Individualized Instruction Goes To College

With approaches like Purdue’s Audio-Tutorial System, students get more learning, less teaching

Sam Postlethwait was a frustrated biology professor in 1961. Sitting in his lecture hall were 380 Purdue University freshmen botany students of such widely varying abilities and academic readiness that he knew he just wasn’t reaching some of them with the material he was presenting. He thought they could all learn it, but not unless they got something more than they were getting. As an experiment, he decided to record one remedial lecture each week on tape and make it available to the faltering students at their convenience. Those who stopped in to listen to the tape were the predecessors of thousands of Purdue students who have since then tasted—and relished—the audio-tutorial (A-T) approach to learning.

The taped lecture was only a crude first step, but it immediately offered the student several advantages. He could “attend” the lecture when he wanted to, he could stop it when things got too tricky, and he could even back it up and try again. This self-pacing was popular with the students trying it, so Postlethwait was encouraged to try some refinements. Why, he thought, should the only route to their brains be through their ears? He altered the taped lectures to include use of the textbook, then the lab manual, letting the students look at illustrations or, if appropriate, stop the tape and read passages. The lecture format became more conversational, informal. The integration of sight and sound then led to use of actual plant materials, which could be looked at, touched, smelled, and manipulated in experiments.

This modest trial didn’t produce spectacular results, but Postlethwait sensed that somehow his teaching had been more effective that semester. The next time around he selected the 36 students in one laboratory section and let them try this new technique, getting their lectures and laboratory exercises combined into “independent study sessions,” and still meeting with the instructor for discussions and quizzes.

At the end of the semester, test results showed no difference between the A-T group and the conventionally taught group. But the group using A-T had done the work in less average time, and each member of the A-T group had been able to spend as much time—whether little or great—as he needed to learn the material.

Encouraged by the time-saving and convenience to the students, the following semester he shifted the whole botany course to A-T. Sequestered in his basement, he spent evenings assembling pictures, pieces of plants, seeds, slides, film strips; adapting experiments to more or less self-contained formats; and, finally, pretending he was facing a student and guiding him through an hour’s study.

He managed to stay a week ahead of the class that first year. The next year, he began to refine the material.

What is hard to believe is that Postlethwait and others like him elsewhere (notably Fred Keller, whose Personalized System of Instruction is very similar. See box on page 13), using commonplace devices that were at hand and driven by a desperation born of the frustrations of teaching, planted the seeds of a quiet revolution back in the early 1960’s. Because they bypassed high technology—there were no videotape machines or computers in Postlethwait’s basement—their systems were able to focus on some basic elements of learning.

The fundamental value of A-T is that it bends to the individuality of the student. Not only does he have some choice of techniques—listening or seeing or doing—and his choice of pacing (including what time of day he wants to do it), but he knows in advance what he is to learn from any particular A-T experience. How? He’s given a list of specific learning or performance objectives before he begins to study any segment. Though it flies in the face of tradition to tell a student specifically what he’s expected to learn, teachers readily judge a student’s success by giving him an exam at study’s end—and the exam is often just a specialized list of learning objectives.
“But they’ll learn it all!”

Experience shows that many more students can achieve high test scores with A-T—that is, learn the subject matter—than with the traditional system. Postlethwait enjoys telling the story of a professor-visitor who chanced upon a mimeographed sheet of these objectives and asked if it wasn’t risky to leave it around where students might see it. Postlethwait replied that they were intended for students.

“But,” she responded, “if they see these they’ll learn it all!”

Many teachers are uncomfortable with A-T techniques. It not only forces them to disclose what it is they’re trying to teach, but dramatically changes the role they have learned to play. Postlethwait recalls a time when he still felt uncomfortable without a regular lecture session, so he required attendance at one each week. Midway through the semester he decided that compulsory attendance wasn’t in keeping with the way he wanted to teach, so he made it voluntary. He assumed his fascinating discussions of botany would be attraction enough, but immediately attendance began to fall off. “At the last lecture I gave up and took all the students out for a Coke—both of them.” Where were the students? In the learning center, more interested in listening to Postlethwait’s taped discussions because they related specifically to what they were expected to learn.

This system, as it existed in Postlethwait’s classes at Purdue in the mid-1960’s, was obviously more geared to the individual than its predecessor instructional system had been. A-T offered a high degree of self-pacing and self-scheduling, including the chance for the advanced student to “test out” without taking the lesson. It offered a multiplicity of sensory inputs. And it shifted the emphasis away from the teacher’s teaching to the student’s learning.
Then, in 1969, Postlethwait took individualization an important step further. A-T is a learning strategy. As a new way to offer an old course it proved highly successful. But then, given the new technique, it became obvious that the curriculum was a limiting factor. And hence were born minicourses.

Intellectual bites/Food for thought

Again, the minicourse was nothing startling, simply another use of the already popular “knowledge modules” adapted to A-T. They broke the course up into more readily managed bites, each a single conceptual unit capable of being done in a single session lasting an hour or two. The course’s curriculum then became a collection of minicourses to be mastered by the student. The first attempt to use minicourses at Purdue was in the botany course (Bi 108) already using A-T, and in a companion course, zoology (Bi 109). When minicourse topics were identified for each it was apparent that many of them were essentially the same. These then became a pool of common courses that students enrolled in either course took. Each course offered, in addition, a series of plant or animal courses, and a series of common optional courses. In all, Bi 108-109 operated out of a pool of 76 minicourses, only about half of which any student would take in a semester. And, obviously, a student taking both courses could simply skip the minicourses he had already taken and go on to some of the optional ones.

Learning by A-T

Open from 7:30 a.m. to 10:30 p.m. Monday through Friday, with teaching assistants present, the Purdue Bi 108-109 learning center is rarely without students. When a student enters he picks up a list of objectives for the minicourse he is about to take, then finds one of the booths that are set up for that course. Space limitations—there are 64 booths for 800 students—restrict the number of courses that are available at any one time. But, then again, having many students working on the same minicourse at roughly the same time encourages personal interaction between them, an educational process of acknowledged importance.

Sitting in a booth, with earphones on, he starts the tape, and his instructor begins talking to him. At intervals he is directed to refer to his lab manual, told to stop the tape and construct a hypothetical experiment, directed to look at a slide or a film loop, told to get up and do an experiment, and is asked questions. If he’s puzzled he can find the graduate assistant on duty and get help. If he’s restless or inattentive he can take a break and chat with other students doing the same. When he’s satisfied that he’s learned what he’s supposed to—with reference to the objectives—he rewinds the tape, tidies up the booth, and leaves. Whenever he’s ready he can take a quiz on the minicourse.

Getting grades

Lest it seem that the A-T minicourse system, with its concept of mastery of material for everybody, is insufficiently demanding for the better students, it should be pointed out that mastery of the required number of minicourses means a course grade of C. There are, however, essentially no D’s or F’s, only Incompletes for those who fail to learn the minimum. Students with an insufficient number of passed minicourses can repeat the course and take those they missed (and more) and get a letter grade. Credit for a minicourse passed is permanent, and even local high school students who take them in advance can retain credit should they enter Purdue and take Bi 108-109.

Grades higher than C are earned by accumulating additional points through a variety of means. Periodic exams that test problem solving and synthesizing ability, additional minicourses, research projects, teaching fellow students, extra readings—all garner points for the ambitious student who wants an A or B, though the good student can get an A by his exam performance alone.

The “Incomplete” grade is rarely used at most universities, being reserved for those instances when emergencies prevent a student’s finishing up the coursework on time. But self-instructional systems make use of that grade for an entirely unforeseen and honorable reason: The student was unable to master a minimum of concepts in the time available. In effect, it removes time as a factor in achievement since course credit is given when the material is learned, not when the semester ends.
Clearly, A-T suggests eventual blurring of the dimensions of both semesters and formal courses and poses problems to administrators. Those enthusiasts of self-instruction challenge the university, as a teaching institution, to adapt itself to more effective organization for learning. Then, they say, the extension of the university’s continuous education to the admittedly important public realm of continuing education will be that much easier.

The university, of course, is faced with some professors who want clearly defined and limited teaching assignments, who already have courses prepared and don’t want to spend the time it takes to convert them to A-T, and with the problem of providing coherent educational programs for 20,000 or 30,000 students—who may or may not be motivated or responsible.

Robert Hurst at Purdue, who worked with Postlethwait in developing minicourses for Bi 108—109 and who is in charge of the course now, admits that only a professor dissatisfied with his current teaching is likely to be motivated to take on the A-T burden. Hurst himself spends 60 hours a week working on that one combined course. But he’s rare at a large university: someone whose job is solely to teach, a vocation he deliberately chose after sampling the researcher’s life when he got his Ph.D. in biology at Purdue several years before. It’s not sur-

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Another Approach—Keller’s Personalized System of Instruction (PSI)

An educational approach very similar to Postlethwait’s A-T system, and one attracting a comparable amount of attention, was developed at the University of Brasilia in the mid-1960’s by psychologist Fred Keller, J. G. Sherman, and their Brazilian colleagues. It, too, stresses self-pacing and is oriented towards mastery of stated objectives, but is less hardware-oriented and includes the large-scale use of undergraduates as tutors and proctors. In PSI a student can take tests over and over as much as it takes to show he knows the material, and can then get an A. Like A-T, which originated in a specific discipline, biology, and is only recently beginning to branch into other disciplines, PSI was used predominantly in psychology courses until a few years ago. PSI is also referred to as self-paced study or, sometimes, the Keller Plan.

But one of the PSI’s more successful introductions was in a second semester freshman physics course (including topics in special relativity and electromagnetism) at the Massachusetts Institute of Technology. Its success there in the spring of 1969 has led to other experiments with PSI in physics and engineering courses at MIT. An estimated 500 teachers in the United States are now using the method in a wide range of disciplines. Three national conferences on the method have occurred in the past year and a half.

Ben Green at MIT’s Education Research Center taught that first PSI physics course. In the October 1971 issue of the Journal of College Science Teaching he summarized what he thought were the benefits of Keller’s method to students and teachers; they are nearly as applicable to A-T learning:

“From the student’s point of view, he (1) works at his own rate; (2) works when he wants to; (3) knows what he is responsible for; (4) can get personal help; (5) is not rushed past the hard parts; (6) is not held back on material he already knows; (7) gets over being afraid of tests; (8) knows where he stands; and (9) enjoys being actively involved in learning instead of just listening to lectures.

“The teacher has a new role to play. Instead of broadcasting knowledge (a function better served by books) or being a performer and entertainer (a function sometimes useful, but secondary to learning), he is a manager of a system. He keeps an eye on his tutors and brings them along as teachers. He must prepare the study guides and tests for each unit in advance. He must watch the ‘dials’ in the process: at what rate are students working; what students are in trouble and need his help; what logistical problems threaten.

“If the professor is proud of being a teacher as well as a professional in his field, he takes pride in the fact that: (1) he knows where each student stands; (2) he knows as they pass tests that he has taught them something; (3) he can be absent from class occasionally without upsetting the course; (4) his course is defined on paper and can be reviewed as he thinks of improvements; (5) he can give individual attention to students who need him; (6) he finds that students appreciate his planning; and (7) his administration is pleased that he can teach so much so pleasantly and at such low cost.”

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Self-pacing. Students come and go when they wish; their progress is kept track of on these cards, which also reserve listening booths for as long as they need them.

prising, then, that a great deal of the interest—and there is a great deal—in A-T comes from the smaller schools and community colleges—all primarily teaching institutions. In fact, at schools all over the country, as one might imagine, various types of instructional schemes using audio-visual elements and minicourses have been tried, though few have been on the same scale as at Purdue nor conducted with the same degree of reliance on the system.

Minicourses by the thousands

The idea of a bank of minicourses in many disciplines being built up, and maybe even a national clearinghouse for
Preparing courses. The minicourse development lab provides facilities and assistance to scientists preparing course units in areas of their special competence.

them, is one of the long-range ideas behind NSF's support of a minicourse development project under Postlethwait's direction at Purdue. Somewhat akin to the more traditional textbook curriculum development projects, it draws on experts in different fields and helps them prepare minicourses in their specialties. The project approach, as opposed to the kinds of "survival kits" hastily assembled for the courses now being taught, should improve the chances that the best intellectual strategies and most effective visual and tangible materials will go into the final minicourse. It also provides a period of testing with students to debug each minicourse before it is offered to other schools to use.

That, of course, is the overall goal—to build up a collection of concepts in minicourse format and let other teachers draw on it. A minicourse package contains: the student's study guides (which include a summary, a list of objectives, and printed materials to be referred to during the independent study session); a teacher's manual that tells how to set up the A-T booth and experiments, what other resources will be useful, and sample test questions; a tape script that the local teacher can modify and record in his own voice, or a prerecorded reel or cassette of tape with the author's voice; the visual materials—slides, film loops, photos; and experimental materials not readily available (such as unusual specimens of plants or insects, mineral collections, prepared microscope slides). A school could then buy as many minicourses in a given subject area as it wanted—from individual specialized topics for which no expertise exists locally, to whole cores on which to construct its own curriculum.

One further, still untapped potential: Great teachers are rare, yet their influence on education far exceeds their numbers. One reason is that great teachers are often the ones who motivate a student to begin learning in earnest. Whether the A-T minicourse concept can extend the skills of those special teachers to many students and give them a better opportunity to realize their full potential is an intriguing question.

Flexibility

A-T is a pragmatic approach that has so far picked from the kinds of learning aids available, easily used, and affordable. In doing so it came up with a multisensory approach that, unless the teacher gets hung up on gadgets, is variable by both student and instructor. The fact that self-paced materials and modules (or learning packages or minicourses or whatever one wants to call them) exist from elementary school to graduate school in hundreds of different forms shows how they have already, because of their apparent utility, been integrated into some educational processes.

But any discussion of technology in education leads at some point to the topic of supertechnology—television systems in all their current confusion (cassettes, cables, closed circuit) and computers. Both, says Postlethwait, have a place in A-T, but neither, he adds, if relied on solely, has the advantage of multisensory approach.

TV ought to have advantages over audiotape because it can integrate illustrations that now have to be manipulated separately. But like film, says Postlethwait, we should remember that it consists of both sound and sight—which can be used separately. The problem is that a videotape package is far more difficult to modify and requires more elaborate equipment to produce—as well as more production experience. All those things, at least now, work to the detriment of having materials transportable from producer to small school users. And TV is more expensive all around.

Computers, which are now being used in pilot educational systems (see Mosaic, Vol. 3, No. 3, "Is the Computer Ready to Teach?") still suffer from the limited sensory input to the student, though some use text, illustrations, and sound. "But," says Postlethwait as he picks up a leaf off his desk, "this is where inquiry starts, with something tangible." In an A-T scheme he sees the computers used effectively for simulation experiments and demonstrations, but sees their fundamental role in managing education. Until the computer is brought in, the job of keeping track of which students are taking which minicourses, in what order, may be a limiting factor in the expansion of systems like Purdue's. Students are not prepared to take full responsibility for their own education (that's why the A-T courses have deadlines for getting minicourses completed, quizzes at frequent intervals, class meetings, and other necessary procedures for monitoring a student's progress), but the computer can keep a coherent, timely record of each student's educational program and prevent him from becoming lost in the pile of options available to him.

Where A-T is used

Because A-T resembles conventional instruction in many ways and because forms of it have been introduced gradually in many settings, its pervasiveness may be overlooked. If the steady flow of visitors to operational A-T projects and the speaking demands on people like Postlethwait are any evidence, interest
in A-T is snowballing, and rapid expansion may be expected in the next decade.

One ambitious example is at the new Permian Basin campus of the University of Texas in Odessa, where the whole upper division curriculum in the College of Arts and Sciences is going to be largely self-paced format. At Ohio State University a course in biology with 4,500 students is using A-T approach. At Wytheville Community College in Virginia, 90 percent of the courses are taught using minicourses with specific performance objectives. At the University of Mississippi A-T is used for continuing education of schoolteachers who can take materials back to their own classroom after they've used them. Western Michigan University provides A-T engineering minicourses as a supplement to the regular program. The University of Missouri Medical School uses a combination of computer-assisted instruction and A-T instruction for its students, and the Department of Obstetrics and Gynecology at the Medical College of Georgia has found its students respond enthusiastically to an A-T approach with performance guidelines clearly defined in advance. It's being used in elementary schools in Gary, Indiana, to help students with reading problems. And so on, and so on.

Limitations of A-T

A-T's modest successes so far and its enthusiastic boosters should not blind the potential user to problems he may encounter in trying to adopt A-T. The biggest mistake he could make—and one that has already been made in some places—is to set up an A-T course as if it would run itself once it begins. At Purdue there are always teaching assistants present in the learning center; if they weren't there to answer questions the whole system would probably collapse. In general, the teacher should be prepared for lots of extra work preparing or reworking the materials before the course begins, and plenty of little problems cropping up during the semester. If he's looking for an easier way to teach, he should keep looking.

And although the range of topics suitable for A-T is broad, it is hardly as effective in areas where mastery of the subject isn't a goal—such as courses promoting personal growth or awareness or conveying experiences. Then too, if an instructor is unable or unwilling to write good performance objectives, the students will suffer.

The Future for A-T

The portability, low cost, and variety of A-T packages make it an attractive candidate for a major means of continuing adult education. One could foresee the time when minicourses might be checked out of a library (just as separate books, films, and recordings are now), perhaps to be used in conjunction with the new kinds of television playback devices coming available.

As an educational device, one of the problems remaining is that A-T as it is presently developed still doesn't serve individuality as much as it might. The solution, perhaps, is to make the bites smaller and link them to an effective, computer-based management system. The teachers then will become guides for the students, helping them plot their way through the bodies of knowledge they're interested in and, as always, keeping them moving along.