DOCUMENT RESUME

ED 116 603 IR 002 466

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TITLE	The SCRAPE Model; A Conceptual Approach to Educational Program Evaluation.
INSTITUTION	Texas Univ., Austin. Project C-BE.
SPONS AGENCY	National Science Foundation, Washington, D.C.
REPORT NO	EP-4-11-3-72
PUB DATE	3 Nov 72
NOTE	25p.; For related documents see IR 002 463 and 464
EDRS PRICE	MF-$0.76 HC-$1.58 Plus Postage
DESCRIPTORS	Achievement Gains; Behavior Change; *Conceptual Schemes; *Curriculum Development; Diagnostic Teaching; Educational Programs; *Instructional Design; *Instructional Systems; Models; Program Evaluation; Systems Analysis; *Systems Approach; Systems Concepts; Systems Development
IDENTIFIERS	*Project C BE; SCRAPE

ABSTRACT

Using effectiveness, efficiency, self-sustenance, and communicability as criteria, a conceptual model, called SCRAPE, was developed at the University of Texas to systematically describe educational behaviors. The key elements of the system are: (1) diagnosis and prescription, (2) instructional events, (3) achievement evaluation, and (4) consequent activities. Within each of these elements, behaviors can be classified as either input processing, recording, monitering, or output. Having outlined a course in this fashion, an instructor could then use the assistance of an instructional engineer to determine which teaching processes should be human and which should substitute technology; the engineer could then take the responsibility to design the nonhuman elements of the educational system. This report offers a paradigm for developing educational systems, and it includes detailed examples of the variables that could effect each element of the system. (EMH)

THE SCRAPE MODEL

A Conceptual Approach to Educational Program Evaluation

EP-4/11/3/72

by

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*The materials contained herein were supported by PROJECT C-BE under Grant EPP7104422, "The Use of Computer-Based Teaching Techniques in Undergraduate Science and Engineering Education," from the National Science Foundation to The University of Texas at Austin, Drs. John J. Allan and J.J. Lagowski, Co-Directors.

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THE SCRAPE MODEL: A CONCEPTUAL APPROACH TO EDUCATIONAL EVALUATION

Paul G. Liberty, Jr.

This paper presents background considerations on the design of educational systems and then presents a conceptual model (SCRAPE) to guide educational program-planning and evaluation. It specifies the kinds of considerations and the kinds of data collection procedures needed to evaluate educational projects. Some specific variables are presented to illustrate how to make operational and how to use the SCRAPE model.

Although the SCRAPE model focuses upon computer-based education (C-BE) applications, it has planning and evaluation applicability for any educational or social action project. The value of the model is that it specifies the "elements of possible concern." It allows the investigator to identify potential variables (which can be very diverse in educational-social programs) and then consciously to decide which variables will be included in the evaluation design. Following these decisions, the investigator can specify statistical designs and plan the analyses.

An Educational System

Instructional technology has primarily been defined in terms of student behavior. In the February 1968 issue of the National Society for Programmed Instruction Journal, Don Tosti commented on the absence of individualized instructional systems that were behaviorally based and were both practical and self-sustaining. In defining the objectives of any operational system, Tosti formulated the PRIME (PRescription, Interaction, Motivation, Evaluation) model, which was at the time being employed at the Westinghouse Learning Corporation in Albuquerque. The remaining portion of this section is quoted (with comments added concerning Project C-BE applications) from Tosti, even though the PRIME model was not conceived with the computer in mind.*

*Tosti, Donald T. Prime--A general model for instructional systems. NSPI Journal, 1968, Vol. VII (2), 11-15.

System Objectives

Any practical educational system must be:

1. effective
2. efficient and economical
3. self-sustaining
4. communicable.

> Effectiveness. Effectiveness is defined in terms of learner achievement. Both the relative achievement of the individuals and the number of individuals who achieve the educational objective must be considered.
>
> . . . If a sizable portion of the learner population does not achieve the stated objectives, the program should be modified or abandoned. Experimental systems may be allowed to operate below the expected criterion for a short time, but such systems eventually must come up to or exceed proposed [italics added] standards.

In addition, the results of the experimental program must inevitably be compared against the results of other competing programs. (The above points out that both criterion-referenced testing, involving expected standards of performance, and norm-referenced testing, involving comparisons between individuals and programs, are required to ascertain program effectiveness.)

> Efficiency and Economics. In the design of the system, considerations of economy and efficiency can be determined only after some educational objectives or function of the system are specified. Once this has been accomplished, refinements can be viewed as changing the ratio of objectives met or functions accomplished to a learner-time base, a teacher-time base, or a dollar base. An example of the resulting dependent variables might be reading-gain per learner hour or learner assignments per instructor hour.
>
> Self-Sustaining Operations. It is important that the system be constructed in a form that will allow experimental personnel to be withdrawn from the actual operation without disrupting the program. Only by such a procedure can it be determined if the operation is independent of the skill and art of those involved in its organization. This step is the first requisite for reproducibility [and transferability].
>
> Communicability. Implementation is a necessary component of any applied system. The key problem in implementation is the ease with which the system can be communicated. This requires two strategies. First, the procedures used in the system must be refined to make them as clear and easy to learn as possible and, if possible, be related to a general model. Second, since the system necessitates a change in teacher activities, teacher training units must be developed.

The PRIME Model

Research into classroom management and instructional materials has led Westinghouse Learning Corporation (WLC) to formulate a generalized four-part model for the classroom....[the PRIME model is shown in Figure 1 below].

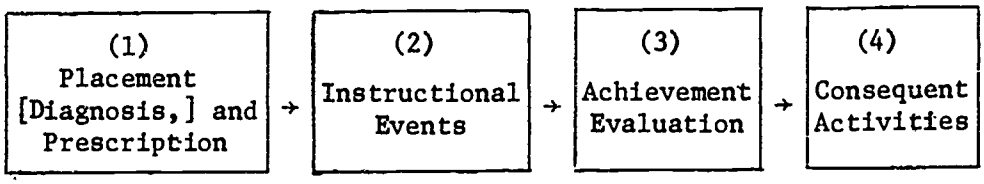

Figure 1

Components 1 and 3 are derived in part from the application of the technology of repertoire assessment developed in the testing and guidance fields.

Component 2 is concerned with the technology of presentation, an area to which people in programed instruction have contributed a wealth of information. Unfortunately, those who are knowledgeable in the technology of presentation have been somewhat unconcerned about the work of researchers involved with educational systems development, and there is a definite tendency for the systems people to belittle the technology of the programers.

Often, the time allotted to program writing is considerably underestimated.

Component 4 can be considered an application of the technology of motivation, which has been primarily identified with the contingency management system....

Within the C-BE program, there would appear to be a number of different strategies that instructor/developers might employ to motivate students (e.g., no final exams, no term papers, "work as you want," etc.). Any evaluation should assess student motivations for signing up for a C-BE project course and reasons for completing or not completing it.

This breakdown of components may not exhaust all possible important factors...[However, it is possible] to describe many of the gross characteristics of these [four] components and describe the methods that have been employed.

Placement and Prescription....The primary objective of the prescriptive process is to direct the learner through those materials necessary for him to achieve the desired objectives.

The prescriptive method usually involves two phases--initial assessment and differential assignment.

The initial assessment attempts to list existing characteristics of the learner which will be useful in determining future assignments. The most common characteristic examined is present achievement level. In some systems, such as those used by the Job Corps, this is the only measurement used to initially place learners. [Some C-BE project

directors may elect to use measures of] interests, aptitudes, or learning styles to aid in assignment...

Prescriptive methods have some resemblance to techniques used in branching programs, but the simplest form of "pure" prescription is found in multi-level programs.... Each section of such a course is designed in a multi-level amplification format. The highest and smallest level of amplification consists of a set of self-prescriptive pre-test items covering each section's content. The learner is not expected to be able to pass at this level unless he is using the course for review purposes; or is, for some other reason familiar with the section's content. If he can pass this prescriptive pre-test and the corresponding post-test, he is directed to the pre-test of the next section.

The second or intermediate level of amplification consists of a narrative summary with a corresponding intermediate prescriptive test. In most cases, the reader will find that he can pass a number of sections at this level. If not, he will be directed to the third level which is written on a still more amplified level....

This form of prescription allows the teacher to assign certain instructional units, exercises, or supplementary activities to the learner based on his pre-test achievement results, and the teacher's knowledge of the materials, and the learner's past performance. Some branching and linear programs have used short tests to skip learners ahead. An extension of this logic is found in prescriptive methods which measure whole knowledge areas. Thus, a learner who is weak in a specific arithmetic skill, such as division of fractions, may not have to learn addition of fractions (unless he tests poorly in this area too). The resulting assignment should include only those skills which he requires.

Prescriptive tests may take the form of pre-tests or post-tests, or may be imbedded in the curriculum. Usually the pre-test type is used to ascertain the existing skill-areas of the learner or any other behavior which may facilitate the acquisition of new skills. These initial measurements indicate an appropriate starting point and also aid in future assignments by identifying areas of strength or weakness.

General techniques employed in the construction of achievement tests are applicable. The difference between diagnostic tests and prescriptive tests lies in the latter's division into behavioral clusters which consider the terminal and intermediate objectives. The subject matter is analyzed and divided into many sub-areas or steps according to the skills needed to emit appropriate responses from the entry level to the terminal objective.

The outcome of a prescriptive pre-test may lead directly to a curriculum decision or may indicate the need for more precise testing. Flowcharts may be employed as devices to aid the instructor to make accurate prescriptions as shown in Figure 2.

Prescriptive Test Results (Test Form P01)								
Pre-test A	Pass	Pass	Pass	Fail	Fail	Fail	Fail	Fail
Pre-test B	Pass	Pass	Fail	Fail	Pass	Pass	Fail	Fail
Pre-test C	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail
	↓	↓	↓	↓	↓	↓	↓	↓
	Take test P07	Enter math M5	Enter math M0	Take test P11	Enter math M5	Take test P04	Enter math M2	Enter math M1

Figure 2

Figure 2 indicates that some of the results tell the teacher to assign a particular instructional unit. Other results indicate further testing.

The primary difference between prescriptive tests and other evaluation devices is that these tests are used to make curriculum decisions. They are not used for learner control or for grading purposes. The control function is handled by the progress check test (see achievement evaluation). No grade should be given on these tests, and the learner need not be directly aware of the results.

Probably only a few C-BE projects will have courses permitting "multiple access points." However, as test items are written to assess the specific course objectives, the possibility of assembling test items to yield prescriptive as well as evaluative information certainly becomes available.

Instructional Events. Several of the operating programs employ combinations of individualized and group instruction. It is important to note that the objectives of the PRIME model may be accomplished by either method.

The decision as to which subjects will be presented in individualized form and which by group instruction [e.g., rear-screen projection] is dependent in part on whether good individualized material is available, the cost of preparing or purchasing such materials compared with present efficiency and the occasional need for the teacher to assume the lecture role....little [if anything] has been done to determine what learning factors would lead to the decision to have courses or parts of [C-BE] courses [taught in lecture]... or a seminar discussion form....the union of this technology [of presentation] with practical considerations of the classroom is a pressing need.

There are several types of individualized instructional materials commercially available. The Job Corps has been able to assemble a basic remedial, education curriculum composed only

of individualized materials. This curriculum was drawn from extant material and only slightly revised for the Job Corps. Most of these materials are linear programed texts, reading laboratory packages, and workbooks.

Achievement Evaluation. Most individualized instructional systems provide for some form of achievement feedback control.... The presence of frequent achievement assessment tends to control the learner's behavior by the knowledge that he soon will be tested on what he is studying.

Many recent programs contain progress check tests. The progress check is a short test covering a small segment of material. It is not only used for control purposes but has definite motivational properties. Often in individualized instruction, it is difficult for the learner to see his progress. The progress check, which allows the learner to demonstrate his newly acquired skills, aids in alleviating this problem. This demonstration of mastery is often the only formal, positive consequence employed in some individualized instructional systems.

Progress checks have a number of possible uses. Several of the prescriptive oriented systems employ progress checks to make further differential assignments. This usually results in reams of evaluation records that can be reasonably handled only by a computer. In the contingency management system, progress checks are employed as indicators of task completion, signaling to the learner that he now may engage in some preferred activity.

In programed material, which has not been revised to include progress checks, additional work must be done to adapt them to the PRIME system. For example, several linear programs designed to teach English cover the subject matter well. But the units are generally too long, and the learner has no opportunity to demonstrate his ability until he has covered as many as 1,000 frames. In experimental work, the introduction of progress checks has increased the efficiency of this program.

Consequent Activities. The establishment of sound, lasting motivation is at once the most important and the most difficult step in building and applying an effective system of instruction. The initial interest intrinsic in most educational programs often wanes after the first few hours of instruction. Full attainment of the learning objectives designed into any given self-instructional program is very difficult unless proper motivation is provided.

Motivation is of utmost importance in all areas of education. No matter how well-conceived, organized, and behaviorally sound a presentation may be, students will learn nothing from it unless they attend and respond. Yet, until recently, there existed no formal method of reliably producing learner motivation.

Motivation is often loosely termed the energizer of behavior; it is said that individuals are motivated to eat, to sleep, to make money, to be famous, etc. However, such a broad definition does not aid in determining which methods will maintain activity in

classroom learning tasks. Therefore, it is necessary to limit this definition to a more specifiable condition. When an individual initiates and completes a given task, it might be said that he has "task motivation." If the task is the construction of a retaining wall, and the learner completes it, he has task motivation. If the task is the completion of a page of graded reading material, and the learner completes it satisfactorily, he has task motivation. Task motivation, then, is a descriptive, summarizing term for the complex of behaviors displayed by a learner when he is attending to and responding appropriately to his given task assignment. [Italics added.]

Task motivation is particularly important in individualized instructional systems where there is no teacher or peer pressure to maintain performance. Generally speaking, programed instructional materials are published with no specific directions or recommendations to control motivation. The learning results of these materials are generally good when learners complete them, but the rate of completion is often extremely slow.

To keep the student in the learning environment or to keep him responding at a normal rate, his learning activity must lead to some preferred consequence. Laboratory studies of reinforcement typically use the preferred consequence of eating or drinking to motivate animal behavior. Equivalent kinds of reinforcement can be used with children. However, it is awkward to use this kind of payoff for learning activities in the classroom. Humans cannot be starved, nor can candy be placed in their mouths for correct responses. This creates an impossible position: rewarding consequences are necessary but impractical.

Those who will object to the simple treatment of behavior and reinforcement presented here may argue that human motivation is a highly complex affair, involving much more than the simple matter of the consequences that behaviors produce. This may be a valid premise, but it surely is not a sound reason for ignoring the simple facts of life. Acceptance of the fact that human motivation is affected by individual emotions, ideas, hates, and loves, should not rule out also accepting the importance of the consequences of behavior.

The formal administrative technique employed to provide positive consequences for all learning activities has been termed "contingency management." Contingency contracts may be oral or written.

The following procedures have been developed by Westinghouse Learning at the Capital Job Corps Project. The names of available courses are typed on plain 3" by 5" cards. These are called task cards and are filed in boxes in the front of the room. The task cards are yellow. Blank, white cards represent "breaks." The classroom manager explains in simple terms that the system will help trainees learn if they organize the cards so that a task they like occurs after a task they do not care for. The following guidelines are placed on the contract by the classroom manager. Each contract must contain at least three tasks, and the contract is to be completed before the trainee may leave class for the day. There is no restriction on either the number of breaks or the maximum number of tasks. Each day the trainee prepares a new contract....

> Upon completion of a predetermined task phase of his contract, the Corpsman may take a break. He reports to the classroom manager that he is ready for a break, and then selects from a group of cards numbered from 5 to 20 in increments of five. The card he selects determines his break time. He then goes to the RE [reinforcing event] area. There he can play cards, smoke, read magazines, talk to his friends, sleep, sit, or get coffee. When his break is over, he returns to his study room to complete the contract.

Within the C-BE Projects, directors may desire to devise and try out certain activities that will promote and perpetuate "task motivation." Since computer-based education presents students with new task requirements, it may be necessary for projects to determine what degree or "student control," periodic feedback to students, and student choice is important to learning outcomes. Higher-than-conventional dropout/incomplete rates in some C-BE courses and disruptive personality effects within some C-BE students indicate a need to relate students' motivational/personality characteristics against subsequent course performance in C-BE projects.

[End of citation from Tosti]

A Behavior Systems Approach

From the description of the PRIME model, it can be seen that a behavioral system rather than an instructional system has been posited. Behavior systems are networks of interrelated behavioral events which act upon certain kinds of input variables to transform them into particular output variables. The emphasis thus is on behavior, i.e., functions, acts, and results. The physical entities that produce these behaviors may be human or machine.

Five Categories

The function of the behaviors in the system may be divided into five major categories: input behaviors, processing behaviors, recording (storage or memory) behaviors, monitoring behaviors, and output behaviors. Each one of these classes of behaviors may constitute a major subsystem of the behavior system. Evaluation takes place within each of these categories and may be labeled as input, process, and product types of evaluation. Context (needs assessment) evaluation is omitted here.

It is a prime concern of behavior systems engineers to define objectives of the behavior system as a whole in terms of the products that the system is to generate from the given input. Such a definition will follow the sentence-function, "Given input I, the system will produce output O," where appropriate substitutions for the variables I and O will generate the objective sentence. Temporal, quality, and other criteria may be added, but the general form of the objective sentence will not change.

Behavior Engineering

Within C-BE projects, once the project director or other staff decides what the desired output will be when a given input is made, the component designers are responsible for determining what components are necessary to produce each of the specified behaviors. The components (there are at least five in innovative education projects) may be human or non-human, and they may be readily available or may have to be developed. Some of the behaviors can be produced by a single person or device. Others may have to be produced by a combination of several persons and/or devices; in the case of C-BE, this usually involves developing a human component [the student through a special device (the computer), or supplementing an available human's skills (the teacher's) with appropriate devices (the computer and simulation assignments)]. At a simpler level, the optimal solution may be to add an electric calculator to a system instead of teaching arithmetic operations to the human. Both short- and long-term objectives of the behavior system will determine the optimal solution in most cases.

Then, after the director has specified the objectives and the components designers have stated what the particular component should be, an instructional engineer will have the task of developing necessary non-human aspects while the behavioral engineer is responsible for the development of the human aspects. Both instructional (non-human) and behavioral (human) engineers have to develop behavioral specifications that will meet the component design and the overall behavioral system design.

It is not only necessary, therefore, for C-BE projects to focus on the preparation of educational materials (subject matter), but also to take into account the total systems objectives which include the characteristics of the learner, teacher, the curriculum (materials), and the socio-educational setting in which the desired behaviors are to occur.

A Conceptual Paradigm for Evaluation

A potentially useful schema for conceptualization of the variables to be considered in an evaluation design is shown in Figure 3 below.

SCRAPE Model

The model emphasizes student (learning) outcomes (L_S) and the various factors that are presumed to affect student performance in C-BE courses.

Student Entering Characteristics	Curricular (FOCAL) Characteristics	Educational Environment (BACKGROUND) Characteristics
$L_S = f\ (S,C,R,A,P,E,$	$CBE_1, CBE_2, CBE_3, CBE_4, CBE_5,$	$E_T, E_{TS}, E_D, E_C E_{PC}, E_M)$
(OUTPUT BEHAVIORS) (INPUT CHARACTERISTICS)	(INSTRUCTIONAL PROCESS CHARACTERISTICS)	(CONTEXT CHARACTERISTICS)

Figure 3

Outcome (Dependent Variable) Behaviors

L_S = learning behavior (outcomes) of individual student to be described, explained or predicted, such as:

(1) level of score on content posttest;
(2) whether or not criterion was reached;
(3) comparison with conventional (and C-BE) courses;
(4) student attitude change;
(5) student personality change;
(6) enhanced mental abilities;
(7) change of major;
(8) intent to take another C-BE course;
(9) intent to take another course in same department or related area.

Student Entering Characteristics

S = Social class characteristics of student

C = Cultural (Anglo, Black, Brown, etc.) characteristics of student

R = Readiness of student for computer-based education

A = Abilities and aptitudes of student

P = Personality characteristics of student

E = Educational success and academic background of student

Curriculum Characteristics

CBE_1 = Type of content emphasis in course

CBE_2 = Type of computer used in C-BE course

CBE_3 = Presentation mode in C-BE course

CBE_4 = Entry skills to course

CBE_5 = Interim, or unit, scores*

Educational Environment Characteristics

E_T = Teacher (instructor) characteristics.

E_{TS} = Teaching style of instructor.

E_D = Departmental attitudes toward C-BE and prior C-BE experiences of faculty and students in department.

E_C = College attitudes toward and experiences with C-BE.

E_{PC} = Previously existing course and prior educational experiences of students prior to C-BE course (control groups).

E_M = Educational milieu of C-BE course: where, when, how, what; time of day of course; time required, if any, to spend on computer.

Although admittedly simplistic, the paradigm does provide directors, curriculum developers, and evaluators with a way to approach program planning

* A particular course might have several discernible or distinct components or units. The intent in CBE_4 and CBE_5 is to focus on prior learning, both prior to the course and during the course prior to end-of-course evaluation of learning, for purposes of pupil-learning evaluation and curriculum effectiveness evaluation.

and program evaluation conceptually. It attempts to serve the purpose of identifying crucial variables that might affect performance. The paradigm has been found useful in "getting all the cards on the table" so that the entire staff, often busy with only part of the picture, can discuss the full range of possible activities in the program. The paradigm can be expanded, of course, through the addition of variables or the specification of finer variables. For example, personality characteristics may be enumerated P_1 to P_n. Also, the paradigm permits systematic selection and/or development of tests and other types of instrumentation.

Additionally, the paradigm lends itself to conceptualizations of what variables are to be treated in a research-evaluation-statistical design. For example, the typical research design might exclude all variables except CBE_1 and E_{PC} (the prior curriculum), thereby providing comparisons of student effects between the new C-BE curriculum and the previously existing curriculum. A more enlightened design might include several levels (high, medium, low) of A (student academic ability) in a comparative study of both types of curriculum. Another design variation might include levels of E (prior academic success, i.e., GPA) of students, P (sex of students), and R (readiness of student, e.g., motivation, attitudes, attitude toward machines, fear of computer, etc.) for C-BE instruction.

Finally, at the level of evaluation across C-BE projects, the paradigm affords administrators, committees, and evaluators a number of "conceptual handles," or conceptual discriminators, that may help to contrast and compare the separate projects.

SCRAPE and Other Outcome Variables

Although the primary output, or effects, variable in C-BE projects is student learning, the model can just as easily treat other variables as outcome (dependent) variables. Personality change in students might be one such variable, where the concern is to explore whether C-BE alters certain personality traits, such as task-orientation and affiliational-orientation of students. Also, CBE_5, secondary outcomes (e.g., score on a later curriculum unit) might be investigated by employing CBE_4 levels of performance

(90% and above, 80-89%, and 70-79%) on a criterion test covering CBE_4 content. (Does performance on the CBE_4 criterion test relate to differential learning outcomes on CBE_5?) And, finally, for the curriculum developer, curriculum unit CBE_4, or its parts, would be investigated for evidence that students are meeting criterion standards on this unit.

When the curriculum developer finds that certain types of students fail a unit one or more times, he may desire to examine the program internally for existence of certain types of difficulties that students indicate on tests or call to his attention; he may need to rewrite some portion of the curriculum. He or the evaluator may observe or interview students to determine the nature of problems encountered by the students. Or, the curriculum developer may have found that specified criterion standards were met and go on to further developmental activity, while the evaluator may feel compelled to determine the characteristics of the 20% of the students who did not meet criterion--in other words, what distinguished these students from those who reached criterion standards sooner. The evaluation information obtained may contribute important information for the curriculum designer, and the information may be extremely important in identifying and subsequently shaping the crucial factors that are necessary for the introduction and implementation, here and elsewhere, of C-BE programs. Thus, the evaluation function is a continual study for expected and unexpected outcomes and a search to identify reasons, at least initially, through ex post facto analyses.

It may be apparent that both product and process evaluation exist within the SCRAPE model. Process evaluation, simply stated, is concerned with documentation and feedback processes that permit a project to know what things (expected and unexpected) are happening throughout the year. The process evaluative function is concerned to a great extent with identifying critical information easily so as to facilitate program correction and alteration. Product evaluation (pre- and post-testing) during the development years of a project is important but not sufficient to insure that a program is operating effectively. Thus, process evaluation is especially important in action-research situations in which a program is underway and any alterations, or other decisions, must be made before

the end of the school year.

Some Possible Variables

In order to begin estimating the magnitude of data to be collected within a C-BE project, an attempt is made below to specify variables that seem important enough for inclusion primarily for purposes of Product Evaluation.

Student Learning Outcome Variables

Immediate and Related Academic Variables

(a) Grade in course (1 digit)
(b) Proportion of course content learned (2 digits)
(c) Whether or not specified criterion was reached (1 digit)
(d) Number of semester hours taken during present semester, exclusive of C-BE course(s) (2 digits)
(e) Number of semester hours in any other C-BE course(s) (2 digits)
(f) Semester GPA, all non-C-BE courses (3 digits)
(g) Semester GPA, all C-BE courses (3 digits)
(h) Semester GPA, all courses (3 digits)
(i) Incomplete in C-BE courses (1 digit)
(j) Incomplete in non-C-BE course(s) (1 digit)
(k) Dropped C-BE course, passing (1 digit)
(l) Dropped C-BE course, failing (1 digit)
(m) Number of non-C-BE course(s) dropped, passing (1 digit)
(n) Number of non-C-BE course(s) dropped, failing (1 digit)
(o) Major is different from major stated before course started (1 digit)
(p) Major changed to be in C-BE course area at end of semester when C-BE course taken (1 digit)
(q) Pre-test in course (comprehensive) (3 digits)
(r) Post-test in course (comprehensive) (3 digits)

Concurrent Variables

(a) Took advanced exam in another course in area of C-BE course. (1 digit)

(b) Took and passed advanced exam in another course in area of C-BE course. (1 digit)

(c) Evidence of development in a C-BE course of

(1) a level in a C-BE course taught skill that exceeds level in regular course. (2 digits)

(2) a level of a skill that is achieved in a C-BE course but usually is not obtained in non-C-BE course. (2 digits)

(d) Major is different from stated major at start of C-BE course. (1 digit)

(e) Major is different at start of a C-BE course but is declared to be in the C-BE course area at end of the semester when C-BE course was taken. (1 digit)

(f) Course-Instructor Survey ratings of: (50 digits)

(1) Course

(2) Instructor

(3) Computer assisted instruction methodology

Long-term Variables

(Variables still to be specified.)

Student Characteristics Variables

Social class (S) (1 digit)

Cultural group (C) (1 digit)

Readiness of student for C-BE (R): a questionnaire (2 digits)

Abilities and aptitude measures (A)

(a) High school GPA (3 digits)

(b) High school rank (2 digits)

(c) High school courses taken in C-BE related course area (2 digits)

(d) High school GPA in C-BE-related course area (3 digits)

(e) SAT-verbal score (3 digits)

(f) SAT-mathematics score (3 digits)

(g) SAT-total score (4 digits)

Personality Characteristics (P)

(a) Sex (1 digit)

(b) Age (2 digits)

(c) Orientation Inventory (Bass)

  (1) Task orientation (2 digits)

  (2) Affiliation (person) orientation (2 digits)

  (3) Self-orientation (2 digits)

(d) Orientation to College

  (1) Vocational (1 digit)

  (2) Intellectual (1 digit)

  (3) Academic-social (extra-curricular) (1 digit)

  (4) Self-identity seeking (1 digit)

(e) Machine vs. man scale (2 digits)

(f) Reasons for taking C-BE course (26 digits)

(g) Expected grade in course - C-BE (1 digit)

(h) Expected grade in course - standard (1 digit)

(i) Number of hours spent on computer, total (2 digits)

(j) Number of hours spent on computer in:

  (1) First six weeks (2 digits)

  (2) Second six weeks (2 digits)

  (3) Third six weeks (2 digits)

(k) "Volunteer" vs. "non-volunteer" (1 digit)

(l) Degree of expected liking for C-BE course (1 digit)

Educational Success and Background (E)

(a) Academic classification (1 digit)

(b) College in which registered (2 digits)

(c) Major (2 digits)

(d) College GPA (3 digits)

(e) GPA in C-BE course area (3 digits)

(f) GPA in C-BE-related course area (3 digits)

(g) Major changes, number (1 digit)

(h) Prior C-BE course taken (1 digit)

(i) Previous exposure to CAI, C-BE (1 digit)

(j) Diagnostic or prescriptive test level at which student begins instruction (3 digits)

Curriculum Characteristics (C-BE)

Type of C-BE program emphasis (simulation, computation, etc.) (2 digits)

Academic level of C-BE course (1 digit)

Subject Area of C-BE course (2 digits)

Secondary component emphasis (e.g., math component to support physics) (4 digits)

Scores on interim, or unit, tests (20 digits)

Environment: Educational Setting Characteristics

Teacher characteristics

(a) Teacher or no teacher in course (1 digit)

(b) Graduate student or professor--rank (2 digits)

(c) Sex of instructor (1 digit)

Teaching style of instructor

(a) Type or level of interaction with students required in course. (1 digit)

(b) Degree of interaction with students, from students' report - time (2 digits)

(c) Degree of interaction with students, from instructor log - time (2 digits)

(d) Student rating of level (importance) of help provided by instructor (1 digit)

Departmental attitudes toward C-BE: questionnaire (2 digits)

College administrators' attitudes toward C-BE: questionnaire (2 digits)

Previous course (before C-BE course) information

(a) Whether C-BE course is "replacement" course or new course (1 digit)

(b) Data from previous course (sections of it):
  (1) Achievement of students (6 digits)
  (2) Ratings by students (6 digits)
  (3) Other information for comparisons (6 digits)

Educational Milieu

(a) Readiness to accept innovations in community (setting); pooled ratings of principals involved in innovating (3 digits)
(b) Time of day C-BE course is taught (2 digits)
(c) Required amount of time to be spent on computer in hours (2 digits).
(d) Classroom tests or computer-test (2 digits)
(e) Other homework, term papers (2 digits)
(f) Distance to computer for student (2 digits)
(g) Average waiting time required for students--experiential data (2 digits)
(h) What did students do while waiting? (Study, talk about non-course things, talk about C-BE course matters.) (1 digit)
(i) When were tests given? (1 digit)
(j) When were tests scored? (1 digit)
(k) Was proctor present? (1 digit)

Process Evaluation

Process evaluation involves the collection of data for documentation and feedback. Its purpose is to trace developments within the project for purposes of ascertaining whether or not objectives on student learning and curriculum are being reached and to detect "hangups" in the learning process, whether or not these derive from machine, students, lack of materials, inaccessibility, etc. In other words, the question to be answered is: "What data are necessary for us to determine that our program is on course, not only against previously stated, expected outcomes, but also from potential or actual unanticipated disruptions?" A feedback network should pick up these problems; documentation is necessary so that subsequent efforts here and by others will be alert to pitfalls.

Process evaluation will utilize a number of criterion variables posited in the immediately preceeding section (Some Possible Variables) for product evaluation. The criteria will be applied during the course of the project instead of at the end of the project.

Note again that objectives, both process and product, will exist, formally or informally, in those seven components that appear to be common to educational programs. These components are (a) instructional; (b) curriculum development; (c) materials/equipment; (d) staff development; (e) space-time structures; (f) community involvement--in general, the external relationships affecting and being affected by the project and (g) management: coordination of series of steps producing coordination of the internal components (a-e above) and the external world (f). These components were previously specified in "Handout for Evaluation Seminar," Paper No. 2.

Other Thoughts on Behavioral Model

As previously indicated, the conceptual paradigm, SCRAPE, can be rewritten so that other variables besides student learning variables are treated as outcome (dependent) variables. Thus, a personality variable may be investigated if it is hypothesized that C-BE exposure will change personality; for example, change affiliative orientation to task orientation.

A sheet that one project evaluator (Gavenda's project) believes to represent the minimum information to be obtained from each student completing a session at the terminal is attached as an appendix.

A conceptual paradigm lends itself to formulation of multivariate statistical design. It (SCRAPE) allows for pre-post study if a comprehensive subject pre-test is given, for experimental (C-BE) vs. control (non-C-BE) group studies, and for comparisons between C-BE programs when non-content variables are of interest.

Curriculum development checkout can be accomplished within the context of the model. Developers will probably want to relate student performance on units to student results on earlier units. Ability levels of students and other variables might be employed to determine what vari-

ables affect learning and non-learning (criterion reached or not reached) or levels of learning. Developers will probably wish to become vary familiar with item analysis procedures to help determine what items are causing problems (and what kinds of problems) to students. Curriculum developers may also wish to create small experimental groups for tryout of materials. This procedure affords quick feedback and such in-depth feedback from students as may be needed to understand the students' problems.

The model also can be applied with prescriptive-diagnostic-type programs wherein students are tests for the level at which instruction should begin. This concern can be subsumed under "Educational Background of Student."

APPENDIX

Developed by Ben Manny

For each session:

DATE (6 bits) day

TIME (4 bits) nearest hour

LESSON IDENTIFICATION (5 bits) - (32 lessons)

Total correct time (9 bits) in minutes, 8 1/2 hours max.

Total TM time (12 bits) in seconds, approx. 4096 max.

4096 = 1 hour

409.6 = 6.8 min.

TYPE OF DAY (3 bits)

Value of Session (3 bits)

Main purpose of Session:	Type in program Debut program Run debugged program Combination of above	Classwork Play with machine Demonstrate machine to friends Own program work

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Type of Day Scale:

1.	2.	3.
One of my worst days; nothing has gone right	A bad day	An average day
4.	**5.**	
A good day	One of my best days	

Value of Session:

1.	2.	3.
Ruined my day	Waste of time; gained nothing	Average session; learned a little
4.	**5.**	
Learned a lot; time well spent	One of my best sessions; time could not have been spent better	