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ABSTRACT

The adaptation is proposed of an evaluation technique to the needs of the State Department of Education of the Commonwealth of Massachusetts by demonstration in a selected group of schools. Improving educational quality through Comprehensive Achievement Monitoring (CAM) is accomplished by providing students and educators with longitudinal and comprehensive information which will permit systematic and effective adaptations of instructional treatments to changing demands. The proposal begins with a statement of the rationale of CAM, a comparison of three evaluation models, and a discussion of evaluation issues. Seven major components of a two-stage plan for implementation of the CAM technique in selected school districts in the 1970-71 school year are outlined. The proposal concludes with a budget for the planning and demonstration stages. (Author/TA)

Project Comprehensive

Achievement

Monitoring

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Technical Memorandum TM-23 November 1969

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# Improving Educational Quality

through

# Comprehensive Achievement Monitoring:

## A Proposal for a State-Wide Demonstration

by

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A proposal submitted to the State Department of Education of Massachusetts. The proposal reported herein was performed pursuant to a grant from the Charles F. Kettering Foundation to the Principal Investigator, Dr. Dwight W. Allen, Dean, School of Education, the University of Massachusetts.



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## Overview

The Project For Comprehensive Achievement Monitoring (CAM) at the University of Massachusetts, Amherst, proposes to initiate and develop for the Commonwealth of Massachusetts an evaluative system which can furnish information useful to students and educators alike in adapting study patterns, pacing and sequencing of instruction, developing curricula and, generally, improving the quality of education. It is widely understood that learning results from one's interaction with his total environment. However, the Project has chosen to focus on the variables related to classroom instruction for two reasons. First, instruction in the classroom or in related learning situations is the core of education. Students learn most of their academic skills through interacting with their teachers, schoolmates and the facilities which the school system puts at their disposal. Second, the Project has unique strengths in the evaluation of the learnings which are produced in this context. These strengths can provide information particularly useful in judging the quality of learning and suggesting adaptations which may be deemed appropriate in improving it.

Basic to evaluative technique proposed is the concept of monitoring. As will be demonstrated below, earlier methodologies of evaluation suffered from the weakness of narrow and sparse measurement. CAM proposes evaluation of continuing progress through the use of monitors at frequent and natural intervals in a course. This permits feedback to the teacher and the student at regular intervals. It facilitates adjustments in instruction and study which normally would not have been recognized as needed until a mid-semester or semester were over.

Basic to CAM is the concept of comprehensiveness. It encourages, indeed even necessitates, a clear and comprehensive formulation of the objectives of a course and avoids the shoals on which many evaluation efforts flounder, i.e., fuzzy and

poorly conceived notions lumped under the rubric of achievement. Further, it uses a multi-variable model of school achievement. The variables include: (a) sociological variables dealing with family and social background of the students; (b) school related variables such as ADA, expenditures per child, urban-suburban character of the school; (c) student variables such as rate of learning and retention and initial achievement, and personality and vocational interest profiles.

## A Comparison of Three Evaluation Models

Comprehensive Achievement Monitoring (CAM) will be described and its unique features characterized. After this description two more familiar evaluation models (e.g., usual classroom testing, and curriculum project evaluation) will also be described and their strengths and limitations mentioned to contrast them with CAM. Finally, the pattern and quality of information generated by the models will be compared.

### Description of Comprehensive Achievement Monitoring

CAM is a system for testing achievement on every objective of a course, at frequent test administrations throughout the course. At each test administration, performance on objectives not yet taught is pretested, performance on objectives just taught is immediately post-tested, and performance on objectives taught earlier in the course is measured for retention. Parallel test forms, comparable in difficulty and content, are all used at each test administration, but each student receives a particular form only once during the course. Each form typically has an item for each objective. Each item is used on only one test form. The function of a particular item changes in relation to the time at which its objective is taught. Testing may take place at regular intervals (e.g., every two weeks) or at the end of certain instructional units. Computer based analyses and reports are made.

Specification of objectives. The most fundamental preparatory step for the use of CAM is the specification of the objectives to be evaluated, in testable, behavioral terms. Objectives may be categorized according to numerous dimensions, and possibly organized into instructional units. Written objectives for a variety of closely related projects or courses may be collated and pooled. It is then possible to identify and select for evaluation those objectives which are common to several projects, and those that are unique to a project. Objectives are typically related to achievement; however, CAM is equally suited to measuring changes in attitudes or perceptions. The pool of objectives is called an objective bank, and a computer program is available to handle the large amount of data involved.

Test items. The second step toward the use of CAM is the construction of test items. Every item is tied specifically to a single objective, and multiple items are constructed for each objective. All items, keyed by objectives, may be stored in a computerized item bank, ready for sampling or available for revision.

Construction of test forms. The number of test forms, or monitors, must at least equal the number of test administrations planned. Tests are made parallel in content by using the technique of stratified random sampling. Forms are also randomly comparable in difficulty. If an item analysis can be run (perhaps on a pretest or an earlier version of the course) for indices of difficulty and discrimination, the forms may be made more exactly comparable in difficulty.

Monitors are intended to be short tests, perhaps ten to thirty items. Whether or not a single form covers all objectives for a course is a function of the proportion of objectives to items-per-form. It may be necessary to randomly sample (without replacement) the objectives, before doing the same on the test items for each selected objective. This technique of sampling must insure that, across forms, all objectives are equally represented. The same consideration holds when items-per-form exceed the number of objectives; in this case, some objectives may be represented by more than one item on some forms.

Student test groups. Students are divided into test groups in order to use all test forms at each administration. Test groups are best constructed using random sampling of strata of students based on ability or prior achievement in the subject. This assures that each group has a range of students which gives representativeness to the data for each test form.

It is most desirable, for several reasons, to include every student in every test administration, and when set up this way, CAM has been found to be a satisfactory substitute for usual classroom testing. However, it is possible to use only a sample of the student population, especially if the number involved in a project approaches one thousand or more. Many different sampling designs are possible. Using the total student population in one test group is the design for the conventional project evaluation. Unequal-sized test groups may sometimes be an administrative necessity.

Test administrations. Test administrations may coincide with the completion of instructional units, or they may be set at regular intervals throughout the course. The latter has advantages in terms of ease of administration, and comparability of results from similar courses taught at different schools.

Appended package tests. It is possible to add a section to any monitor, and have the results incorporated with the rest of the CAM data. This feature

lends flexibility in that, should a specific diagnostic test seem desirable at any point, the data can easily be assimilated.

Data analysis and reporting. Output from the computer programs is as follows:

For individual students

After each administration:

1) total score on that and all previous administrations.

2) a graphic presentation of the above.

3) a right-wrong indication for each item on the monitor, coded by the objective represented.

At the end of the course:

4) average scores, across all monitors taken, on items categorized by use into three groups--pretest, immediate post-instruction and retention of varying lengths of time.

For whole group or subgroups (e.g., one classroom; highest and lowest quartiles)

After each administration:

1) percent answered correctly out of all items across all monitors, for each objective.

Periodically, as desired (e.g., every 3-5 administrations):

2) trend data, or achievement profiles, for total score and for each objective.

At the end of the course

3) same as number 4 under individual students.

4) item analysis (using whole group only), treating each item in three separate ways, by its three functions--pretest, immediate post-instruction, and retention measure.

Data are analyzed, and reports printed, by computer. Data can be collapsed in various ways, to be most useful to students, teachers, project directors, or state evaluators.

Specificity of objectives. Any instruction, no matter how it is to be evaluated, can call for a high degree of specificity of objectives CAI, however,

rigorously prescribes and requires such specificity. It is the base upon which the detailed testing, analysis and feedback of the program rest.

Specificity of objectives allows similar curricula to pool and match their objectives. What is common to all curricula, or to several, is readily observable, and provides a meaningful, detailed comparison. Objectives unique to individual curricula can pinpoint actual differences concretely and precisely.

Test items tied to objectives. Each test item is constructed to measure achievement on a particular objective. Therefore, test data always relate to definite objectives, rather than aggregates of objectives: this allows evaluation procedures to be matched with specific goals of the curricula. In this respect, CAM differs significantly from conventional curriculum project evaluations, where standardized materials are used, which have not been closely tied to the specific objectives for the curriculum.

Modification of curricula. Conventional curriculum project evaluation may provide some criteria upon which to base one kind of decision about an existing project: "drop it" or "continue it". These criteria are global rather than related to specific contributions of the project. Perhaps one of the most valuable characteristics of the comprehensive achievement monitoring model is that it is able to provide information upon which to make specific recommendations for retaining strong components of a project, and modifying weak ones. No project is as effective as possible, as set up at its inception; therefore, a far more pertinent decision about it, now possible with the CAM model, is "drop" or "continue with these modifications."

Data more valid. If there is time on a test for one question for an objective, then estimates of group achievement on that objective will be more valid if a variety of questions is used across the group, rather than the single question typical of both classroom tests and project evaluation. It is important to note that the increased validity and comprehensiveness calls for no sacrifice in the

economy of data collection, since each student need still answer only one question.

Pretest of all objectives. All objectives are pretested before any instruction has been given. First, it is important to know whether students have already acquired information or skills from outside sources, to that the project need not lose students' interest by covering material that they can handle already. Secondly, an index of effectiveness must ultimately be an index related to change in student achievement, attitude or perception. In order to document change, it is necessary to have at least two comparable measurements of the same characteristic, taken at two different times.

There is reason to continue pretesting on objectives to be taught later in the project, because outside learning experiences, or interaction between material taught early in the project and that scheduled to be taught later, may both very reasonably cause changes in performance during the project. This may lead to alterations, either in the sequence of instruction, or the amount of time spent on certain objectives. When the level of achievement rises on an objective not yet taught, it may be closely related to material just taught, in which case, instruction in the later-scheduled unit could be moved up to take pedagogical advantage of the relationship. Another possibility is that, without changing the sequence, certain instructional units might be condensed, and the pace of instruction stepped up. A single pre-course test, will not provide information for making the above decisions.

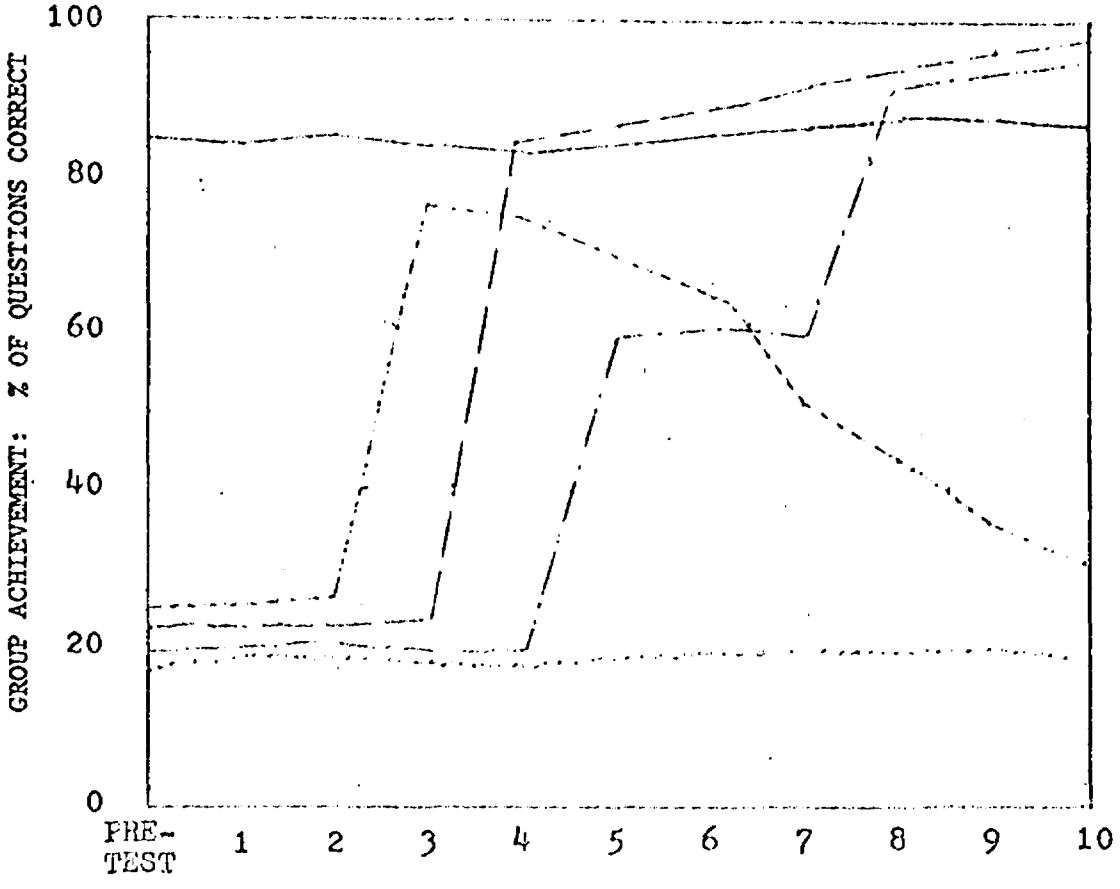
Immediate post-instruction test. The usual classroom test covers only material just taught. CAI estimates of group achievement on just-taught objectives are comparable to those available from classroom testing. The number of students usually involved in projects makes it possible to test each objective with a substantial variety of items, without lengthening any one form of the test.

Continual measure of rentention. Since objectives continue to be tested after they have been taught, throughout the rest of the course, there is a continual test of retention. Intervals between "teach" and "test" times are of varying length, and can be matched for precise analysis. For example, it would be possible to measure retention spanning approximately six weeks on all material of a course except what is presented during the last month or so. Therefore, estimates of achievement can be systematically made for each of the instructional units after a specified interval.

Achievement profile. There are comparable data on achievement for every test administration. This makes it possible to plot students' achievement on any given objective (or group of objectives) for the entire course. This plot, called an achievement profile, gives a graphic presentation of the changes in group achievement throughout the course. This achivement profile is a unique characteristic of the information available form the CAI model, and is very useful in describing and reporting results of course and project research.

Figure 1 presents hypothetical achivement profiles for five objectives from a course. Brief comments below the graph give possible interpretations. It is obvious that achievement profiles provide a wealth of information, at whatever point in the course they are drawn. On the pretest in the foregoing example, all objectives except number 2 show achievement at the chance level, or about 20% (five-option multiple-choice items). Several decisions could have been made after test administration one:

1) Objective 1 was not learned--reteach it in some other way; 2) Objective 2 has tested high on both the pretest and test administration 1--it would be safe to skip instruction in this objective. After test administration 5, two other decisions might have been made: 1) Achievement on Objective 3 seems to be slipping--review is needed, preferably soon; 2) Objective 8 seems closely related to Objective 5--perhaps it should be taught now instead of later.




..... Obj. 1: taught, but students did not learn; with rapid feedback, could be corrected with change in instruction.

——— Obj. 2: previously known and not taught; without pretest, this looks like student learning.

- - - - Obj. 3: taught and learned, but forgotten

— — Obj. 4: well taught

— . — Obj. 8: appears related to objective 5, because achievement increases when 5 is taught.

Figure 1. Hypothetical achievement profiles of group achievement on five objectives.

Continuous data available. Data are available from every test administration. It is possible to look at group achievement on a single objective, groups of objectives, or total content of a course, though this last is generally less useful. Data can be summarized in a variety of ways, through the use of selected computer programs now available. Desired data are always available within a few days for decision-making; it is not necessary to wait weeks or months for meaningful analyses. Many evaluation systems are not able to analyze and report results with sufficient speed and organization to make the information most useful to its recipients. Analyses can be tailor-made for project directors or state evaluators.

One economic advantage of periodic feedback is that a project need not continue to its end to discover, after all funds are spent, that the goals of the project have not been accomplished. Modifications can be made in the program if student performance does not move in the expected direction.

Description of Usual Classroom Testing

The usual classroom testing situation includes the following sequence of events: first, a set of objectives if specified for a limited instructional period, usually from one to four weeks; second, an instructional treatment is devised and administered to the students; and lastly, a test at the close of the instructional period is administered to measure the extent to which the objectives taught during that period have been achieved.

Students' achievement on material taught during instructional period one is tested at test administration one. Achievement for period two is tested at administration two, and so on, throughout the course.

There is usually a "final test" administered at the end of the course, for which there may be varying amounts of review offered. Sometimes major tests are administered at other times during the course e.g. just before report cards are issued.

Flexible weighting. There is great flexibility in the relative emphasis accorded various objectives during the year. Decisions may be made at any time; content may be added, dropped or modified. The testing is tailored to the content as the course progresses.

Individual student testing. Usual classroom testing can yield diagnostic data on individual student achievement on the few specific objectives which have been taught.

Tests related to objectives. Usual classroom testing may meet the criterion of close relationship between objectives and test items, when the school program is defined in behavioral objectives, and the teacher makes some effort to relate the items directly to the objectives.

No pretesting. There is usually no pretest information on students' prior achievement on any objective. Teachers usually assume that student achievement is due solely to the instruction given them in class. Furthermore, they do not know whether learning one objective has affected understanding of another objective. Students may also have experiences in other courses, or outside of school, either before or during a course, which contribute to their understanding of various objectives, whether or not they have been taught yet.

No test of retention. There is no information on students' retention of objectives which have been taught earlier in the school year, except in the event of some sort of major test. At that test administration, the interval between time of instruction, and time of test-of-retention, is different for every objective taught. The interval may span almost a full school year, or be only a week or two. There is seldom any data attached to such test results about the date of instruction on a given objective.

No comparison of student achievement over time. It is very difficult to compare students' achievement from one point in time to another, because at each test administration, an entirely different test is used; there is seldom any overlap in content, and the overall difficulty can vary enormously from one test to another. The only possible comparison of achievement from one time to another must use a student's rank order in his class. This still leaves no way to examine changes in a total class's achievement over time.

Description of Curriculum Project Evaluation

A frequently used strategy for evaluating curriculum projects is to administer an extensive achievement test at the conclusion of the project. This may consist of a test, or battery of tests, sometimes composed specifically for the project, but usually prepared and distributed commercially, e.g. standardized achievement tests.

There is sometimes a pretest administered before the start of the project, which is either the same as the posttest, or an alternate form of it, but presumes to measure the same objectives.

A single posttest or a pretest-posttest costs less than a more effective and complete evaluation system such as CAM. There is a minimum of clerical and administrative work needed in actually giving the test, and if a commercially available test is used, it may simply be purchased; no staff or time is needed to develop a test tailored to the objectives of the curriculum. What little analysis on results can be done, is relatively easily accomplished.

Deficient immediate post-instruction testing. In terms of immediate post-instruction achievement, the usual curriculum project evaluation measures only the objectives taught at the very end of the project in a way similar to usual classroom testing (i.e., immediately following the instructional treatment). This means

that project directors do not have information on the direct effect of instruction immediately after students have been exposed to it.

Tests of retention. The interval between the teaching of an objective, and the end-of-course test, varies for each objective. Such intervals range from a week or two, to a full school year. Therefore, an estimate of achievement based only on a posttest is an aggregate of immediate post-instruction achievement, short-term retention, and long-term retention. This composite score may be made up of several subscores, but such subscores still do not indicate much about the time interval since instruction.

No comparison of scores. There is no need to discuss comparability of scores from one time to another if the testing is done at only one point in time. Pretest-posttest problems are discussed below under sample attrition.

Test items not specific to objective. In posttests which are designed to cover an entire course at only one administration, there is great variation in the specificity with which test items have been matched to the objectives of the course. This problem is especially apparent when standardized achievement tests are used, where general subscores are roughly matched with the stated objectives of the project. When only standardized tests and materials are used in a post-project evaluation, there is a definite lack of systematic information about the achievement on specific objectives in the program.

Inappropriate weighting. In giving one large posttest, especially a standardized test, the problem of weighting of objectives presents itself. A variety of objectives could be poorly measured while other objectives are heavily emphasized. It is likely that the intended pattern of emphasis in the course will not be reflected in the evaluation instrument.

Test not comprehensive. Not only will there be too little emphasis on certain objectives, but it is possible that some objectives will not be measured at all.

Lack of comprehensiveness in an evaluation technique is a serious shortcoming.

Problems of sample attrition. All of the above weaknesses in the usual curriculum project evaluation design are relatively unimportant when compared with the most serious problem of all: the turnover of students. Those students who were pretested before the program, and received the early segments of instruction, are simply not there at the time of the posttest. Effectively, this reduces the hard data to a posttest on students still enrolled in the project during the final week, even if a pretest were administered. Therefore, the results may represent very little more than immediate post-instruction testing on the objectives taught just before the posttest. Pretest information, if it has been gathered, relates only to the incoming abilities of a sample of students roughly similar to that available for posttesting. The assumption is made that students coming into the project are similar to those leaving it, but the data cannot be used statistically in analyzing changes in student achievement, since change should only be measured for individual students or identical groups of students.

Comparison of the Pattern and Quality of Information of the Models

The amount and quality of information available from the three models of evaluation described above will serve to summarize the characteristics of each.

Comparison of information. CAM yields more information than either the usual classroom testing or conventional curriculum project evaluation. The pattern of data resulting from each model may be fitted into a matrix, in which the rows indicate all the objectives or instructional units of the course, and the columns represent the possible test administrations during the entire project. A cell of the matrix which is filled in, represents an estimate of achievement for that objective or unit, at that test administration.

The usual classroom testing pattern is illustrated in Table 1. The diagonal line of X's at the last administration indicates a final test, presumably covering

all the units of the course.

Table 2 illustrates graphically the lack of information available from the usual pretest--posttest curriculum project evaluation. This illustration makes the assumption, not necessarily well-founded, that a single test does in fact provide information about every instructional unit.

It is readily apparent in Table 3 that CAM makes available data on group achievement for all of the objectives specified for a course, at each time of testing. This comprehensiveness of the data provides the necessary information for the variety of purposes discussed earlier in this section. It is easy to see how CAM contrasts with the other models of testing, where information is generally available either on a few of the objectives, or as a composite score for all objectives, at a single time.

Comparison of quality. Table 4 displays seven types of information, and estimates their quality as provided by each of the three models.

Conventional curriculum project evaluation is fair to poor on all of the dimensions described. These shortcomings are inherent in the use of single test long enough to provide detailed information about student performance on a large number of objectives is fatiguing and therefore less valid than short tests. One long test excludes systematic pretest, immediate post-instruction, and detailed retention information. Attrition takes a heavy toll of a pretest sample. Feedback is limited to a post mortem on the project's strengths and weaknesses.

Usual classroom testing provides for the measurement of performance on specific objectives on an immediate post-instruction basis. By repeated testing, the effects of attrition may be minimized. If usual classroom testing data were collected across similar projects after similar objectives had been taught, extensive information would be available for comparing projects. However, an accurate comparison of projects must also include pretest and retention information. The former is used to adjust for incoming aptitude and achievement

TABLE 1

Usual Classroom Testing: Estimates of Achievements Available for a Group of Students by Unit and Test Administration

| | Time | | | | | |
|---|---|---|---|---|---|---|
| Unit | 1 | 2 | 3 | 4 | ... | T |
| 1 | X | | | | | X |
| 2 | | X | | | | X |
| 3 | | | X | | | X |
| 4 | | | | X | | X |
| . | | | | | | |
| . | | | | | X | X |
| . | | | | | | |
| U | | | | | | X |

TABLE 2

Pretest-Posttest Curriculum Project Evaluation: Estimates of Achievement Available for a Group of Students by Unit and Test Administration.

| | Time | | | | | |
|---|---|---|---|---|---|---|
| Unit | 1 | 2 | 3 | 4 | ... | T |
| 1 | X | | | | | X |
| 2 | X | | | | | X |
| 3 | X | | | | | X |
| 4 | X | | | | | X |
| . | X | | | | | X |
| . | | | | | | |
| . | | | | | | |
| U | X | | | | | X |

TABLE 3

Comprehensive Achievement Monitoring Evaluation
Estimates of Achievement Available for a Group
of Students by Unit and Test Administration

| | Time | | | | | |
|---|---|---|---|---|---|---|
| Unit | 1 | 2 | 3 | 4 | ... | T |
| 1 | C | C | C | C | C | C |
| 2 | C | C | C | C | C | C |
| 3 | C | C | C | C | C | C |
| 4 | C | C | C | C | C | C |
| . | | | | | | |
| . | C | C | C | C | C | C |
| . | | | | | | |
| U | C | C | C | C | C | C |

TABLE 4

Quality of Information
Available from Three Evaluation Models

| Information | Model | | |
|---|---|---|---|
| | Usual Classroom Testing | Usual Project Evaluation | Comprehensive Achievement Monitoring |
| Evaluation specific to objectives | *** | ** | *** |
| Pretest of objectives | * | * | *** |
| Immediate post-instruction testing | *** | ** | *** |
| Evaluation of retention of objectives | * | ** | *** |
| Comparability across time | * | * | *** |
| Achievement profiles | | | **** |
| Continuous feedback | ** | * | **** |
| Immunity to sample attrition | *** | * | **** |

NOTE: Quality of information rated as excellent (****), good (***), fair (**), poor (*), and not available (blank).

differences in students, and the latter for long-term retention, or payoff of the project. Neither of these is specifically available from classroom testing. Feedback occurs frequently during the project, but provides information about only one instructional unit at a time.

Comprehensive Achievement Monitoring provides information for evaluation comparable, or superior, to the other evaluation models. Its superiority lies in the areas of particular importance to project evaluation: systematic pretests and measures of retention of objectives. Feedback can be provided continuously and comprehensively so that the projects can be critiqued and adjustments made before their end.

Evaluative Issues

Comparability. Similarity of instruments and comprehensiveness of the data generated are necessary to obtain indices of effectiveness on a state-wide basis or within a school district. It would be difficult to observe change in academic achievement if the measures taken at one time, or in one school, were not directly comparable with measures taken at another time or in another school. Further, it is of crucial importance in evaluating educational programs that there be a systematic, on-going, objective accumulation of information about the achievement of all behavioral objectives. Both of these concerns are provided for within the structure of CAI.

Another issue in sharpening the evaluative process and improving the quality of instructional treatment and curriculum design, is that of clearly specifying behavioral objectives and performance criteria. It is inherent in the CAI design that courses be thoughtfully and systematically planned, without, however, destroying opportunities for creative and ad hoc improvisation.

Flexibility. Comparability does not necessitate a single standardized evaluative instrument as CAI has shown. Wide diversity in course structure must be accommodated. What comparability demands is that the objectives of different

programs for the same subject be carefully specified and tested. For it is impossible to compare course achievement levels from school to school, or even from class to class, if the evaluator is ignorant of the dimensions in which they differ. However, carefully specified courses can be compared on their common components by the CAI technique.

## The Design of the Project

### Scope of the Project

Purpose. The major goal of the project is the more comprehensive and accurate measurement of the quality of education as a basis for the improvement of education. Common weaknesses in school curricula such as unneeded redundancy, low student achievement, or poor retention, are difficult to identify. However, without an awareness of the weaknesses, it is impossible to make specific, concrete corrections. The notions of quality control in manufacturing, where a constant sampling of the products identifies irregularities and below standard units, closely parallel the concern underlying the project.

To create an effective monitoring of the quality of education the project must develop components for the evaluation. The major component is available, i.e., the methodology and design of an evaluation system. The project proposes to provide the staff needed for the evaluation by training state and school personnel, and to write the required behaviorally stated educational objectives as well as the items needed to measure student achievement.

The demonstration, dissemination, and continuation of Comprehsive Achievement Monitoring will be explicitly built into the design of the Project. The use of the monitoring by teachers in public schools under the supervision of State Department of Education personnel will serve as a demonstration of the technique which can be visited easily from any point in the State. The dissemination of the technique to other members of the school districts, to other districts in the State, and to other organization in the country will be carefully planned as a continuous ongoing component in the project. The continuation will be planned as a cyclic process to include more teachers and schools in each period of the cycle. The professional growth of the participants is a form of permanent benefit which will certainly continue.

Sample Population. The project will involve professionals of several levels. To ensure understanding and support for the technique State Education Department personnel, school administrators and teachers will be part of the project. Twenty schools in a state-wide distribution will be selected as representatives of categories like size, organization and wealth. Each school will participate at one or two grade levels in upper elementary or high school in mathematics. Approximately three hundred students from each school will be involved.

Operation. The operation of the project will include both sequential and overlapping activities. The sequential activities will include (a) the development of a bank of behavioral objectives and test items, (b) the preparation of training materials for the State and school personnel, (c) the offering of workshop experiences for each type of personnel, (d) the design of CAI tests, (e) the printing of tests and objectives, (f) the setting of data processing, and (g) the year-long collection, analysis and reporting of data. The overlapping activities would be superimposed over the sequential activities. They would be (a) the evaluation of the project by questionnaires and interviews and (b) the dissemination of the ideas. Each of the activities will be discussed in detail.

Dissemination. For the project to continue after its year of operation, an explicit, well-supported effort must be mobilized to disseminate information to several audiences. The audiences will be (a) the teachers in other grade levels and subjects within the same schools, (b) the personnel at neighboring schools, and (c) the staff of other state and national organizations. The dissemination process must be an active, rather than a passive process. Although traditional techniques such as journal articles and presentations at professional meetings will be used, more active forms of dissemination will be used like (a) creating a close network of information for participating schools, (b) intra-school workshops to promote the operation within the school, (c) invitations to neighboring schools for visitations, and (d) invitations to neighboring states to visit.

Plan of Operation

Each of the following sections will discuss in detail different phases of the project. The phases are separated into two stages, planning and demonstration of CAI in Massachusetts. Dissemination will be a component of both stages. The chronology of the phases is displayed in Table 5, Schedule Report Bar Graph and Figure 2, Flowchart for Improving Educational Quality through CAI.

Selection of sample populations. The populations in the project will include state level personnel, school districts, school administrators and teachers, academic courses and students. The major criterion for selection will be an expressed interest in participating in a CAI demonstration program. The openness to learn new ideas in evaluation and to work in an innovative program are of primary importance to the large scale demonstrations.

The state personnel will be selected because of their direct involvement with instruction or evaluation in the schools, e.g., Supervisors in Curriculum and Instruction, Testing, and Educational Research. Their responsibility to the demonstration will be to help in the supervision of the monitoring in one or two schools during the year and support the dissemination efforts. They will be asked to contribute to the development of materials and to enroll in a workshop on CAI.

School districts will be chosen as a representative sample of the districts in the state. The credibility of the demonstration will be increased, if the problems and successes can be clearly shown in an environment close to most of the schools in the state. They will be distributed throughout the state and possibly follow regional lines.

From the school districts wishing to participate a sample of about 20 will be selected. The school district will commit an administrator, e.g., department chairman, assistant principal, or principal, and two teachers to the demonstration. These personnel will enroll in a workshop during the summer on CAI and

Table 5

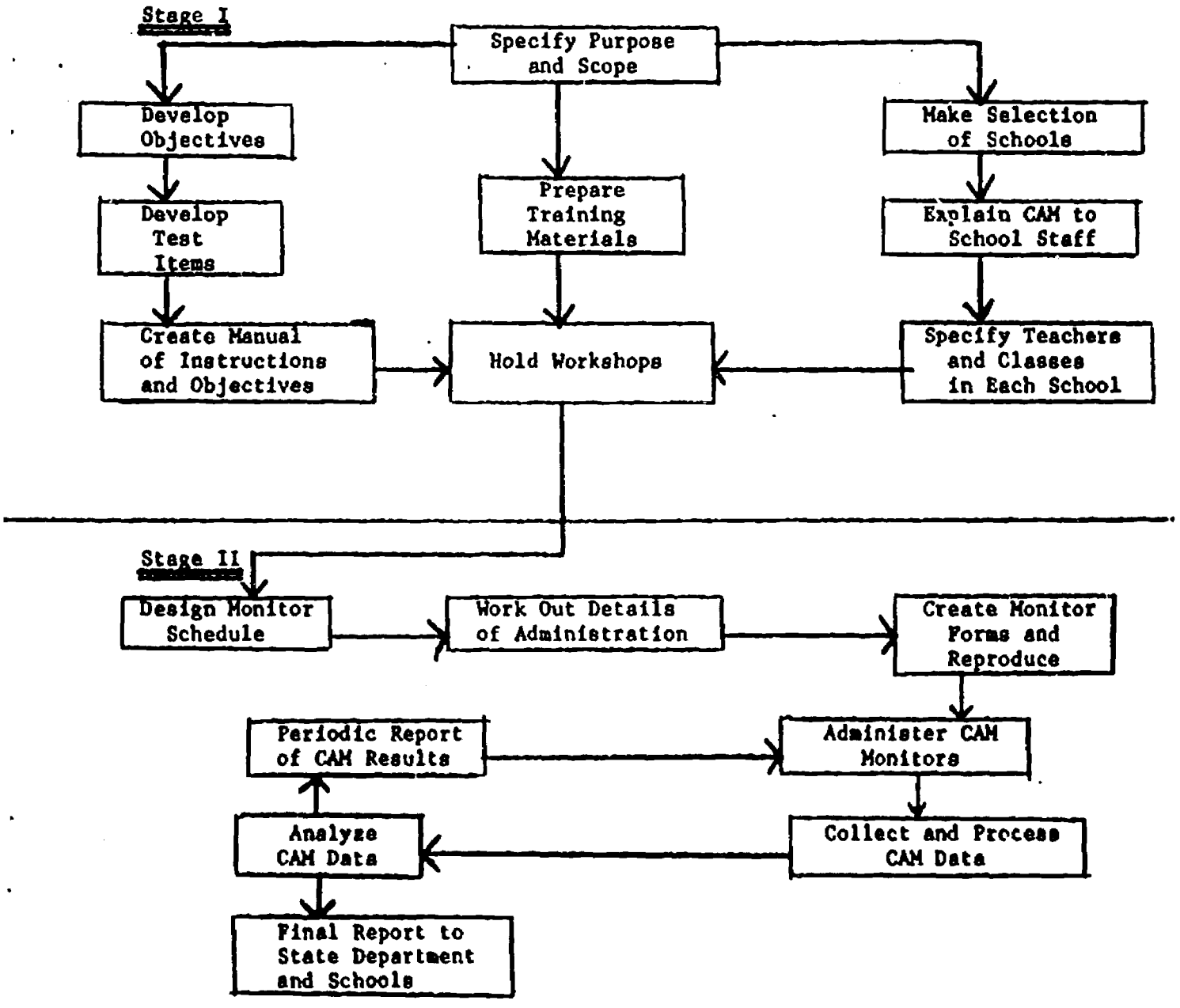
Schedule Report Bar Graph

(1 January 1970 to 30 June 1971)

| Work Item | Stage I | | | | | | Stage II | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JAN 1970 | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | JAN 1971 | FEB | MAR | APR | MAY | JUN |
| 1. Sample populations | ********** | ********** | | | | | | | | | | | | | | | | |
| 2. Objective and items | | | | | | | | | | | | | | | | | | |
| a. Initial preparation | ********** | ********** | | | | | | | | | | | | | | | | |
| b. Revision | | | | | | *** | | | | | | | | | | | | |
| 3. Training materials | | | | | | | | | | | | | | | | | | |
| a. Supervisor's workbook | ********** | ********** | | | | | | | | | | | | | | | | |
| b. Supervisor's manual | ********** | ********** | | | | | | | | | | | | | | | | |
| c. Teacher's workbook | | | ******** | | | | | | | | | | | | | | | |
| d. Teacher's manual | | | ******** | | | | | | | | | | | | | | | |
| e. Printing manuals | | | | | *** | | | | | | | | | | | | | |
| 4. Workshops | | | | | | | | | | | | | | | | | | |
| a. Supervisors | | | | | | *** | | | | | | | | | | | | |
| b. Teachers | | | | | | *** | | | | | | | | | | | | |
| c. In-service | | | | | | | | * | | * | | * | | * | | * | | |
| 5. CAM monitoring | | | | | | | | | | | | | | | | | | |
| a. Computer programming | ********** | ********** | | | | | | | | | | | | | | | | |
| b. Printing tests and objectives | | | | | | | | *** | | | | | | | | | | |
| c. Keypunching | | | | | | | ******** | | | | | | | | | | | |
| d. Periodic data processing | | | | | | | | | * | * | * | * | * | * | * | * | * | * |
| e. Final data processing | | | | | | | | | | | | | | | | | | * |
| 6. Summative evaluation | | | | | *** | ********** | ********** | ********** | ********** | ********** | ********** | ********** | ********** | ********** | ********** | ********** | ********** | ********** |
| 7. Dissemination | ********** | ********** | ********** | ********** | ********** | ********** | ********** | ********** | ********** | ********** | ********** | ********** | ********** | ********** | ********** | ********** | ********** | ********** |

Figure 2

Improving Educational Quality
Through Comprehensive Achievement Monitoring



use CAI during the year. Each school will monitor from 200 to 300 students in one or two courses.

The benefits to the schools will be directly felt in the training and practice of the staff which will prompt valuable professional growth in the areas of behavioral objective writing, test item writing, and CAI data collection, analysis, and interpretation. The materials, e.g., objectives, items, results and monitoring, developed in other grade levels and subjects will be available to all schools. The in-service promotion and work sessions both within the school district and across demonstration schools will serve as a major support of the ideas and means of causing their continued use.

The courses at various elementary and secondary grade levels in mathematics will be used in the demonstration. Other subjects on a trial basis may be considered. The mathematics curriculum was selected because solid foundation of past research has been performed in this area.

Preparation of objectives and items. A major component in the evaluation of instruction must be a clear definition of the curriculum and of the student's performance in each objective.

To maximize the number of courses, for which objectives and items are available, a three step strategy will be followed. First, all of the objectives which are available from courses previously monitored by Project CAI' will be collated along with the items used to measure them. They will form the nucleus of the objectives and items developed for the demonstration.

Second, the project will use consultants, who are specialists in each course, to write a preliminary set of objectives and items for courses not included in the objectives available and to fill in gaps in the existing materials. The materials produced in step one and two will be printed and made available to the participating teachers during their training workshop.

Thirdly, the teachers selected for the project will select, add, and revise objectives and items to tailor them to their specific course. The revisions and additions made by the teachers will be included in the final version which will be duplicated and made available to the participating schools. The schools will, therefore, obtain a comprehensive list of possible objectives and items which they will be able to use in the future to continue expanding their use of either CAM monitoring or performance curricula.

The Project CAM computer program to store the text of the objectives and items may be used to facilitate the selection of objectives and the production of the CAM monitors. It has facilitated the ease of working with testing materials needed for Cam monitoring of achievement. The computerized object and item bank would allow the dissemination and use of these materials, but have to be keypunched which require more resources then typing.

Preparation of training materials. Persons confident of their ability to use CAM monitoring would be the most potent stimulate to the spread and continued use of CAM monitoring in the state. Specific training and reference materials must be available to the personnel participating in the project. They will be prepared to meet the gaols of the project. A training manual or workbook for state level and administrative personnel will present excercises in all aspects of the CAM monitoring process, i.e., from defining curricula in terms of behavioral objectives and performance test items through computer data processing and data interpretation of results. Explanations in a step-wise fashion with extensive excercises can give the pre-service practices necessary to feel comfortable with the ideas of CAM. During the school year, these supervisory will be asked many different questions, technical, theoretical, mechanical, and must have a ready reference manual to help in answering them. The reference manual will also be prepared.

For the teaching staff both training and reference manuals are also important, but they must address themselves more specifically to the activities involving

teachers, students, and parents. Excercises in curriculum definition and the interaction of curriculum goals with instructional activities will be emphasized. Further, the interpretation of computer output for teachers in evaluating their curriculum and in counseling with individual students. Similar to the supervisors the teacher will have a reference manual which can be used to answer questions to them.

A question and answer bulletin will also be written for the students and possible for parents. These will provide concise answers to the most frequently asked questions. Audio-visual presentations may also be prepared.

Each of the manuals will go through a pilot test for readability, thoroughness, and usefulness with a sample of individuals from the appropriate populations because many training materials have only limited usefulness without adequate preliminary trials.

Training and in-service workshops. Workshops at the end of the school year and the beginning of the vacation will train the participants for CAI monitoring during the coming year. The workshops will be organized by the Project CAM staff. They have been divided into sections, first one for supervisors and then another for teachers. The reasons for this division are (1) the lower staff requirements for two workshops with one half the total number of participants to be trained, (2) the supervisors will receive more technical and theoretical training than the teachers, and (3) if the supervisors are trained first several can be used as trainers for the teachers workshop.

During the school year supervisors will run intra-school in-service workshops for the teachers as a means of discussing problems, presenting more information, and disseminating ideas to school staff members not yet using CAI monitoring. Also, the project's staff will organize five workshops for all individuals using CAI monitoring in the state. The state-wide workshop will be used to disseminate information about experiences at other grade levels.

CAM monitoring procedures. The details of the CAM monitoring procedure have been well worked out. Several modifications in the experimental design and computer analysis procedures will tailor the monitoring to the specific configuration of schools and of information desired. The discussion will highlight the procedures so that realistic estimates of manpower and financial requirements can be made.

The collection of data requires the specification of (a) the source of data, (b) the sample of objectives, items and students, (c) the structure of the CAM monitors and (d) the schedule of monitoring periods. The students' responses to the achievement items will be the major source of data. An effort to collect attitude data on a regular schedule will be made. In keeping with the model of evaluating instruction, a set of aptitude and demographic information about the students and teachers will be collected.

The quality and usefulness of the information generated by the CAM monitoring depends primarily on the careful sampling of objectives, items and students. About one hundred objectives chosen for similar courses at different schools may have an overlap in objectives. An overlap would allow a comparison of achievement by a similar set of students in different environments. The sequence and pacing of the objectives will provide a clear picture of the curriculum goals.

Items will be available to measure the student achievement of each of the objectives. Teachers, curriculum consultants, and Project CAM staff will prepare items which will be systematically and further edited and pretested in the field. The items and objectives may be stored on computer tape in the objective and item bank computer program written by the Project CAM staff. The program would allow especially quick and completely accurate distribution of them.

Each school will determine, in cooperation with the demonstration project staff, courses and classes within the course to be monitored. The assignment of students to each of the testing schedule groups is one of the procedures used to

increase the accuracy of the estimates of student achievement. The scheduling is based upon the background data available about the students and used to maximize the number of comparisons which are possible. The resulting assigned schedules must be keypunched for the computer.

The structure of the CAM monitors used in each course must be carefully designed. They must represent a set of randomly parallel tests which provide the type of information needed to accurately evaluate the curriculum and provide meaningful information to individual students. The Project CAM staff will be responsible for this phase of the project. They will also supervise the printing and distribution of the monitors to the schools. The structure of the monitors, their correct answers, and the classification of each question in at least four dimensions must be coded and keypunched for the computer and the Project CAM staff will supervise this phase.

The schedule of monitoring periods during the year depends upon the overall goals of the monitoring. Each school will be considered individually and a schedule which will meet the project goals will be developed. The data will be collected at each school and forwarded by messenger or mail to the University of Massachusetts for further processing. There will be an attempt at overnight turnaround.

The organization of the data will follow the procedures shown to be most successful in school oriented data processing. The students responses will be recorded on answer sheets to be optically scanned and a versatile computer program used to develop a data-bank from the CAM monitoring procedure. The computer program edits, collates and records on computer tape all of the data collected about students and their responses to test questions.

The analysis of the data concerns the frequency of the analysis and the type of analysis. The frequency of the analysis will depend upon the frequency of monitoring. A bi- or tri-weekly schedule seems most appropriate. In addition

to the periodic analysis, computer programs are available to plot graphic representations of the longitudinal data and produce an item analysis which checks the reliability of the items.

The types of analysis are not limited to those described above. A variety of other periodic reporting comparisons, and statistical analysis should be designed to meet the needs of the project.

The reporting of the analyses will be made to several audiences. The primary reports will be made to the students being monitored and their teachers. These impacts on the students' learning will be greatest by putting the analysis of the results directly into the hands of the participants. The school administrators and the demonstration project staff in the state education department and at the University of Massachusetts will receive summaries of results reported to schools.

The means of reporting must be efficient, rapid and comprehensive to complete the cycle of evaluation. The finest data will have no impact on the educational program of a school or district, if they are not readily available. The report of the analyses is printed by the computer in a form which can be easily read by teachers, students, and the demonstration project staff.

Summative evaluation of the demonstration project. Although CAM monitoring is a system of evaluation, its usefulness in the natural setting to school personnel and to students needs to be clearly documented. A systematic set of interview questionnaire items designed to elicit the opinions of students, teachers, and administrators will be used. Useful instruments are already available and are included in appendix C.

Dissemination. Teachers, administrator, and state department personnel will accept and use CAM monitoring only if information about CAM is thoroughly distributed. Specifically, the demonstration project must be systematically described and discussed throughout the state. The dissemination efforts must be

organized by at least one full-time project staff member with adequate resources. Dissemination will be directed towards several audiences and may call on outside consultants to develop the optimum strategy for certain audiences.

State level personnel will be one audience toward which the dissemination effort will be directed. Other audiences will include personnel at schools not participating in the project, personnel teaching grade levels and subjects not using CAM monitoring in the schools participating in the project, and the general educational community. Each of these audiences must be informed, so that they will support one another.

A wide variety of activities are planned for the dissemination. They will rely very heavily on personal visitation and participation in invitational, afternoon orientations to CAM in the demonstration schools. A newsletter to participant schools to report events which occur during the first year of CAM monitoring will help to cement the participants together. Articles written for professional journals will reach the larger educational community.

## Possible Effects of CAM

### Effects for the Student

A prima facie benefit is that a high percentage of students enjoy the monitors and look forward to taking them. This is no small gain when one considers the mixture of fear and loathing with which students often anticipate tests. A major task of the school is to create a positive attitude in the student with regard to education and the possibilities of growth in the contemporary American school. Reasons for the positive feeling of students for the monitor are perhaps linked to their non-threatening character. The data analyses which are reported to the student allow him to compete only with his past classmates. Profiles of personal achievement are reported to the student and not to his classmates. Intrinsic motivation is fostered. Secondly, the student becomes less obsessive about absolute scores and more concerend with his relative progress. He understands that he is not expected to "score high" in the earlier phases of a curriculum or even in the later phases; that making a right or a wrong answer is less important than the entire learning process which can give him a relative mastery over a period of time in a specific field.

Also, though the student may not be explicitly aware of it, the learning opportunities which he is afforded are generally more congruent with his achievement, his attitudes and his behavioral deficits. This is achieved through the on-going pretesting and increasingly delayed posttesting which are built into the CAM design.

### Effects for the Classroom Teacher

One of the major advantages of CAM is that it encourages the teacher to take a fresh look at an entire curriculum. In order to design a comprehensive monitoring program, it is necessary to know with clarity and precision what one's learning objectives are. Teaching if facilitated when curriculum is seen as a series of

learning tasks that need careful consideration and precise articulation.

From the data analysis which is reported to the teacher following each monitor, the teacher is enabled to make appropriate modifications in the pacing and the sequencing of learning tasks. When these tasks were less rigorously conceptualized and articulated, it is much more difficult to assess what class and individual achievement and therefore prescribe remediation. Self-corrective feedback suffered from the double fault of being defective and late. CAM obviates these difficulties because the objectives and items have been rigorously designed.

CAM fosters a high degree of professionalism in the area of curriculum design and teaching method. It gives classroom teachers a criterion against which to assess their growth in a non-competitive way. Class achievement profiles provide the teacher with a personal record of teaching performance for self criticism.

The workshops, in-service training sessions and professional meetings which will be held at appropriate intervals facilitates communication between classroom teachers who find that they have mutual concerns, and similar problems.

There is a saving in time to the classroom teacher once the monitors have been designed. Absent are such time-consuming tasks as making up tests, "correcting" and evaluating them.

Effects for the School

The school as a whole is furnished with data processing and analysis which is more detailed, in-depth, and unbiased then might be furnished otherwise. The basis for compararive study, for curriculum and methods evaluation and for inter-school communication and interaction is furnished. CAM also fosters staff differentiation and inter-departmental interaction. This is because the implementation of CAM requires the cooperation of school faculty and staff at various levels and professional competencies. Schools do not have to allocate entire days to the administration of school-wide standardized tests.

Effects for the State Department of Education

As with those who function at the local level, personnel in the State Department of the Commonwealth can benefit from professional growth through the process of developing testing materials, curriculum designing and participating in workshops. CAM, if administered on a state-wide level provides the state with a ready-make base for comparative studies of the quality of education and it's correlated with such variables as size of school, urban or rural character of the school, expenditures per pupil, and regional or local character of school.

CAM, further, may create a network, which facilitates the cross-fertilization of ideas in many areas beside that of CAM itself.

## BUDGET

The planning and demonstration stages have been divided into separate budgets. The planning stage will produce (a) manuals which can be distributed throughout the State for general instructional purposes, (b) objectives and items for a base from which teachers could prepare additional materials, and (c) workshops which would be valuable professional opportunities by themselves. The planning stage could be funded and operate independent of the demonstration stage although the converse would not be possible.

# Budget

## Summary

(1 January 1970 to 30 June 1971)

| Stage | Date From | Date To | Category | | Amount |
|---|---|---|---|---|---|
| I | 01/01/70 | 30/06/70 | 1. Selection | | $ 3,040.00 |
| | | | 2. Objectives and Items | | 11,686.80 |
| | | | 3. Training material | | 7,808.00 |
| | | | 4. Workshops | | 13,292.00 |
| | | | 5. Programming | | 5,085.00 |
| | | | 6. Summative Evaluation | | 700.00 |
| | | | 7. Dissemination | | 2,666.00 |
| | | | 8. Indirect Costs | | 1,520.00 |
| | | | 9. Local Contribution | $18,500.00 | |
| | | | SUBTOTAL | | $45,797.80 |
| II | 01/07/70 | 30/12/71 | 1. Administration | | $ 8,776.00 |
| | | | 2. Workshops | | 12,450.00 |
| | | | 3. CAM Monitoring | | 54,180.00 |
| | | | 4. Summative Evaluation | | 8,280.00 |
| | | | 5. Dissemination | | 13,474.00 |
| | | | 6. Indirect Costs | | 1,056.00 |
| | | | 7. Local Contribution | $ 6,600.00 | |
| | | | SUBTOTAL | | $98,216.00 |
| TOTAL PROJECT | | | | | $144,013.80 |

Budget
Stage I
(January 1970-30 June 1970)

| Item | Terms | Amount |
|---|---|---|
| 1. Selecting Sample Population | | |
| A. Salaries | | |
| Director | 1/4 X $1000./mo. X 4 mo. = $1000 | Local |
| Associate Director | 1/2 X $600./mo. X 4 mo. | $1200. |
| Secretary to Assoc. Director | 1/2 X $500./mo. X 4 mo. | 1000. |
| B. Travel | | |
| In-state for dir. and Assoc. dir. | ($.08/mi. X 150 mi./trip+$2.25food/trip)X 2tp/wk. X 16 wk. ($14.25/trips) | 466. |
| C. Equipment and supplies | | |
| Typewriter rental | 1/2 X $22./mo. X 4 mo. | 44. |
| Dic./trans. rental | 1/2 X $25./mo. X 4 mo. | 50. |
| Supplies | | 100. |
| D. Other | | |
| Telephone | $45./mo. X 4 mo. | 180. |
| Office Space and furniture | (20 ft X 30 ft) X $.50/sq.ft./mo.X 4 mo. = $1200 | Local |
| | TOTAL | $3,040.00 |

Budget
Stage I
(continued)

| Item | Terms | Amount |
|---|---|---|
| 2. Writing Objectives and Items* | | |
| A. Salaries | | |
| Coordinator | 1/2 X $550./mo. X 4 mo. | $1100. |
| Writers (one for each of four grades) | 4 X $350./mo. X 4 mo. | 4600. |
| Secretary | $500./mo. X 4 mo. | 2000. |
| Clerical assistant | $1.50 hr. X 120 hrs. | 180. |
| B. Travel | | |
| Consultant | $100. for airfare | 100. |
| | $8.80 from airport | 8.80 |
| | $18.00 per diem for 5 days | 90. |
| C. Equipment | | |
| Typewriter rental | $22./mo. X 4 mo. | 88. |
| Dic./trans. rental | $25./mo. X 4 mo. | 100. |
| D. Other | | |
| Consultant for NLSMA | $100./day X 5 days | 500. |
| Research Assistant | $350./mo. X 4 mo. | 1400. |
| Pilot test duplication | $.04/copy X20 copies/pg. X 400 pages (i.e., 400 items) | 320. |
| Optical scanning | $.05/sheet X 1 sheet/test X 100 student/test | 400. |
| Computer time | $5./min. X 2 min./test X 80 tests | 800. |
| | TOTAL | $11,686.80 |

*(CAI will provide 2000 items and 2000 items will be written; all will be pretested; Local contribution = $6000.)

Budget
Stage I
(continued)

| Item | Terms | Amount |
|---|---|---|
| 3. Preparing training materials - four documents | | |
| A. Salaries | | |
| Associate Director | 1/4 X $600./mo. X 4 mo. | $ 600. |
| Writer | $600./mo. X 4 mo. | 2400. |
| Secretary for writer | $500./mo. X 4 mo. | 2000. |
| B. Travel | | |
| None | | |
| C. Equipment | | |
| Typewriter rental | $22./mo. X 4 mo. | 88. |
| Dic./trans. rental | $25./mo. X 4 mo. | 100. |
| Supplies | $50./mo. X 4 mo. | 200. |
| D. Other | | |
| Research Assistant | $350./mo. X 4 mo. | 1400. |
| Xerox | $30./mo. X 4 mo. | 120. |
| Printing | $2./copy X 100 copy/doc. X 4 doc. | 800. |
| Graphic artist | $50./day X 2 days | 100. |
| | TOTAL | $7,808.00 |

Budget
Stage I
(continued)

| Item | Terms | Amount |
|---|---|---|
| 4. Workshops (two) | | |
| A. Salaries | | |
| Director | 1/4 X $1000./mo. X 2 mo. = $500. | Local |
| Assoc. Director | $600./mo. X 2 mo. | $1200. |
| Secretary to Assoc. Director | $500./mo. X 2 mo. | 1000. |
| B. Travel | | |
| Teachers | $.08/mi. X 150 mi./trip X 20 trips | 48. |
| C. Equipment and Supplies | | |
| Typewriter rental | $22./mo. X 2 mo. | 44. |
| Dic./trans. rental | $25./mo. X 2 mo. | 50. |
| Supplies | $100./mo. X 2 mo. | 200. |
| D. Other | | |
| Teachers stipends | $175./wk. X 2 wks./tchrs. X 40 tchr. | 6000. |
| Teachers room/board | $50./wk. X 2 wks./tchr. X 40 tchr. | 4000. |
| Constultant: statistics | $150./day X 5 days | 750. |
| | TOTAL | $13,292.00 |

Budget
Stage 1
(continued)

| Item | Terms | Amount |
|---|---|---|
| 5. CAI monitoring - computer programming | | |
| A. Travel | | |
| Programmer | California to Massachusetts | $ 325. |
| B. Other | | |
| Computer programmer | $100./day X 20 days | 2000. |
| Computer time | $300./hr. X 8 hours | 2400. |
| Computer programs | CAI contribution = $10,000 | Local |
| Computer programmer | $18./day X 20 days | 360. |
| | TOTAL | $5,085.00 |
| 6. Summative evaluation | | |
| A. Other | | |
| Research Assistant | $350./mo. X 2 mo. | $ 700. |
| | TOTAL | $ 700.00 |

Budget
Stage I
(continued)

| Item | Terms | Amount |
|---|---|---|
| 7. Dissemination | | |
| A. Associate Director | 1/4 X $600./mo. X 4 mo. | $ 600. |
| Secretary to assoc. dir. | 1/2 X $500./mo. X 4 mo. | 1000. |
| Clerical | $1.50/hr. X 80 hours | 120. |
| B. Travel | | |
| Associate Director | $.08/mi. X 150 mi/trip X trip/mo. X 4 mo. | 48. |
| C. Equipment and supplies | | |
| Typewriter rental | $22./mo. X 4 mo. | 88. |
| Dic./trans. rental | $25./mo. X 4 mo. | 100. |
| Supplies | | 50. |
| D. Other | | |
| Telephone | $20./mo. X 4 mo. | 80. |
| Postage | $20./mo. X 4 mo. | 80. |
| Printing newsletter | 500 copies X 10 pages/copy | 300. |
| Dissemination consultant | $100./day X 2 days | 200. |
| | TOTAL | $2,666.00 |
| 8. Indirect costs | 8% X $19,000.00, i.e., funds subject to indirect costs | $1,520.00 |
| 9. Local contribution | $18,500.00 | Local |
| | TOTAL STAGE I | $45,797.80 |

Budget
Stage II
(continued)

| Item | Terms | Amount |
|---|---|---|
| 1. Administration | | |
| A. Salaries | | |
| Director | 1/4 X $1000./mo. X 12 mo. | Local |
| Associate Director | 1/2 X $ 600./mo. X 12 mo. | $3600. |
| Secretary to Assoc. Dir. | 1/2 X $ 500./mo. X 12 mo. | 3000. |
| B. Travel | ($.08/mi X 150 mi./trip + $2.25/trip)X 4 trips/mo. X 12 mo. | 684. |
| C. Equipment and supplies | | |
| Typewriter rental | 1/2 X $22./mo. X 12 mo. | 142. |
| Dic./trans. rental | 1/2 X $25./mo. X 12 mo. | 150. |
| Supplies | $20./mo. X 12 mo. | 240. |
| D. Other | | |
| Telephone | $10./wk. X 4 wk./mo. X 12 mo. | 480. |
| Postage | $10./mo. X 12 mo. | 120. |
| Xerox | $30./mo. X 12 mo. | 360. |
| Office space | (20 ft. x 30 ft.) X $.50/sq.ft./mo. X 12 mo. = $3600 | Local |
| | TOTAL | $8,776.00 |
| 2. In-service Workshops | | |
| A. Travel | | |
| Teachers to workshops | $.08/mi. X 150 mi./trip X 20 trips/workshop X 5 weeks | $1200. |
| B. Supplies | | |
| Supplies | $100./workshop X 5 workshops | 500. |
| C. Other | | |
| Teacher's Stipends | $50./tch. X 40 tchr./workshop X 5 workshops | 10000. |
| Consultant | $150./consultant/workshop X 5 workshops | 750. |
| | TOTAL | $12,450.00 |

Budget
Stage II
(continued)

| Item | Terms | Amount |
|---|---|---|
| 3. C/E monitoring expenses | | |
| A. Travel | | |
| Supervisor trip to demonstration schools | $.08/mi. X 150 mi./trip X 10 trips/mo. X 10 mo. | $1200. |
| B. Other | | |
| Designing CAI tests | $100./grade X 8 grades | 800. |
| Printing tests and objectives | $.20/copy X 100 copies/test X 20 test/grade X 8 grades | 3200. |
| Keypunching | $4./hr. X 40 hr./wk. X 8 wk. | 1280. |
| Periodic Processing ($5.00/student) | $.50/test X 10 tests/student X 300 student/school X 20 schools | 30000. |
| Final Processing | $.50/student X 300 st./school X 20 each (achievement profiles and item analysis) | 3000. |
| Research Assistant | $350./mo. X 10 mo./asst. X 1 asst./5 schools X 20 schools | 14000. |
| Telephone | $10./wk. X 4 wks./mo. X 10 mo. | 400. |
| Postage | $30./mo. X 10 mo. | 300. |
| | TOTAL | $54,180.00 |
| 4. Summative evaluation | | |
| A. Travel | | |
| Research Assistant | $.08/mi. X 150 mi./trip X 2 tp./sch. X 20 schools | 480. |
| B. Other | | |
| Research Assistant | $350./mo. X 10 mo. | 3500. |
| Consultant | $150./day X 2 days | 300. |
| Supplies | | |
| Questionnaire | (writing, typing, pretesting, admin.) | |
| for students | 12,000 copies (pre and post) | 700. |
| for teachers | 60 copies (pre and post) | 300. |
| Optical scanning | $.05/sheet X 12,000 sheets | 600. |
| Computer time | $300./hr. X 8 hr. | 2400. |
| | TOTAL | $8,280.00 |

Budget
Stage II
(continued)

| Item | Terms | Amount |
|---|---|---|
| 5. Dissemination | | |
| A. Salaries | | |
| Associate Director | 1/2 X $600./mo. X 12 mo. | $3600. |
| Secretary to Assoc. Dir. | 1/2 C $500./mo. C 12 mo. | 3000. |
| B. Travel | | |
| Director | $100/trip X 2 trips to Washington, D.C.+ $60/trip X 2 trips to N.Y.C. | 320. |
| Associate Director | $100/trip C 1 trip to Washington, D.C.+ $60/trip X 1 trip to N.Y.C.+ $80/trip X 1 trip to LRDC in Pittsburgh+ ($.08/mi. X 150 mi./trip + $2.25/trip)X 2 trips/mo. X 12 mo. | 342. |
| C. Equipment and supplies | | |
| Typewriter rental | 1/2 X $22./mo. X 12 mo. | 142. |
| Dic./trans. rental | 1/2 X $25./mo. X 12 mo. | 150. |
| Supplies | $20./mo. X 12 mo. | 480. |
| D. Other | | |
| Telephone | $40./mo. X 12 mo. | 960. |
| Postage | $20./mo. X 12 mo. | 480. |
| Printing newsletter | $500./issue X 5 issue | 2500. |
| Dissemination consultant | $100./day X 5 days | 500. |
| Final Report | 500 copies of 100 pages | 1000. |
| | TOTAL | $13,474.00 |
| 6. Indirect costs | 8% X $13,200.00 i.e. funds subject to indirect costs | $1,056.00 |
| 7. Local contributions | $6600 | Local |
| | TOTAL STAGE II | $21,210.00 |

# Appendix A

## Technical Memoranda and Bibliography of the Project for Comprehensive Achievement Monitoring

## Technical Memoranda

| Number | Title | Author |
|---|---|---|
| AR-1 | First Annual Report | Gorth |
| TM-2 | Description of courses monitored by Project CAM | Gorth & Popejoy |
| TM-3 | Monitoring schedules developed for research by Project CAM. | Gorth, Stroud, & Knight |
| TM-4 | The relation of repeated, comprehensive pretesting and student's achievement | Gorth, Allen, Popejoy, & Stroud |
| TM-5 | A comparison of comprehensive versus unit pretesting and student's achievement | Gorth, Allen, Popejoy, Stroud |
| TM-6 | The evaluation of item performance in an item sampling case | Lindeman, Gorth, & Allen |
| TM-7 | Computer-Based, insturctional-testing data bank | Popejoy, Gorth, Grayson & Stroud |
| TM-8 | Separate analyses of regression | Stroud & Gorth |
| TM-9 | Educational innovations monitored by Project CAM | Gorth |
| TM-10 | Longitudinal comprehensive achievement monitoring in science education | Gorth & Allen |
| TM-11 | A computer program to evaluate item performance by internal and external criteria in a longitudinal | Gorth, Grayson & Lindeman |
| TM-12 | A computer program to tabulate performance profiles of longitudinal performance testing using item sampling | Gorth, Grayson, & Stroud |
| TM-13 | The project CAM data blak for 1967-1968 | Gorth |
| TM-14 | A computer program to compose and print tests for instructional testing using item sampling | Gorth |
| TM-15 | Investigating a linear model of learning in ninth grade algebra | Stroud & Gorth |
| TM-16 | Analysis of the Project CAM data for 1967-1968 | Gorth & Pinsky |
| TM-17 | Monitoring schedules developed for research; 1968-1969 | Pinsky & Gorth |
| TM-18 | Demographic, aptitude, & attitude surveys of the students, teachers, and schools in Project CAM | Gorth & Pinsky |
| AR-2 | Second Annual Report to the Charles F. Kettering Foundation | Allen & Gorth |

These reports and further information may be obtained by contacting the Project CAM staf or writing to William P. Gorth, Director, Project CAM, School of Education, University of Massachusetts, Massachusetts 01002.

## Technical Memoranda

| Number | Title | Author |
|---|---|---|
| TM-19 | Issues in comparing achievement patterns illustrated with data from a naval training program | Burke & Gorth |
| TM-20 | CAM described for state level evaluation of urban education projects | Gorth & Wightman |
| TM-21 | Descriptive analysis of MS420, eleventh grade algebra, first semester | Pinsky & Gorth |
| TM-22 | Descriptive analysis of MA442, one semester eleventh and twelfth grade trigonometry | Pinsky & Gorth |

## Professional Meetings

Gorth, W. (Organizer) Comprehensive Achievement Monitoring. Symposium presented at the meeting of the American Educational Research Association, Los Angeles, February, 1969.

Gorth, W. and Allen, D. A new design for evaluation in mathematics education. Paper to be presented at the meeting of the National Council of Teachers of Mathematics, Minneapolis, April, 1969.

Lindeman, R., and Gorth, W. and Allen D. Item analysis in an item sampling case. Paper presented at the annual meeting of the National Council of Measurement in Education, Los Angeles, February, 1969.

## Forthcoming

Gorth, W. (Organizer) Designing instructional systems with longitudinal testing using item sampling techniques. Symposium to be presented at the American Educational Research Association, Minneapolis, March, 1970.

These reports and further information may be obtained by contacting the Project CAM staff or writing to William P. Gorth, Director, Project CAM, School of Education, University of Massachusetts, Amherst, Massachusetts, 01002.

## Working Papers

| Number | Title | Author |
|---|---|---|
| WP-1 | The classroom teacher's manual for Comprehensive Achievement Monitoring | Gorth |
| WP-3 | Anxiety, achievement, and Project CAI | Gorth, Paulson, & Sieber |
| WP-4 | Data processing for achievement monitoring | Gorth & Pinsky |
| WP-5 | Seven premises in search of a conclusion OR the game | Yamashita |
| WP-6 | An instructional management system designed with Comprehensive Achievement Monitoring (AERA, 69) | Pinsky |
| WP-7 | Instructional objectives, achievement monitoring, and learning. what, how, why, and where of Comprehensive Achievement Monitoring (AERA, 69) | Gorth |
| WP-8 | A new design for evaluation in mathematics education. longitudinal Comprehensive Achievement Monitoring (NCTM, 69) | Gorth & Allen |

## Publications


Gorth & Grayson. A program to compose and print tests for instructional testing using item sampling. Educational and Psychological Measurement, 1969, 29, 173-174.

Gorth, Grayson, & Lindeman. A computer program to evaluate item performance by internal and external criteria in a longitudinal testing program using item sampling. Educational and Psychological Measurement, 1969, 29, 181-183.

Gorth, Grayson, & Stroud. A computer program to tabluate and plot achievement profiles of longitudinal achievement testing using iter sampling. Educational and Psychological Measurement, 1969, 29, 179-180.

Gorth, Allen, Popejoy, & Stroud. A comparison of comprehensive versus unit pretesting as related to student achievement. Psychology in the School, 1969, 6, 391-393.

Gorth, Grayson, Popejoy, & Stroud. A tape-based data bank for educational research or instructional testing using longitudinal item sampling. Educational and Psychological Measurement. 1969, 29, 175-177.

Wightman & Gorth. CAI: the new look in classroom testing. Trend, 1969, Spring, 56-57.


These reports and further information may be obtained by contacting the Project CAI staff or writing to William F. Gorth, Director, Project CAI, School of Education, University of Massachusetts, Amherst, Massachusetts, 01002.

Appendix B

Participating Schools With
Comprehensive Achievement Monitoring

| | |
|---|---|
| Hopkins High School<br>Ray Weidner, Director<br>Chuck Thiele<br>James Whitney | Hopkins, Minnesota |
| Andrew Jackson High School<br>Roy Carlson, Principal<br>Jean Stromquist, Chairman<br>Robert Christiansen<br>Richard Clark<br>David Larsell<br>James Norton<br>Donald Romine<br>Jeanne Steed | Portland, Oregon |
| Kailua High School<br>Hilton DeFiello, Principal<br>Clare Callan<br>June Yamashita | Kailua, Hawaii |
| John Marshall High School<br>Dr. Gaynor Petriquin, Principal<br>Max Lane<br>Ray O'Dell | Portland, Oregon |
| Lincoln-Sudbury High School<br>Alex Marshall | Lincoln, Massachusetts |
| Ballston SPA<br>Gerald Murphy | Ballston SPA, New York |
| Board of Cooperative Educational Service of Westchester County<br>Walter Goodman | Yorktown Heights, New York |
| Levittown Public Schools<br>Louis Pucci, Principle Investigator<br>Jack Robbins, Director | Levittown, New York |

Appendix C

Summative Evaluation

Student questionnaire

and

Teacher Interview

Project CAM

Questionnaire of Student Opinion

(last) PRINT NAME (first) COURSE SCHOOL

This sheet contains statements of opinion. This is NOT a test. We just want to know what you really think about CAM testing.

CIRCLE THE ONE LETTER BEST DESCRIBING YOUR OPINION.

Example:
I enjoy work as much as play. (If you slightly agree, you would circle C.)

| | Disagree | Slightly Disagree | Slightly Agree | Agree |
|---|---|---|---|---|
| | A | B | (C) | D |
| 1. There is usually enough time to answer all of the CAM test questions. | A | B | C | D |
| 2. There are too many CAM tests given in this course. | A | B | C | D |
| 3. A lot can be learned by just taking the CAM tests. | A | B | C | D |
| 4. The CAM tests don't help me to know what I should study next. | A | B | C | D |
| 5. It would help me to learn more if there were CAM tests in my other classes. | A | B | C | D |
| 6. We should not be asked to answer questions on things that have not been taught in class. | A | B | C | D |
| 7. The computer report of my CAM tests helps me figure out what material I haven't learned very well. | A | B | C | D |
| 8. There aren't many things in this subject that are interesting. | A | B | C | D |
| 9. The CAM tests are not fair measures of what I know. | A | B | C | D |
| 10. Tests like CAM tests should be used in most of my other courses. | A | B | C | D |
| 11. Most of the time I can't understand what the CAM test items really mean. | A | B | C | D |
| 12. The CAM tests help to point out material we will have to learn next. | A | B | C | D |
| 13. I like to take CAM tests. | A | B | C | D |
| 14. I get my CAM test results back too late to do any good. | A | B | C | D |
| 15. If we have to have tests, they should be like the CAM tests. | A | B | C | D |
| 16. Most of the other students in the course like to take CAM tests. | A | B | C | D |
| 17. It would be better to quit CAM testing and have only tests like we used to have. | A | B | C | D |
| 18. The CAM tests don't tell what I really have learned in this course. | A | B | C | D |
| 19. I could not tell from the CAM tests if I was improving in the course. | A | B | C | D |
| 20. The CAM tests are good because the teacher can find out what the class needs help on. | A | B | C | D |

Please answer these questions as honestly and as thoroughly as you can. Your answers will help to improve the CAM testing program.

(a) Write down several specific advantages that you can see in using CAM testing and reporting. Be specific. Particularly mention things which you like about CAM testing or which you feel may be better in CAM testing than regular testing.

(b) Write down several specific disadvantages that you can see in using CAM testing and reporting. Be specific. Particularly mention things which you dislike about CAM testing or which you feel may be better in CAM testing than regular testing.

(c) What do you do with the CAM computer reports of your CAM tests?

(d) What improvements would you like to see in CAM testing or reporting? Be specific.

(e) Do you feel your grades should be based on your CAM test results and why?

(f) How hard do you try when you take the CAM tests? Do you always try this hard?

## Post Course Interview of Teachers

1.00 Description of Structure, Content, and Enrollment of Course

2.00 Preparing Performance Objectives

2.10 How did you prepare objectives, e.g., write or select?

2.20 What is your general attitude toward defining the goals of a course in performance objectives and why?

2.40 When did you prepare the objectives for your course?

2.41 How much time did you spend the first time you prepared objectives for your complete course, e.g., total working days or weeks for all people involved in course?

2.42 If you rewrote the objectives, how much time did the rewrite take?

2.60 Are you able to modify the objectives during the course and then reteach them?

2.62 On what basis did you modify the objectives, i.e., where did you get information suggesting they should be changed?

2.80 Did you add or delete objectives for your course?

2.82 On what basis did you add or delete?

4.00 Preparing Questions for CAM

4.10 What is your general attitude toward preparing questions and how did you prepare them, e.g., write or select?

4.20 When did you prepare questions?

4.21 How much time did you spend preparing questions?

4.30 What kinds of difficulties did you encounter when you were preparing questions?

4.41 Before using CAM did you reuse questions from year to year?

4.42 Before using CAM did you reuse questions during the year, e.g., test-retest?

4.60 Do you modify questions from regular or CAM testing systematically?

4.62 On what basis do you modify questions?

6.00 Test Preparation

6.10 How did you prepare tests for CAM?

6.21 When did you prepare the usual tests for your course?

Post Course Interview of Teachers

6.22 When did you prepare CAM tests?

8.00 Student Scheduling

8.11 How was the CAM testing schedule prepared, i.e., for time and student assignment?

8.20 How much time did it take to schedule students?

10.00 Administration of CAM Tests

10.11 How did you administer CAM tests, i.e., what were the mechanics of getting the correct test to the correct student?

10.12 Compare the time and effort between CAM and regular test administration.

10.13 What is a good frequency?

10.21 What are the difficulties in CAM test administration?

10.22 What changes could be made to lessen these difficulties?

10.30 How would improved CAM test administration compare with regular classroom testing?

11.00 Scoring and Analysis of CAM Data

11.10 Who scored and analyzed the CAM tests?

11.20 What scoring or analyses did you perform?

12.00 Teacher's Perceptions of Student's Response to CAM

12.10 What is the students' general attitude toward CAM testing?

12.20 What do you think they like about CAM testing?

12.30 What do they dislike about CAM testing?

12.40 How consistent are their efforts while taking CAM tests, i.e., do they sometimes try and sometimes not?

12.51 What per cent do you think really try hard?

12.52 What per cent do you think do not try at all?

12.60 How would you suggest improving student efforts?

12.61 What effect would counting CAM testing in grades have on student interest.

12.70 How do the students use the feedback?

12.71 What per cent of the students use the feedback?

12.72 Do the students each have their own copy of the objectives?

12.80 How would you suggest improving student feedback?

Post Course Interview of Teachers

12.91 How much of a learning device is the CAM testing?

12.92 How much of a learning device is the CAM feedback?

14.00 Teacher's Perceptions of Congruence of Questions and Course

14.20 What aspects of student performance on the objectives are measured adequately by the questions?

14.30 What aspects of the student's performance on the objectives are not measured?

14.40 What objectives are not measured?

14.50 At what level of difficulty are the questions written, e.g., mastery level where everyone should be able to answer them by the end of the course?

16.00 Teacher's Attitudes Toward CAM

16.10 What are the good aspects of CAM monitoring?

16.20 What are the bad aspects of CAM monitoring?

16.30 How do you feel the monitoring should be improved?

16.40 How do you use the feedback and with what per cent of the students?

16.41 How would you use it?

16.42 Do you have enough time to use the feedback?

16.60 Do you use it for grading?

16.62 What per cent of the final grade in the course depends on the CAM testing results?

18.00 Dissemination About Project CAM

18.10 With whom have you discussed CAM and what were their reactions (get number of people, their occupations)?

18.20 To whom have you made presentations about Project CAM?