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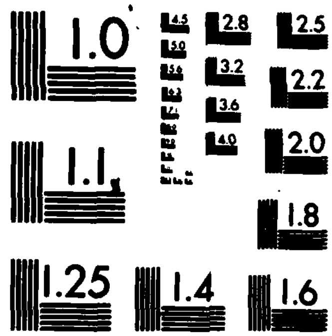

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The Rand Corporation
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INTRODUCTION

The number of microcomputers in public schools increased a whopping 230 percent between fall 1980 and spring 1982 (NCES, 1982). Despite this seemingly impressive number, and despite the ballyhoo that is made about computer-assisted education, there is much less to this number than meets the eye. Although roughly 100,000 microcomputers can be found in our public schools, this number translates into about 1 microcomputer for every school, or 1 micro for every 20 classrooms, or 1 micro for every 450 students. From these numbers, it is easy to see why most classrooms do not have ready access to micros; why there is insufficient time for most students to become literate beyond superficial operational characteristics of the machines; and why there is insufficient time for most students to receive computer-assisted-instruction (CAI) in any concentrated amount.

Clearly, this paucity of microcomputers is a major obstacle to reaching national goals for computer literacy and CAI, but it is not the only one. Two other obstacles would remain even if more microcomputers were available. They are the lack of adequate courseware and the lack of teachers well-enough versed to use computers effectively in their instruction.

The goal of this study is to set forth guidelines for designing educational courseware that meet teachers' needs and for educating preservice and inservice teachers in the instructional uses of microcomputers. To this end, the study examines the relationships among teachers' attitudes toward computers, their knowledge of computers and the subject matter taught, and their uses of microcomputers for instruction. This paper describes the study and reports preliminary impressions and findings.

DESIGN OF THE STUDY

We posit that school-district policies toward the implementation and support for instructional uses of microcomputers along with the characteristics of the community and students served (e.g., socio-economic status) will influence how many and in what ways teachers use micros in instruction. Of additional importance is the influence of certain teacher characteristics on their decisions for instructional uses of micros. These characteristics include their attitudes about computers for education and in society, and their knowledge about computers and the subject-matter in which they use computers. In this study, district- and school-policies, and the characteristics of students serve as the context that moderates the focus of the study, teachers' uses of micros for instruction (see Fig. 1).

We planned to sample five school districts in California that systematically varied in microcomputer implementation and support policies, and student population served.[1] Within each of these five districts, two teachers who were identified as unusually successful in using micros for instruction were to be selected in each of two schools at the elementary, junior- and senior-high levels. All told, we expected to interview and observe 60 teachers (5 x 2 x 2 x 3), 30 principals (5 x 1 x 2 x 3) and 5 staff responsible for microcomputers in each district. While the design was straight-forward, someone

[1]For cost reasons, the study was limited geographically to California.

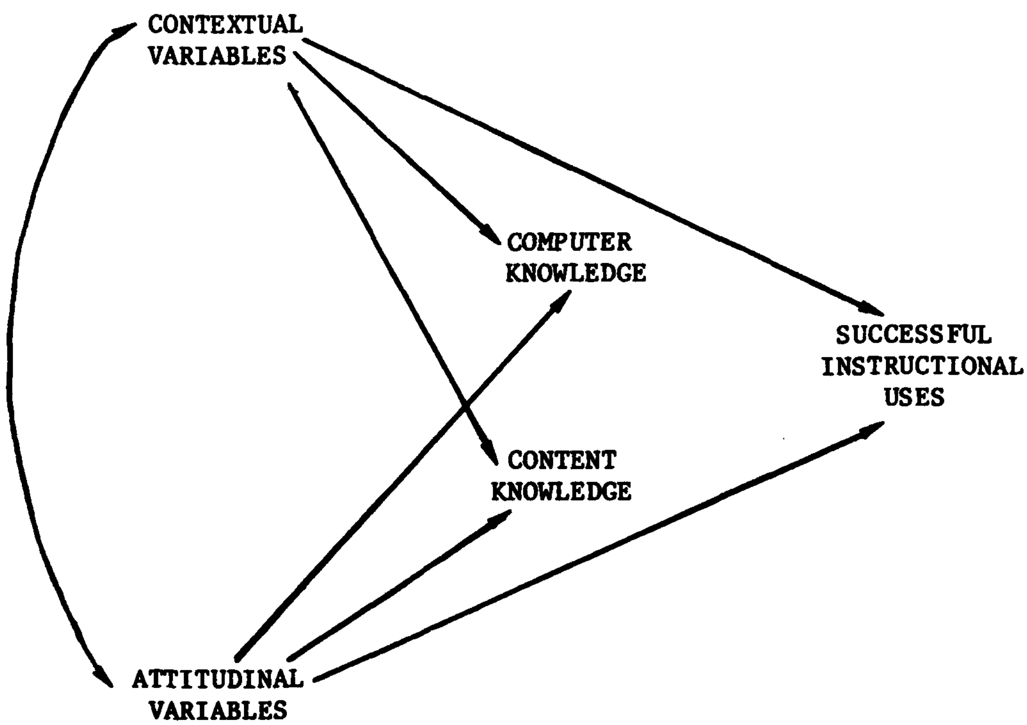

Fig. 1--Schematic of conceptual framework

forgot to set up the world of education so we could implement it. We found that rarely, if ever, would two unusually successful computer-using-teachers be located in one school, let alone reproduced in more than one school or at more than one grade level within a district.

The fact is, at least in the 43 computer-using districts in California that we have already contacted, the burden of meeting national goals of computer literacy and CAI is placed squarely on the shoulders of a very small, dispersed cadre of teachers--"computer buffs"--in a school district. Our sampling plan, then, was modified such that we searched the state seeking nominations for these teachers wherever they would be found. In order to find 60 such teachers, we will probably visit 40-50 schools and over 20 districts.

SELECTED IMPRESSIONS AND PRELIMINARY FINDINGS

Variation in District Implementation and Support Policies for Microcomputers. We found that districts vary greatly with respect to implementing microcomputers. Perhaps the most salient variation occurs in centralized coordination, which appears to be unrelated to district size or wealth. In one high school district, for example, policies are carried out by a central computer committee comprised of knowledgeable district staff and teachers and/or administrators from each school. Decisions about the purchase and kind of microcomputer, selection of courseware, provision of staff development, and the like are coordinated by the committee. Equity across high schools in numbers of computers, availability of courseware and staff development, and use of micros across subject matters is a major goal of the committee. Needless to say, we had little trouble finding this district and once found, had little difficulty getting consistent nominations of successful teachers.

Contrast this with a unified school district that has given lip-service to the importance of micros but has not formulated policies regarding implementation and support, and has not provided leadership in coordinating individual schools' efforts to provide literacy or instruction with micros. The chaotic state of the district is reflected in the fact that district personnel consistently referred us to other district personnel who, in the end, knew nothing about computer use, least of all what their colleagues knew. We suspect that these kinds of differences will ultimately affect the instructional uses of microcomputers. But how particular policies help and hinder teachers remains to be seen.

Variation in School-Building Policies. Principals play a key role in creating effective schools. We were particularly interested, then, in how principal's policies for implementing and supporting computers might affect teachers' instructional uses of them.

So far, we have found in interviews with principals of computer-using schools little variability among their implementation strategies. Perhaps the three most striking findings are these. First, almost all principals favor instructional use of microcomputers. From what meager discretionary funds they have at their disposal (e.g., $4,000), they allocate or support departmental allocation of a respectable percentage to computer goals (e.g., purchase of hardware, courseware, or staff development). They give teachers release time to attend computer workshops or conferences. And they encourage teachers' computer-related interests and activities. Second, they place much of the responsibility for expanding the school computer program on the teachers. They do not coerce teachers into using micros but instead provide subtle encouragement. They delegate responsibility to committed teachers or to someone in the school's central office (e.g., a vice-principal) to manage the details of their computer implementation policies.

What is remarkable is that all of this occurs in the face of considerable lack of knowledge about microcomputer hardware, courseware, or training alternatives on the part of principals. Very few principals owned a computer or knew how to use one for instruction, administrative tasks, or even recreation, despite professed interest in and commitment to computer literacy. What does this indicate? Perhaps it says something about effective management style--that is, positive attitudes, material encouragement, and especially delegation of responsibility to a committed individual, are more necessary than computer knowledge.

Variations in Teachers' Instructional Uses of Micros. In order to determine how various factors influence teachers' instructional uses of micros, it is necessary to develop a working idea of what constitutes "successful use." For this, we turned to the educational technology literature and found little to offer that was systematic or that considered how use of micros in instruction might be "successful" from the teacher's perspective.

For a definition of successful computer use, then, we turned to research on teaching and found the teacher decisionmaking perspective to be most useful. An important part of teaching is a planning process, in which teachers integrate information about students, the subject matter, and the classroom and school environment in order to reach decisions about instructional activities. Goals, content, activities, and methods are orchestrated to maintain a flow of activity. Furthermore, teachers monitor ongoing activities and proceed as planned unless something interrupts the flow of activity.

To define successful computer use within this theoretical perspective, we first assume that classroom computer use fits within teachers' ongoing planning and decisionmaking processes. Next, we assume that teachers can make reasonable choices among alternative courseware for reaching one or some combination of goals, and among the modes of instruction (e.g., drill and practice, simulation) given their knowledge of the subject-matter, computers, and the characteristics of students in their classes. Successful computer use will arise when teachers make reasonable decisions about matching the computer and available courseware to their instructional goals, the subject-matter structure, the nature of students, and the instructional context. Nevertheless, once the planning decisions have been made, the teacher must possess the interactive teaching skills in order to carry out the plan.

This conceptualization leads to a definition of successful use of micros for instruction as the appropriate integration of computer-based activities with teachers' instructional goals and with ongoing instructional activities, which changes and improves on the basis of feedback that indicates whether goals are achieved. Instructional goals include achievement (mastery of basic skills and concepts) and motivation (time on task, interest). Ongoing instructional activities include subject matter concepts, and teaching aids (texts, labs). Computer-based activities involve the types of CAI used (e.g., drill and practice, simulation), the grouping of students for computer activities (e.g., by size, ability), and the assignment of courseware to students along some criteria. The appropriateness of integration involves both the breadth of computer-based activities, as well as the mix of selectiveness decided on (e.g., differentiations among computer activities for types of students or goals). Finally, feedback refers to the monitoring of processes and outcomes to evaluate and perhaps revise uses of computers in instruction.

Below, we describe these elements (see Table 1) and present a few important impressions that have emerged from the data thus far. Achievement-related instructional goals refer to teacher's goals for subject-matter mastery, including both basic skills and higher cognitive skills, such as understanding concepts and using appropriate problem-solving procedures and strategies. Motivational goals are described as positive attitudes toward the subject-matter, such that student's level of interest enables them to spend the amount of time necessary to reach the achievement goals, and encourages them to continue their studies in the subject-matter. A third category, goals for classroom management, refer to teachers' maintenance of an orderly classroom environment, often by establishing rules

Table 1

ELEMENTS OF SUCCESSFUL COMPUTER USE

A. Instructional Goals

(a) Achievement (e.g., basic skills, concepts)
(b) Motivation (e.g., attitudes, time on task)
(c) Behavior management
(d) Unique computer goals

B. Student Instructional Activities

(a) Subject matter concepts (science, math)
(b) Instructional aids (courseware, textbook, dittos)

C. Computer-Based Activities

(a) Modes of instruction (e.g., drill and practice, tutorial)
(b) Student grouping
(c) Matching students with courseware

D. Feedback Mechanisms
(a) Computer-managed instruction
(b) Monitoring strategies

for appropriate individual behavior for appropriate group behavior through student cooperation or teamwork. Finally, teachers using microcomputers often have goals relating to the computer itself, apart from the subject-matter in which the computer is used. These may include operating the computer, basic understanding of how it works, or ways to use the computer as a learning tool.

Not surprisingly, we found that teachers most frequently mention achievement and motivational goals, followed by computer goals. Classroom management goals are rarely mentioned. Teachers' goals may be influenced by such factors as their attitudes about teaching and computers, their subject-matter and computer knowledge, and the context in which teaching occurs. Thus far, our impression is that contextual variables influence achievement and computer goals, while teacher attitudes determine motivational goals. For example, teachers who emphasize mastery of basic skills and computer-related goals typically teach in districts where similar goals are stated district priorities. Motivational goals have priority for teachers who express more non-traditional beliefs about teaching and learning. Our observations suggest that these teachers often have more "open" classroom environments and more innovative teaching styles and practices in general. Whether the emphasis of certain types of goals over others effects successful microcomputer use remains to be determined.

Teachers typically plan instruction by sequencing instructional activities which cover topics prescribed by some established subject-matter curriculum. Subject matter concepts or topics to be covered, in 5th grade math for example, are often standardized within a district according to state-adopted guidelines. Therefore, the teachers we interviewed were very similar with respect to the subject matter concepts or topics covered in their math and science classes.

However, the distribution of microcomputer uses in math and science instruction was quite uneven. Micros are more frequently used in math than in science instruction. This occurs at the elementary level, in part, because science is not mandated and, in part, because there is much more courseware available in math than in science and what is available fits into the standard curriculum, e.g., drill and practice programs in multiplication, division, and fractions. At the high school level, the natural fit between computers and mathematics affects greater computer use in math than in science. Computer programming is most often taught in mathematics departments and students learn programming in order to solve math problems on the computer. Again, science courseware is lacking and science teachers most frequently use micros as a tool for problem solving and data analysis and occasionally find appropriate computer simulations.

Teachers plan their use of instructional aids, such as textbooks, courseware, dittos, for each instructional activity. Virtually everyone, of course, uses a textbook, but elementary teachers more frequently use dittos or worksheets and manipulables in connection with their instructional activities. Without exception, teachers coordinate computer uses with other instructional aids and with the curriculum. The type and degree of coordination varies for different reasons. Availability of courseware is again important, since a greater supply of CAI math courseware theoretically enables math teachers to obtain more appropriate courseware than science teachers can find. Newer high school math textbooks often include computer programs to be used in conjunction with the curriculum. On the other hand, science teachers must write their own programs to produce appropriate computer-related instructional aids. The science teachers we interviewed had many ideas about how to use the computer in instructional activities and to coordinate computer uses with other instructional aids; they simply lacked the time to instantiate their ideas.

Thus far, we have observed considerable variation in computer-based instructional activities. The modes of instruction in use are mostly drill and practice; we have observed fewer tutorials or simulations. Most of the student groupings involve individual students spending equal time on the computer using the same courseware. This is due, in part, to the shortage of terminals and courseware. However, we have noticed three phenomena that seem to characterize successful integration of computers in instruction. First, when some of the more successful teachers assign students to computer-based learning activities, they attempt to individualize the computer instruction. Usually this takes the form of assigning more difficult courseware to more able students, but the basic equation involves differentiation of courseware subject matter content or time on task along important student characteristics, such as ability.

The second phenomenon associated with successful integration capitalizes somewhat on the limited availability of terminals. In addition to individual student assignments, some of the more successful teachers devise activities for groups of students (usually 2-4).

Frequently, groups of similar ability work with courseware that is matched to their ability level, but creative strategies for composing groups and assigning courseware are also seen. This can involve giving students special roles within groups, or creating competition between groups, for example.

Finally, teachers who have successfully integrated microcomputers into instruction are more likely to see feedback regarding computer activities. Frequently, they seek courseware that records student performance or (ideally) diagnoses errors. In addition, they informally monitor the process of computer use. The ways computers are used evolves over time, with less successful experiences guiding these changes.

Some of these examples of successful integration represent ideals. Progress toward these ideals, however, appear to be influenced by teachers' knowledge and attitudes and by the physical environment for computer use. Micros are more likely to be integrated into ongoing instruction--and used in different ways--when they are inside or directly accessible to the classroom. What is intriguing about this observation is that decisions about how to configure microcomputers often contravene their hoped-for uses. Districts with centralized planning often find lab-type arrangements easiest to implement. Secondary schools frequently favor lab or media center arrangements, whereas elementary schools are more likely to put micros inside classrooms. The implication is that some of the most creative examples of integration of computers in classroom instruction are occurring in elementary schools.

However, differences between teachers seem to figure most prominently in how computers are used for instruction. Varying modes of use and student grouping, and matching courseware to students require some knowledge of possibilities for computer activities and the ability to recognize good courseware and match it to students. Thus far it appears to be a matter of courseware knowledge rather than hardware knowledge, and in our experience so far, programming knowledge does not seem very important. Successful integration also seems to be a matter of attitude--positive attitudes towards what computers can do for students and the willingness to give students some freedom around the computer.

These impressions--if substantiated in our data analyses to come--will help us formulate recommendations for training and for courseware. Based on our impressions to date, for example, we may recommend more inservice emphasis on courseware selection and evaluation, and less on technical training and programming. We will have much more to say on this in future work.

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