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ABSTRACT

The Jefferson County Public School System in Colorado is conducting a study which implements a digital time-shared computer as support for a systems approach to instruction. This study currently involves one elementary school but it will support a total of thirteen schools in the future. The computer support includes computer-generated criterion test forms. The items for the test forms are randomly selected from a test-item bank. Additional computer support includes the use of a remote document reader for test scoring and updating student academic records. The records are updated using test results and teacher certification of mastery. Data from academic records is being studied to determine its usefulness for formation of instructional groups in a multi-unit elementary school. The design of feedback reports to teachers is being studied to optimize the report's usefulness in instructional processes. The effects on teachers' roles caused by the computer support of an existing instructional system are being observed. (Author)

COMPUTER SUPPORT FOR A SYSTEMS APPROACH TO INSTRUCTION; PROBLEM STATEMENT AND DATA ENTRY TECHNIQUES

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The Jefferson County Public Schools is conducting a study which implements a digital time-shared computer as support for a systems approach to instruction. This study presently involves one elementary school but it will support a total of 13 schools in the future. The computer support includes computer generated criterion test forms. The items for the test forms are randomly selected from a test-item bank. Additional computer support includes the use of a remote document reader for test scoring and updating student academic records. The records are updated using test results and teacher certification of mastery. Data from academic records is being studied to determine its usefulness for formation of instructional groups in a multi-unit elementary school. The design of feedback reports to teachers is being studied in order to optimize the report's usefulness in instructional processes. The effects on teacher's roles caused by the computer support of an existing instructional system are being observed.

COMPUTER SUPPORT FOR A SYSTEMS APPROACH TO INSTRUCTION

PROBLEM STATEMENT AND DATA ENTRY TECHNIQUES

by Eugene A. Collins and Dean C. Larsen

Many programs for individualizing education have been developed during the last ten years. An outcome of these experiences has been the identification of a problem which is common to all attempts to individualize. The problem is one of data management. At any given time students in a particular group may be at many different places in the curriculum, each student in the group having different learning needs. Information about the learning needs of each individual is usually available. However, techniques have not been developed for effectively managing this information for optimizing the instruction for each student.

This paper is a description of a National Science Foundation[1] project located in The Jefferson County Public Schools, Jefferson County, Colorado. The project is designed to develop computer support for an existing instructional management information system in schools attempting to individualize instruction. The primary purpose of the project is to develop the data management techniques required to group students with similar learning needs.

The Jefferson County Public School district has defined curriculum in language arts, mathematics, and reading by stating explicit student performance objectives. Procedures for monitoring student progress against these objectives have been identified. The programs have been implemented through grade 8. In mathematics, criterion test items have been developed parallel to the objectives. Levels of mastery have been established. Dependency hierarchies between objectives have been identified, and multiple learning activities have been designed which relate to these objectives.

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Teachers are keeping records on individual student performance against the objectives. However, these records on individual student performance are not generally used as a basis for selecting appropriate learning activities. Furthermore, in most schools, the formation of student groups for instruction is not accomplished through use of past performance records. That is to say that student records are not widely used as input into the formation of groups of students for instruction or into the design of instructional strategies. As a result, effective grouping of students for experience with appropriate learning activities does not always occur. Students may be provided instruction in skills which they have previously mastered or for which they do not have the necessary prerequisite behaviors.

While systematic diagnosis of student's individual needs may occur, this diagnostic information is not always available in a useable form when students are grouped for instruction. This is due primarily to the fact that instructional decision makers have too much data. They do not have the procedures nor the time necessary to process it.

The project described here is developing a solution to this problem. Funded by The National Science Foundation Office of Experimental Projects and Programs, Experimental Programs Group, the project is titled The Computer Support for a Systems Approach to Instruction. A computer system which will allow instructional decision makers to process records on student performance is presently being developed. The outcome of the application of this system will be the formation of student groups for instruction.

The system is being developed on a Hewlett-Packard 2000 series time-shared computer. Communication and remote data entry are handled over telephone lines with a General Electric Terminet 300 terminal and a Bell and Howell Mark Document Reader.

Development is taking place at Normandy Elementary School. After refinement and field testing the system will be installed in a total of eleven schools in the Bear Creek/Columbine Area of Jefferson County. These schools will be added in two waves over a period of four years after the system implementation is completed in the development school.

The system is being developed in a manner which will provide for the maintenance of performance information on children in any discipline. Currently, mathematics performance records of students in the development school are being managed on the computer. Four years of performance history are being maintained on each individual. In order to insure that these performance records are current, two system components for updating them have been developed. The first component provides update by application of criterion referenced testing for mastery. The second component allows update by teacher certification.

When teachers are interested in testing students over any subset of objectives, in mathematics, they call for a test using the test generation subsystem. This subsystem generates a recipe for the test by randomly selecting items for each objective from an item bank. The item bank contains approximately 80% multiple choice items. The recipe produced by the computer lists the items to be used on the test, the order in which they are to appear, and the correct answer. Multiple choice items are listed first followed by items requiring more detailed student responses. This recipe is used by an aide who constructs the test by drawing items from the item bank.

The decision has been made to use only two test items per objective. The criteria for mastery is that both items must be answered correctly.

The test is administered to students. They respond to multiple choice items on an answer card shown in figure 1. Students respond to non-multiple choice items on their test paper. These non-multiple choice items are then graded and transcribed to the answer card by an adult. An answer key is filled out from the test recipe. This key is entered through the mark document reader along with the student answer cards. Grading of the test is done by computer. The student's academic performance records are automatically updated by the system. A summary of test results is printed out for teacher analysis.

The advantages of this procedure are numerous. First of all, there is total flexibility regarding which objectives are tested together. Random selection of items from the bank is also assured. More than one form of each test can be generated, and there is no need for computer storage of the answer keys. Automated grading and record update is provided along with enough human interface to allow for non-multiple choice items.

A second component of the system allows for update of student records through teacher observation and subsequent certification of mastery. This is a necessary component of the system because many mathematics objectives through the second grade are not appropriately measured using paper and pencil. Student behavior described by these objectives includes verbal response and application of manipulative devices. These behaviors must be observed and recorded by the teacher. Furthermore, this teacher observation and certification is an appropriate assessment of student behavior beyond second grade.

The need to update records by teacher observation and certification is being supported by the form shown in figure 2. The form is initially blank on the left side. The heading, containing stude[illegible] name, system number,

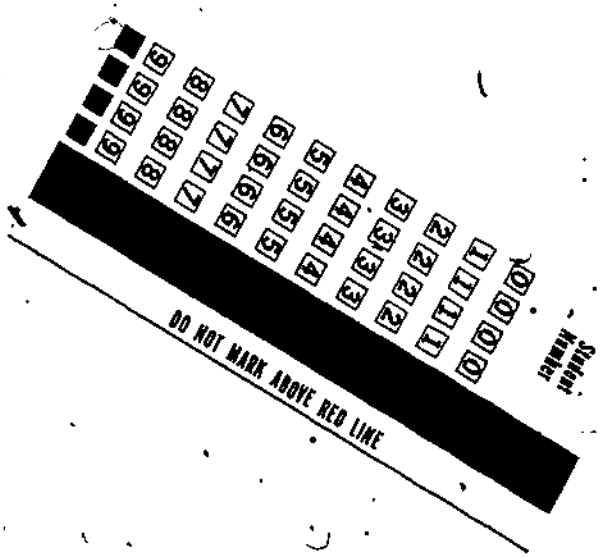

figure 1

Mathematics

Student Number 459

Name
BOY [redacted]

Date
April 8, 1976

Level	Objective	Mastery	# of Masters in Group
D	8		43
D	9		24
D	16		29
D	31		26
D	33	M	27
E	22		28
E	42		12

figure 2

mathematics level, etc. is printed by the terminal. Forms for each student in a particular group are kept together in a folder. Teachers observe individual student behavior. Mastery of particular objectives is then certified by marking the appropriate code on the computer readable part of the form on the right side. These forms are read periodically by the mark document reader which has the capability of reading both 3¼" and 8½" width forms. Student records are up dated accordingly.

As mentioned before, the form in figure 2 is initially blank on the left side. Alternative types of individual student profiles are being printed remotely by the terminal in this space. The project staff and teachers are working together to determine which forms of the individual student profile are most helpful to the teachers in supporting their efforts in observing students.

Now that many of the mass data entry problems have been solved, the primary task of the project is being pursued. The task is to increase the useability of the data for teachers, using it to form instructional groups. The development school, as well as many of the other project schools, is implementing Individually Guided Education. Under this model, schools are organized on a multiunit basis. Each unit is composed of 100 to 150 students with up to three years age difference. The formation of such multiage units increases the heterogeneity of the unit with regard to student's previous background and experience. This increased variety enriches the learning experience which can be brought to any instructional subgroup formed within the unit. This heterogeneity is important to learning in any discipline.

Within a multiage unit, instructional subgroups are formed in the skill disciplines on the basis of common, student learning need. These skill disciplines are typically mathematics, reading, and language arts. Based on their observations and previous experience with students, teachers identify

clusters of objectives for which they think instruction is needed. Student's needs with regard to these objectives are assessed. If instruction is needed, appropriate student groups are formed.

The multiage unit organization along with the procedure for subgrouping on the basis of skill needs has the following advantages. Some of the heterogeneity present in the total unit is maintained in the instructional subgroups. Furthermore, variability in student achievement in any subgroup is reduced. This allows the opportunity for planning an optimal learning experience for each subgroup.

Student learning needs related to any cluster of objectives in mathematics are assessed in two ways; through diagnostic test procedures and through the analysis of historical records of student performance.

When a team of teachers feels the need to regroup within their unit, the objectives for potential instruction, during the next instructional period, are identified. A pretest is constructed over prerequisite objectives using items from the test item bank. After administration of the pretest, the results are analyzed by the teachers and the project staff. Subsequently, student subgroups are formed. The criteria for this subgroup formation are recorded as precisely as possible.

While the teachers are providing instruction, the project staff uses the computer to probe the historical performance data in an attempt to form similar groups. The stated grouping criteria are used as a guide for developing alternative algorithms for subgrouping. These algorithms are programmed and executed. The composition of the suggested groups which result is then compared with the composition of groups actually receiving instruction. In the future this procedure will be repeated regularly. The desired outcome is the discovery of generalized algorithms for probing historical performance data to produce instructional groups which are similar in composition to those obtained through pretesting.

Any successful application of computer technology to support instruction requires attention to the interface problems which exist between the user system and the technical system. The level of technical literacy on the part of educators is of primary concern. They need enough technical literacy to understand both the power and limitations of the computer and to comunicate precisely with it. The required level of technical literacy may be different for each educator. This depends on the educator's role in the schools and the person's relation to the information system. These various roles and relations must be observed. The necessary level of technical literacy must be identified and provided.

The problem of understanding and precisely modeling the users original information system is of equal importance. Technical staff members must recognize their role as one of modeling the users information system rather than redesigning it to meet some external constraints. Only if a precise computer model is produced will meaningful computer service be provided.

These interface problems are much more severe than generally recognized. They are solved only through well planned procedures which increase person to person communication. In order to increase person to person communication, the project has chosen the procedure of on-site development and slow expansion to other schools over a period of several years.