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The Mesa Arizona Pupil Tracking System

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A computer-based Pupil Tracking/Teacher Monitoring System was designed for Mesa Public Schools, Mesa, Arizona. The established objectives of the system were to:

(1) Facilitate the economical collection and storage of student performance data necessary to objectively evaluate the relative effectiveness of teachers, instructional methods, materials, and applied concepts.

(2) Identify, on a daily basis, those students requiring special attention in specific subject areas.

The system encompasses computer hardware/software and integrated curricula progression/administration devices. It provides daily evaluation and monitoring of performance as students progress at class or individualized rates. In the process, it notifies the student and collects information necessary to validate or invalidate subject presentation devices, methods, materials, and measurement devices in terms of direct benefit to the students. The system utilizes a small-scale computer (e.g., IBM 1130) to assure low-cost replicability, and may be used for many subjects of instruction.

Introduction

Many educators have long desired to thoroughly evaluate the relative effectiveness of teachers, instructional methods, materials, and applied concepts in terms of their direct benefit to the individual student. The major obstacle to such evaluation has been the manpower and effort necessary to continuously collect and process student achievement data. In fact, only with a certain degree of difficulty are many schools able to collect data sufficient to grossly recognize "problem" learning situations and generally identify student progress.

The staff of Mesa Schools wished not to just re-evaluate the traditional education process, but to establish a dynamic "closed-loop" system that would provide data and facts sufficient to pinpoint deficiencies in any resources of a total educational system. Resources here include teachers, presentation methods, instructional techniques, course curricula, applied

concepts, and measurement devices. The focal point of the "closed-loop" system is the individual student and his rate of progress in attaining discrete knowledge/performance objectives.

In support of the concept, the Mesa educators developed and "field tested" curricula software including definition of learning objectives, logical progression, presentation methods/devices, and measurement instruments. Their reasoning was that the curricula software, in concert with a high-speed computer plus properly designed storage files, computer programs, and supporting procedures, would in fact constitute an initial closed-loop system. The Jet Propulsion Laboratory was contacted to assess the feasibility and cost considerations of the desired computer system.

Following determination that the system was indeed possible and also practical within existing Mesa resource constraints, detailed systems analysis and design were initiated. During a period of four months, the design was refined as the result of extensive contact with Mesa personnel at all levels and reflected in a final design/specification document. The document became the basis for selection of computer hardware and software via a competitive bid process, and refinement/elaboration of the curricula software by the Mesa staff.

A small scale (IBM 1130) computer was selected, and Fremont Junior High School was chosen as the most representative test site. The 800 math students of that school were divided into three equal groups to determine the validity of the devised Pupil Tracking System during most of the 1972 Spring term. One was a control group, instructed within the "traditional" class framework; another was monitored by the computer-based system; the third was monitored by manual devices similar to those of the computer-based systems. The results of that four-month trial were interpreted by Mesa as sufficiently successful to warrant expansion of the Pupil Tracking System to all math students of the school, plus those in select reading classes. The basic reasons for this decision were that the system in fact:

(1) Allowed students to progress at their best rate while consistently identifying learning problems as they occurred.

(2) Collected sufficient information to permit analysis, and facilitate evaluation, of education resources in the context of benefit to the student.

System Components

The components of the Pupil Tracking System are described below (Fig. 1).

(1) A definition of the discrete learning objectives to be attained by students, their sequential relationship, and normative time intervals for each. This information was defined by Mesa educators and retained within the computer files.

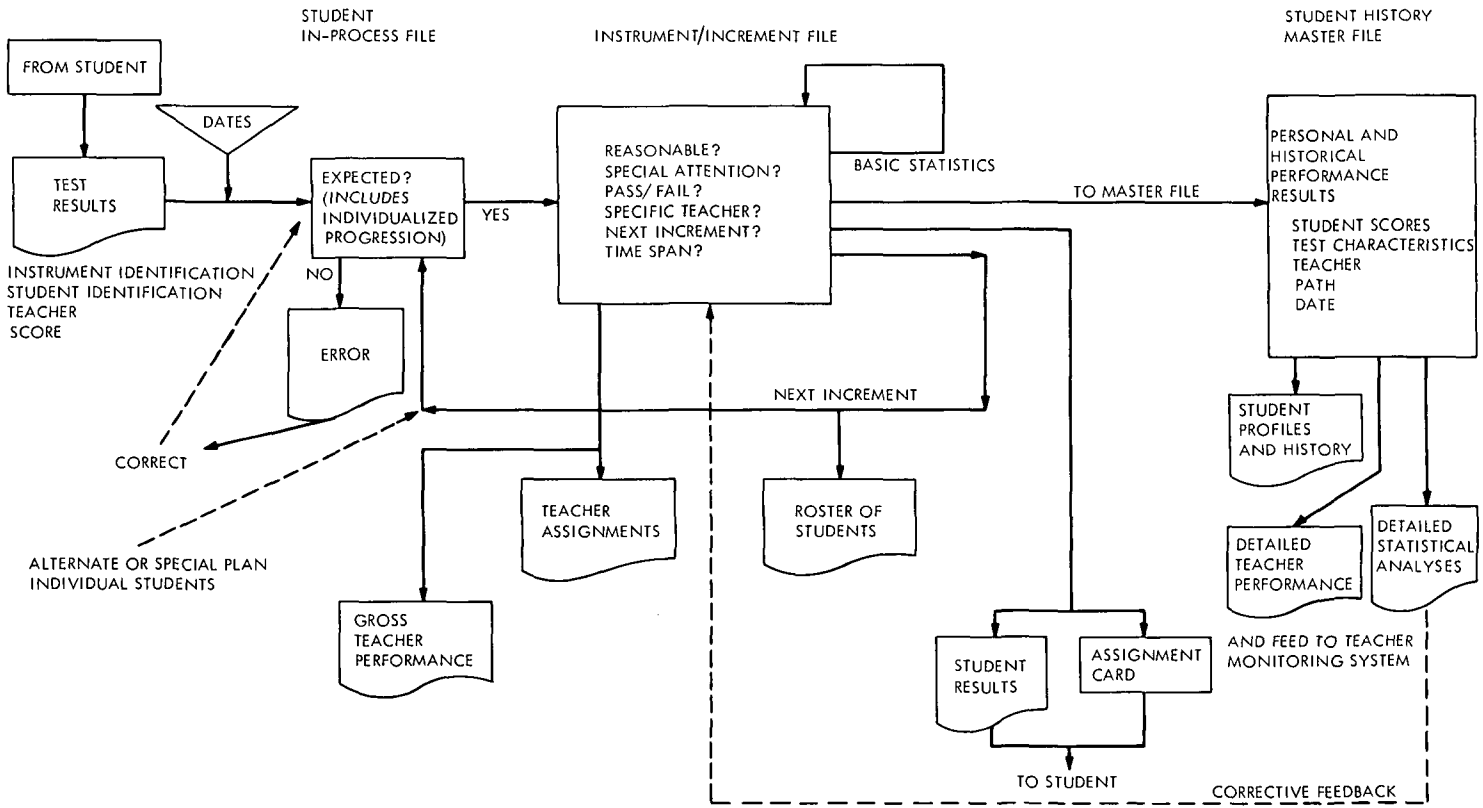

Fig. 1. Arizona Mesa Pupil Tracking System, Information and Logic Schematic

(2) Instruments (tests) that reliably and validly determine whether each learning objective is achieved. Such instruments were devised by the Mesa educators, and keyed to the appropriate objective(s). To permit computer scoring, analysis, and score retention, the correct test responses were recorded as masks within the computer file.

(3) The definition of texts, presentations, and reference media that efficiently assist students in attaining the learning objectives. As established by the Mesa staff, this definition is retained in the computer files and utilized to offer students a choice of learning activities.

(4) Computer files that store the directive, historical, and current status information. Items 1 to 3 above are classified as "directive" because they define objective interrelations, paths of progression, and criteria against which progress may be measured. Historical performance results are retained to permit detailed analysis by instrument, objective, student, or several other perspectives. Current status information is stored within the computer by student name index and "cycled" to detect nonperformance. The three basic computer files are the Student In-Process File (Current Status), the Instrument/Increment File (Directive and Analytical), and the Student History Master File (Historical).

(5) Media by which the Mesa staff and students can successfully communicate with the computer system and vise versa. Special punched cards are used by students to directly enter their answers to objective mastery tests, while concise reports are generated to indicate performance, status, and analyses.

(6) A computer, in this case an IBM 1130 with card reader/punch, printer, one disk drive, and 8192 words of storage capacity.

(7) Computer programs that update the necessary files in accordance with the directive file entries and provide the appropriate reports. All Pupil Tracking System programs are written in the 1130 RPG language, and may be executed (with minor modifications) on larger IBM computers.

(8) Operational procedures that assure consistency and safeguard the contents of valuable files.

System Operation

To initiate the tracking system, students are "enrolled" through entry in the Student In-Process and Student History Master Files, and all initial study increments are defined in the Instrument/Increment File. Special or individual progression paths may also be defined within the Student In-Process File.

The system produces an increment in-process student roster on a daily basis for grouping of instruction and to alert the teacher of potential

problems. The roster lists the students by the increment "in process", indicating the number of days they have been in the increment, the number of times they have attempted the performance test, their final score result, and days on the previous increment plus the next group of increments in which the student will be enrolled. Optionally, the student roster lists only those students who require individual attention because they have exceeded the standard time or number of attempts allowed.

In addition to producing reports describing the increments by title, various limits, objectives, learning activities, and test answers, the system collects and lists the frequency of failing by the number of attempts, the frequency of passing or acceleration, the number of days, and the frequency of participation in each activity by result (fail, pass, or accelerate).

Inquiries into a student's progress or master records are also possible. The Progress inquiry provides the student's current status as well as a complete description of his individual progression path. Inquiries into the Student History Master File can provide a simple plot of up to 15 selected scores or a list of selected semiquantitive, narrative, and/or measurement elements based upon types of data and date limits specified. These items are intended for the student or parent conferences.

A list of students who participated in a given increment within the date, score, and/or time intervals specified can be produced from the Student History Master File for grouping purposes. The information listed includes each student's passing score, number of attempts, total time, time above or below standard, and learning activities utilized. A comparison of the scores of any top increments for all students who participated in the increments can also be produced.

Normal Processing Cycle

During daily operations, the student determines if he is prepared to answer questions determining his mastery of the study objective, or if he needs to perform an additional learning activity. If the student decides to perform a learning activity, he chooses the activity from a list provided by the system upon completion of his last increment. When prepared to test his mastery, the student refers to a set of questions designated by a prepunched "assignment card", which was generated by the system upon completion of his last study increment. He circles the appropriate answers on the assignment card and punches those answers into the card with a "porta punch". This operation requires only a few seconds, and affords computer entry via a completely machine-readable document; student and increment identities are entered in the assignment card when it is created by the system.

Upon receiving the card, in either an individual or batch mode of operation, the system verifies the student/increment data by accessing the Student In-Process and Instrument/Increment Files. If no error is found, the test is scored and a result (fail, teacher decision, pass, accelerate) is

determined. The result (and optionally the score) is accepted and recorded by the system, while a report of the student's test result plus his next assignment card are prepared for him.

The new assignment card and printed report are provided to the student, who reads the assignment and its objectives and chooses a learning activity from those listed. After choosing an activity, he notes its number by circling the proper positions on his assignment card. Upon completing the activity, the student again determines if he is prepared to take the test or needs to participate in another activity.

The test scores and assignments are used to update the frequency statistics maintained in the Instrument/Increment File, and to create measurement records for the Student History Master File.

Results

Based upon one semester of experience with the system, the Mesa School District Administrators and the Fremont Staff concluded that it warranted expansion in the following semester to all math students at Fremont, plus select reading groups. The system is under consideration for expansion to other Mesa schools for both its intended function (daily monitoring) plus long-term monitoring required for a district-wide federally funded program of career education.