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Computer managed instruction is a technological concept that links computers, other information processing technologies, the curriculum, and the teacher for more efficient and effective instructional management.

Computer-Managed Instructional Systems: An Essential Component of Educational Reform

by David Bryant and Dr. Bettye MacPhail-Wilcox

History may record the 1980s as the decade of performance reforms in public education. Concern for accountability has renewed interest in testing students and teachers, and momentum for school and teacher appraisal plans that are linked to student performance continues to build. Though few would argue with the intended consequences of these reforms, many would protest their efficacy. Reforms based on the beliefs that more testing and the adoption of merit pay or career ladder plans are sufficient for improving school productivity are ill-founded. They are oversimplistic in the identification of performance problems in education, and they ignore the question of what teachers can reasonably be expected to accomplish in the current context of public schools.

For example, nationally normed standardized tests are not appropriate means for judging school and student performance. These tests **do not adequately:** (1) measure the more significant aspects of cognitive development; (2) reflect the curriculum adopted or emphasized in the locality; (3) tap the social and psychomotor attainments of students; (4) empower teachers to improve instructional diagnosis or prescription; (5) account for the effects of student socioeconomic circumstances or level of mastery prior to the most recent set of instructional activities. They are, therefore, of limited utility in identifying or encouraging quality education.

Furthermore, conclusions about teacher performance which are based on these standardized test scores **do not:** (1) distribute responsibility for learning between the student and the teacher; (2) recognize the many factors affecting learning which are beyond the control of either teacher or student; (3) acknowledge the inherent injustices of comparing the student performance records of teachers with qualitatively different groups of students and kinds of subject matter. When reforms are not tempered by these realities, they are destined to disillusion all who are involved with them.

In addition to these metric problems, current reforms fail to address the technical difficulties of planning, presenting, and monitoring classroom instruction on the basis of individual student needs. Though this has been a problem of long standing in public education, it is exacerbated by: (1) organizational technologies designed for masses of students rather than individual students; (2) organizational structures which ignore differential learning rates; (3) the increased diversity of needs among students populating public school classrooms today; and, (4) the use of manual accountability systems of instructional management.

In short, the performance reform movement, while intended to foster educational improvement, may actually inhibit it by displacing the goals of improved classroom instruction and student performance with time consuming and ineffective accountability systems. These conditions will neither help the teacher improve instruction nor adequately reflect what students have acquired through schooling. Without other substantial changes, current performance reforms will result in an artificial form of accountability which trivializes rather than improves learning and teaching.

One promising technological solution to some of these problems is computer managed instruction (CMI). In the sections which follow, CMI will be defined and described. Ways in which it can help to resolve many of the problems cited will be described, and some of the policy issues underlying the use of CMI will be presented.

Computer-Managed Instruction

In modern schools, computers are used by administrators, students, and teachers. They are employed as management and communication tools by administrators. Students study them as well as use them, and teachers either teach about them (literacy, programming), use them to provide instruction (computer assisted instruction), or use them to manage instruction (computer managed instruction). Managing instruction is a complex process incorporating all of the intricate steps of selecting, implementing, and assessing the content and process objectives of a curriculum. It requires that students be diagnosed and placed in a curriculum with appropriate instructional materials and pedagogical techniques, and that performance be monitored. Under the best circumstances, these activities are undertaken and recorded for each individual student. It is this time consuming process of managing and monitoring instruction at the level of the individual student which CMI can improve.

CMI is a technical concept that links computers, other information processing technologies, the curriculum, and

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the teacher for more efficient and effective instructional management. Though CMI systems existed in the 1960s, not until the advent of powerful microcomputers did this technology become more accessible to all teachers. This accessibility has increased teacher control over the management process and made it possible to introduce criterion referenced outcome measures. Depending upon equipment and software sophistication, CMI systems can perform very simple or complex sequences of instructional management activities. The least sophisticated CMI system performs recordkeeping tasks only. More sophisticated systems can test students, analyze performance, diagnose mastery levels, prescribe instructional objectives, materials, and activities, schedule the next assessment, and produce a permanent record of student activities and performance levels.

The strengths of CMI systems derive from an instructional philosophy which encompasses individualization of instruction, high quality learning objectives, and the use of technology for data analysis and management. The computer alone does not insure successful instructional management. Without comprehensive instructional objectives which are tied to valid measures of them, the assessment of individual progress could not occur. Hence, the computer's role is to aid the educator in data manipulation and management for better analysis, decision-making, and reporting.

Clearly, CMI has the potential to help teachers manage and monitor the increasingly diverse instructional needs of students in a classroom. In addition, such systems can maintain an auditable trail of instructional activities and student performance levels. But, before CMI systems can be used effectively, policy makers must clearly specify the goals to be obtained by students. Educators must then determine the instructional objectives, materials, and methods appropriate for particular groups of students and the means by which student progress will be assessed and reported. While these may seem a simple and straight forward set of tasks, each is affected by contentious, substantive, and potentially costly policy issues.

State and Local Control

Because state and local governments share legal and financial responsibility for public schools, there is political tension about what the curriculum will include and how accountability will be monitored. While state governments are interested in an efficient and uniform system of education about which summative performance judgments can be made, localities are equally concerned about responsiveness to community and individual needs and formative progress assessments. This tension is one determinant of the kind of data that will be part of a CMI system and how it will be used. Consequently, issues associated with curriculum content and accountability measures must be confronted if CMI is to be effective from both the state and local perspective.

Additional tensions are produced by heavily reliance on state adopted textbooks. Discrepancies among the curricula provided in textbooks, state mandates, and local preferences are not uncommon. If CMI is to be efficient and effective, these discrepancies must be tractable, and the CMI must not add to them. This raises the issue of whether standardized, generic, or customized CMI systems are most appropriate for public education.

A standardized CMI system is a stand-alone curriculum. It contains prescribed objectives, test items, analytical procedures, and information management strategies. A generic CMI system is a shell that allows each educational unit to specify its own objectives, tests, prescriptions, resources, and information handling routines. A customized CMI system is standardized for a specific purpose—to match the curriculum in a textbook for example. Standardized and customized CMI systems are usually more sophisticated and comprehensive than others. They are developed by experts and widely marketed, so that the substantial costs of producing these systems are offset by subsequent profits to the manufacturer.

A hybrid of the customized and generic CMI offers one solution to the shared responsibilities of state and local governments for education. Such a system might be customized at the state level, containing objectives, test items, test analyses, instructional prescriptions, and recordkeeping which reflect state mandates. In addition, this system should be flexible enough so that localities can add objectives, instructional routines, test items, and analytical procedures. From the state perspective, the customized portion of the CMI system would provide for efficient implementation of a state mandated program of studies and centralized monitoring of performance. Cost efficiences would accrue from volume purchasing and updating of the CMI, contracted distribution plans, and standardized user training programs. From the local perspective, additions to the CMI system could provide a measure of responsiveness in the curriculum and student assessment procedures which would empower teachers to engage in diagnostic-prescriptive instructional cycles.

Because comprehensive CMI systems require such a large data base, they should be developed for subunits within a discipline. Or, CMI might be used for basic skill instruction only. Whichever route is selected, CMI data bases must be capable of integration if their utility is to be maximized.

Institutionalized Mediocrity

While it is easy to imagine the efficiencies and utilities of CMI, they must not come at the expense of quality education. Policy makers must be wary of the threat of institutionalized mediocrity that can accompany large scale technologies. When emphasis shifts to objective measures of teacher and student performance, what is tested is a significant determinant of what is taught. Instructional objectives and related test items may represent minimized learning because it is easier to develop objectives and test items with high validity for low level cognitive skills than for the more complex skills of critical reasoning and problem solving. Failure to plan for instruction and assessment in these more complex skills will trivialize learning and provide grossly misleading data about the quality of teacher and student performance.

This is a critical consideration with large scale technologies like curriculum guides, textbooks, CMI systems, and teacher evaluation systems. When they are tightly linked to graduation, promotion, tenure, and compensation, these systems will institutionalize curricula and performance expectations. Once in place, massive technologies, like these, exhibit an inertia that is difficult to overcome, despite evidence that they have outlived their usefulness. Consequently, CMI systems must be adaptable, easily modified, and comprehensive. Periodic review of curriculum, instructional routines, assessment strategies, and data manipulations are essential. Otherwise, the technology will not be responsive to a changing society, nor will it foster high levels of student and teacher performance.

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Teacher Appraisal, Program Evaluation, and Student Performance

Can CMI data be used in teacher and program evaluation plans? As demands for accountability continue to rise, more accurate, reliable, and valid appraisal systems are essential. Although the degree to which teachers and programs can influence the performance of particular students is debatable, it is unlikely that student performance measures will be abandoned as one source of appraisal data.

Evaluation research indicates that teacher performance, as measured by student performance, is unstable. That is, it varies from student-to-student, class-to-class, year-to-year, and subject-to-subject. Research also indicates that some forms of pedagogy are more effective with some students than others and that instructional strategies vary in their potency to produce particular kinds of student outcomes (e.g. the ability to recall vs the ability to analyze critically). Most researchers conclude that it is inherently unfair to compare teachers' performance without adjusting for student, subject, and other important contextual variations.

With a comprehensive CMI system it is possible to access individual student data and classify students in multiple ways. Variables such as socioeconomic status, prior performance level, intelligence, instructional activities, and the like can be used to stratify samples of students and to make statistical adjustments for instructional differences. These adjustments can improve the validity of teacher performance comparisons for individual and groups of students. This kind of information would be useful for both summative and formative evaluation. In fact, teachers would have a tool for conducting their own formative appraisals. They could inquire about the success of particular instructional materials and pedagogical practices for particular individual or groups of students and make attendant adjustments.

Furthermore, CMI data can be stored, making it possible to monitor student performance on a daily, weekly, quarterly, semester, year, or year-to-year basis. With the availability of state wide criterion test items that are geared to curriculum objectives and instructional prescriptions, CMI systems can enhance the evaluation of particular programs. For example, special state funded summer programs, minimum competency remediation programs, exceptional children programs, vocational education, and the like could be compared across districts, schools, or teachers. These data might be used for both program adjustment and program evaluation. In fact, if CMI data were linked to fiscal data, cost effectiveness studies and program budgeting would be possible.

Without complex information processing technologies that are comprehensive, flexible, and integrated, individualized instruction, teacher, and program assessment based on student performance are not practical. The time and reporting demands are so overwhelming that instruction and learning are displaced in order to accommodate the management process. If, on the other hand, basic skill tests can be scored by by optical scanners or directly on a computer while software manipulates, stores, and reports instructional data, improved instruction and assessment are possible. When teachers are relieved of the burdensome clerical tasks associated with instructional management, they will have more time for academic instruction, and they will have faster access to the kinds of information necessary for informed instructional decisions.

Legal and Ethical Concerns

As access to student and teacher performance data increases, responsible handling of that information becomes critical. Student records are protected by the Family Educational Rights and Privacy Act, and individual test scores of students are among the protected class of data. Because many microcomputer systems often have only minimal security systems, there are major concerns about data integrity and unauthorized access which policy makers and administrators must address. In addition to policies and practices which limit physical access to performance records, electronic "locks and keys" are available. However, electronic security systems entail additional costs.

Policy makers must also be wary of the many validity issues associated with interpreting CMI data. As a general rule, the average citizen is not a very sophisticated user of information. Human information biases often result in the neglect of base line data, overgeneralization, inappropriate comparisons, the attribution of causal relationships on the basis of correlational data, and a host of other logical errors. For example, a strong correlation between test scores and instruction by one teacher, may not be due to the teacher's proficiency. it may be due to a characteristic that all students assigned to that teacher exhibit, such as high socioeconomic status or high entry level performance. Likewise, gain scores may be misleading in that some learning gains are more difficult to obtain than others or the performance trend may be due to regression to the mean.

These concerns suggest that educators must become more sophisticated users and interpreters of information, and they raise a red flag regarding the release of teacher appraisal data derived from student performance measures. Teacher performance appraisal documents are not public information, and one might infer that student test scores for a particular teacher are a part of these documents. Legal issues aside, however, it would be inappropriate to release such information without an interpretive context that accounts for or details data interpretation limitations such as those noted in the previous paragraph.

Summary

CMI systems offer educators a means of accomplishing multiple objectives. A hybrid form of CMI, customized to state curricula, texts, and assessment plans, which can be tailored local needs, can provide accountability data and information for instructional improvement. Such a system could bring individualized instruction, summative and formative personnel appraisal from textbook descriptions to classroom realities. While reducing the clerical demands that accountability strategies place on teachers, CMI can provide an auditable trail of planned instructional interventions and student performance.

Herbert Kohl, classroom teacher, education critic, and author of several books, cautions educators about the use of CMI. "But ultimately, all of this analysis would trap me into the same kinds of activity: getting scores, finding numbers to record on the machine, digitizing my students. Even the computer's best analysis wouldn't tell me how to deal with human problems or suggest solutions—and I wouldn't want it to. Teaching is my business, not the machines."

Kohl's assumptions underestimate the significant number of factors about students that teachers must consider when planning for instruction and monitoring student performance. Learning style, brain modality, prior achievement, and special learning problems are but a few factors which affect the quality of individualized instruction. Few teachers have the capacity to process all this information for multiple students, maintain a mental inventory of all the resources and materials available to help the student ac-

quire a particular skill, and diligently assess and record student progress. Other professions which rely on extensive data to make complex decisions use computers to manage that data. Why should educators expect less?

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