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ABSTRACT

This paper presents the designs underlying an IPI approach to ninth grade science implemented in the Jamesville-DeWitt schools in New York State. Briefly described are the generalizable instructional model, evaluation systems for assessing individual performance and the effectiveness of the instructional program and the support systems which make the program possible. (Author)

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A CMI MODEL FOR AN INDIVIDUALIZED LEARNING PROGRAM IN NINTH GRADE SCIENCE

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Abstract

This paper presents the designs underlying an IPI approach to ninth grade science implemented in the Jamesville-DeWitt schools in New York State. Briefly described are the generalizable instructional model, evaluation systems for assessing individual performance and the effectiveness of the instructional program and the support systems which make the program possible.

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A CMI MODEL FOR AN INDIVIDUALIZED LEARNING PROGRAM IN NINTH GRADE SCIENCE

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The project on which this report is based is supported by the New York State Education Department, under the aegis of Experimental Programs directed by Robert P. O'Reilly. The project is directed by Olcott Gardner, Director of Research, Jamesville-DeWitt Central Schools, DeWitt, New York. Principal consultants for the project are Robert P. O'Reilly and Howard Berkun, Division of Research, New York State Education Department, and Ronald K. Hambleton of the School of Education, University of Massachusetts.

The Jamesville-DeWitt (JD) project is part of a series of efforts designed to introduce into New York State Schools new generalizable systems for refining instructional programs and for managing and reporting individual student progress. The JD system is in part an effort to test the feasibility of managing the instructional process and the learning process of individuals via a small, third-generation computer installed in the school.

Rationale

Our first attempts to initiate new approaches to evaluation in the schools focused on implementing the Comprehensive Achievement Monitoring (CAM) model. Implementation of this model is based on the following components:

1. Defining course objectives in behavioral terms;
2. Preparing several test items to measure each instructional

objective, usually three to five;

3. Organizing test items into a series of parallel forms, in which the objectives are equally represented in each test form;

4. Administering all test forms on each test occasion. (Since CAM testing takes place periodically--usally at two or three week intervals--by design it is usually possible to have each student take each test form once during the course);

5. Analyzing and reporting of test results to students, teachers, and administrators. (The test scoring and analysis functions of CAM are computerized.)

The system provides an appropriate data base for decision types 2, 3, and 5 listed in Table 1 and 2. Essentially CAM is a formative evaluation technique designed to support the refinement of instructional programs, but is also useful for measuring student progress in a course (Gorth, Schriber and O'Reilly, 1970; Hambleton, 1971; Hambleton, Gorth and O'Reilly, 1971).

Experience indicates that teachers can usually be interested in implementing CAM as a course refinement technique, and with appropriate assistance, will perform the relatively arduous supporting tasks of preparing objectives and items, structuring their curricula, and other necessary activities. There are, however, numerous additional problems in implementation which prevent full systematic use of the technique. Among them are:

1. Vaguely defined instructional models or models used for instruction are only vaguely understood by teachers;

2. Turn-around time is frequently inadequate due to problems with data logistics;

Table 1

Student and Program Management Decision Classes by Relevant Performance Dimensions and Appropriate Evaluative Method

Sample Questions	Decision Class	Performance Indexes	Method of Evaluation
Are there school-to-school discreprencies in levels of school inputs known to affect achievement?	Type 1: Add resources; change priorities; reallocate relative distribution of resources.	Input measures on dimensions such as staff, facilities, equipment, services.	Survey relative status annually. Compare against standard.
Are some educational units achieving relatively better than others in relation to goals, independently of student and community inputs? Is this the effect of a school input and/or a special program?	Type 2: Adjust school inputs: modify, extend, maintain, terminate programs.	Scaled output measures on common dimensions (e.g., reading achievement, number graduations.)	Several samples of output in a given year; control on student and community inputs; variation in program method and media. Compare on common outputs and/or external criteria.
Are the terminal objectives (TO's) of the program being achieved?	Type 3: Redesign program areas don't teach; reteach; de-emphasize; emphasize more; reorder by sequence of TO's; reorder by relative emphasis; emphasize-deemphasize by student type.	Scaled output measures on indexes specific to each TO.	Quasi continuous sampling of each output dimension; student characteristic data. Several samples on each TO required at each sampling point. Compare TO output against program standard.

Table 1 (con't)

Is the structure of the program adequate in each TO area? (Are the enabling objectives (EO's) appropriately sequenced with appropriate media and materials?)	Type 4: Redesign internal structure of program: reorder sequencing of EO's; revise media; add branches ; retrain teachers; terminate procedure and select new approach.	Performance data relative to each EO and specified mastery levels.	Individual performance on EO's or sampling of EO performance. Compare EO outputs against program standard; determine contributions of EO's to TO's.
Are students achieving mastery of TO's? Is mastery being maintained?	Type 5: Allocate student learning effort: determine point of student departure; continue student on path; terminate and send back to previous part; enrich student path.	Output measures on each TO; rate of progress on achievement of TO's.	Pretest students on TO's; post test students on TO's. More than one sample required for pretest and post test; Sample individual student performance on TO's over time.
Why did student fail to achieve TO?	Type 6: Reallocate student learning effort: reassign to points within TO component; assign to new branch; review on selected EO's; assign to different program; diagnose point of student failure relative to EO's.	Additional output measures on each EO.	Analyze student performance on EO's and related prerequisites/supporting abilities. Retest student on EO's subsequent to reassignment.

Table 2

Type of Testing Required by Decision Class

Decision Class	Type Achievement Measure	Applicable Model Available
Type 1	Not Applicable	Status Survey NYSED 1970; Cohen 1970
Type 2	Criterion-Referenced, Norm-Referenced Testing minimally applicable	Extension of CAM to sampling of students and items
Type 3	Criterion - Referenced	Conventional CAM
Type 4	Criterion - Referenced	Mastery Testing, and CAM
Type 5	Criterion - Referenced	Mastery Testing, Curriculum embedded tests, and CAM
Type 6	Criterion - Referenced	Mastery Testing, CET, and Diagnostic on supporting EO's; related tests of general and specific abilities

*Mastery Test: Pre- and Post Testing, remedial Post-

*CET: Single items embedded in curriculum materials which provide a partial signal on daily progress

3. Cost of data processing and analysis in external facilities; and
4. Inadequate teacher training in the use of criterion-referenced evaluation systems; curriculum design, instructional design, etc.

Programs 2 and 3 above become even more constraining when the information needs of an individualized program of assessment are considered. For program refinement, testing is primarily on the terminal objective level and delays of one to two weeks in processing can be tolerated. Individual assessment, however, implies more or less continuous tracking of performance at the course objective level, and a system which will deliver data for decision-making on a day-to-day basis. This also represents a substantial increase in information processing over the requirements of CAM data. Typical batch-mode computer service in external facilities is ordinarily inappropriate for individual assessment and barely appropriate for the CAM analysis; the time-share mode has not been proved economically feasible for either form of analysis.

The problems noted with the CAM system and projected individual assessment programs seem to be adequately met in the JD system, which is based on a generalizable curriculum model and uses a small, in-house, high-speed computer. Prior experience with this processing mode indicated that costs are substantially below time-share and external batch modes. Turn-around time is dramatically improved, as the schools involved in-effect begin operating their own data processing centers. There is, however, much developmental work remaining for the JD system, particularly the test of the individualized evaluation system to be described.

The Instruction Model

The 9th grade science course through which the JD model is being implemented is organized into "modules" which consist of a series of instructional events arranged in an assumed hierarchy of behavioral objectives leading to mastery of a single concept or group of related concepts. Each module employs a variety of instructional modes encompassing the spectrum from large group lectures to independent reading assignments. The day to day instructional activities which, when taken together make-up a module, are organized into a hierarchy of smaller units called learning activity packages (LAPs).

A typical module begins with a pretest which is used as a basic diagnostic tool along with measurements of a student's social relationships, interests and overall acheivement to prescribe a sequence of LAP's for the student. Each LAP is designed around the smallest number of behavioral objectives possible and secondary diagnosis is built into each LAP to provide both self-testing by the student and criteria for a higher level of diagnosis by the teacher.

The flow of the process continuously returns to teacher diagnosis which places the teacher in a role of designer and manager of learning opportunities for students in independent learning situations, rather than as the provider and dispenser of what is to be learned. Within this framework the teacher has a significant amount of direct contact with each individual student, since he is responsible for diagnosing a student's learning problems and then guiding him to learning activities and materials which will meet his needs. The teacher also maintains some of his traditional functions in that he aids in small group discussions and takes charge of instruction in large group settings.

Program Refinement Using CAM

Subjects for the current year of developmental work are 350 ninth graders of both sexes. All subjects are participating in a CAM testing program and the individual testing program, the latter of which is in its early developmental stages.

The CAM application focuses on 80 objectives, identified as the terminal behaviors in 13 instructional modules. For each objective, four alternative multiple choice items were constructed. Using stratified random sampling, the items were used to construct eight parallel test forms. The total pool of 320 items divided into the eight test forms is scheduled for administration at eight equally spaced intervals during the course of the year; each test form is assigned on a random basis to each student, with no duplication of administration of forms.

Data for each CAM testing are now being punched on cards and processed via the CAM computer program and CDC 3600 at the University of Massachusetts. Results of the analysis are returned in about 10 days of the testing. The results for individuals include right-wrong scores identified by objective and total score. Individual results are updated at each analysis. The data for individuals are further summarized as group data in the form of raw scores and difficulty levels. Samples of computer output made available to students and teachers after each test occasion are provided by Hambleton, Gorth and O'Reilly (1971). The individual and group data from this CAM application are specifically appropriate for two of the decision classes identified in Table 2: (1) Type 3, program refinement; and (2) Type 5, determining student progress on terminal course objectives.

To improve turn-around time for the CAM analysis, and to provide the rapid turn-around time required for the individualized testing system, a Digital Equipment Corporation PDP-12B computer, with a BA-12 peripheral expander, card reader, teletype, keypunch and mark-sense input capabilities has been installed in the school. The PDP-12B has the capability of scoring 200, 20-item tests per minute and recording all student responses and summary data on magnetic tape for retrieval. This machine configuration is now being programmed for the individualized testing system. A mark-sense card procedure has been designed for use in the machine and has received an initial test. In a similar experimental program, the CAM pupil and course profile analysis capability has been translated into programs which have been running in the PDP-12. These programs are now being modified for use in the JD system and will shortly replace analysis via the CDC 3600 facility. Primary output from the CAM analysis in the PDP-12 will consist of raw scores identified by objective for each student and raw scores and difficulty levels by objective across individuals. Profiles will be obtained by cutting and pasting the results of individual monitors.

The Individualized Testing Model

In progress is the development of a decision-making model which will provide the guidelines for individual assessment. Within each instructional module, there exist five major decision-making points. To provide information for decision-making at 4 of these points the following tests are administered: module pretest, module post test, lap pretest, and lap post test. At the fifth point, a combination of information including a student autosurvey, direct observation by teachers, and curriculum embedded tests are used. (It is also important to note that this information which is collected for student assessment is also used for formative evaluation.)

Briefly let us consider each decision point separately. As each student begins to work on a module, a pretest is administered. Since items in the pre-test are closely tied to the general objectives of the LAPs, on the basis of the student's successful performance on some of the items it is possible to omit the corresponding LAPs from the student's prescription for the module. Such a procedure will insure that students will be working only on learning experiences directed toward goals which have not been mastered previously. The module post test which is either the same test or a parallel form of the module pretest can be used for prescribing remedial work for a student, for grading, and for evaluating the effectiveness of instruction in the LAPs.

As with the module pretests, LAP pretests are used to prescribe a set of objectives within the LAP that the student must demonstrate competency in before moving on to the next LAP in his prescription. LAP post tests are used to determine the extent to which students have satisfactorily completed the objectives of the LAP.

As the student proceeds through a LAP he is tested continuously on the subject matter. When the student does not perform up to expectations, remedial work is prescribed. Since there is a wide variety of learning disabilities, a great deal of attention is being directed toward diagnostic methods and the development of remedial programs.

At the present time, the computer is being used to record student progress on a daily basis as well as to score tests. Daily computer reports to the teachers will be extremely useful for diagnostic purposes, since they will enable the teacher to know the position of each individual in the LAP, achievement progress by each student in the LAP, as well as individual achievement in the module. Eventually the computer will also be used to prescribe programs of study for the students.

At our present stage of development there are still many important questions to answer. For example, since the LAPs within a module, as well as the objectives within a LAP can be arranged in hierarchies, is it possible to develop tailored testing procedures for the module and LAP pretests? If applicable, tailored testing would undoubtedly prove to be more efficient than the present testing arrangement. How much information about a student is needed to optimally prescribe a program for him? Could we incorporate testing procedures which would reduce the effect of guessing on test scores?

Expected Benefits

There are a number of cost-effective components in the Jamesville-DeWitt

IPI program. The first of these is found in the computer system which generates, on a timely basis, data on programs and individuals for administrators, teachers and students at a cost considerably below comparable data provided by facilities external to the school. Secondly, the higher student to teacher ratio in the IPI science program produces additional savings relative to conventional classroom instruction. Instructional costs are further reduced by the introduction of the computer which performs many of the functions that are typically handled by teacher's aides in other IPI programs. Finally, the programmed format of the instructional materials produces greater efficiency in terms of average time required for a student to complete course requirements.

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