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AUTHOR Goldschmid, Barbara; Goldschmid, Marcel L.
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ABSTRACT

This paper reviews the principles, implementation, management, formats, problems, and research in modular instruction. A module is defined as a self-contained, independent unit of a planned series of learning activities designed to help the student accomplish certain well-defined objectives. The learner is able to proceed at his own rate, choose his own learning mode, select among a variety of topics, identify his strengths and weaknesses, and recycle if necessary. Ideally modules should include a pretest, objectives, criteria for success, instructional activities, a posttest, and remedial instruction. When designing a module, the following steps are recommended: a) identification of the subject matter to be taught, b) definition of a set of objectives and evaluation items, c) a decision upon the hierarchy of the objectives and sequence of instruction, d) statement of rationale, e) development of a pretest, f) design of units of written instruction and selection of study materials, g) provision of instructional options, h) design of a posttest, and i) arrangement for a resource center. Examples of five actual formats are included; student, instructor, and administrator problems are indicated; and there is a brief review of research, a glossary, and a bibliography. (MBM)

MODULAR INSTRUCTION IN HIGHER EDUCATION: A REVIEW

by
Barbara Goldschmid
&
Marcel L. Goldschmid

CLD

C O N T E N T S

INTRODUCTION *

In recent years, there has been an increasing focus on individualized instruction in Higher Education. On the one hand, crowded classrooms and large classes foster anonymity in teaching and learning: Students not only lack direct contact with their instructor, but often do not even get to know each other. On the other, many studies have recently reemphasized what teachers have known all along: There are great differences in how each student learns. Thus, emerges the need for instructional systems which can make higher education available to large numbers of students and, at the same time, offer an individualized learning experience.

Among the various systems of individualized instruction proposed so far, modular instruction is one of the newest and combines many advantages of a number of separate instructional innovations, such as performance objectives, self-pacing, and frequent feedback.

In the last two years in particular, a number of colleges and universities have successfully implemented modular courses and increasing interest in this approach is developing on many campuses. It is for this reason that the present paper has been prepared. Its purpose is to review the principles, implementation, management, formats, problems, and research in modular instruction.

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* The contributions to this paper by CLD's George Geis, Charles Pascal, Bruce Shore, and Ann van Hemert are gratefully acknowledged.

1. PRINCIPLES

1.1. What is a Module?

- For the purpose of the present discussion a module is defined as:

  > A self-contained, independent unit of a planned series of learning activities designed to help the student accomplish certain well-defined objectives.

- While differences in definition exist, it seems to be generally agreed that a module is a curriculum package intended for self-study: It is auto-tutorial.

1.2. What is Modular Instruction?

- Modular Instruction (MI) may be defined as instruction which is either partly or entirely based on modules.
- Creager and Murray (1971) point out that "current uses of modules range from one or a few modules inserted into a traditional course, through complete courses that consist of a prescribed sequence of modules, to courses that offer the student the choice of a certain number of modules among a large set of modules (p. 11)." They predict that in the "near future, whole curricula or interdisciplinary programs may be designed around modules, with each student's program tailored to his individual needs (p. 11)."

1.3. What is the Purpose of Modular Instruction?

- One purpose of MI is to allow the student to proceed at his own rate. The belief that self-pacing is desirable is based on two generally accepted assumptions (Burns, 1971):

  "No two learners achieve at the same rate;"
  "No two learners are ready to learn at the same time (p. 55)."

- Another purpose is to allow the student to choose his own learning mode. Choice among different learning modes is desirable, if we assume that:

  "No two learners achieve using the same study techniques;"
  "No two learners solve problems in exactly the same way;"
  "No two learners possess the same repertoire of behaviors (Burns, 1971, p. 55)."

- MI may include a large variety of instructional activities, such as

  1. reading textbooks and articles
  2. examining photographs and diagrams
  3. viewing films and slides
  4. listening to audio-tapes
  5. examining demonstration materials
  6. participating in projects and experiments
  7. participating in relevant "extra curricula" activities.

- A third purpose of MI is to provide a choice among a large variety of topics within any given "course" or discipline, if we assume that

  "No two learners possess the same pattern of interest"

  "No two learners are motivated to achieve the same goals (Burns, 1971, p. 55)."

- A fourth purpose is to allow the student to identify his strengths and weaknesses and to "recycle" (through remedial modules, repetition, or a change in learning mode) (Klingstedt, 1971), if we assume that

  it is desirable to save student time (frequent evaluation permits early diagnosis);

  it is desirable that as many students as possible, or all, achieve the stated objectives.

1.3.1. Summary

The purpose of Modular Instruction is to individualize instruction so the learner will be able to:

1. Proceed at his own rate (self-pacing),
2. Choose his own learning mode (instructional activity),
3. Select among a variety of topics, and
4. Identify his strengths and weaknesses and recycle, if necessary.

1.4. Advantages of Modular Instruction for the Student

- If carefully designed, and if alternatives are included, MI can offer the following advantages to the student:

1. Flexibility. MI adapts to individual learner differences by providing flexibility with respect to the pacing, format, and content of instruction.

2. Motivation. Student choice is likely to increase motivation, hence, effort.

3. Cooperation. MI reduces competition and threat of failure. Consequently, cooperation is increased: Students share the responsibility for learning with the teacher.

4. Objectives. The modules are designed so that the student may easily identify the objectives and, therefore, proceed directly (without second-guessing) to achieve them.

5. Feedback. Modules have their own built-in assessment of progress: They provide the student with immediate and continuing feedback.

6. Recycling. MI includes provision for specific remedial work (weak areas are quickly identified). The student does not have to restudy large amounts of subject content.

7. Mastery. MI avoids the artificial procedure of grading on a normal curve. Because of the nature of the learning process in MI, and because real achievement is measured, potentially all students can master the subject (i.e., there is a much higher percentage of "A"'s and "B"'s).

1.5. Advantages of Modular Instruction for the Instructor

- To the instructor, MI can offer these advantages:

1. The instructor has time to focus on deficiencies of individual students without involving the whole group with each problem.

2. Similarly, the instructor has more time for "enrichment" lectures or special presentation.

   (1. and 2. are obviously also advantages for the students).

3. MI frees the instructor from both lecture preparation and many routine administrative tasks (the latter are usually assumed by non-professional personnel - mostly students).

4. Since modules are independent, single-topic units, they may be used intact in different courses, eliminating redundancy within and between departments thereby decreasing staff preparation time. Similarly, modules may be exchanged among universities.

5. Since modules are developed empirically (i.e., tested and revised until they are effective), student learning is greater and therefore satisfaction for the instructor increased: He is doing a job, for which he is paid, well.

6. Concentrating on the process of learning can be an exciting and scholarly activity. Questions, such as

   - How do students learn?
   - How can the instructor facilitate learning?
   - What is a relevant and necessary sequence in instruction?

   provide real challenges to any instructor.

7. Students, after completing modules on "How to develop a module", can become assistant curriculum designers and provide the instructor with additional instructional materials.

1.6. Formative Evaluation

- Traditional development of instructional materials (e.g., textbooks, films) is usually done in large sequences or portions and away from students. Revision based on student learning is therefore difficult and seldom carried out.

- Modules cover less content and can be tested in the developmental phase on a small number of students. This, as well as the provision for pre- and post-testing allow for empirical validation, i.e.,the possibility of rendering instructional materials effective in terms of student learning.

1.7. Comparison between conventional and modular instruction.

- A summary of the differences between conventional and modular instruction is presented in Table 1.

Table 1*

COMPARISON BETWEEN CONVENTIONAL AND MODULAR INSTRUCTION

Characteristic	Conventional Course	Modular Course
Learning Experience	Oriented toward teacher performance, with emphasis on teaching	Oriented toward student performance and individual instruction with emphasis on learning
Role of Instructor	Disseminator of information	Diagnostician, prescriber, motivator and resource person
Objectives	Usually not stated in precise observable terms	Stated in terms of student behaviors and presented before instruction begins
Rate (or pacing)	Students must all go at the same rate	Each student can proceed at his own rate
Instructional Activities	Mostly lectures and written assignments, media used on basis of instructor's feelings about them	Many different instructional activities are used to optimize learning, media used on basis of efficacy established through trial use by students

*Adapted from Postlethwait & Russell (1971).

(Table 1 continued)

Characteristic	Conventional Course	Modular Course
Individualization	Group-oriented	Highly individualized, each student can use any or all of the instructional materials available
Participation	Passive	Active
Reinforcement	Mostly only after major examinations	Immediate and frequent, after small units of material studied
Testing	Student attends lectures, then takes test (sampling the material "covered") which determines his grade for the entire course	Designed to measure mastery of the objectives stated at the beginning of the course, purposes are assessment of prerequisite skills, diagnosis of strengths, weaknesses and mastery
Test References	Norm-referenced tests are used ("grading on a curve")	Criterion-referenced tests are used; success is independent of performance of fellow students
Mastery	It is expected that one third of the students do "well", one third "not so well", and one third "fails"	Given enough time, all students are expected to achieve mastery of the objectives
Course success	Mostly judged subjectively by the instructor	Objectives and evaluation assure that the instructor is able to correct faulty instructional materials and knows when his course is successful in terms of student learning

2. IMPLEMENTATION

2.1. Implementation of Modular Instruction.*

- Ideally, the learner begins MI by taking a pretest which will indicate the appropriate level: Too little familiarity with the subject area to be explored might be as detrimental to successful learning as too much.

- If the student does not have all required prerequisites, he may need prior remedial instruction. If he is already competent in the area of a particular module, he can proceed to a more advanced module or to one with a different content.

- Upon completion of a module the student is again evaluated. The post-test might be identical to the pretest.

- If the post-test indicates that the student has not achieved mastery of the module's objectives, he might be recycled through the module or through parts of it or he might take a remedial module. If he does succeed, he proceeds to the next (or, to another) module. (The pre- and post-test also allow for empirical validation of the module itself).

The learner's options are charted in Figure 1.

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*For selection of content for modular instruction see Shore (1971).

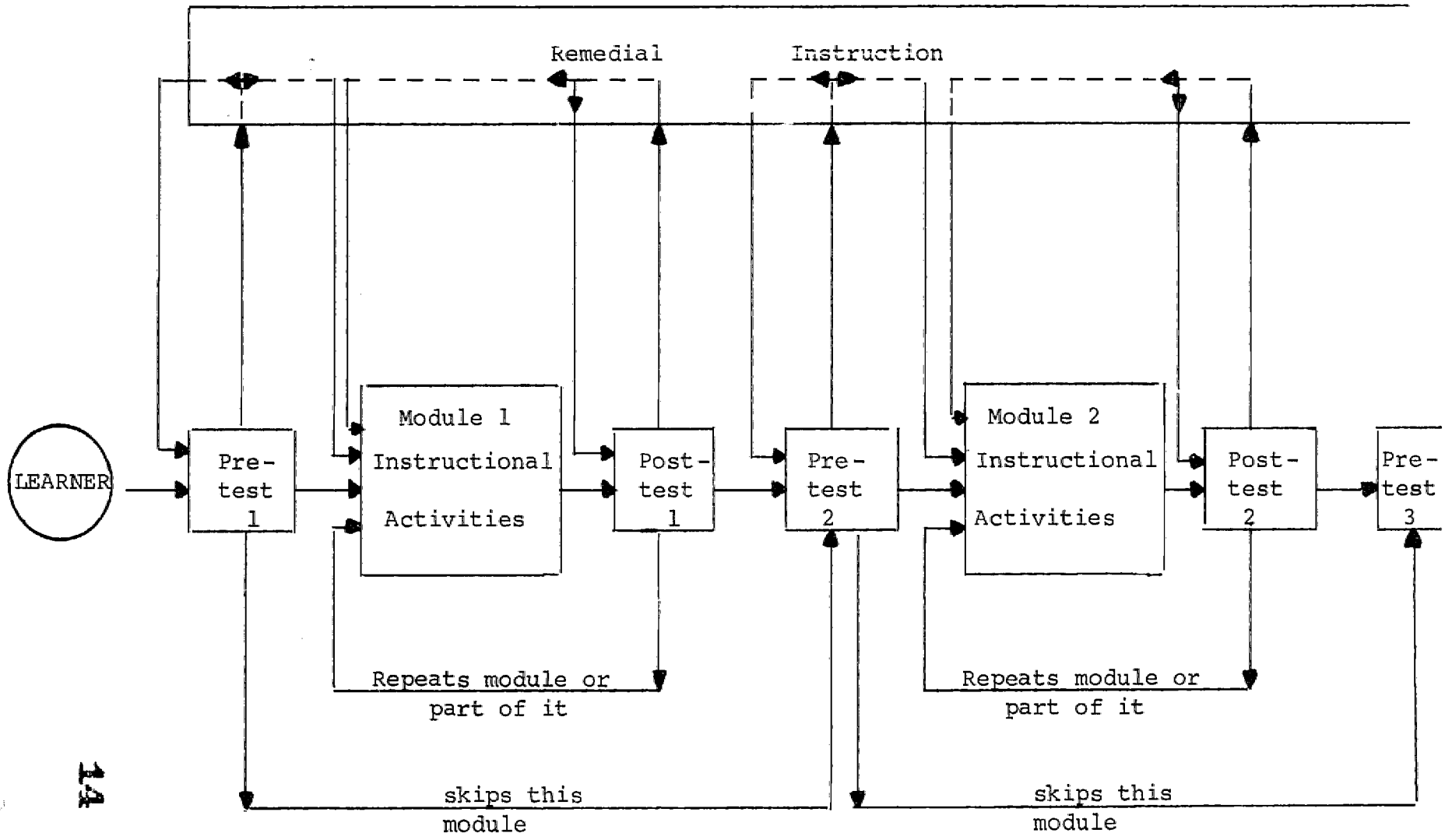


Figure 1

Flow Chart of Learner's Options in Modular Instruction

2.1.1. Summary.

Ideally modules include

- a pretest
- objectives
- criteria for success
- instructional activities
- a post-test
- remedial instruction

2.2. General Formats: Alternatives for Different Aspects of MI

- In designing modular instruction a variety of formats can be used. Some of the possible alternatives for three major aspects of MI are described below.

Content

- Student must complete all modules, or he may choose to complete only a certain number.
- The objectives are listed and the student may design or choose activities which help him to achieve mastery of the objectives.
- Within each module some or all of the material is compulsory.
- Some or all of the course content is modularized.

(see Table 2 for various alternatives)

Study Time

- Study facilities and materials are available throughout the day and evening or only some of the time.
- All or some of the material is studied individually (i.e., independent work on module may be supplemented by group discussion, lectures, etc.).

Sequence

- The learner must take the modules in a fixed order or can choose his own sequence.

Table 2

DIFFERENT MODULE STRUCTURES

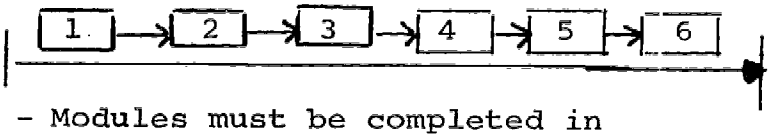
KEY

- COMPULSORY MODULE
- OPTIONAL MODULE
- CHOICE OF STUDY MODE WITHIN MODULE
- SPECIAL TOPIC MODULE: MAY BE USED ONLY TO RAISE MARK ONCE BASIC COURSE REQUIREMENTS ARE MET

AMOUNT OF WORK TO BE COMPLETED TO FULFILL COURSE REQUIREMENTS →

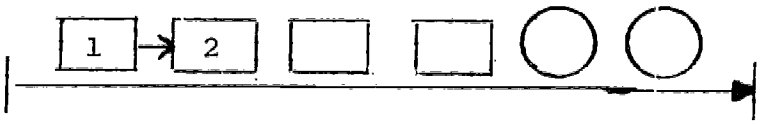
INCREASING FLEXIBILITY ↓

1. ALL MODULES COMPULSORY



- Modules must be completed in specific order.
- Within each module, all material is compulsory.

2. MOST MODULES COMPULSORY



- Only some of the modules (background material) must be studied in sequence.
- Student may choose among a few optional modules to complete course requirements.

3. ONLY A FEW COMPULSORY MODULES

- Bulk of course is in optional modules which may be studied in any sequence.
- Course mark may be "boosted" by completing a "special topic" module (increase quantity).
- Within each module, student may choose one or more "routes" of study.

INCREASING FLEXIBILITY

4. NO COMPULSORY MODULES (some may be "recommended")

- Specified number of modules must be completed (as in 1 to 3).
- Large selection of modules.
- May raise mark through extra modules, projects, or work completed with "honours" (increase quality).
- Within each module, student has a variety of study "routes" from which to choose.

5. NO COMPULSORY NUMBER OF MODULES

- Very large selection of modules.
- No compulsory modules.
- Content still in modular format, but the student may obtain credit in many ways.
- Credit points assigned according to scope or difficulty of activity student undertakes.
- Specific total of points to complete course rather than required number of modules to complete course. "Honours" work will raise mark.

2.3. Evaluation in Modular Instruction

Evaluation plays a critical role in well designed MI since it provides feedback to the learner as well as to the instructor. (see also Geis & Roid, 1971).

- As far as the learner is concerned, the purpose of evaluation includes the assessment of pre-requisite skills, the diagnosis of difficulties and the confirmation of mastery.

- The evaluation of student performance also serves as an assessment of the instructional system (e.g., a module) and provides direction for the design of instruction.

- It is important that the evaluation criteria reflect the specific objectives stated at the beginning of a module.

- A number of techniques can be utilized to evaluate a module, including
  - paper-and-pencil tests,
  - oral quizzes,
  - performance tests,
  - projects,
  - group projects,
  - construction of modules

- Final grades in MI are awarded in a variety of ways. In some cases, students who have successfully completed all required modules automatically receive an "A". In others, a "B" or "C" is earned, if a certain number of units has been mastered, with

additional credit given for extra modules, special projects, the reading of articles or books, or for excellence in execution. In such a system, the student has considerable choice in deciding his own grade level and the method for achieving it. In most cases, however, grades are not given on the basis of a comparison among all students of the class ("grading on a curve") but rather on an absolute basis ("concept of mastery").

THE CONCEPT OF MASTERY*

If one assumes that most students can master what instructors have to teach, the main task becomes finding the means by which the largest portion of the students will obtain mastery of a given subject.

Therefore the concept of mastery is contrary to the notion of "grading on a curve" which implies a professor expecting to "fail" some of his students.

* See Bloom (1968).

- Consequently grades in MI are usually somewhat higher than average and "may have means of B or B+ and modes of B+ or A" (Corey & McMichael, 1970, p. 9). This should not be surprising if one considers the fact that students acquire and retain more material (Corey, McMichael & Tremont, 1970).

- Reinforcement and feedback in MI are immediate, since the material to be taught is presented in small units. Thus, deficiencies in student performance can be corrected at once. This again results in a feeling of accomplishment on the part of the student which rarely manifests itself in courses with only a final examination.

2.3.1. Summary.

- The purposes of evaluating the learner include
  - assessment of prerequisite skills
  - diagnosis of difficulties
  - confirmation of mastery
  - assessment and design of learning system
- Final grades may be awarded in different ways based on a variety of test-formats.
- Because MI is based upon the "concept of mastery", grades tend to be significantly higher than in traditional instruction.

2.4. In Which Disciplines has MI been Used?

MI has been used in a variety of disciplines besides Biology. For example, Psychology (Corey, McMichael, & Tremont, 1970; Homme & Tosti, 1971; Ringness, 1970), Engineering, Sociology, Education, Mathematics, English, Chemistry, Linguistics and the growing field of Environmental and Social Concerns (Butler, Gopnik, Southin & Chambers, 1971) have also made use of modules.

- It should be emphasized that, contrary to common belief, MI is not only useful for teaching skills, facts, or simply "imparting information". Properly developed and administered, MI can find applications in many areas often thought of as "beyond" the capability of self-instruction. For example, Lysaught (1968) reports that self-instructional materials are used by medical practitioners and inters and deal with current controversies about diagnosis, treatment, and theoretical issues.
- One essential criterion, however, has to be observed: The objectives of a modular unit must be stated clearly. This does not exclude the humanities or the arts where according to some observers a tendency exists to "rely on vague generalities, defending them in humanistic or creative terms (Allen, 1971, p. 2)."

Behavioral Objectives*

describe in observable terms what the student should be able to do at the end of an instructional unit (e.g., a module) in order to demonstrate that he has mastered its content.

* See also annotated Bibliography of Books on How to State Behavioral Objectives. Centre for Learning and Development, McGill University, 1971.

The objectives of MI are not necessarily limited to those stated in behavioral terms; not all aspects of a course can be defined precisely, "but there is virtually no course that does not have at least some components which can be defined in behavioral terms, and which then become susceptible to this approach (Allen, 1971, p. 2-3)."

3. MANAGEMENT

3.1. General Administration

- "The boundaries of a module are definable only in terms of the stated objectives (Murray, 1971, p.5)." Therefore, in some cases, management (if preparation is not included) might be limited to the distribution of study-guides and manuals, individual counselling, and the administration of tests, all to be handled by one single professor (depending on class size) in a reasonable amount of time. In other cases, as in those of large modularized introductory courses, the traditional staffing (one professor assisted by several graduate teaching assistants) as well as the manner of administration might be significantly altered. Additional clerical and laboratory personnel time might be necessary which would increase costs. However, MI is not to be regarded as "automized" instruction, neither have modules been specifically designed to cut the cost of instruction - at least not so far.

- Elements of a typical management system include*:

Preparation:

. Selection of subject content and materials.

. Organization of content in instructional units (modules) and definition of objectives.

. Appropriate matching of objectives with instructional modes.

. Planning how the student's progress will be monitored and recorded.

. Deciding how the final evaluation of students will be made.

Administration:

. Presentation of (or arrangement for) the instructional activities.

. Monitoring the student's progress.

. Recording the student's progress.

. Feedback to the student.

. Evaluation of the student's final progress.

Intensive Contact with Individual Students:

. Taking part in the student's learning experience.

. Personally guiding the student's study.

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* The following is adapted from Homme & Tosti (1971).

3.2. Costs

- Corey and McMichael (1970) report on findings "not based upon a formal cost analysis but rather upon informal discussions with administrators and others who have used this method elsewhere (p. 12)." They claim that "when compared with teaching classes of 200 students by the lecture methods, personalized instruction, once established, probably costs about the same, may cost more and probably could not cost less (p. 12)."

- It also has been pointed out "that at present the question of the cost of modules is virtually unanswerable (Creager & Murray, 1971, p. 12)."

- Considerations in evaluating the costs of a course based upon MI might include*

  . Time of the instructor who prepares the modules**;

  . Cost of visual (or audio-visual) aids, clerical staff, art work, laboratory equipment, if any or all of the above are used;

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* For more details see Pascal (1971).

** McDonald and Dodge (1971) report that it takes "about 50 hours to develop the material for a (module) involving perhaps a half-dozen instructional objectives and eight or ten activities. This involves making tape lectures; designing, developing, and gathering visual materials; preparing packaged laboratories which can be available to the student when he needs it; and providing the necessary reference work so that the student can have some options as to his reading in the subject matter area (p. 51)."

- Cost of duplicating study guides, manuals, or other components of the module;
- Cost of space.

- A final point should be made, however. Cost should be considered only in the context of improving instruction. Corey and McMichael's (1970) data support the conclusion that the expense of developing personalized courses based on MI is justified by better learning, greater retention and favorable student evaluation (p. 13).

4. HOW TO DEVELOP A MODULE

4.1. Formulae to develop a module

- Kurtz (1971) and Klingstedt (1971) have independently recommended a number of steps to be followed when designing a module and/or modularising an entire course. Both formulae closely resemble each other in principle, but deviate somewhat in practical detail. They may be summarized as follows:

  Step 1: A minimum number of objectives are stated in terms of observable behavior.

  Step 2: A hierarchy of these objectives, which determines the sequence of instruction, is constructed.

Step 3: A diagnostic measure (e.g., a test) is designed in order to determine which competencies each student possesses when entering the module (or course). There is correspondence between test items and the behavioral objectives.

Step 4: A rationale for the module (or course) is stated. This involves the value of a particular unit and explains to the student why it is beneficial to him to achieve the stated objectives. "The learner must value what he is about to learn if it is to 'stick' (Klingstedt, 1971)."

Step 5: Instructional activities (the core of the module) are designed to help the student acquire the competencies stated in the objectives. They may include the use of laboratories, the viewing of slides or films, the listening to tapes, etc. Important is the provision of options so that the student may choose among different learning modes and modules.

Step 6: A post-test is designed to measure the student's achievement of the objectives. Parallel forms of the test should be constructed in order to validate the competencies. There should be close correspondence between test items and objectives.

Step 7: A resource (or "drop-in") centre should be established to provide access to all readings and/or materials necessary to complete the module (or course).

4.2. Two additional points

Two more important points should be raised with respect to module production. The first one has to do with "Step 1" in the development of modules, and the second concerns module construction in general:

4.2.1. While most of the literature on behavioral objectives postulates the statement of clearly defined objectives as a first step, in practice most instructors begin by identifying the subject matter (i.e., specific topics) to be taught (Feldhuser & Treffinger, 1971). The first step, then, might involve dividing the course as is into small dependent or independent units, i.e., the modules-to-be. A second step would then be the statement of behavioral objectives.

4.2.2. It has been reported that success in developing modules depends largely upon two general criteria:

- The introduction to any given discipline has to be in sufficient depth in order to allow the student to identify worthwhile and relevant problems for independent study.
- Training has to be provided in the techniques needed to pursue answers to the problems chosen for independent study (Thornton, 1971).

4.3. Summary

When designing a module, the following steps are recommended:

- Identification of the subject matter to be taught.

- Defining a set of objectives and evaluation items.
- Deciding upon the hierarchy of the objectives which in turn describes the sequence of instruction.
- Statement of a rationale.
- Development of a pre-test.
- Units of written instruction are designed and study materials chosen to help the student attain the instructional objectives.
- Providing instructional options.
- Design of a post-test.
- Arrangement for a resource (or "drop-in") centre.

5. EXAMPLES OF ACTUAL FORMATS

5.1. In Biology 108-109, Department of Biological Sciences, Purdue University, Lafayette, Indiana (Hurst & Postlethwait, 1971; see also Postlethwait, Novak, & Murray, 1970), the development of modules was expressely related to the desire of implementing the concept of mastery. The original content of the two courses was arbitrarily divided into sixty units each of which was considered a module worth between 0.5 and 4.0 credit points and being an

independent part of the total course program. The modules were distributed in four series:

1. modules (or "minicourses") relating to all living things
2. modules pertaining mainly to plants
3. modules dealing primarily with animals
4. modules covering optional topics.

- For completion of the two courses the student is required to take series 1, 2 and 3 in their entirety, and twenty credit points of series 4. It is planned to introduce alternate modules which will provide a different approach to the same subject matter. Also, a greater number of options will be made available.
- Students are required to participate in a half-hour quiz session each week (eight students and one instructor) at the end of which the instructor decides whether to enter a "C" (for completion) in the record of each student. The students are also asked to take a written test (immediately afterwards or later) administered and corrected by a secretary who informs the student of the results at once.
- If the student completes all required modules, he has a grade of "C". Grades of "A" or "B" are earned by doing work beyond the "C" level. The student may

- take three exams for an "A" or a "B" given at regular intervals throughout the semester (40 credit points each)
- read journal articles
- get extra-points for excellence on oral performance and/or
- do a miniature research experiment.

- If the student fails to complete a required module, he receives an "I" (incomplete) but is allowed to make up the modules in the following semester.
- A secretary does all the "bookkeeping", administering and scoring of quizzes and is able to handle adequately eight-hundred students in a fourty-hour week.
- Modules are set up in audio-tutorial booths and students are given a schedule of the sequence and quiz dates. The module material is changed over the weekend but at least one booth for the module offered the preceding week remains unchanged for those students who received an "I". Also, it should be noted that the number of booths set up varies according to the length and degree of difficulty of the material to be learned. (Some modules are available in seven, others in eighteen booths.)

5.2. At Columbia Junior College, Columbia, California, (McDonald & Dodge, 1971), Audio-Tutorial Packages are used in Biology. A course in the ATP format

consists of a variety of packages designed around a single concept integrating "laboratory, lecture, and other learning activities to obtain the desired instructional objectives (p. 45)." Each package is structured in the same way and includes:

1. A Rationale

   A statement explaining why the objectives of a "package" are desirable.

2. A Primary Idea

   A "statement of a major conceptual idea (p. 46)."

3. The Secondary Ideas

   These are subdivisions of the Primary Idea and are designed to guide the learning toward understanding the Primary Idea.

4. The Objectives

   They contain information on:

   - prerequisites and where and how remedial instruction can be obtained
   - behavior and degree of competency required at the end of the module
   - how this behavior may be evaluated
   - suggested time for completion of each Secondary Idea.

5. The Instructional Activities

   The activities required or recommended for each Secondary Idea include readings (text-books and journals), cassette tape lectures, slides, film strips, film loops, 16 mm films, small group meetings, individual discussion with the instructor, etc. "The range of activities available to students is limited only by the imagination (p. 47)."

6. Depth Studies

They are provided for those students who have successfully completed the Secondary Ideas but wish to further pursue the subject matter. They may be presented in the format of an oral or written report, or may become themselves Audio-Tutorial Packages which then are kept on file for other students. It has been found that student-prepared packages are often as good or even better than those prepared by the instructors.

5.3. "Biology and Social Change/Environmental Issues", a course offered conjointly at Sir George Williams and McGill Universities , (Chambers & Southin, 1971 a, b), is in many ways much more ambitious than the two Biology courses described above. It is described schematically in Table 3 (next page).

5.4. One of the advantages of not being the first to introduce an innovation is the ability to profit from the triumphs and mistakes of those before you. The Biology Department at the Université du Québec à Montréal (UQAM) is in the enviable position of being able to select from three different innovative Biology programs to create a new form of modular instruction that is an innovation in its own right (Desnoyers, Mergler-Racine, & Bhéreur, 1971).

Table 3

BIOLOGY AND SOCIAL CHANGE/ENVIRONMENTAL ISSUES
Course at Sir George Williams and McGill Universities

Course Content	Supporting Systems or Modes	Output	Credit (in points)
MODULES	Class Hours		
Control Genetic Disease Birth Control Euthanasia ...n = 14	a) Mondays: Lectures (usually guest speakers)	Exam at end of year	7
	b) Wednesdays: Film screenings on module topics	Cine-Club-members order & show films, lead discussion	up to 15*
Medical Issues Drug Use Human Body Compulsory Medicine ...n = 17	c) Fridays: T.V.	T.V. Program Tape	Prod. Res. Team 8 Techn. cre 15
	Drop-In Centre	Direct Action in community. e.g., in teach-ins	up to 15*
Liberation Women's Liberation Gay Liberation Concept of Race ...n = 7	- administrative centre - module files, materials - place for discussion - place for consultation - advertises events, projects, skill exchange	Study Groups submit detailed report	3
Environment Air Pollution Water Pollution Frail Ocean ...n = 40	Human Resources - student teachers - advisors (staff) - community volunteers	Seminars Short Courses (Directed) Research report	up to 15* up to 15*
		Oral Exam on module	3
	Individual Study	Journal of impressions on reading and activites	15
		Action Letter	3
	Newsletter	Newsletter Article	up to 15*

- All modules are Optional (although some prerequisites are suggested)
- Modules may be selected from one, some, or all topics. No minimum number of modules to be completed
- * Points are negotiated or contracted according to the scope the project

18 pts= D
24 pts= C
30 pts= B
30 pts of which 16 or more are honours= A

- The AINVEQ (Apprentissage par INVestigation en EQuipes) design is derived from three sources:
  1. Postlethwait's Audio-Tutorial method which guides individual students through study materials and small experiments in special carells equipped with study quides, film projectors, tape recorders, plant specimens, etc.
  2. The "Investigative Laboratories" method of the commission on Undergraduate Education in the Biological Sciences which uses mini-research projects to stimulate the spirit of investigation and to introduce the student to research methods and experimental design.
  3. The UQAM Biology Department's program of applied work, with students working in teams, just as do "real" Biologists.
- In he AINVEQ system the material is divided into mini-courses with stated objectives and a program of activities that the students may follow tc attain these objectives (lectures, tapes, film strips, group discussions, labs).
- The students work in teams of three or four and choose whether they will follow the procedures as outlined in the study guide or whether they will devise their own plan of study.
- Cubicles with all necessary materials are reserved for each group one morning a week, and the professor is available for consultation at that time.

Through this format, the originators of AINVEQ hope to achieve their main objective, to develop skills and qualities desirable in future biologists: Skills in research methods, efficient use of biological information, facility with experimental design, development of analytical and critical thinking, the spirit of investigation and the ability to work effectively in teams.

5.5. Commercially developed modules are also available, for example, from Individual Learning Systems, Inc. (ILS), San Rafael, California and General Learning Press, N.Y.

Modular courses published by ILS include Psychology, Ecology, Physical Anthropology, Basic Spanish, and American History. In order to illustrate their approach, one of their courses, Behavior Technology: Motivation and Contingency Management (Homme & Tosti, 1971), is described in more details below. It consists of

- a Student Manual describing
  - . the course content
  - . individualized instruction
  - . how to check and "plot" the progress made

- Unit One: Elements of Motivation
  - Module 1. A Technology of Behavior Exists
  - Module 2. Reinforcement
  - Module 3. The Management of Contingencies
  - Module 4. Building the Behavior Repertoire

- Unit Two: Contingency Management

  Module 1. Schedules of Reinforcement
  Module 2. Aversive Control & Avoidance Behavior
  Module 3. Problems in Contingency Management

- Unit Three: Contingency Contracting

  Overview

  Module 1. Rules of Contracting
  Module 2. Conditions Necessary for Contracting in the Classroom
  Module 3. Types of Contracting
  Module 4. Problems in Contingency Contracting

- Unit Four: Self-Management

  Module 1. Behaviorism and Self-Management
  Module 2. Management of Coverants of the Mind
  Module 3. Some Applications of Coverant Control
  Module 4. Problems in Coverant Control

- Selected Readings in Behavior Technology: Motivation and Contingency Management

- A Student Reference Book

- Unit Tests and Course Post-Test

- an Instructor's Manual

The authors suggest that this modular course requires about twenty hours of student time and may serve as a base for a one-hour credit course on the college level.

- General Learning Press has modules available in Economics, Psychology, Political Science, and Sociology. Topics include
  - The Economics of Technological Advance
  - Assessing Human Motivation
  - The French Revolt: May 1968
  - Political Elite Recruiting
  - Sociological Theory: A Contemporary View.
- In contrast to ILS' modules, the units published by General Learning Press are essentially chapter-like summaries on important issues by recognized authorities in the field.

6. PROBLEMS

6.1. For the Student

- Self-discipline has to be demonstrated in pursuing independent study.
- The shift from the lecture method (passive) to MI (active) might be difficult.
- Choice among the available resources (e.g., different instructional modes, modules, etc.) might prove frustrating.

6.2. For the Instructor

- The time required to design MI is usually a major problem. Other professional activities compete with a professor's teaching and course-preparation time. Once modularization of a course (or of part of it) has been achieved, the problem of extra time for course preparation subsides. Ideally, professors would be freed of other demands while introducing MI and initially, at least, would teach only a small number of students.

- Lack of concrete rewards may be a problem. Research and publications offer in most cases greater rewards to a professor than attempts to innovate instruction and, as is the case in MI, to optimize learning.

- The professor has no longer "center-stage billing": his feeling of authority vis-à-vis the "audience" (his students), enhanced through the one-way communication in traditional instruction, is diminished or eliminated. He might resent this loss.

- The self-pacing nature of MI may have a delicate side-effect. The professor must be prepared to answer challenging questions from students about all the material to be learned, since some of his students will be fast and others slow learners. He cannot "cram" before a lecture to be prepared to answer questions of a fraction of the course. However, often experimenters with MI report a rewarding experience in meeting the challenges of students who have become involved (McDonald & Dodge, 1971, p. 51).

6.3. For the Administrator

- Finances could, in some cases, be an obstacle.

  - Additional clerical time might be necessary to record which student has completed what modules, etc.

  - Additional laboratory personnel may be required to assist in the setting up and running of equipment for several modules at a time.

- However, a thorough investigation of what resources are available on campus and who is available to assist on a voluntary basis (may be from outside campus) might minimize this problem.

- Also, qualified undergraduate assistants (who may receive academic credit or a small financial remuneration) have proved to be valuable aids (Corey & McMichael, 1970).

. The lack of flexibility in scheduling activities might be a problem. Access to the instructional resources has to be maximized.

. Grading and exam procedures must be adapted to MI.

7. RESEARCH

7.1. Corey, McMichael and Tremont (1970) report that students taking a course using personalized instruction learn more and rate the course higher than students in a traditional lecture course.

- "One semester (19 weeks) after data were gathered in the original study the same final exam was given without prior notice to students in the second half of the introductory psychology course. Of the students who were included in the original experiment, 30% from the personalized instruction group and 24% from the control groups were available for the retention test (p. 1).

- "It was found that the experimental group scored 9.7% higher than the control group. We concluded that the superiority of personalized instruction is a durable effect (p. 1).

7.2. At Columbia College in Columbia, California, McDonald & Dodge (1971) found that most students taking the Biology course in the modular format

- liked the approach
- were favorably impressed that they were partly responsible for their own education, since they had to organize their own time
- realized that they had to be actively involved in their own learning in order for it to occur
- finished the course with a grade of "A".

- It was also noted that the above-average student overprepared for tests since he does not believe that he will only be tested on the material stated in the Instructional Objectives.

- Problems encountered were mostly of a technical nature (scoring and keeping students' records, testing individually, etc.). But the experimenters also singled out the necessity for the instructor to change his attitudes as an area of concern. Since there is no need to design lectures around a 50 minute period of time, there is also no place for "filler material" without real meaning for the subject matter to be explored.

- In constructing Instructional Objectives, the instructor is constantly confronted with these soul-searching questions:

- Why do I want to include this material in the module?
- Is it really relevant to the subject matter to be learned?

- As a conclusion, McDonald and Dodge point out that MI "seems to fit the needs of a large number of students and provides for them avenues of learning which are founded upon success, not failure (p. 52)."

7.3. In Biology 108, an Introductory Biology course at the freshman level given at Purdue University, Lafayette, Indiana, in 1969-70, Hurst & Postlethwait (1971) found that out of 414 students, 53 received an "A", 76 a "B", 205 a "C", and 80 an "I" (incomplete).

- The high number of "Incompletes" was explained by the fact that many of the 80 freshmen left university during or after the first semester. Also, many of those students were expected to complete the course in the following academic year.

- The grade distribution was found to be below the expected results, but still to be higher than in traditionally taught courses.

(A particular advantage of MI was also noted: A student seriously injured in an accident who required a long convalescent period chose to continue the course. The portability of MI made it possible for him to complete a few modules in the hospital through the help of a tape recorder and the printed module materials).

7.4. In an experimental self-directed learning program at Meramec Community College (St. Louis, Missouri), Hunter (1971) found that out of the 28 students enrolled, 21 completed the term, 5 received an "Incomplete" and 2 had withdrawn. Of the 21 students, 15 obtained an "A", 5 a "B", and one a "C".

- The following questions were raised:

1. Can community college students assume a major responsibility for their own learning?

   The answer was found to be a firm "yes", considering grades and student supervisor ratings. However, it should be noted that each participating student had been interviewed and counseled at the beginning of the term as to his responsibility for self-directed learning.

2. Will efficiencies of time, space and money be increased through self-directed learning strategies?

   - Program cost was found to be the same as for direct education

   - The use of facilities appeared to be more efficient, since students used the library and the laboratories as space and time allowed.

3. Will students learn as much when using self-directed learning techniques?

   It was found that students learn better when using self-directed learning techniques (grade point average: 3.66).

4. Do students gain self-reliance and continued interest in learning?

   This question could not be answered directly, since no base line had been established for self-reliance and interest in learning. But the questionnaires completed by both students and supervisors indicate that most students demonstrated self-discipline and that the students' interest in the subject matter increased, which was interpreted as a result of experiencing self-directed learning.

5. Are faculty and other staff members comfortable with self-directed learning activities?

The supervised self-directed learning program at Meramec Community College has been extended: In January 1971, 53 students were enrolled for a total of 162 credits, in 33 different courses, with 25 different course supervisors.

C O N C L U S I O N

Rapidly changing "knowledge" and increasing information, large numbers of actual and potential (e.g., part-time and evening) students, shrinking financial resources, and growing dissatisfaction with our mass educational system, all make it necessary to search for more effective and individualized instruction.

While designing and implementing high quality modular instruction will no doubt prove challenging and time consuming to most instructors, it offers many advantages and exciting possibilities. Because of its flexibility, its adaptability to large numbers of students, and its emphasis on individualized learning, modular instruction has become one of the most promising alternatives in higher education.

8. SOME QUESTIONS AND ANSWERS

Question: "Aren't these individualized systems only useful for teaching facts or information?"

Answer: No. In medicine, for example, more and more self-instructional programs have been developed in those clinical areas which some persons had considered as being "far beyond" the capability of self-instruction.

Question: "Can I publish the modules I develop, and do they count as publications?"

Answer: Of course you may publish the modules you developed and tested on your own students. For copyright information contact Information Canada in Ottawa and if you are a member of C.A.U.T. and have a particular problem pertaining to copyright, you can write to Professor Donald C. Savage, C.A.U.T., 66 Lisgar, Ottawa K2p OC1. (For copyright information in the United States, see brochure entitled Office of Education Copyright Program Information published by the U.S. Department of Health, Education and Welfare).

As for credit for published modules, this will be up to the Faculty and/or Department involved. Published course materials should be given the same recognition as textbooks.

Question: "How long is a student allowed to work on a module?"

Answer: It is true that in MI, mastery of the subject matter is of greater consequence than the time required to achieve it. But "it is conceivable that, in exceptional cases, the time factor should be a part of a terminal-behavior objective (Hurst & Postlethwait, 1971, p. 30)." In any event, the number of repetitions of post-tests can be limited and completion time for any given module may be suggested by the instructor.

Question: "Isn't it well known that a new teaching method may produce better learning simply because of the 'Hawthorne effect', i.e., because it is novel and not because it has any enduring value?"

Answer: To assess this hypothesis, Corey, McMichael and Tremont (1970) replicated an original study (retention measure) after one year, after both student body and instructional staff had become somewhat accustomed to a course being given by personalized instruction. The difference in scores between classes taught by MI and the traditional lecture method was 13.1%. (Even greater than it had been in the original study: 10.9%). Thus novelty alone does not always account for superiority in personalized instruction.

Question: "Aren't you giving away grades in MI if you have means of B and B+ and modes of B+ and A?"

Answer: The instructor does not give away anything. The student must earn the grade by satisfying certain concrete requirements. Also, it has been shown that students acquire and retain more with this method. And students themselves report doing more work in courses based on MI.

Question: "Isn't MI void of human interaction?"

Answer: No, because it is understood that the professor and/or teaching assistant, and/or senior undergraduate proctor are available to answer students' questions and to provide encouragement, inspiration, motivation and personal contact. Thus, the instructor's role may in fact become more humanistic and less mechanical than before. In addition a number of MI systems supplement the independent work on modules by group discussions, lectures, tutoring, etc.

Question: "What kind of study materials should one use?"

Answer: This is up to your imagination and, of course, dependent upon the subject matter you teach. Caution should be taken, however, in assuming for all students adequate prior experience with the material to be used. Also, complex diagrams and charts, long film or slide sequences should be avoided. Perhaps the best criterion to apply is whether the materials are essential or helpful in reaching the objectives.

9. GLOSSARY

AUDIO-TUTORIAL APPROACH	A self-instructional method, mostly used in Biology, centred around a carrel; incorporates objectives, a programmed audio-tape, printed study guides, visual aids and actual biological materials.
AUTO-TUTORIAL MATERIALS	Materials designed for self-instruction.
BEHAVIORAL OBJECTIVE	An expected outcome stated, at the beginning of an instructional unit, in observable terms, i.e., in form of a student's behavior (e.g., "at the end of this unit, the student will be able to...")
DEVELOPMENTAL TESTING	Part of the validation process of instructional design in which the instructional material is continuously tested on students and revised so as to identify and correct weaknesses.
EMPIRICALLY VALIDATED INSTRUCTION	Instructional method or material which has been tested on students and found effective in facilitating mastery of stated objectives.
EVALUATION	Assessment of student achievement or of the quality and effectiveness of instructional materials or activities.

FORMATIVE EVALUATION	The assessment of the quality and effectiveness of instructional units during their development.
INSTRUCTIONAL ACTIVITY	An activity designed to cause or help the student to learn the stated objectives.
TEACHING OR LEARNING MODE	May be thought of as instructional technique, e.g., lecture method, seminar method, independent study, etc.
MASTERY	Achievement of a predetermined level of accomplishment.
MINI-COURSE	Same as MODULE.
MODULAR INSTRUCTION	Instruction based partly or entirely on modules.
MODULE	A self-contained, instructional package of materials and prescriptions of activities designed to bring about student learning of specific objectives.
POST-TEST	A test which is taken at the conclusion of an instructional unit and designed to evaluate student achievement with respect to certain specific objectives.
PRE-TEST	Same as post-test, but taken at the beginning of a unit.

REINFORCEMENT	May be thought of as reward.
REMEDIAL INSTRUCTION	Instruction designed to help the student restudy certain materials indicated by the post-test as "not mastered."
VALIDATION	See EMPIRICALLY VALIDATED INSTRUCTION.

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