorporate into the alternative module(s). For example, if the best predictor set included reading ability and test anxiety, and if the main track module consisted of a large step programmed text with few embedded questions and practice exercises, a good alternative module might be an audiovisual presentation which included more embedded questions with explanatory feedback and a larger number of practice examples. It must be emphasized that unless considerable attention and care is given to the selection of variables in the student characteristic data pool (including the use of task analysis procedures and available theoretical frameworks to guide the selection of variables most likely to be predictive of student performance in the instructional unit or course), the task of determining what type of alternative module to develop becomes more judgmental and risky.

Evaluating Alternative Module Performance

The student characteristic variables identified through the preceding procedure, and against which certain strategies are selected for incorporation into alternative modules, then become the aptitude variables used in the evaluation of alternative module effectiveness in meeting the needs of the students for whom they were designed. Alternatives are compared to the main track module. That is, the evaluation is an ATI question of determining whether the subgroup of students having trouble with the main track module can perform at more satisfactory levels with the alternative modules.

To answer the ATI question, students must be randomly assigned to the main track and alternative modules for a period of time necessary to collect performance data on at least 80 students per module. Regression slopes are then calculated for each module and aptitude variable in the design set, and tests of significant differences between the slopes are calculated to determine if a significant interaction exists. (The linear models approach suggested by Ward and Jennings, 1973, can be used in the calculation of both main effects and interaction tests.) If a significant interaction does exist, the regression lines are plotted per module, aptitude variable, and dependent variable of interest in order to (a) determine if the interaction is in the predicted direction and (b) eval-
uate whether the performance gains for the alternative module are sufficient to continue alternative module implementation. If the alternative module is not performing as intended, decisions must be made as to whether to revise the alternative module or to remove the alternative and revise the main track module.1

Alternative Design and Development Guidelines

No matter how strong and logical a particular set of predictor/criterion variable relationships are for a given main track module, there is always a fair degree of "art" involved in making good student/treatment matches. For this reason, this section sets forth a number of guidelines to help educators in selecting strategies for designing alternative modules.

First, the characteristics of the main track module should be listed. These characteristics include the format, structure, media, content, and difficulty level of the main track module, or any other characteristics which may be relevant to student performance levels (e.g., kind and amount of practice, type of visuals, information density, etc.). Once these characteristics are well understood, the task of determining what else might be done becomes easier.

Second, in addition to identifying the best predictors of main track module performance, it is necessary to identify the direction of the predictor/criterion relationship and the relative importance of variables in the cognitive versus affective set in the prediction of student performance on the main track module. Knowing the direction of the predictor/criterion variable relationship allows one to determine whether an alternative treatment should be compensatory (designed to circumvent certain student deficiencies), remedial (designed to correct certain student deficiencies), or preferential (designed to compliment certain student strengths), in the sense discussed by Salomon (1972). Knowing the relative importance of cognitive versus affective predictors allows one to determine whether the choice of strategies should be from predominantly the cognitive or the affective domain. Thus, one should examine the correlations between the best predictors and the dependent variables, as well as the relative proportion of variance (R²) accounted for by variables in the cognitive and affective domains.

Third, once one has a good understanding of the main track characteristics and of the kinds of students that appear to have the most difficulty successfully completing the main track, it is helpful to then list the possible tasks. For example, if students of low reading ability are consistently having trouble with printed main track modules, a list of alternative strategies might include different types of audiovisual media, the use of visual organizers and aids, or other techniques to improve the information density such as repetition and typographical cueing. McCombs and McDaniel (Note 3) have presented a number of generalizations for instructional treatment design that compensate for poor memory/processing abilities or low motivation that may be helpful in this regard. In addition, Allen (1975) has discussed a number of generalities in the area of learned ability/instructional media.

Finally, by way of an illustration of the proposed process of alternative module design, consider the following example. In this example, assume that when using stepwise multiple regression to predict student scores on a printed main track module with fairly high information density, the predictor/criterion variable relationships shown in

Table 1 were found.

In this situation, we see that curiosity and spatial ability are positively related to performance, while verbal reasoning is negatively related to performance. Also, 44 percent of the variance is accounted for by combining all three independent variables, with 16 percent of this variance being accounted for by curiosity (an affective variable), 15 percent of the variance being accounted for by spatial ability (a cognitive variable), and 13 percent of the variance being accounted for by verbal reasoning (a cognitive variable). From these relationships we know that although curiosity was the best single predictor, the two cognitive variables are accounting for significant proportions of the score variance. Additionally, we know that students who are low in curiosity and spatial ability are having difficulty with the main track module, and that students who have high verbal reasoning ability are also having difficulty.

Given these hypothetical predictor/criterion variable relationships and the type of main track module, one instructional strategy that might be worth pursuing would involve building an alternative module that aroused curiosity (e.g., through pre-questions or the use of interesting examples) and compensated for low spatial ability while acting preferentially for students of high verbal reasoning ability (e.g., through the use of visual organizers or other strategies to help students relate the information to their existing structures). Thus, although certainly not conclusive, this type of strategy could be designed and developed in the form of an alternative module that is both empirically derived and based on a rationale to facilitate learning for a group of students who might be able to profit from some kind of alternative module.

Module Assignment Guidelines

The final area of concern once alternative modules have proven to be effec-

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tive is to determine the procedures and rules to be used in assigning the main track versus alternative modules to particular students. Assuming that most operational settings would not have the benefits of computer-based adaptive decision models for making individualization decisions, it is necessary to devise some manual decision-making method that can be easily implemented in the classroom. A number of approaches could be taken, ranging from simply the use of teacher judgment in the selection of particular student/module matches to the use of complex decision tables which specify conditions and predictor variable values to be met. A suggested approach to the task of deriving appropriate decision rules which can be easily implemented is described in the following paragraphs.

The first step in determining which students should get which instructional modules is to examine the aptitude score ranges that result in the best student performance per module, using the ATI evaluation results and interaction plots. For example, if the score range on a measure of logical reasoning were 1 to 40 and the interaction plot indicated that Module A led to superior performance for students in the range of logical reasoning scores from 1 to 20, while Module B led to superior performance for students in the range from 30 to 40, it would be fairly easy to set up a simple heuristic (if... then) rule that specified which module to assign students whose scores fell in one of these two ranges. Obviously there are exact statistical procedures for determining the critical regions of significance for ATIs and these could be used if so desired (cf., e.g., Cronbach & Snow, 1977). In deciding what to do with students whose scores fall in some middle range of the aptitude measure, one could simply apply a random assignment procedure—or use that student’s score on another one of the aptitude predictor variables.

If there were several significant predictors used in the design and evaluation of main track versus alternative modules for a particular task, one could either use all of a student’s score values in determining which module to assign, or could base the decision on one of the aptitude variables felt to be of greatest importance in that student’s particular case. Whatever the decision as to aptitude variables, the important thing is to specify in some type of decision table format the ranges of scores associated with superior student performance per module for each significant aptitude predictor.

Procedures for smoothly handling the actual assignment of students to modules assumes that individual student records exist on which aptitude scores are recorded. Depending on the type of instructional context, decisions about which module for which student could be made at the beginning of the instruction and given to the student for the entire unit or course, or they could be made on a short-term basis. Whenever procedure is used, it is recommended that records be kept of the students’ actual performance with the modules assigned. This will allow for an ongoing evaluation of the effectiveness of the rules being used in module assignment and will provide the information necessary to revise those rules that are not performing as intended.

Summary

The procedure presented in this article is an attempt to synthesize recent thinking about the design of ATI studies and the development of alternative main track of instruction. The proposed working model will hopefully allow those concerned with individual differences in the classroom to apply limited resources where individualization is most needed.

References

6. McCombs, B. L. Identifying individualization parameters, strategies and treatments, with the explicit purpose of deriving a method that can be implemented in an operational instructional environment. In addition, an attempt was made to conceptualize ATI research as feasible for implementation as part of a dynamic decision-making instructional environment in which one considers the appropriateness of alternative module development in light of empirical data on the performance of a single

References


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**Volume 1 of the Journal of Instructional Development Now available as one bound book . . .**

The first two pilot issues of the Journal of Instructional Development (JID), published in Fall 1977 and Spring 1978, are now available as one bound book. Volume 1 of JID contains articles on a wide range of topics relating to instructional development, such as:

- **Teaching Conceptual Networks** by Susan M. Markle
- **Types of Capabilities and Learning Hierarchies in Instructional Design** by Robert M. Gagne
- **Needs Assessments: Internal and External** by Roger Kaufman
- **Research, Theory and Instructional Development: A View from the Trenches** by Robert M. Diamond
- **Instructional Development: Fruit Fly or Lemming?** by Ivor K. Davies
- **An Alternative for Task Analysis in the Affective Domain** by Wellesley R. Foshay

You’ll want to include Volume 1 of JID in your professional library. AECT member price: $5.75 (Nonmember price $7.95). Order from AECT Publication Sales, 1126 16th Street, N.W., Washington, D.C. 20036. Orders under $15 must be prepaid. A $1 charge plus postage will be added to billed orders.
In this issue two curriculum related books are being reviewed. Both volumes have a direct impact upon the professional field of instructional development in that there has always been some discomfort about where "curriculum development stops and instructional development begins." Although neither reviewer (one a curriculum developer professional, the other a professional instructional developer) specifically addresses this question, both make references to portions of the volumes under question as being more pertinent to curriculum development or more pertinent to instructional development. Some controversy should be generated concerning this often confused area of gray as we continue to attempt a more specific definition of our professional concerns. The two areas have always felt some discomfort: some curriculum developers have viewed educational technology as the "young upstart infringing upon our profession," some instructional developers have viewed curriculum developers as "those old fogies who don't pay any attention to how subject matter is presented, they only care about scope and sequence in the total school picture." It's interesting to note how there really is some agreement, at least between these two reviewers, about the strong points of each professional area.

The Handbook of Curriculum Evaluation focuses, as is evident, on evaluation—the nature, the stages, and the tools of curriculum evaluation. All these topics are of interest to our field both in that we need to know how others are going to evaluate our work, and because there are some very helpful evaluation hints contained in all sections.

Secondary School Curriculum Improvement is a more traditional curriculum development text with a new twist: the relationship between curriculum development and instructional development is explored although not in depth. The reviewer saw this exploration beginning and refers to it a couple of times when pointing out segments of particular interest to instructional developers.

Finally, a 20 volume set being marketed as the Instructional Design Library by Educational Technology Publications is reviewed. This review treats the volumes in the context of a reference library. Individual volumes of the library will be reviewed as discrete books in future Book Review sections.

... there really is some agreement, at least between these two reviewers, about the strong points of each professional area.

The Instructional Design Library, Series Editor: Danny G. Langdon, 20 volumes, Educational Technology Publications.

The result of a rather large undertaking of Educational Technology Publications is a new Instructional Design Library, presently comprised of 20 volumes, with 20 new volumes on the way and an additional 10 volumes to be published in early 1982 for a total of 50 volumes.

This product is advertised as a library of instructional designs, "... something to which you can turn to find answers about how to structure learning." A slight contradiction turns up immediately: although promoted as a library of instructional designs, the series editor states "what you will find in this Library are a number of instructional strategies ..." So what do we have, instructional designs or instructional strategies?

Turning to AECT's Educational Technology: Definition and Glossary of Terms, instructional design is defined as:

The part of the instructional development process that is analogous to the Design Function of the Domain of Educational Technology model—i.e., the generation of specifications for Learning Resources/Instructional System Components. (Not synonymous with, though often confused with, instructional development and instructional product development.) (p. 172)

As viewed by the series editor, however, an instructional design is:

A format or strategy which prescribes student learning requirements and the events for achieving the requirements. Such formats or strategies include: prescriptions of instructional outcomes and events for student use only; or a guide for teacher implementation; or a guide for teacher implementation; or a prescription through which a medium presents and guides instruction only; or a combination of these. (Introduction, p. 7)

Returning to the Glossary, instructional strategy is defined as:

The overall approach to instruction to be incorporated in the instructional system or instructional product; it includes the types of system operation, format, stimuli, responses, feedback, generalities, instances, difficulties, mathematically information, approach, presentation organization, sequence, scope, size of step, and pacing to be used. (p. 222)

Keeping these definitions in mind, let's look at the titles of the volumes presently within the Library:

1. The Adjunct Study Guide, Danny G. Langdon (100pp)
2. Algorithms, Ivan Horabin and Brian Lewis (80pp)
3. The Audio-Tutorial System, James
“Educators, training directors in companies, instructional writers, learning researchers, and almost anyone involved as behavioral change agents in student learning, will find some uses for the IDL.” (Introduction, p. 3)

The purpose of the IDL (Instructional Design Library) is to provide handy reference information to the practitioner during instructional development activities. This purpose is furthered by the organization of the volumes within the IDL; there is a “common sectional layout within which to describe each design [so that] the reader would have no difficulty in locating within each book descriptive information about that design which could be compared and contrasted to another design having similar orientation (such as group oriented instruction).” (Introduction, p. 11)

Each volume has six basic sections: “Use,” “Operational Description,” “Design Format,” “Outcomes,” “Developmental Guide,” “Resources.” The “Use” section describes the range of applications; the “Operational Description” gives an introduction and an overview of how the design (strategies) works, a general overall statement.

The “Design Format” section is a thorough explanation of the design which identifies, labels, provides examples and gives a detailed functional explanation of the design. The “Outcomes” section addresses one primary question: Why should a particular strategy be used? In addressing this question, four sub-questions are addressed:

1. What will this strategy do for students?
2. What are the advantages to the teacher?
3. What are the administrative and organizational benefits?
4. What does this strategy do to promote learning effectiveness and efficiency?

The “Developmental Guide” section gives the reader a general idea about how to develop the strategy under examination. Of necessity, this section is often incomplete—the individual authors spend a varied amount of time discussing developmental aspects. The series editor points this out in the introduction and assumes that the reader has basic development skills; the developmental portion of each volume attempts to address the unique activities (sometimes in checklists, other times in narrations, etc.) associated with developing the specific strategy under question.

Finally, the “Resources” section gives the reader a reasonably thorough treatment of where to go to get further information concerning the strategy discussed within each individual volume. Again quoting the series editor:

In summarizing, we see in each book flow of descriptive information and sample illustrations which begins with a general account of use; to an overview of the operational features of the design; to specifics on the parts, by example, of that design; to the outcomes it can produce; to how one generally goes about developing the instructional design; to, finally, a listing of additional resources where further information is available.

So much for the audience to whom IDL is addressed and the objectives of the authors in preparing the IDL volumes. The real question we need to address here is “How good a job was done?”

In preparing one answer to that question, the reviewer used the IDL as the series editor suggests—as a library of references concerning instructional strategies—for over 3 months. During these months the IDL sat either on my desk, or on a shelf within 2 feet of my chair. Reasons for using the volumes as references ranged from pure curiosity (what do Thiagarajan and Stolovich have to say about Instructional Simulation Games?) to providing information to instructional developers (maybe backward chaining is an appropriate strategy in this case) to preparing a position paper concerning the need to vary instructional strategies whether in the classroom or producing mediated instruction for self-instructional purposes.

In conscientiously attempting to use the IDL whenever I felt the references would or could be of value, keeping track of those references I find that, on the average, I used the IDL once every other working day in the office. Each volume was consulted at least twice; I deliberately sat down and read completely eleven of the volumes.

So far this review has discussed:
1. What is the Instructional Design Library;
2. For whom was the Instructional Design Library produced;
3. How are the individual volumes structured;
4. How has the reviewer (member of the intended audience in that the reviewer administers an instructional development center, does perform instructional development activities and prepares reports concerning the use of instructional strategies) used the Instructional Development Library?

Questions yet to be addressed within this review are:

1. How does the IDL stand up as a reference tool;
2. How does the volume structure contribute to the utility of the IDL;
3. What is the quality of the information presented in the IDL;
4. The payoff question—recommendations concerning the acquisition of the Instructional Design Library.

As a reference tool which presents valuable information in an easy to use format on a readily available basis the IDL does a reasonable job. Naturally, with a variety of authors, the writing and the value of the information is somewhat inconsistent. Yet, sufficient information is given in each volume for the reader to (a) get a good idea of just what is involved with each instructional strategy, (b) the variety of uses of each strategy, (c) basic information on how to use each strategy, and, (d) where to go for additional detailed information about each strategy. For example, in thinking about backward chaining as an instructional strategy Alden informs us (in Backward Chaining) that:

1. "... you should consider this instructional design only if the task performance you are required to teach can be described as a series of situationally dependent activities that lead linearly or in successive approximations to the task goal." (p. 6, "Use")
2. The benefits of the use of backward chaining are: "Almost all people obtain reinforcement from correctly completing a task performance that they perceive as being difficult... Backward chaining is a design for organizing instructional content so that this type of reinforcement operates throughout the lesson... provides a systematic means for designing learning exercises... makes use of a seemingly unorthodox sequencing strategy..." ("Operational Description," p. 9)
3. The "Developmental Guide" section gives explicit directions on "General Steps of Performance" which do provide enough information to the reader to enable one to use backward chaining as an instructional strategy.
4. Finally, Alden gives a limited number of references for further information about the topic.

All the above information is compactly presented in 69 pages; it's easy to sort information which provides a concise synopsis of backward chaining.

The ease of use of these volumes is at least partially due to the organization of the volumes. Once the reader has used two or three of the volumes he quickly gets used to the structure and it becomes very easy to find any information which is presented.

Generally the quality of information presented within the IDL is good, sometimes excellent. Tutorials (Volume 20) is a fine example—the topic is clearly covered, the volume is well written, the requisite information is there and easy to find. However, there are a few problems. Often the information presented is not as complete as this reviewer had hoped it would be. This leads directly into the final topic concerning the IDL: Recommendations for acquisition of the IDL.

As stated earlier:

1. The IDL is a handy reference, without effort this reviewer found many uses for it;
2. Enough information about each strategy, generally, is contained in the volume to enable the reader to gain a basic understanding, and for most readers (in most cases) to use the strategy in the instructional development process;
3. The IDL is comprehensive, when the next 30 volumes are completed this will certainly be the most comprehensive reference tool of its kind available to instructional developers.

There is some hesitancy to all this. This hesitancy centers around the following characteristics and impressions:

1. The IDL, while comprehensive in the topics it addresses, often does not give a comprehensive overview of the individual topics. This reviewer was disappointed in several of the volumes; for example, Audiovisual Training Modules. With the huge amount of research which has been devoted to the many aspects of the varied audio and/or visual materials which might be used in education or training, it is a bit disappointing to find that only 90 pages have been devoted to the use, the benefits to be derived, the "specifics" on the "parts" of audiovisual training modules, the outcomes it can produce and how one goes about producing an audiovisual training module. The resources for additional information are also very disappointing—a total of 16 references are given (two books, seven Kodak booklets, two other booklets, three articles by the volume author and one audiovisual training module also from the volume author). Possibly by consulting these 16 references the intrigued reader will begin a chain into the real literature concerning the use, benefits, production and results of using audiovisual training modules.

2. In general, many of the volumes really shouldn't be volumes. The reviewer would have a very hard time justifying recommending the purchase of "books" which range in length from 69 pages (Backward Chaining) to 114 pages (The Personalized System of Instruction). The individual volume price for each of these books is $9.95. You can get the library (20 volumes) for $179.50—a per-volume price of $8.98 each. As an administrator of an instructional development center I would like to have a copy of the Library available to instructional developers; on the other hand I do not believe I would recommend the developers individually purchase the Library, nor would I authorize funds for a Library for each developer. I would recommend one full set for the use of all within the Center.

The above criticism is in two parts: some of the volumes (although certainly not the majority of the volumes) are too weak to recommend purchase; all of the volumes are expensive. If the IDL were in pamphlets, or if the number of volumes were reduced to, say, six volumes (roughly 300 pages each) and priced at, say, $14.00 each, this reviewer would enthusiastically endorse the Library. No matter which books (in education at any rate...) you buy, you get some "tripe": the same is true with the Library;
accepting that, $84.00 would be a reasonable price to pay for six volumes containing the information contained within the 20 volume Library.

Educational Technology's Lawrence Lipsitz states 'This is an enormous project, surely, representing a very large commitment to the field of instructional design and development.' This reviewer agrees—with some reservation; the effort didn't have to be quite so large (in quantity of volumes), and, the commitment is somewhat tempered by the cost of the Library.

In conclusion, the Library is worth having at the disposal of instructional developers. The Library is a worthy addition to the reference literature for practitioners within the field of instructional design and development. The value of having this Library will, no doubt, increase with the addition of the 30 more volumes to be produced. I only wish I could feel that the price of the Library was going 75 percent for the information and 25 percent for the appearance rather than vice versa.

Addendum: The 20 volumes which are to be available approximately February, 1980 are:
1. The Core Package. Richard C. Mentzer.
2. Direct Instruction. Siegfried Engelmann.
7. The Lecture Method of Instruction. Martin M. Broadwell.
10. PLATO. Harold F. Rahmlow, Robert C. Fratini, and James Gesquiere.
15. Student Planned Acquisition of Required Knowledge (SPARK). Margaret Norton, William C. Bozeman, and Gerald Nadler.


"Too little, too late" has many times been the phrase used to describe the evaluation efforts associated with the design and utilization of new instructional programs because in many cases evaluation may only be seriously considered after the implementation of such programs. If the Handbook of Curriculum Evaluation has a central theme to it, it is that program evaluation is a continuous process, beginning before development starts and continuing through the entire life of the program. Any instructional development project could surely benefit from adopting this point of view.

The Handbook of Curriculum Evaluation, edited by Arieh Lewy, is truly an international book. First published by UNESCO, the work was supported in part by the International Institute for Educational Planning, the International Curriculum Committee, and the German Foundation for International Development. The contributors represent 10 different nations on five continents. This is an important point as most of the examples used in the text are drawn from international curriculum projects, usually of a nationwide scope.

The book is well written and logically organized, with a liberal use of headings, subheadings, italics, and summary charts and tables. This facilitates its use as a "handbook," to the extent that information is easy to find. The book is organized into three major parts: the "Nature of Curriculum Evaluation," "Stages of Curriculum Development and Evaluation," and "Evaluation Instruments and Strategies."

Part I consists of one chapter, the "Nature of Curriculum Evaluation." Here Lewy provides a review of just what he believes curriculum development to be. Although he suggests that a variety of definitions of curriculum are in use around the world, his definition seems to include those functions which many have come to regard as the domain of instructional development (especially developers themselves). Many readers who regularly practice ID may be disturbed to discover that the book, in general, makes no real distinction between curriculum and instruction. Further, instructional development, as currently perceived by ID practitioners, is never mentioned. Nevertheless, he is successful in noting the importance of distinguishing between development and evaluation. His definition of evaluation would appear to be quite acceptable to instructional developers.

Part II, "Stages of Curriculum Development and Evaluation," presents a model of curriculum development with corresponding roles of evaluation. While the model may appear too simplistic, it probably represents a compromise of the 13 contributors to the text. Again, while one may legitimately debate whether each stage of the model should be the purview of curriculum developers or instructional developers (or both), the evaluation components seem valid for both arenas.

The first stage, "Determining General Educational Aims and Specification of Major Objectives" (Chapter 2, written by T. Neville Postlethwaite), deals mainly with concerns regarding what to teach and sources for generating information for decision-making purposes in this area. Examples are drawn almost exclusively from curriculum development projects in developing nations and educators in the United States may have some difficulty in transferring such experiences to their local situations.

"Evaluation at the Planning Stage" (Chapter 3, written by Chew Tow You) is the next part of the model. Here is where the instructional developer will feel most at home as the chapter discusses a variety of planning activities (formulation of objectives, specification
tional subject-matter lines. Topics here range from extraclass activities to career and adult education, and include separate treatments of independent study and the use of technical devices in instruction. It is in these sections that the book departs most from the usual considerations of curriculum. While the treatment of these topics may be superficial from the professional designer's point of view (there is little here not included in the standard texts on instructional design and educational technology), one does get a convincing report on the extent to which technical developments in instruction have been applied in several curricular areas in the high school. The virtues and limitations of large- and small-group instruction are discussed in detail in this part of the book as well.

Concluding chapters of the book deal with evaluation of instructional programs and development of new ones. This is for the most part gloss material; it is covered in greater seriousness and with more commitment elsewhere in the literature, and the instructional design professional may find little of interest here. Ideas that demand more time such as the nature of the teacher's workplace, the need for humanistic concern to re-assert themselves in the school, the notion that not every student needs to learn the same content, the possibilities for learning in places and times beyond the "box and bell", these truly revolutionary ideas are lifted up for recognition, then set down again with no time taken to examine their finer points or trace their implications. One is reminded again that this is a textbook, a piece of educational technology in itself, and that it bears inherent limitations regardless of its content or the hopes of its creators. Issues are touched upon though, and the committed reader will return to them again in another place, through another medium to examine just how his work is going to be affected by them. The inclusion of discussion topics and prompts for further study, together with a very thorough bibliography will assist in this process.

Secondary School Curriculum Development is an honest, workmanlike effort true to its title. It can get one started in developing materials and courseware with an awareness of the milieu of high school studies in the late 1970's, and is of particular value to one only recently or superficially aware of the field. As such, it is necessarily dated, and is unlikely to be of much more than archival value in four or five years. By then, of course, Messrs. Trump and Miller or one of their colleagues will have published an updated version. In the meantime, this book merits consideration by those who wish to catch up with this (surprisingly) dynamic field.—Reviewed by John Clarkson, Director of Instructional Services, Crete-Monee School District #201U, Crete, IL.

networks for learning

From simple card files to complex computers, information and learning networks are everywhere. AECT's latest filmstrip describes the concepts behind networking and what it means to the media and library staff. AECT developed this color, sound filmstrip for the Leadership in Library Education Institute at Florida State University and drew upon both the ERIC Clearinghouse for Information Resources and the National Commission on Libraries and Information Science for the latest information on networking and networks. AECT visited the ERIC Clearinghouse, the University of California at Irvine, the National Education Association and Bellevue (Washington) Community College to get examples of networks in operation. The filmstrip comes with a booklet that includes common network terms and definitions, acronyms of networks, a selective, annotated bibliography, and a brief administrator's overview of computerized networking in libraries and universities.

Networks for Learning: color filmstrip, 85 frames with 11 minute audiocassette (audible and inaudible advance pulse) and information booklet on networks, $16.95 for AECT members, $19.95 for nonmembers. Order from AECT Dept.A, 1126 16th Street NW, Washington, DC 20036. A $1 charge plus postage will be added to all orders that are billed.
One of the most frequently voiced comments of instructional developers is "I wish I knew who else is doing, or has recently done, any development on X." This desire for current information concerning ongoing and recently completed projects provides the rationale for this new JID department to be called ID Project Abstracts.

Simply stated, the purpose is to provide a communication link among developers concerning projects. By definition, any abstract will be brief. The intent is to provide awareness information. Then anyone who is interested can contact the developer directly for further information.

Unlike descriptions of other projects which will be in JID, abstracts will not focus on the new and different. We expect most reports will describe the more "garden variety" projects which consume a large portion of most developers' efforts. Also we are encouraging abstracts describing current projects in order to play a matchmaker role.

There is no standard format for items submitted to ID Project Abstracts; however, a number of general guidelines should be followed.

1. It must be brief, (maximum 250 words).
2. It must include name and address of contact person.
3. It must indicate whether project is ongoing or completed (expected completion date would be desirable).
4. It should describe objectives of project.
5. It should describe intended audience.
6. It should describe delivery system (if known).
7. It may contain any other information the author feels is appropriate.
8. It should be double spaced.

That's all there is to it! No footnotes or bibliography expected or desired. No extensive rewriting or editing to delay your submitting your abstract. As they say in the TV ads "do it before midnight tomorrow" you might just help someone else and yourself, too.

Abstracts should be sent to:
Kent Gustafson
Educational Systems Development
123 Erickson Hall
Michigan State University
East Lansing, MI 48824

...a communication link...

PROJECT TOPIC
Effective Learning and Study Skills

Background

Because more and more students who enter the Agricultural Technology program at Michigan State University lack adequate preparation, a project was undertaken to develop students' learning and study skills so that they could meet the academic standards of the University.

Project Description

A total learning system (course) was developed. The elements of the system are: (a) an evaluation of students' entry skills, (b) an orientation session, (c) several lecture/discussion sessions, (d) individualized learning modules, (e) materials to improve reading and comprehension, (f) a course evaluation, and (g) instructors' materials.

The specific individualized learning modules developed for this course are: (a) "Textbook Study Techniques," (b) "Taking Effective Notes," (c) "Increasing Your Vocabulary," (d) "Improving Your Comprehension," (e) "Increasing Your Reading Rate," (f) "How to Take Objective Exams," (g) "How to Take Essay Exams," and (h) "Developing Effective Learning Strategies."

The lecture/discussion sessions were carefully planned to augment the learning modules by employing a different approach to the same topics. In addition, instructors maintained close contact with the students throughout the term. Such contact provided opportunities for limited counseling, informal evaluation of skills, and assistance in the transfer of skills to actual academic course work.

Project Evaluation

Ongoing formative evaluation has indicated strong student approval of the dual approach, i.e., modules augmented by in-class practice and feedback by instructors. Data acquired both during the term in which students were enrolled in the study skills course and in subsequent terms indicates that the course is effective: grade point averages improved and the drop-out rate declined. The self-instructional modules have been bound into a single volume and are available along with the instructors' guide.

For further information, contact Dr. Colleen Cooper, Learning and Evaluation Service, 17 Morrill Hall, Michigan State University, East Lansing, MI 48824.
PROJECT TOPIC
Biological Science

Background

For decades, educators have sought to find the elusive match between student aptitudes and alternative instructional packages. A project underway at Michigan State University seeks to extend previous work that identified important student characteristics and dealt with them differentially during instruction.

Project Description

Faculty teaching "Biological Science 202" hypothesized that three classes of variables interacted to influence student learning: structure of the subject matter, student characteristics, and instructional modality. A systems approach to computer modeling of student differences and performance in the course was developed and it was learned that a significant portion of the students who score low on tests have problems generalizing from specifics and seeing relationships between concepts presented in different contexts.

Careful, fine-grained analysis of one unit in the course ("Ecosystems") was then performed and a network diagram showing both the concepts to be learned and their relationship to each other was made.

A comparison of student differences in ability to generalize from specifics with the learning tasks required by the ecosystems concepts suggested it would be useful to develop "concept maps" which explicitly relate concepts from different contexts, usually only implicitly presented, in the form of a spatial array, a map. These concept maps (instructional treatment) were produced, evaluated, and compared to written statements containing the same information. Students having the concept maps scored significantly higher on tests over the material than students who had only written statements.

Project Evaluation

Because the project was designed as a long-term investigation into a fundamental problem, evaluation after 1 year of development would be premature. However, data from the first year has demonstrated that the intersection of curriculum requirements and student characteristics is a potentially useful approach to developing alternative instructional packages for different students. The framework that has been developed so far will be submitted to the National Science Foundation for additional funding.

For further information, contact Dr. Jean Enochs, Science-Math Teaching Center, McDonel Hall, Michigan State University, East Lansing, MI 48824.

PROJECT TOPIC
Family Medicine Faculty Development Program

Background

At Michigan State University there is a great need for faculty members in the field of family medicine. The "Family Medicine Faculty Development Program" seeks to recruit faculty, help them acquire instructional skills, and explore with them ways in which they can function effectively in their new roles. Most of the participants in the program are physicians who have recently joined the family medicine faculty or who expect to do so at the end of their training.

Project Description

The program consists of four components: (a) a year-long traineeship, (b) a 3-month traineeship, (c) a series of 1-week training sessions, and (d) short-term workshops on key topics in the teaching of family medicine. The four components are interconnected. The year-long traineeship uses the 3-month traineeship as a core, extending and augmenting it for greater depth and variety of training. The workshops provide topical information and basic skills and serve as part of a program for cooperating institutions.

Project Evaluation

The program is scheduled for 3 years operation under the sponsorship of the Bureau of Health Manpower, U.S. Public Health Service. It is in various stages of development and implementation. The first 3-month training block was offered from April 1 through June 30, 1979, and the second from September 16 through December 15, 1979. Initial evaluations by trainees have been highly favorable, although the program is new for summative assessments.

This abstract was prepared and submitted by Deborah Orban. For further information, contact Dr. Robert G. Brigham, OMERAD, A217 East Fee Hall, Michigan State University, East Lansing, MI 48824.