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ABSTRACT

This publication, published quarterly by the American Institute of Biological Sciences, focuses on biology education in colleges and universities. Included in this issue are articles dealing with adapting available materials to an individualized instructional format, science seminars for liberal arts freshmen, the role of physiology in anatomy courses, a profile diagram for focusing thought on environmental problems, and the implementation of computer-assisted instruction in biology using structured and nonstructured mastery strategy with varying feedback specificity. (MH)

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Adapting Available Materials To An Individualized Instructional Format: A Problem

Robert N. Hurst

Individualized instructional strategies offer many new curricular possibilities in the hands of an imaginative and innovative instructor. At the same time, individualized instructional materials are difficult to produce, demanding and consuming time, energy, and resources at the least. Pity that more materials are not available commercially. But they are! They are lurking there, submerged and screened many times by "stuff" you really cannot use. Most are so restricted by copyright laws that they deter the majority of instructors from using them in a format in which they could be most useful, as instructional tools. It is as if some developers and producers of supposed instructional aids are determined to make their potential instructional aids unavailable as *real* instructional aids either by specifically denying duplication rights and adaptation privileges or, what is worse, by not specifically encouraging adaptation and alterations.

Much thought and technological expertise have gone into the development of many of these packages—time and resources that could not be invested by most individuals. But a cassette-filmstrip presentation on population genetics which is commercially available may not fit an instructional program which involves students with a printed study guide containing among other things behavioral objectives and written exercises. However, if permission could be obtained, or better yet, if adaptation were encouraged, much of the script and many or all of the frames of the filmstrip might be used and a study guide prepared to accompany these materials.

Also, if instructors of large courses require 10 to 20 carrels of a given instructional package to service their students and the commercial product is marketed at $30 a package, chances are good they will not use the product even if it were acceptable as is. And when it is not quite acceptable as is, its non-use is practically guaranteed.

If, however, permission could be obtained to prepare additional filmstrips or perhaps even pirate 20 frames or so and have them copied in slide format, plus if permission could be obtained to pirate parts of the script in print or sound format for $100 to $200 above the initial cost of one package, chances are good the package would be used. The problem of

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control by the producer of this type of practice would be horrendous, but the thought of passing up potentially beneficial learning materials is more distressful. It ought to be possible to limit the use of such materials to the students of the instructor who obtains permission and pays the premium for pirating privileges.

For example, if there are sections of a 16 mm film, which has been purchased by an institution or an individual, that are worthwhile or even critical to an instructional package but the rest of the footage is of little or no value, there ought to be a reasonable way of obtaining rights to use those sections in either film or video format with that instructor's students. This privilege should not be given for pirating a rented film unless an assigned pirating privilege fee is adequately high. If, however, a 20-minute film is purchased at a cost of $350, is it not possible to offer the same film for $500 with "in-house" pirating and duplicating rights? A 16 mm film, even if all good, is not a format that lends itself to individualized instruction, yet much of the footage (often without the commentary) may be of great value if available in video or 8 mm format

Some 16 mm producers are now offering their productions in video format, but still with listed no-duplication rights. One $350-videocassette is of no value in a course for 500 students viewing the footage individually, and the six or more copies that ought to be available for that number of students are prohibitively expensive.

The producers of 8 mm film loops should also look at their marketing procedures. Each of these 3- to 4-minute loops costs about $25. This is indeed reasonable if the instructor shows the film to 5 to 20 groups of 30 to 100 students once each semester; it will last for years. However, if the instructor teaches 800 students a semester in an individualized format so that each student views the film independently, a single loop has a good chance of not surviving one semester, even given the best of care. Cost becomes prohibitive. The options are to (a) "capture" the film on videocassette which, though they wear out, are dirt cheap for the three to four minutes of tape required, (b) do without a potentially excellent teaching aid, (c) do away with individualized instruction, or (d) pay the price.

The first option is probably taken by many, but never without some qualms, possibly guilt feelings, and perhaps even some anxiety. The next two options are repugnant, but the implementation of the second is probably widespread (speaking with some authority I can personally attest to this). The last option is no option at all, but the way most headstrong innovators must now go. Is it not possible to sell the first loop for $25 and offer to sell TV duplication rights for in-house use for an additional $100 or $200? That amounts to about $112-$212 profit on a loop sale that otherwise might not be made, as the second option is exercised, or merely $12 profit, as the first option is exercised, in spite of the possible emotional and legal hazards.

The primary argument against selling inexpensive pirating privileges undoubtedly would be the impossibility of enforcing such policies. But the problem would not be any greater than policing situations falling into the first option at the current time. By following one course of action the companies would at least make a few more bucks and the students would benefit. Obviously, for the producer the former is more important than the latter, but hopefully there is some chance that most companies have gotten into the educational materials business not only to make money but to help students learn. What is more, even if pirating options are offered, the purists of those with more liberal budgets might even continue exercising the last option and replace worn out film prints with more film prints if they are equipped better for that format. But at the same time, those less fortunate would at least be offered the pirating option.

The in-house pirating privilege fee could be scaled according to how much of a given commercial package was pirated, how many copies would be made, and so on. The problem with setting fees is one of "reasonableness." Obviously, it is possible, at the present time, to obtain permission to use and even alter parts or all of an available instructional package. The trouble is that set fees are directed primarily at the commercial use of existing materials and are hence unreasonable. Recently I attempted to obtain permission to use a single photograph, one which was terribly outdated in terms of clothing styles of the individual pictured. It was found in a publication with a 1958 copyright. The photograph was to be used in an in-house study guide for my own students, and it would have contributed immensely to the impact of the study guide. The reply to the request for permission was the standard rate of $100 per photograph. In spite of several letters sent to the publisher, the fee remained unchanged. So there was "no sale"

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AIBS EDUCATION REVIEW. Published by the AIBS Education and Communications Department, 1401 Wilson Blvd., Arlington, VA 22209. Editorial Board: Vernon Avila, Edward Buss, Robert Coler, Donald Dean, Robert Hurst, Bill Rushing. Editorial Staff: Richard Trumbull, Publisher; Richard A. Dodge, Editor; Sophie Dodge, Managing Editor. Subscription free to AIBS members. Published quarterly. © 1976 American Institute of Biological Sciences, Vol. 5, No. 2, May 1976.

in this case, and the $10 fee I offered for use of the photograph was saved; but the cause of education was probably not served as well as it might have been.

The time and effort required for an instructor to write for permission to use materials, given current policies, can also become prohibitive. Producers of educational materials, especially those appearing in the last few years which are designed for use with small groups or individuals, should take positive steps to make it easy for potential pirates to request and obtain permission to alter or adapt and to pay a reasonable fee for this permission. A sampling of the materials that fall into this category would include Ward's Solo-Learn, Lab Aids Incorporated's Lab Aids, BSCS's Single Topic Inquiry Films, Educational Methods Incorporated's Programmed Biology Series and Kits, Eduquip's kits and programs, Learning Resources Company's kits and cassette programs, BioFilm's learning program, Hach's test kits, W. B. Saunders Company's Visual Aids, Science Software System's multimedia presentations, University of California Media Center's recordings. There are also countless other programs from other sources: films and filmstrips from National Geographic Educational Services, Moody Institute of Science, McGraw-Hill, Life Education Programs, Learning Resources Company, BFA Ealing, and Harper and Row; printed separates from Freeman, Westinghouse Learning Press, Saunders, and McGraw-Hill; and so on.

To the potential developer looking for some ideas, some visual aids, or technology to make the task of producing an individualized instructional package easier while at the same time developing a package to help students learn the concepts designed into the package, the preceding list is recommended. In that group, however, there are only a few instructional materials sold as small separates or instructional products which *expect* or *encourage* you to adapt these materials to your own situation. You should stay away from programs involving copyrighted cassettes sold without duplication rights. Look for the package which will give you a script instead, with an open invitation to alter the script as you see fit, and then make your own recordings and as many copies as you require. The script may cost you more initially, but it becomes inexpensive when compared to the cost of several prerecorded and copyrighted cassettes. Shop for filmstrip producers who for a reasonable fee will permit you to photograph a few frames and make duplicates of those frames which can assist you in the development of an instructional package that might not require nor be able to use the entire filmstrip.

The paradox in this situation is that the producers of all these new and exciting kits, programs, cassette-filmstrip programs printed separates, etc., in their attempt to give us greater flexibility in our instructional program, have foisted upon us an equally confining lockstep in most cases. They are saying, "Use our products as produced or do not use them at all." This is what we have had all along. Granted, some programs may be done so well or fit a given instructor's format so well that they can be plugged in as is and used as intended. But chances are great that really innovative instructors will want to pick and choose from this program and that and no program is 100% acceptable or 100% adequate for what they see as their own and their students' needs. We should in no way diminish this role of the instructor. Instead we should actively work toward freeing his or her imagination, creativity, and inventiveness by making potential instructional materials more available and flexible. Producers of educational materials have had it their way for so long perhaps it's time to see what they can do to let us have it our way.

Editor's Note: In an effort to elicit various points of view, the manuscript for this "problem" was submitted to a commercial publisher of audiovisual-cassette materials; a nonprofit organization with long involvement in curricular materials development; and an academic chairperson recognized as a leader in the use of mediated instructional materials. The reactions of the reviewers were predictable, but nevertheless, are anonymously included, with the permission of the author, at the end of this article. Reader reactions and possible solutions are encouraged, and may be subjects for further exploration of the problem.

For the record, recommendations of the reviewers were (a) do not publish, (b) publish with the following changes, and (c) publish as is. The author has reacted to the reviewers' comments.

Review by Commercial Publisher

The manuscript represents the editorial opinion of the author and tends to be a rather subjective expression of uninformed opinion.

In my experience, producers of copyrighted educational materials (particularly in the sciences) are anxious to accommodate users of their products. Licensing policies permitting the limited reproduction of copyrighted materials are in use and under development by many producers. In every case, the so-called "fair use" standards have been considered and incorporated.

Unauthorized duplication can have a very negative effect on the very people the author purports to want to help. This is an area of considerable concern to educators and producers alike and should be the subject of good objective thinking. The author has failed to consider all points of view.

Review by Nonprofit Organization

This paper seems to be addressed primarily to publishers, asking them to change their marketing procedures and pricing policies for educational products. My major criticisms are

- It is addressed to the wrong audiences. It should be submitted to a publication trade journal.
- The plea is two-faced; change copy policy and reduce charges. This argument is naive in a "free enterprise" economy. The writer should reduce his argument to principles and defend his principles rather than try to exhort publishers to reduce their markups.
- The arguments of publishers and authors are not apparently known or attended to.
- The argument doesn't make a scholarly contribution to knowledge or problem solution.

Review by Academic Chairperson

We believe this could be one of the most impactful articles published by the *AIBS Education Review*. Having struggled with this problem for the past eight years, we agonized through each new individualized set of materials Bob mentioned in his article, knowing that if we adapted or used any of them, we could be violating the sacred, though vague, copyright laws.

We not only wholeheartedly support publication, but maybe even recommend sending copies to all the commercial producers of excellent learning packages now available.

Science Seminars For Liberal Arts Freshmen

Alice Bourke Hayes

The Department of Natural Science is a small academic department which offers science courses for liberal arts majors. In my 14 years in the department, I have had many freshmen students, so I am particularly sensitive to the new student's potential. I have become convinced that a variety of educational experiences should be available to provide the most favorable learning situation for each student. Many educators endorse creative approaches to education, but in practice wind

AIBS Activities

AIBS to Sponsor Allied Health Symposium at Annual Meeting

The American Institute of Biological Sciences will sponsor a one-day symposium on the Role of Biology in Allied Health Education at the 1976 Annual AIBS Meeting at Tulane University, 2 June 1976. The symposium organizer and general chairman is *Martin D. Brown*, former AIBS Governing Board Member and currently Dean, Health Arts and Sciences, Fresno City College, California

Symposium speakers include:

- *Joseph Hamburg*, University of Kentucky: Identifying the Scientific Needs of Allied Health Professionals
- *Raymond C. Bard*, Medical College of Georgia: The Role of Biology in Baccalaureate Allied Health Programs
- *Marion M. Brooke*, Center for Disease Control: Responsibilities of Teachers to Students and Community
- *F. Robert Owens*, Parkland College: Health Technicians—The Biologist in a Supportive Role

For further information about the symposium, contact the symposium chairman, *Martin D. Brown*.

AIBS Forms Allied Health Task Force

At the recommendation of its Education Committee, the American Institute of Biological Sciences has established a task force to consider the biological education for the allied health professions. The task force, under the chairmanship of *Martin D. Brown*, Dean, Health Arts and Sciences, Fresno City College, California, and former AIBS Staff Biologist, will conduct its initial meeting during the Annual AIBS Meeting at Tulane University, 1 June 1976.

Subjects to be addressed by the task force include:

- strategies to improve the quality of biology education to allied health majors,
- designs on improving communications between biologists and allied health educators,
- and a number of other issues confronting the biological sciences education of allied health majors.

Members of the task force include: *Beulah Ashbrook*, Director of Education, The American Society of Allied Health Professions; *Raymond C. Bard*, Dean, School of Allied Health Sciences, Medical College of Georgia; *Marion Brooke*, Associate Director for Health Laboratory Manpower Development, Center for Disease Control; *Gerald Griffin*, Director, Department of Associate Degree Programs, National League for Nursing; *Robert E. Kinsinger*, Director, Division of Education and Public Affairs, W. K. Kellogg Foundation; *Mary Jane Kolar*, Director of Education, American Dental Hygienists Association; *Ralph Kuhli*, Director, Department of Allied Medical Professions and Services, American Medical Association; *F. Robert Owens*, Chairman, Life Sciences Division, Parkland College; *Kenneth Skaggs*, American Association of Community and Junior Colleges; and *Martin D. Brown*.

For further information about the activities of the task force, contact Martin D. Brown.

up with sections that "meet MWF at 11 in groups of 50-200, examined at least twice per term, graded A-F" (Woodward 1972). The department also offers large lecture classes, small discussion classes, and average-size lecture-lab classes.

A new format called the Freshman Learning Group (FLG) was initiated three years ago. The distinctive features of the FLG are:

1. *Enrollment is restricted to freshmen.* A statistical analysis of the FLG population (Tribble 1974) showed that 45.7% of the students responding to a questionnaire indicated that they "felt more comfortable" in competition with other freshmen only.

2. *Class size is limited to 10 students.* Small classes are common in upper-division courses in the major field, but rare at the freshman level. The FLG is an opportunity for human contact and guidance from a professor who cares and who is concerned with the personal intellectual progress of each individual student.

3. *Special topics are chosen for these courses.* Courses are proposed by individual faculty members. The proposals usually focus on subjects that are not covered in traditional classes and have special interest for the professor. Since course proposals are initiated by the faculty themselves, those who do participate have a deep commitment. The Loyola faculty all have teaching experience, a Ph.D. or equivalent, and scholarly background in the area proposed for study, so no special additional qualifications were required of FLG professors. The determination of whether the FLG would be counted towards the faculty member's teaching load was the responsibility of the individual department sponsoring the course. In most cases, the FLG counted as 3 hours toward the full teaching obligation of 9 (including graduate) or 12 (undergraduate only) contact hours per week. Few departments offered more than one or two FLG's so the overall student/faculty ratio per department was not significantly affected. About 5% of the full-time faculty of the university participated in this program.

FLG's included such diverse topics as Chicago Theatre, Islam, Lasers, and Museums and Galleries in Chicago. The topic I proposed was "The Natural History of the Chicago Area." Course proposals are reviewed for appropriateness and probable freshman interest by the Dean of Freshmen. The prospective courses then undergo the routine evaluation process—approval by the department, review by the Core Curriculum Committee, and final approval by the Dean of the College and the Faculty-Student Academic Council.

In 1972-73, 24 FLG's were offerred in which 201 freshmen (about 20% of the freshman class) participated. In 1973-74, the program was offerred again to a comparable group. In both years, although one would expect that few nonscience majors would crowd to enroll in intensive science courses, the natural science courses had full enrollment and an informal waiting list.

The follow-up study (Tribble 1974) showed that 48.6% of the students initially were strongly in favor of the FLG program; after completion, 62.9% were strongly in favor, and 98.6% would recommend the FLG program to incoming freshmen.

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Course Structure

The 10 students and I met at least one afternoon each week from 1 to 4 or 5 p.m. during the spring semester. Each topic was introduced with a 45- to 50-minute lecture accompanied by handout notes and reading recommendations. The course was flexibly structured, so that after the introduction of the topic, the remaining two to three hours might be devoted to lab analyses, field work, a guest lecture, or a discussion. Obviously, no topic is thoroughly treated, but enough is presented so that curiosity is stimulated and resources for further study made known. Although students are free to pursue the specific topic of their choice, required weekly class sessions guaranteed that every student received basic information on all topics. There were no examinations, but the course was graded, primarily on independent research projects conducted by each student. Twice-monthly conferences informed me and the students of their continued progress.

The course has more content than an independent study course, but there is little pressure since the basis of grading is the quality of the research project. Some freshmen cannot handle a completely unstructured course. Others are prepared to share responsiblity for their own education (Barton 1973) and will profit from the opportunity to do so. The FLG format provides a workable balance (Green 1974) between the disorganized time-wasting muddle of "What shall we do?" and the efficient but often rigid "Do this."

Emphasis on local natural history—the backyard, the dorm, the campus, the community, the city—provided an intense awareness of the environment. Topics were neither artificial nor remote. Students became involved in their own community as they became involved in scientific study and showed ingenuity in developing their topics.

Although the initiative for the FLG program emphasized its value in developing teacher/student relationships, the students also developed mutual respect and friendship. I heard many comments revealing their appreciation of the achievements of fellow students when individual research was reported. They were impressed with one another! I took advantage of every opportunity to let the students share their hard-earned expertise with the group rather than present the material myself.

Course Content

The areas introduced included geology, arrival of man, history and growth of the city, meteorology, water and waterways, flora, fauna, and public health and sanitation. There is, of course, no handy textbook for such a course. For each class session I prepared a bibliography of basic references in the subject area and specific references for Chicago. I also prepared a three- to five-page outline summarizing pertinent Chicago area information on the topic. Each student received a copy of the Environmental Protection Act of Illinois, the Environmental Protection Agency annual report, and the Open Lands Project Conservation Resource Guide. Departmental copies of *Environmental Currents*, the newsletter of the City of Chicago Department of Environmental Control, and the Chicago Board of Health Newsletter were also made available. The administrative departments of the city, the departments of Public Health, Streets and Sanitation, Forestry, Water and Sewers, Parks, and the Metropolitan Sanitary District generously cooperated and sent current information and annual reports for our study.

I have emphasized the Chicago area, but obviously every location holds its own promise (Belman 1972, Kieran 1959). In addition to class lectures and reading recommendations, I used the following activities in one or both years:

• *Geology:* Lab work–examination of specimens of the rocks and minerals of the area (hardness, streak, fluorescence, density) and the departmental fossil collection; analysis of locally collected soil samples (pH,N,P,K, particle size, water retention). Field work–observation of wind and water erosion along the lake front; beach and dune formation; evidence of ancient coral reefs, sea cliffs, spits, glacial moraines, and ridges in Chicago topography; collection of soil samples; observation of horizon layers at construction sites. Lectures–students were encouraged to take advantage of the resources of the city, as geology lectures were offerred in the spring at the Chicago Academy of Science, the Chicago Public Library, and the Chicago Museum of Natural History.

• *Meteorology:* Field work–measurement of microclimates (temperature, humidity, barometric pressure) around campus; sampling and testing for air quality (CO, CO_2, SO_2, NO_2); sound level readings. Lectures–guest lecturer John Coleman of CBS-TV Weather presented a seminar on the major characteristics of Chicago weather and current research on effects of pollution and urbanization on weather patterns.

• *Water and Waterways:* Field work–water sampling in Lake Michigan, North Shore Channel, North Branch of the Chicago River, Green Lake, Des Plaines River. Lab work–qualitative analysis of water samples (pH,N,P,K,Pb,Hg,Si,Cl, coliform bacteria, algae, copepods, protozoa). Lectures–an NSF student-originated study of chloride levels in Lake Michigan was being conducted at Loyola under the directorship of a senior, J. Buttmer, with the guidance of R. Hamilton of the Biology Department. (The report on this work of fellow students was particularly stimulating to the freshmen.)

• *Flora and Fauna:* Field work–two field trips to Indian Road Woods (late March and early May) for spring flowers and birds. Lab work–herbarium study and slide talks on the amphibians, reptiles, birds, mammals, and insects of the area. Lectures–an "open classroom" lecture by Floyd Swink at the Morton Arboretum, Lisle, Illinois.

• *Public Health:* Field work–D. Gallay of the Chicago Environmental Control Board led three field studies (sewage filtration plant of the Metropolitan Sanitary District, a sanitary landfill, and an industrial waste commercial plant); also visited the water filtration plant. Lectures–K. Wisiol of Commonwealth Edison discussed energy needs and the future.

Student Projects included field studies, laboratory investigations, and library research. Several led to community action and drew local publicity. The following list of titles gives some indication of the range of topics chosen: *Geology*–the geological history of Chicago, a comparison of Chicago area farm soils treated with organic and inorganic fertilizers, a comparison of Chicago urban soil with Louisiana farm soil; *Meteorology*–the lake-snow effect and tornadoes in Chicago; weather predicting from a simple instrument station established in Loyola Hall; *Waterways*–a study of Green Lake, a history of the Illinois Michigan Canal, sewage treatment systems; *Community*–a history of Hegewisch, noise pollution and the Chicago Transit Authority, noise levels and O'Hare Field, air pollution on the northwest side of the city, heart disease and preventive programs, venereal disease (facilities and programs), Chicago Board of Health; *flora and fauna*, the effect of herbicides, fertilizers, and detergents on *Cladophora spp* isolated from Loyola Beach, analysis (the identification, distribution, and relative age) of over 200 trees on the Loyola Lake Shore campus, a study of the factors regulating the nonsynchronous bloom times of three campus magnolia trees, a study of changes in the populations of fish in the Great Lakes, Dutch elm disease in Illinois.

My experiences with the FLG format lead me to recommend it highly as an alternative to the large lecture class format or the independent study program because of its obvious advantages for the freshman student.

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New Report on the Salaries of Scientists, Engineers and Technicians

Salaries of Scientists, Engineers and Technicians–A Summary of Salary Surveys is a comprehensive biennial report presenting information on starting and advanced salaries in industry, government, and educational institutions. The seventh edition (December 1975) has just been published by the Scientific Manpower Commission.

The 112-page report includes salaries for scientists, engineers, and technicians broken out by field, highest degree, sex, years since first degree, age group, category of employment, work activity, type of employer, geographic area, academic rank, Civil Service grade and grade distribution, and level of responsibility. Data were compiled from 44 sources, both published and unpublished, and cover the period 1972-75 with some trend data beginning as early as 1961.

Some highlights:

- Despite a 24% drop in the number of offers made to new bachelor's graduates, salary increases in the various engineering specialties rose from 9 to 15% in 1975, with B.S. chemical engineers receiving the highest salary offers ($1,196 per month). Offers to accounting graduates increased 6% to $981, and to business graduates 5%, while offers to graduates in all other fields rose less than 5%.
- Women, too, received fewer job offers, despite an emphasis on affirmative action. Women majoring in accounting and most engineering disciplines received slightly higher salary offers than men, but in all other disciplines their salary offers were lower.
- The median starting salaries of chemists in 1975 either decreased or increased only slightly from 1974 depending upon degree level. Salaries of experienced chemists rose 8.6% to $19,000 at the B.S. level; 7.6% to $23,000 at the master's level; and 6.0% at the Ph.D. level.
- Beginning salaries for Ph.D.'s in mathematics decreased from 1974 to 1975, with salaries in business and industry dropping to an average $18,700 from the 1974 figure of $19,000.
- Average salaries for selected white-collar occupations in private industry increased 9.0% during the year ended March 1975—the largest annual increase recorded in the 15-year history of this Bureau of Labor Statistics series.
- Despite an increase in the median salaries of experienced engineers in all areas of employment in 1974, salaries did not keep pace with the rising cost of living. The overall average annual salary for all engineers in 1974, without regard to age, type of employer, supervisory status, or degree level, was $19,000.
- On 1 October 1975, all federal workers received a 5% pay increase rather than the 8.66% increase recommended by a federal panel.
- Faculty salaries rose 5.8% in 1974 and total compensation, including fringe benefits, rose 6.4%, but the increase was less than that of the cost-of-living index. The American Association of University Professors reports that the average salary of all faculty members in all ranks in all kinds of colleges and universities was $16,403 in 1974-75; with total compensation averaging $18,709. Women faculty members, on the average, received 17.5% less total compensation than men.

The seventh edition of *Salaries of Scientists, Engineers and Technicians—A Summary of Salary Surveys* (December 1975, 106 + vi) includes 128 tables and 11 charts. It is available from the Scientific Manpower Commission, 1776 Massachusetts Avenue, N.W., Washington, DC 20036 for $15 prepaid. The sixth edition (August 1973) and the fifth edition (June 1971) are available at $3 each or $5 for both, If ordered with the new report.

For information, contact: Eleanor L. Babco, (202) 223-6995 or (202) 467-4325.

An Opinion

Should Anatomy Divorce Physiology?

Monroe Cravats

There are courses in botany, genetics, microbiology, and zoology. The only marriage seems to involve anatomy and physiology, and even that marriage is performed under special circumstances, usually for nonbiology majors such as those majoring in health education, physical education, and nursing. These students have limited space in their programs and, of necessity, the two courses are merged.

Where possible, freshman biology may be a prerequisite for the course or the course may be spread out for one year. If the course is expanded to one year, why not separate anatomy from physiology and give the present course? This is difficult to do because these courses would require additional prerequisites such as chemistry.

Ordinarily, however, anatomy and physiology are one semester courses of six hours each: three in lecture and three in laboratory. There is a tremendous amount of material for scientifically naive students to master in a short time. (Note how thick the textbooks are getting year after year.) What could be done to give the students a knowledge of anatomy and physiology without overwhelming them?

First, by necessity anatomy should remain with physiology for these students. A decision then has to be made as to which topics to offer and which to delete. If the students will be taking a licensing examination, the teacher might supply lists of information to them; if they have to know the names of approximately 200 bones and 400 muscles, this information could be separate from the course itself.

It is also helpful in such a course to have the same person teach the lecture and laboratory parts and to have the two parts blend so that the teacher may be flexible in the time devoted to either.

Next, the subject areas ought to be organized wherever possible according to physiological topics rather than, as is the usual case, anatomical topics. Sample listings might include "transport" and "homeostasis" rather than "circulatory system" or "urinary system."

Supportive services should be available to the student. The teacher should be prepared to allow a great deal of time to give individualized help to the student.

Anatomy and physiology should serve as an inspirational course so that the student may desire to pursue the discipline in the future. The course should not stand as a frightening summit which the student must conquer in order to graduate.

Monroe Cravats is at the York College of the City University of New York, Jamaica, New York 11432.

Editor's Note: Reaction to this opinion is solicited.

Bio-CMI Implementation Using Structured and Nonstructured Mastery Strategy with Varying Feedback Specificity

C. Benjamin Meleca
Sandra A. Drabik

A system of Computer Managed Instruction (CMI) developed at The Ohio State University (OSU) in cooperation with South Dakota State University provides an exciting instructional model for individualized learning based on repeatable testing. A sophisticated computer program was designed and implemented in the introductory biology program at OSU using Coursewriter III program products available from IBM. Coursewriter III provides an author language, telecommunications support for remotely located computer terminals, and utility programs for the collection and storage of student performance data. The basic system was modified at OSU so that the centrally located IBM 370-158 computer would support quiet, high-speed terminals, i.e., Hazeltine 2000 cathode ray tube (CRT). This specific CRT is capable of elaborate displays at high speeds (120 cps). Printers could easily be attached to the Hazeltine should hard copy be desirable.

Four Hazeltine 2000 computer terminals were installed in the Bio-Learning Center for student use. Two additional terminals were available to instructors for student data retrieval and counseling. In such an audiotutorial environment, students had a possible 65 hours per week accessibility to all instructional modules and learning materials (i.e., super 8 mm films, videotapes, kodachrome slides, prepared slides, demonstrations, and laboratory exercises) covering the integrated lecture-laboratory-observation, throughout the 10-week academic quarter.

The Bio-CMI program was designed and written to use the curricular materials developed for the introductory biology program in the College of Biological Sciences, namely the *Bio-Learning Guide* (Meleca et al. 1975). The behavioral objectives, written for various cognitive levels, were taken directly from this text.

Since specific details of the CMI model have been described in an earlier publication (Allen et al. 1972), this paper reports the implementation of the model and the results of a study which investigated the effects of involving structured and nonstructured mastery learning strategies with varying levels of test item feedback and varying levels of student abilities as measured by the ACT Program Placement Examination.

Learning Environment

The main vehicle used in the transfer of biological information at OSU was the Bio-Learning Center (Meleca 1973). This system followed the philosophy that instructional programs should be learner oriented and that a variety of media and teaching strategies, flexibly scheduled, should be used in an effort to help students achieve behavioral objectives. Bio-CMI used the established humanizing environment of individualized instruction in the Bio-Learning Center and further used the power of the computer to provide meaningful diagnostic testing and feedback to guide students in the process of learning. In the OSU program, students learned to make their own decisions in the management of learning experiences with a minimum of supervision but with feedback given by computer, instructor, and the instructional team. The effectiveness of the students' decisions was analyzed in counseling sessions with the teacher.

Literature Survey

Studies dealing with the concept of mastery learning date back many years (Courtis 1925, Mackinder 1925, Washburne 1925, Whipple 1925). In general these studies, as reported by Wentling (1973), indicate an advantage for mastery learning over nonmastery learning strategies.

More recent studies at the college level by Amthor (1968) and Johnson, Gnagey, and Chesbro (1970) undertook comparisons between treatment groups using mastery learning and students in a more traditional method of learning. Although Amthor's study reports a significant difference in achievement in favor

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of students in the mastery learning situation, Johnson, Gnagey, and Chesbro contradicted those results. In other studies to determine the effectiveness of mastery learning in relationship to time spent on instruction, Washburne (1925), Sutherland (1925), and Ward, Carter, Holmes, and Anderson (1925) showed that mastery learning actually decreases the mean amount of time needed to complete the instruction.

Early studies investigating the concept of feedback or knowledge of results agreed that some knowledge of performance improved future performance (Plowman and Stroud 1942). In a study by Sassenrath and Garverick (1965) involving differential feedback from exams on retention and transfer, 120 students in each of four treatment groups received one of four degrees of feedback ranging from (a) classroom discussion, (b) looking up wrong answers in the textbook, (c) checking over answers from wrong answers on a bulletin board, to (d) no feedback on questions. As expected, students receiving feedback providing for discussion performed best. In another study involving "knowledge of results and incorrect recall of plausible multiple-choice alternatives," Karraker (1967) found that no knowledge of results resulted in significantly more errors for 72 college freshmen responding on a multiple-choice test with a recall criterion test taken later. When no feedback was provided, students were found to recall more plausible wrong responses as being correct. However, this was not the case with the treatment group receiving feedback. Simply stated, students who made errors on multiple-choice examinations without being provided knowledge of results tended to make the same error on recall examinations.

In another study, Sullivan et al. (1967) found that students receiving immediate feedback appear to employ a different learning strategy from "no feedback" students in learning instructional materials. Although these researchers did not find significant differences on criterion test performance between the two groups, students receiving no knowledge of results scored significantly higher on mastery tests than did students receiving immediate feedback. However, as many as 15 students from the "no feedback" group failed to complete the instructional program compared to 3 in the "immediate feedback" group.

Approaching the literature and researching current studies reveal an increasing sophistication and rigor of the research on instructional development. The complexity of such investigations is evidenced particularly when one focuses on the contradictions. In a study involving varying feedback specificity, Goldstein et al. (1968) found that, contrary to typical findings, the percentage of feedback had no influence on final performance. However, the more specific the "knowledge of results" the more precise was the guidance of behavior. From this study it appears that "some traditional concepts regarding the role of feedback in establishing and maintaing performance may require revision."

Sturges (1969) investigated "verbal retention as a function of the informativeness and delay of informative feedback." She concluded, paradoxically, that neither delay of feedback, nor the form of feedback, had an effect on immediate retention. However, seven-day retention was found superior with a 24-hour delay when feedback included both correct and incorrect alternatives. A 24-hour delay had no effect on retention when feedback included only the correct alternative. Sullivan (1967) and his associates found that students receiving immediate feedback to responses on mastery test items scored significantly lower than students receiving no knowledge of results. They learned that the "no feedback" group spent more time studying the textual materials than the "feedback" students. Whereas the "feedback" group attempted to use the instructional value of the immediate feedback on their responses to mastery items, the "no feedback" students spent more time studying their textbooks. Criterion or performance tests were comparable for both groups. Results of another study by Sullivan et al. (1971) contradict Sturges' (1969) investigation; immediate feedback of knowledge of results was more effective than a delayed feedback procedure.

Ammons (1956) made the statement that "knowledge of various kinds which the performer receives about his performance affects his behavior." He summarized these effects by making 11 generalizations, each followed by the available supporting evidence from research studies. Examples of such generalizations are (a) knowledge of performance affects rate of learning and level reached by learning; (b) knowledge of performance affects motivation; (c) the longer the delay in giving knowledge of performance, the less effect the given information has; and (d) when knowledge of performance is decreased, performance drops. Ammons stated that highly motivated students (i.e., students performing at a high level of proficiency) are encouraged by knowledge of results. However, increased feedback may "actually lead to a decrease in motivation" when students are not performing well.

Gunter (1973) noted that relatively few studies investigated or reported structured and nonstructured strategies. Studies by Brown (1966), Olson (1957), Rainey (1965), and Hovey, Gruber, and Terrell (1963) found no significant difference between control and experimental treatments. However, Mager and McCann (1961) found support for their hypothesis that learning is enhanced when students are allowed to make decisions concerning their learning experiences.

Bloom (1968) studied the effects of attitude toward instruction, correlating them with total achievement. Students who were successful in learning tended to have a favorable attitude toward instruction. In a more recent study, Wentling (1973) stated that attitude toward learning may be important in developing and maintaining good attitudes beyond formal training at the university level. However, he reported no significant difference in attitude toward instruction between the learning strategies (i.e., mastery versus nonmastery treatment).

Wentling (1973) compared the effects of a mastery strategy of instruction with those in a nonmastery strategy, with varying levels of test item feedback from unit achievement tests. A 3 x 2 x 2 factorial design was used with instructional strategy, feedback specificity, and mental ability as factors. The five-week study of 116 male high school students found mastery strategy to be superior in terms of final achievement. Varying test item feedback treatments showed that partial item feedback, as opposed to none or complete item feedback, "appears most desirable when time trade-off is justifiable."

Whereas Wentling's study looked at mastery versus nonmastery learning strategies with varying test item feedback, the research reported here used the computer in a controlled experiment to generate criterion referenced tests at random as a measure of achievement in two mastery learning strategies with three levels of feedback given to students regarding their responses on multiple-choice test items. The dependent variables under investigation in this study were (a) final cognitive achievement, (b) time spent at the computer terminal taking cognitive tests, and (c) attitude toward instruction. The independent variables under consideration were (a) instructional strategy, (b) feedback specificity, and (c) ACT score.

Method

Subjects

The subjects were 105 university students enrolled in an introductory biology course in the OSU College of Biological Sciences during the autumn quarter 1973. The students were randomly assigned to either a structured or a nonstructured learning strategy group within one of three recitation sections representing different levels of test item feedback.

Procedure

Students attended three 50-minute recitation periods per week during a 10-week academic quarter. In addition to this experience, students worked in an audiotutorial mode in the Bio-Learning Center (Meleca 1973). All students, regardless of experimental treatments, were expected to use the Bio-Learning Center to complete nine instructional modules (i.e., six core or required and three out of four "optional" modules). Each instructional module, designed to contain one week's learning activities, had been keyed to specific behavioral objectives.

A test item bank of approximately 6000 multiple-choice items had been developed via item analysis and categorizing test items according to (a) instructional module, (b) behavioral objective, and (c) level of cognitive difficulty. Test items were written by faculty members in the introductory biology program and administered to approximately 2600 students for item analysis. Of the 6000 test items available, 2249 were used in the Bio-CMI test bank.

After an initial orientation to individualized instruction and Bio-CMI, students were given an off-line diagnostic pretest, which was used to assess the entry behavior or biological knowledge of students at the time they began the course. The 58-question multiple-choice examination was designed to test the objectives of the six core modules. Data received by the instructors as a result of analysis by a pretest scoring procedure included each student's total performance and specific performance in each module. Each student's course of study for the quarter was prescribed on the basis of the off-line pretest performance. The management strategy allowed a student to skip modules on which he or she had demonstrated proficiency; mastery criterion was assigned at 76%. Grading was determined by weighting the test items according to cognitive difficulty. Questions were divided into three levels of difficulty which encompass the six categories in

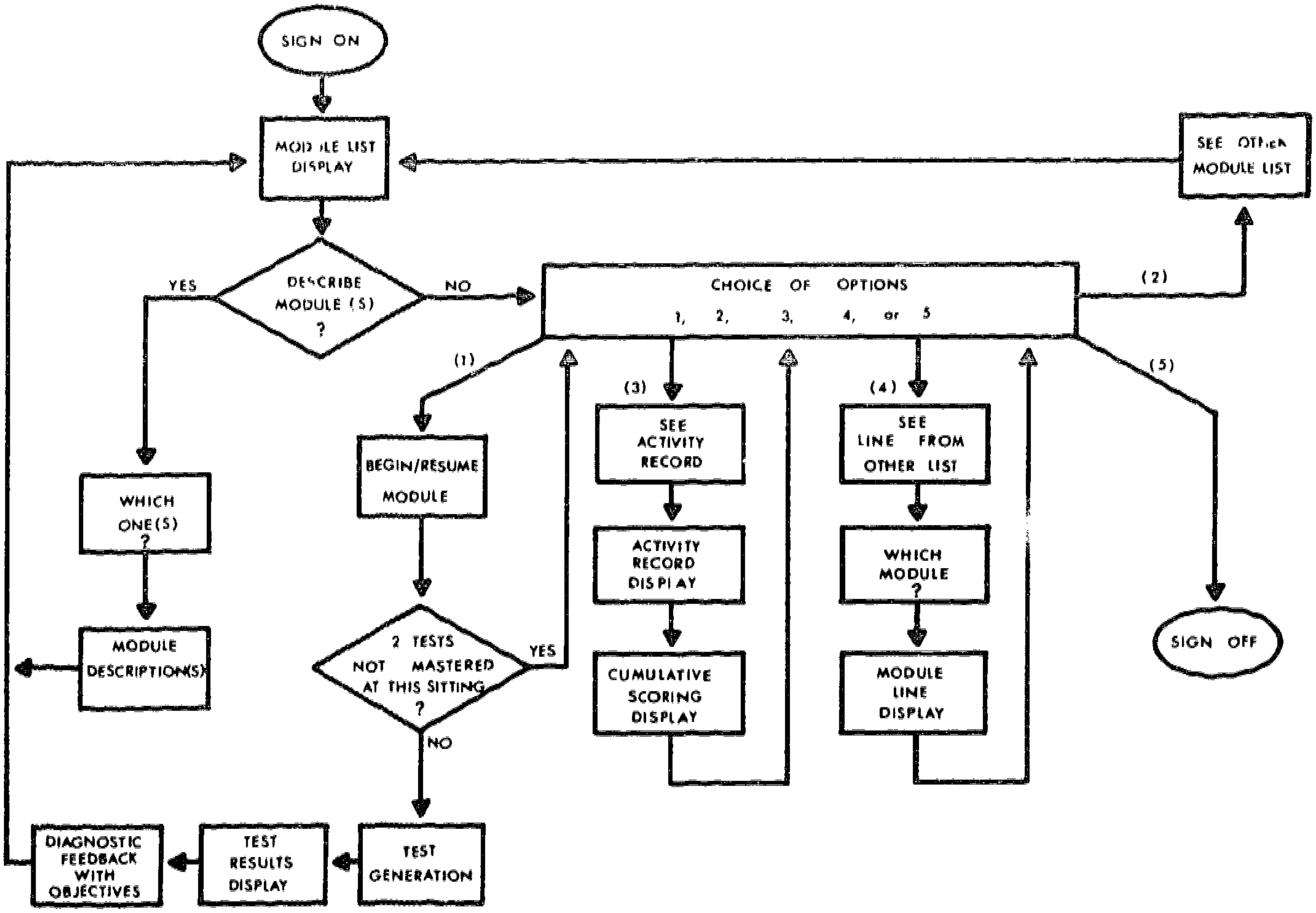

Figure 1. Flow chart

Bloom's Taxonomy of Educational Objectives: Cognitive Domain (1956). These levels were (a) knowledge and comprehension, (b) application and analysis, and (c) synthesis and evaluation (*a*-level items = 1 point, *b*-level items = 1.5 points, and *c*-level items = 2 points). This number was divided by the total number of items (also weighted) on the tests. Students were given their highest cumulative score on a module.

After the off-line pretest, all test taking was done at self-initiated times on Hazeltine 2000 computer terminal (see Figure 1–Flow Chart). Tests generated for the benefit of student guidance were given a "no risk" situation–they could be taken as often as needed for the achievement of mastery.

Each module of instruction began with a randomly generated pretest from the test item bank. Each test was unique but equivalent to all other tests on that module as to level of difficulty and number of items generated per behavioral objective. These criteria were established by the instructor, (i.e., instructor options). For Biology 100, approximately 70% of the test items are of the cognitive level (*a*-knowledge comprehension); 20% are of the *b*-application analysis level; and 10% are of the *c*-synthesis evaluation level of difficulty. All students were encouraged to take a module pretest without prior preparation and to use the diagnostic pretest results to determine course of study based on the list of objectives not mastered, which were given after every test. A student obtaining mastery (76%) on the pretest moved on to the next module. Otherwise an alternate test or criterion test was taken on the same module. Students were encouraged to take as many criterion tests as they wished to achieve mastery and go on to the next module or to continue testing in order to raise their grade.

The study employed a 2 x 3 factorial design (Figure 2) and was concerned with the investigation of three independent variables. The first of these variables was the type of instructional strategy used: mastery learning in a structured or mastery learning in a nonstructured treatment. Structured sequences were established for Groups S_1, S_2, and S_3. Students in Groups N_1, N_2, and N_3 were permitted to attempt any module at any time, whether or not mastery was achieved on a specific instructional module. Mastery strategy philosophy was still in effect even though some students chose to attempt several instructional modules before mastery of each. Ultimately, mastery of the core and optional units was necessary to complete the course even in the nonstructured group. When students in Groups S_1, S_2, and S_3 were ready to begin the next module, they could only do so when mastery had first been achieved on the previously ordered module. Once mastery was achieved, students were free to try to improve their scores as many times as desired before proceeding further.

The second independent variable studied was feedback specificity on multiple-choice items. Three levels of specificity of feedback were used. Groups S_1 and N_1 (level one) received no feedback as to correctness on test items; S_2 and N_2 (level two) received partial feedback (i.e., correctness of response statement was made after student entry); and Groups S_3 and N_3 (level three) received total item feedback (i.e., correctness of response and correct response).

		INSTRUCTIONAL STRATEGY (Mastery)	
		Structured	Nonstructured
FEEDBACK SPECIFICITY	None	S_1	N_1
	Partial	S_2	N_2
	Complete	S_3	N_3

Figure 2. Instructional strategy

A third independent variable investigated was the ACT score, which was used as a covariate in the analysis to help adjust for initial differences in student ability and preparation. Its use as a predictor of achievement and time at the computer terminal was also investigated. The American College Testing (ACT) Program placement examination was developed to assist colleges in placing entering students in classes most appropriate for their ability and preparation. Five ACT scores were available as predictor variables: English usage, mathematics, social studies, natural science, and a composite score. Prediction equations provided course directors important data needed in program development. Individual ACT scores were taken from student records housed in college offices. Achievement and time at the computer terminal were measured by cumulative scoring (grade earned) and time data on each student. Attitude toward instruction was measured at the completion of the 10-week course.

Criterion Instruments

Three dependent variables were investigated in this study: (a) final cognitive achievement, (b) time spent testing at the computer terminal, and (c) attitude toward instruction. Final cognitive achievement was measured by the cumulative scoring of nine criterion tests randomly generated from a test item bank. Each test was unique but equivalent to all other tests on that instructional module as to level of difficulty and number of test items generated per behavioral objective. Diagnostic tests consisted of four-alternative multiple-choice items with one correct response.

The second dependent variable was time spent taking criterion tests at the Hazeltine 2000 computer terminals. Time was logged for each student as he or she signed-on and signed-off the CRT. A cumulative record was kept on each subject throughout the study.

The last dependent variable under consideration, attitude toward instruction, was surveyed with a questionnaire developed specifically for Bio-CMI students. One section of the instrument was constructed of instructionally related statements, randomly ordered with both positive (favorable) and negative (unfavorable) statements. A five-point scale ranging from "strongly agree" to "strongly disagree" was used. Other statements in the instrument (section 2) required candid responses which were not scaled for scoring as in section one. Reliability estimates of this attitude survey have not been attempted at this time; therefore, any interpretative (in respect to attitude toward instruction) data should be considered carefully.

TABLE I

ACHIEVEMENT

	Instructional Strategy	
	Structured n = 45	Nonstructured n = 37
$\bar{X}$	81.74	80.19
S.E.	1.80	1.93

TABLE II

TIME

	Instructional Strategy	
	Structured n = 45	Nonstructured n = 37
$\bar{X}$	15.71	13.42
S.E.	0.92	0.98

Results

Tables I and II show the results for instructional strategy in relation to the dependent variables, final cognitive achievement, and time spent at the computer terminal. A two-way analysis of covariance indicated no significant differences between instructional strategies with respect to achievement and time. This result was anticipated since both treatment groups followed mastery learning strategies.

Feedback specificity consisted of three types of treatments: none, partial, and complete feedback. Tables III and IV show the results of feedback specificity in relation to the dependent variables achievement and time. The two-way analysis of covariance indicated no significant difference among levels of feedback specificity. Further, the interaction of instructional strategy with feedback specificity was also nonsignificant. A summary of the least-square means and standard errors from the analysis of covariance is given in Tables III and IV.

These results are counter to those reported by Wentling (1973) and Karraker (1967). Most likely these results can be attributed to the fact that both instructional strategies were mastery learning strategies.

Regarding the dependent variable of attitude toward instruction as measured by an attitude questionnaire, students were highly positive about the Bio-CMI program and favored the nonstructured mastery learning strategy (as opposed to the structured format) and partial or complete test item feedback (rather than none). The positive attitude toward mastery level learning substantiates the studies of Bloom (1968) and Wentling (1973). In terms of program and course development, there was no significant difference in instructional strategies with respect to time spent at the computer terminal. Several students in the study however, were able to complete the 10-week course in considerably less time (e.g., in 5, 6, and 8 weeks instead of the 10). Still other students needed an additional 2 to 4 weeks to complete the program.

Statistical analysis indicated that the covariate, ACT score, was significantly ($p<.01$) correlated with the dependent variable of achievement. With each unit increase in ACT score, the mean score increased 1.43 points. Further, statistical analysis indicated that the covariate, ACT score, was significantly ($p<.01$) correlated with the dependent variable time on the terminal. For each unit increase in ACT score, time on-line decreased by 0.47 hours.

It is not altogether surprising to find that ACT scores were highly correlated with achievement and negatively correlated to time spent at the computer terminal. However, in a mastery learning strategy, one would not necessarily expect such results. Not only was there a high positive correlation between ACT scores and achievement for both instructional strategies, but this factor was observed for students at the higher level of performance (i.e., students earning an A for a final achievement score). The results are also consistent with the belief that students with higher ACT scores need less time for learning than students with lower ACT scores.

TABLE III

ACHIEVEMENT

	Feedback Specificity		
	None n = 28	Partial n = 23	Complete n = 31
$\bar{X}$	83.04	81.32	78.52
S.E.	2.26	2.46	2.12

TABLE IV

TIME

	Feedback Specificity		
	None n = 28	Partial n = 23	Complete n = 31
$\bar{X}$	15.44	15.03	13.21
S.E.	1.15	1.25	1.09

Several implications can be drawn from the results. First, the mastery learning strategy permitted high levels of cognitive achievement for both the structured and nonstructured groups. Secondly, neither instructional strategy nor feedback specificity, nor the interaction of the two, had a significant effect on achievement or time. These results imply that all students, regardless of ACT scores, can be successful (mastery level learning) in this learning strategy. Our records on student data revealed that although students with higher ACT scores were continually attempting to improve their scores, students with lower ACT scores were spending the same time achieving mastery.

Summary

This study was undertaken with the anticipated result of determining which of two types of instructional strategy and which of three types of test item feedback would be most beneficial to students in Bio-CMI. As stated in the results with respect to achievement and time on-line, there were no significant differences among treatment groups. However, the attitude survey indicated that students favored complete or partial feedback on test items to no feedback.

We are in complete agreement with Goldstein (1968) and his associates in concluding that some traditional concepts regarding the role of feedback in establishing and maintaining performance may require revision. Personal observations in the investigation reported indicate that different feedback treatment groups used different study modes. In examining feedback specificity (i.e., none, partial, and complete), we found that students who were provided complete feedback spent less time studying their text and visiting the Bio-Learning Center as well as recitation class, although we did not attempt to measure these variables. Students receiving complete feedback may have received all the knowledge necessary from the question item and the feedback to be successful. We are in agreement that much of the data in the literature is complex and more often contradictory (Ammons 1956, Goldstein 1968, Plowman 1942) concerning feedback specificity—i.e., which kinds of feedback are best for certain tasks; delayed versus immediate feedback; what amount of information received by the performer concerning performance of specific tasks. Obviously, the nature of the terminal behavior must be considered in studying such questions. Although there is little debate as to whether or not feedback or knowledge of results is desirable for the learner, the kind and amount of feedback is task dependent and instructional developers should consider this variable seriously.

Bio-CMI offers considerable potential as a dynamic individualized and personalized instructional medium. It permits students to learn at their own pace while demanding a high level of achievement—mastery level learning. This combination makes the Bio-CMI strategy particularly attractive for use in the learning-teaching process.

Acknowledgments

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A Profile Diagram for Focusing Thought on Environmental Problems

David F. Parkhurst

Recently, in teaching a sophomore-level environmental survey course, I sought a means for encouraging students to view environmental problems broadly—to look at many aspects of any given problem. The result was the profile diagram of Figure 1, which presents 10 different variables that help to characterize problems and their solutions.

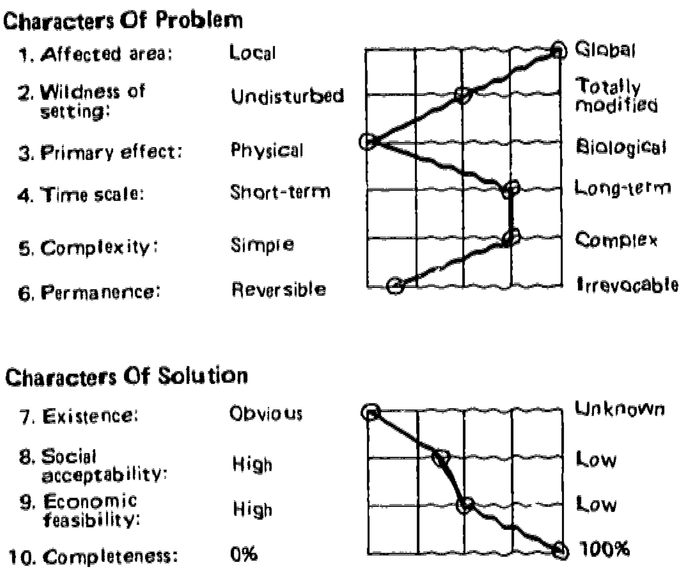

Figure 1. Profile diagram suggesting variables to be considered with environmental problems and proposed solutions. The diagram is filled out for problem 2 (see text).

Along with these diagrams, I presented some sample problems and asked the students to classify them using the profile. Examples were:

1. With a bad cold, you ride the bus from Indianapolis to Bloomington. The person in the seat next to you lights a cigarette. (You are a nonsmoker.)

2. Chlorofluoromethanes, used as refrigerants and as propellants in many spray cans, are extremely stable in the lower atmosphere. With continued use, their concentration apparently builds up and they diffuse upward to the stratosphere. There they decompose, and the resulting free chlorine is thought to destroy ozone. Ozone molecules are major absorbers of ultraviolet radiation, which causes skin cancer in humans, as well as damage to plant cells. The net effect is that continued use of spray cans with these propellants is likely to lead to increased skin cancer and other damage to living organisms.

As an example of the use of the profile, my own judgments for problem 2 are shown in Figure 1.

Often, the range of responses for a given variable and a given problem was quite broad (occasionally spanning the whole range!). Of course, there is not one right response; the important point is that these (and other) characteristics should be considered. In fact, the diagram served as a useful basis for class discussion. I hope the students retained the broad perspective suggested throughout the course, although I did not use diagrams specifically after the first two weeks. If others find difficulties with any of the variables used in Figure 1, or can suggest important omissions, I would appreciate hearing from them.

This profile is similar in concept to that of Kaill and Frey (1973), but is much more general; it was developed independently. In addition, the profile is related to the matrix approach for environmental impact analysis (Leopold et al. 1971), which would be appropriate to cover in advanced courses rather than the simplified general profile discussed here.

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