TEACHERS' BELIEFS, PLANS, AND DECISIONS ABOUT COMPUTER-BASED INSTRUCTION

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Case studies of four special education teachers who used computers were conducted to describe their beliefs and knowledge about computers, their planning and decision-making processes, and patterns of computer use in their classrooms. Particular attention was given to ways in which computers were integrated with teachers' normal routines and to the unique issues and problems that computers presented. For the most part, teachers adapted computers to meet their overall educational goals and to fit into their normal routines for classroom management, instruction, and planning. However, the computer was also a unique innovation that differed from traditional methods. Teachers' beliefs and attitudes about computers, especially their emphasis on the motivational benefits of computers, strongly influenced how computers were used. Computers also presented unique problems for teachers in planning instructional activities and monitoring student performance.

Computer-based instruction (CBI) is a complex educational innovation that presents many difficult issues for teachers. Experimental research has demonstrated the potential of well-designed CBI packages that have clear objectives and instructional methods (Kulik, Kulik, & Bangert-Drowns, 1985; Lieber & Semmel, 1985). But the microcomputer itself is not an instructional method or package; it is a flexible educational tool that can be used in a variety of ways to meet a variety of goals. The effectiveness of microcomputers in school settings depends on how they are integrated with educational goals and activities and with the organizational patterns of schools.

Studies of computer use in special education indicate that computers are often used ineffectively. Observational studies of computer use in special education (Cosden, Gerber, Semmel, Goldman, & Semmel, 1987; MacArthur, Haynes, & Malouf, 1986; Rieth, Bahr, Okolo, Polsgrove, & Eckert, 1988) have found that microcomputers are highly engaging; but those studies also have raised questions about the limited range of computer activities compared to regular education, the appropriateness of computer activities that special education students are engaged in, and the adequacy of teacher monitoring of student performance. Case studies of microcomputer use (Everhart, McCarthy, & Simpson, 1985; MacArthur et al., 1985) and reports based on teacher interviews (Okolo, Rieth, Polsgrove, Bahr, & Yerkes, 1986) have identified common implementation problems, including limited access to hardware, difficulty selecting software appropriate for special education stu-

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dents, classroom management issues, lack of appropriate training, and constraints on teacher planning time.

Any educational innovation is filtered through teachers as they modify instructional activities to fit their beliefs and the instructional and management routines in their classrooms (Clark & Peterson, 1986; Olsen, 1981). The role of the teacher is especially important with regard to microcomputers, because decision making about microcomputers in most school districts is decentralized, with teachers having considerable discretion in determining whether to use computers at all and in formulating goals and curricula (MacArthur et al., 1985; Rieth et al., 1988; Sheingold, Kane, & Endreweit, 1983). Thus, the present study focused on the critical role of the teacher in shaping patterns of computer use in instruction.

The theoretical framework for the study is drawn from the literature on teacher decision making, or, more generally, teacher thought processes (for reviews see Borko & Niles, 1987; Clark & Peterson, 1986; Shavelson & Stern, 1981). This literature encompasses several areas: teacher theories and beliefs, teacher planning prior to instruction, teachers' decisions during instruction, and evaluation after instruction.

Teacher decision making provides a useful perspective for studying microcomputer implementation because it stresses the teacher's central role in managing the integration of microcomputers with the overall curriculum and classroom organization (Winkler, Shavelson, Stasz, & Robyn, 1985). Microcomputers require complex decisions by teachers, such as establishing goals and objectives, selecting materials and planning activities, organizing the classroom, monitoring and reacting to student performance during instruction, and evaluating performance and the lesson for further planning. In addition, teachers' beliefs about computers and about pedagogy are important factors in determining how computers are used. MacArthur and his colleagues (1985) found that special education teachers used computers in varying ways, depending on their overall educational goals and beliefs about the utility of computers. A teacher with a strong focus on basic skills used computers entirely for drill-and-practice on reading, math, and spelling skills, while another teacher, interested in supporting the development of problem-solving and social skills, had her students plan group projects that involved the computer.

Concomitant with the focus on teacher decision making, the study was framed by questions about the relationships between patterns of computer use and the overall educational program in the classroom: To what extent was computer use influenced by teachers' overall educational beliefs and goals, classroom organization, and instructional approaches? On the other hand, in what ways was the computer-in-the-classroom a unique phenomenon, determined by teacher beliefs and knowledge about computers, the planning demands of a complex innovation, and characteristics of the machine and software?

This focus on the interactions between CBI and the overall classroom program was selected for two reasons. First, integration of computers with the curriculum is necessary if computers are to contribute to educational goals (Cosden et al., 1987; Winkler et al., 1985). Second, a focus on the differences between CBI and other educational activities may help explain many of the practical problems observed in implementation. Microcomputers involve different requirements for

planning and delivering instruction than traditional instructional methods. Teacher planning is heavily dependent on the use of well-established routines (Yinger, 1979). The routines that teachers are familiar with for preparing instructional activities, organizing and managing those activities, and monitoring and evaluating student performance cannot be simply transferred to microcomputer activities. Selection of software, scheduling of activities, classroom management, and limited planning time represent major concerns of special education teachers in using microcomputers (MacArthur et al., 1985; Rieth et al., 1988). Teachers also have difficulty monitoring and evaluating student performance at the computer (Cosden et al., 1987; MacArthur et al., 1986; Semmel, 1987).

The purpose of the current study was to describe teachers' beliefs and knowledge about computers, the plans and decisions they made about implementation, and the relationship between those beliefs, plans, and microcomputer activities and the overall educational program. Case studies of five elementary school special education teachers were conducted using the techniques of ethnographic inquiry (Erickson, 1986). Qualitative methods were selected because the essential research questions involved understanding teachers' perspectives about education and computers and describing the complex interactions between an educational innovation and the real-life context of classrooms.

METHOD

Participants

Five elementary school special education teachers participated in the study, including three teachers of self-contained classes for students with learning disabilities (LD) and two special education resource room teachers. For reasons of brevity, one of the self-contained class teachers has been omitted from this report. The two self-contained teachers selected for this report represent contrasting teaching styles and a range of issues about computer use. Participating teachers met the following criteria: a minimum of 2 years' experience using computers in a special education classroom and full-time access to a microcomputer in their classes during the study. A pool of 27 potential participants was identified through prior contacts of the researchers in the district, referrals by special education supervisors, and data on special education teachers who had been assigned a computer. Ten teachers were found who met the criterion of full-time access to a computer. Four of these were eliminated because of limited computer experience, planned maternity leave, principal refusal, or a consulting teacher model. One teacher declined to participate because of other time commitments.

The first author met individually with the remaining teachers to explain the purposes and methods of the study in more detail. Several critical points were discussed in negotiating access to the teachers' classrooms. First, teachers would be fully informed about the purposes of the study. Second, the researchers would not be intervening or advising teachers about computer use, but, rather, observing and interviewing to understand how and why teachers use computers. Third, in the final phase of the study, the researchers would discuss the tentative find-

ings and interpretations with the teachers to seek refinement, confirmation, or discomfirmation. Finally, teachers were assured of strict confidentiality and their right to terminate participation if it interfered with their teaching responsibilities.

The four teachers described in this report expressed interest in the study and readily agreed to participate. Only one teacher explained her motivation for participating. She thought that our presence would encourage her to make better use of her computers. Three of the teachers had participated in previous studies conducted by one of the authors: Two had responded, 3 years earlier, to a phone survey on microcomputer use, and two had participated, 2 years earlier, in a 4-week study of computer-assisted spelling instruction.

District Context

The study was conducted in a large and relatively affluent suburban school district in a major metropolitan area. The district had made a significant commitment to microcomputers. All elementary schools had computers and many had labs with 15 or more computers. The district was in the first year of a 5-year plan to provide one computer per class in all elementary schools.

The district computer curriculum included objectives and units of study for all grades, kindergarten through 12th grade. This curriculum was not mandatory, because many schools did not have sufficient computers yet. The curriculum for the intermediate grades (4–6) is most relevant to this study. The fourth-grade computer unit focused on Logo, primarily as an adjunct to the geometry part of the math curriculum. In fifth grade, students were to learn about word processing. The sixth-grade curriculum included a unit on the use of data bases in studying African countries. The district offered mini-courses for teachers, focusing on the three curriculum areas.

Special education administrators in the school district expressed an interest in microcomputers and worked with computer staff to ensure that special education was represented in computer allocations. Special education did not have any staff with specific responsibility for computer-based instruction, and had not made any curriculum recommendations to special education teachers, beyond preliminary efforts in a summer workshop to review software appropriate for students with handicaps.

Of the schools included in the study, two had computer labs plus several computers on carts, and two had 6 to 10 microcomputers, all on carts. Four of the teachers in the study had one computer in their class; one had two. In addition, one teacher regularly borrowed three or four additional computers for the morning, and one teacher had relatively free access to a computer lab.

Data Collection

Data collection included extensive classroom observations, structured and informal teacher interviews, and document analysis.

Researchers. The two authors and three graduate research assistants with experience in educational applications of computers each assumed primary responsi-

bility for one case. The two authors had been conducting research on applications of computers in special education for 5 years and had studied implementation issues previously (MacArthur et al., 1985). The three research assistants were all doctoral students in education with a minimum of 3 years of classroom teaching experience. Two were in graduate programs focused on educational applications of computers and had participated in other classroom-based studies in the field. The third had served in a school district as director of a computer curriculum development project. A fourth research assistant assisted the second author in making observations at one site. She had a doctorate in education with an emphasis on qualitative methods, but no prior experience with computers in education. In addition, the principal investigator met with each teacher and observed several times in each site.

Observations. Observations began in the third week of September and ended in December or January (observations continued longer at sites making more extensive and varied use of computers). The numbers of observations for the four cases were 13, 23, 26, and 27, and the total hours of observation were 26, 40, 45, and 71.

Interviews. After the first few observations, a semistructured interview of about an hour's duration was conducted with each teacher. Teachers were asked a common set of questions about their overall educational goals, their beliefs about computers, and their plans for computer use. A second formal interview was conducted near the end of the observations, involving individual questions for each site to clarify points of confusion and get teachers' reactions to preliminary conclusions. These two formal interviews were tape-recorded and transcribed.

Informal interviews or discussions occurred frequently at teachers' convenience. In addition, informal follow-up interviews were conducted after completion of observations to resolve questions that became apparent during analysis. Finally, interviews were conducted with school principals.

Documentary evidence. A variety of documentary evidence was collected, including teacher plan books, instructional materials, record-keeping forms, and district and school curricula and policies pertaining to computers.

Analysis

Data analysis occurred concurrently with data collection to permit further exploration and verification of preliminary conclusions both within and across sites (Miles & Huberman, 1984). The research team met weekly to discuss theory, procedures, and preliminary findings. Team meetings began a month prior to data collection to discuss the literature on teacher thought processes and microcomputer implementation, the aims of the research, and methodological issues.

As data collection began, several procedures were used to analyze data and focus team discussions. Initially, team meetings focused on individual sites. Team members read each others' field notes and interviews and discussed their reactions. Second, the original research questions were used periodically to focus discus-

sions. This review of the questions helped define specific questions for each case and led to a gradual expansion and refinement of the questions themselves. New sets of questions were developed around particular issues. For example, as it became clear that different computer applications presented different planning issues, separate but parallel questions were written for word-processing and drill-and-practice applications to highlight similarities and differences.

Third, a coding scheme for the field notes was developed based on the original research questions and was revised and expanded as ongoing analysis revealed new issues. Team members coded their own notes and portions of others' notes, and the coding was discussed. In addition to providing some consistency in use of codes, the process of coding and discussing the codes led inductively to the development of additional codes and issues.

Coding and retrieval of field notes and transcribed interviews was greatly facilitated by the computer. All notes were written on a word processor and codes were inserted in the text files. A text search program (ZyINDEX) was used to retrieve segments of notes by codes and to produce new documents comprising all segments related to given codes.

Fourth, memos were written and discussed by all researchers on some common issues; for example, a memo summarizing teacher goals for computer use was written for each site. Other memos were written and discussed individually as issues and interpretations occurred to individual researchers. The memos became a critical resource for articulating conclusions and systematically searching for confirming and disconfirming evidence within and across sites.

Fifth, near the conclusion of the data collection phase, each case was reviewed in team meetings. Tentative interpretations were articulated, and unresolved questions were identified. In the final interview, teachers were asked to comment on these tentative interpretations and questions, and teacher reactions were incorporated into the analysis.

Finally, when data collection was complete, researchers wrote working case study reports for their respective sites. Case reports included references to field notes, to make it possible to trace the analysis. Case reports were read and discussed by the team.

Cross-case analysis was an ongoing concern from the beginning of the study. Questions and interpretations raised in team meetings in regard to one site became questions to pursue in all sites. The memos were especially valuable for analyzing issues across sites. Following preparation of the individual case reports, the primary focus of analysis became comparison and contrast among cases. Charts were developed to display information according to the key categories in the coding scheme. For example, the first chart compared computer-based instruction to other instruction across all cases on the following categories: teacher knowledge and beliefs, teacher goals and objectives, social organization of the classroom, instructional methods, teacher monitoring of students, planning, interactive decisions, teacher evaluation of instruction, and process outcomes, including student motivation, social interaction, and success rates. This chart summarized the individual case reports in a form that facilitated cross-case comparisons. As the analysis came to focus more on the ways in which computers were integrated into the classroom

versus the ways in which computers were different from other instructional activities, charts were developed to compare computer and noncomputer tasks in particular curriculum areas (i.e., writing and independent practice activities).

In the final stage of the analysis, tentative cross-case conclusions were organized in an outline form, and confirming and disconfirming evidence was sought from each case. In this way, it was possible to examine the generality of overall conclusions and seek explanations for differences. This approach also makes it possible to trace backward through the analysis, because the findings are all referenced to earlier case summaries, memos, and field notes.

RESULTS: INDIVIDUAL CASE STUDIES

The analysis centered on questions about the relationships between teachers' decisions about computer use and the overall educational program in the classroom. Consequently, for the four individual case studies, we describe the school context, the teachers' overall educational goals and programs, their beliefs about and goals for computer use, and their planning for and actual use of computers. Prior to the case studies, we present some preliminary information about the degree of teacher control over whether and how to use computers. Following the case studies, we present generalizations and issues based on the cross-case analysis.

Teacher Control Over Computer Use

Because the study was primarily concerned with the decisions that teachers made about how to use computers, an important preliminary question was how much control the teachers had over whether and how to use computers. What was the role of external factors, such as resource constraints, curriculum requirements, principals, and other professionals, in determining patterns of computer use?

Overall, these teachers were free to use or not use computers as they saw fit within the constraints of available resources. The teachers perceived a number of resource constraints, including access to hardware and software, time for planning and reviewing software, and, for some teachers, lack of training and expert support. Beyond those constraints, teachers saw themselves as having full discretion about computer use.

The decision to use computers at all was made by the individual teachers. In fact, they all were highly interested in the potential of computers and had taken initiative to obtain computers to use in their classes. One teacher commented, "If you have [a computer], it's either you wrote a grant or you have convinced someone that you needed it."

Teachers did not view the district computer curriculum as a requirement. This freedom from curriculum was due in part to the flexibility given to special education teachers with regard to individualizing curriculum in all areas. One teacher's response is representative: "Being in special education, we have that kind of leeway as far as curriculum is concerned." The district curriculum and related teacher training opportunities did exert an influence on teachers' decisions. Three of the teachers mentioned an interest in using data bases in social studies as described

in the district computer curriculum, and one actually used this instructional unit in modified form. On the other hand, only two of the teachers even mentioned Logo (the fourth-grade unit) as a possibility, and one specifically rejected it as irrelevant to her students' needs.

Similarly, the principal and other professionals in the school and district were not seen by the teachers as instrumental in determining how they used computers. The principals in the four schools studied were generally supportive of computer use, and one principal took a personal interest in microcomputers and their use in the special education program. But none of the principals provided direction about how to apply computers. In fact, with one exception, the teachers in the study were seen as the computer experts in their buildings. Other staff occasionally provided ideas or software recommendations, but that was the extent of their influence.

The position of these teachers as primary computer users in their schools and early users in special education should be kept in mind in interpreting the results. Some of the beliefs about computers and personal commitment to planning for computer use that were important to these teachers may not apply in situations in which teachers are asked or expected to use computers.

Ms. Anderson

Context. Ms. Anderson (a pseudonym) taught an intermediate (Grades 4–6) self-contained class in a modern school in an upper middle class, suburban neighborhood. The 10 students in her room included 5 girls and 5 boys (4 black and 6 white). The students were all classified as learning disabled and had reading skills from 1 to 3 years below grade level. Ms. Anderson had a full-time instructional aide.

Ms. Anderson had begun using computers with her class 2 years earlier. She had taken an inservice course provided by the district and shared a single computer with another special education teacher in the school. In that first year, she had taught her students a little BASIC programming. The next year (just prior to this study), she had used primarily math drill-and-practice and problem-solving software, and her students had been introduced to Logo and word processing as part of a computer literacy unit in a lab in another school. This year, for the first time, she had a computer full-time in her classroom, and she also had purchased a computer to use at home. The school had six computers in addition to the two located in the two special education classes.

Educational Goals and Program. Ms. Anderson ran a highly structured, well-organized class, with an emphasis on basic functional skills in reading and writing. When asked about her most important goals for her students, Ms. Anderson mentioned three general areas: First, she mentioned "teaching a child to take responsibility for himself; the ownership of his own behavior; taking the responsibility to bring back his homework, the responsibility towards the other children in the classroom, responsibility towards his parents, in general, just responsibility for himself." Second, she said that one of her "biggest goals in working with LD children is to let them know that even though they are 'different' from most of

the children that they can learn to compensate and be a functional person in today's society." Third, she stressed "functional [academic] goals, being able to read and write and compute to a level that would allow one to survive in today's world."

In addition, Ms. Anderson had a strongly stated goal that the classroom be well organized and structured. She described herself as "super structured" and "a very well organized person." She described a good day as one in which "everything goes as scheduled, as planned. . . . I like to be able to second guess where the children in my classroom are going to have difficulties and have things available to them so that I can clarify questions. . . . Everything goes just as I had envisioned it."

Ms. Anderson's emphasis on structure and her goals of responsibility, independence, and basic skills were evident in the ways she organized the classroom and planned and delivered instruction. The planning for the individualized instruction that formed the core of her program was highly organized. Ms. Anderson used basal readers supplemented by a large, organized file of worksheets for reading, textbooks for spelling, and math worksheets matched to the district's math curriculum. Work was checked each afternoon by the aide, and Ms. Anderson took the student folders home each night to review student performance and make decisions about new assignments. A variety of routines and procedures were used to help students keep track of their work independently. Students had individual work folders with weekly assignment sheets. Schedules were prominently displayed and there were a variety of wall charts for recording each assignment as it was completed.

Group instruction was judged by observers to be consistently clear, well organized, and thoroughly planned in advance. Group instruction usually focused on explaining tasks that students were to do, rather than on presentation of information or discussion. Tasks that students were to do were broken down into small steps, and charts listing the steps were often prepared by the teacher.

Students were highly task oriented and engaged with their work, and they were able to get help when they needed it. Social interactions were not frequent, but they were generally positive and usually focused on work. Cooperative work was not planned by the teacher, though students were occasionally permitted to help each other.

Computer Beliefs and Goals. In discussing her reasons for using computers, Ms. Anderson expressed the belief that computers were especially motivating for students with LD because knowing about computers gave them an expertise that other students did not have, and because computers helped them compensate for some of their disabilities. She thought that the major impact of computers was on "self-concept. . . . When they go home or when they are talking to their friends, they can say they worked on the computer or they use the lingo, 'save' and that type of thing." She followed up on this belief by arranging for her students to help the kindergarten and first-grade children with computers, and she was very excited when one of the fifth-grade teachers mentioned the possibility that Ms. Anderson's students with LD might teach the regular fifth graders to use the word processor. Although she thought that computer literacy had a positive effect on self-esteem,

she was cautious about the value of computer literacy itself. She thought her students would not come into contact with computers at home or in their future jobs.

Her belief that computers compensated for disabilities was linked primarily to word processing. She thought that her students' major disability was in writing, specifically in the mechanics, like spelling and handwriting. The typing and ease of revising on the word processor changed writing from a frustrating process of repeated rewriting to a "game of strategy. They really enjoy writing, revising, and editing. When they're finished, they get a nice clean, clear-cut document that's unhampered by their personal handwriting flaws."

Ms. Anderson also believed that drill-and-practice software was motivating. She thought that students preferred to use programs with a game format and tried to pick such programs.

She believed it was critical to integrate the computer with other instruction. Her only major concern about computer use, other than issues about access to hardware and software, was whether the skills learned on the computer would transfer to paper and pencil and daily life. She compared this question to her concern about the transfer of math skills learned with manipulatives to paper and pencil and functional math performance. She said she would reserve judgment on this issue until she had more computer experience. Although Logo programming was a part of the district curriculum, she thought that it was a waste of time because it was irrelevant to the basic skills her students needed. She had taught some BASIC programming in the first year of computer use but had no plans to do so again.

Ms. Anderson's own motivation for using computers was a combination of personal and professional interest. She had purchased a computer of her own in part to help her adolescent sons with their schoolwork and had become interested herself. She described herself as "hooked" and computers as "habit-forming." She also perceived that using computers would enhance her reputation. "It's also the big thing in the county. If your kids are working on the computer, you're looked on by your superiors as, you know, right up on top with all of the curriculum and that type of thing." She stated that her professional goals for the year were all related to using the computer in new ways.

Computer Use and Planning. The computer fit easily into the overall organization and instructional program of Ms. Anderson's classroom. It was used in four primary ways: drill on spelling, keyboarding drill, word processing, and data bases in science and social studies units. Students also had regular opportunities to use instructional software of their own choice. The drill-and-practice and word-processing software were used in the morning language arts time.

In terms of organization, the computer became one more independent activity for Ms. Anderson. "My class in the past has always been very structured and [the computer] just adds one more structure." Students had daily 15-minute blocks of computer time during their independent morning work. On Monday, they practiced keyboarding; on Wednesday, spelling; on Friday, word processing; and on Tuesday and Thursday they had free choice of a variety of instructional software. Times were clearly scheduled and students recorded completed computer work

on a wall chart. The computer schedule sometimes disrupted group schedules, but Ms. Anderson gave the computer priority and helped students make up the group work.

The spelling software was used once a week to supplement the normal spelling routine of weekly word lists and Friday tests. Ms. Anderson inserted the spelling words for her four spelling groups into the drill program weekly, a task that required 1 to 2 hours biweekly, by her report. The free choice software was all language arts, because she thought that her students did not need extra work in math. Ms. Anderson generally demonstrated these programs to the whole group before the students used them. One way in which these computer activities differed from independent seatwork is that student performance on CAI was not recorded or graded.

Ms. Anderson actively sought out software to review. Instead of using the district review process, which she found cumbersome, she regularly read computer magazines and found a computer store with friendly staff that let her preview software and ordered programs for her. She had definite criteria for selecting software. First, she said, "I want to have an editor feature, something that I can go in and put in my own words or my own information, so I can make it relevant to whatever we are doing here in the classroom." Another criteria was that the directions be easy to read.

Word processing was used as a supplement to the usual writing process, that is, after prewriting, drafting, and editing, students typed a final copy on the word processor. Ms. Anderson emphasized the motivational value of a neat, error-free published product. Rather than taking advantage of the editing power of the computer, Ms. Anderson corrected students' papers before the students typed them. On two occasions, students wrote collaboratively, composing directly on the computer: Two girls wrote a Halloween story together, and the entire class added sentences to a letter to a former student who had moved.

The use of a data base in the social studies unit on Africa was adapted from the district curriculum. Students looked up information on African countries in reference books and entered the information in a computer data base. Ms. Anderson focused on teaching skills in the use of reference materials, rather than on the content about Africa; she viewed the data base as another kind of reference tool and, like the word processor, a means of giving students neat hard copies of information and graphs. The application of a data base in the science unit on weather originated in an article Ms. Anderson found in a computer magazine. She had already planned the weather unit, in which students would take daily weather measurements, when the article gave her the idea of using a data base to record and graph the data. Development of these data-base units required extensive planning, including learning to use the data-base software herself, adapting the school district's social studies data base unit for her students, developing the unit on weather from scratch, and planning to teach the students to use the software.

The teacher instruction provided about the computer was as highly structured and planned as her other instruction. When introducing the word processor or the data base, Ms. Anderson taught one step at a time and provided charts with

detailed instructions for use during independent practice. She also emphasized the importance of component skills, like keyboarding. Ms. Anderson's emphasis on responsibility and independence was reflected not only in the numerous systems for students to keep track of their work, but also in the type of individual help that she gave. She tended to provide procedural advice rather than direct help with a problem; for example, when asked about the operation of the word processor, she would refer students to the written directions rather than explain the answer. Ms. Anderson also monitored students' performance closely and was aware of difficulties as they occurred. For example, when students had problems with word processing commands, she intervened quickly and usually understood the problem.

Students' comments in class indicated that they enjoyed working on the computer, but there were no marked differences in their responses to computer and other activities. They were highly task oriented at the computer, as they were at noncomputer tasks. For example, they were responsible about working through the keyboarding lessons in sequence and using the correct fingering. And, on free choice days, they often worked on the spelling or keyboarding programs.

Ms. Anderson's use of computers developed rapidly over the course of the study. She described her previous classroom use of computers as limited to drill-and-practice that was not well integrated with the curriculum and, occasionally, word processing. At the start of the year, she planned to better integrate the drill activities with the curriculum, by using programs that permitted her to enter relevant content, and to focus on word processing. She achieved these goals, and more; the applications of data bases had not even occurred to her at the start of the year. She believed that full-time access to a computer in the class and a computer at home were necessary for this development. Clearly, her organizational skill and the commitment, effort, and time devoted to systematic instructional planning were critical to her success.

Mr. Franklin

Context. Mr. Franklin taught a self-contained LD class in a school located just a few miles from Ms. Anderson's, in a similar upper middle class, suburban area. The 13 students in his class were all male and were predominantly white; 1 student was Iranian and 1 black. The students were fourth and fifth graders with reading skills from 1 to 2 years below grade level. In general, they were well behaved and cooperative; in fact, Mr. Franklin commented on how easy the class was to manage in contrast to his previous class. In addition to Mr. Franklin, the class had a full-time instructional aide.

Mr. Franklin had considerably more computer experience and greater access to computers than Ms. Anderson. He had been using computers in his class for 3 years. In addition to the computer in his room, Mr. Franklin had relatively free access to the school computer lab. He was the acknowledged computer expert in the school and had taken primary responsibility for running the lab the previous year, in addition to his normal teaching responsibilities. Though the media specialist had assumed this responsibility, Mr. Franklin retained considerable infor-

mal responsibility and privileges. He trained the parent volunteers that provided support in the lab and was frequently consulted about technical problems.

Educational Goals and Program. In contrast to Ms. Anderson's emphasis on structure, academic tasks, and individual responsibility, Mr. Franklin stressed the development of self-esteem and social skills. When asked about his most important goal for his students, he replied that it was "getting confidence in themselves and seeing progress in themselves." He described a good day as being one in which "all the students have completed their work and feel good about it. There is little frustration and everyone leaves on a good note."

He viewed the development of social skills as critical for returning to mainstream classrooms. An important goal for the first couple of months of school was for the students "to come together as a group . . . and support each other." He planned to use a "buddy system" for mainstreaming. "They will go [to mainstream classes] with a partner from this class and if they learn to be a group in here first, I don't think they will have problems interacting with others in the regular class."

In addition to self-esteem and social skills, he emphasized the importance of helping the students to "understand their disability, not to ignore it, but to learn how to compensate for it." He thought it was important to discuss the students' academic and organizational disabilities openly so that they could begin to develop compensatory skills. In discussing academics, he said that his general goal was to keep students from falling further behind in reading and math. He also said that he intended to focus more on writing this year.

Mr. Franklin's classroom had a relaxed atmosphere and a flexible schedule that provided opportunities for social interaction and discussion, both as a group and informally between individual students. Academic work on basic skills occurred in small, teacher-led groups and at independent seatwork in the morning. In addition to daily reading, math, and spelling assignments, students wrote two or three times a week in their journals on self-selected topics.

Mr. Franklin met frequently with the whole class, often during transitions between other activities. In these meetings, Mr. Franklin discussed the schedule and classroom routines, behavioral expectations, special events, and personal topics that students raised. He encouraged student contributions and listened responsively even when students changed the topic. He felt these discussions were important for building group cohesiveness and social skills. Social interaction was common during work periods, as well. Although no formal arrangements were made for cooperative work, except for paired work at the computer, students were permitted to talk quietly about their work and frequently did. Despite the social interaction, students were fairly task oriented and generally completed their assigned work.

The basal reading program and students' individual work folders provided the basic structure for planning and monitoring student work. Mr. Franklin and his aide corrected student work and added new work to the students' folders daily.

Other than routine planning of individual work, Mr. Franklin's planning was informal and general. In describing his own planning, he said that he had a general

idea of where he was going, but that much of his specific planning was done on-the-spot. One reason, he explained, for not having specific plans is, "it's hard to deal with these particular kids. If it goes well, then you can do it." He did not have any written plans for the year, nor did he keep a written teacher planning book with daily plans. Planning for group instruction and new activities was general and entirely in his head. He often met briefly with his aide in the middle of the day to discuss plans for the next activity. An example of his impromptu planning was his first group lesson on the computer. He assembled the class around the computer and said he was going to demonstrate a program. Instead, he got into a discussion of the prior computer experiences of the students. Afterwards, he was pleased with the discussion and what he had learned about the students, although it was not what he had planned.

Mr. Franklin devised a variety of organizational aids, including a chart for rotating classroom jobs and a computerized calendar for homework assignments, but these organizational aids were used inconsistently, and all drifted into disuse after 2 or 3 weeks.

Computer Beliefs and Goals. Mr. Franklin's beliefs about the positive effects of computers mirrored some of his general educational goals for his students. First, he thought that development of computer skills would enhance his students' self-esteem by giving them an advantage over other students. "They've been able to master a skill. . . . Say they go to a junior high setting, they may have a nine-week course in computers where they will be ahead of the class for the first time in their life as opposed to being in the last group. . . . So that's the confidence part, the self-esteem part, the first time being maybe ahead of the class." Second, he thought that word processing would help students compensate for their disabilities. "Most students in here have a written language deficit either in the fine motor . . . or thought processes of written language. . . . And the computer is less frustrating to them than paper and pencil." He also thought the word processor supported the "logical thinking sequences" involved in writing and revising. Finally, he stressed the motivational value of computers, both in drill-and-practice activities and in word processing. Mr. Franklin thought word processing was motivating and built self-esteem, because of the "printed product that will give them some sort of self-feeling that they have completed something that's neat." His belief that drill was motivating was reflected in comments and actions about computer time as a reward.

Mr. Franklin emphasized the importance of integrating computers with other instruction, of using them as "another tool for students." His advice to teachers interested in using computers was to integrate them with other work. At the beginning of the year, he mentioned the possibility of teaching programming in Logo or Pilot, but commented that the students' needs for reading and math skills might make it hard to justify such instruction.

Computer Use and Planning. The computer in the classroom was used primarily for math drill-and-practice, and the lab was used for word processing. Students took more or less daily turns at the computer for drill activities. The schedule

was flexible, and some students missed turns because their other work was not done or received extra turns because it was. The math drill was not carefully integrated with other aspects of the math program. Students were free to use any of the available software, regardless of level, unless Mr. Franklin happened to make a specific assignment that day. He made a chart for students to use to record performance on computer assignments, but it was seldom used. He did not grade the work done on the computer. This casual approach to assigning and monitoring computer drill activities was in marked contrast to his regular routine of assigning and correcting paper-and-pencil seatwork.

This lack of integration may be due in part to the extra effort required to plan computer assignments and the fact that Mr. Franklin did little detailed instructional planning. It may also be explained, in part, by the relatively low priority he placed on drill-and-practice software. Mr. Franklin, in an interview prior to the start of the school year, stated that he used math CAI as an activity to keep the students occupied while he got class organized for the year. Drill was not mentioned in his further discussion of computer plans for the year. It is also true that Mr. Franklin, despite his technical skills, had limited knowledge of educational software. The school had a limited collection of CAI—fewer than 20 titles, not counting tools such as word processors and data bases, and Mr. Franklin used only about half a dozen. He complained about the time required to review software and of difficulties with the district's software review process. He also noted that his budget was limited and thus he tried to use inexpensive software. He did not review any new software for use in class during the 4 months of the study.

Word processing was used regularly for general writing activities. Students wrote in their journals by hand on self-selected topics and went to the lab once a week with the aide to type their papers. They were encouraged by the aide to make mechanical revisions as they typed them, but they did not use the computers for further revision. They usually printed out two copies—as Mr. Franklin put it, "One for me and one to take home and slap on the refrigerator so their parents can see it." Consistent with his emphasis on self-esteem and deemphasis on specific skills, Mr. Franklin usually provided general, positive comments about student writing and did not make corrections in mechanics beyond the help provided by the aide in the lab.

Mr. Franklin described the word processor as being the most important application. His emphasis on writing instruction and his belief in the value of word processing as a motivator and compensatory tool have been mentioned above. In his September interview, the major computer activities he discussed involved writing. In addition to general use of word processing for writing, he planned to produce a class newspaper using a publishing package. He had subscribed to a national newspaper, *USA Today,* which he planned to use for functional reading activities. As the students learned about the parts of a newspaper, they would begin to produce their own paper, which would be published about three times during the year. He was quite enthusiastic about the prospect and talked at some length about how students would write news stories, editorials, and human interest stories, and how they would role-play editors and reporters. However, these plans were never implemented; no newspaper was read or written by the students during

the 4 months of the study or later in the year. Mr. Franklin attributed this to the fact that *USA Today* never began delivery; but he made no alternate plans. His own estimate of the planning required to get the newspaper activity started was 8 or 9 hours of learning to use the software and preparing initial activities.

He also talked in September about plans to teach students to use the various functions of the word processor in ways that were related to writing skills. For example, he mentioned moving blocks of text and learning to sequence events in a story, and using the editing features to correct specific types of mechanical errors. However, no lessons of this sort were observed.

Mr. Franklin's planning style limited his use of computers. Consistent with his emphasis on affective goals, Mr. Franklin provided a warm, supportive environment in which students and adults interacted comfortably and students received individual assistance and feedback about academic work. He had a classroom routine that provided for a smooth flow of activity based on routine planning of small group lessons, individual seatwork assignments in folders, expressive writing in journals and on the computer, and impromptu group discussions. However, he did little detailed instructional planning. The class newspaper, which required significant planning outside of class, never materialized. His use of drill was also limited by the fact that he did not devote planning time to reviewing software. On the other hand, his basic use of word processing within the writing program worked smoothly because it required minimal planning, and it fit with his emphasis on affective growth.

Ms. Baker

Context. Ms. Baker taught in an elementary school located in an upper middle class, suburban neighborhood close to the schools of Mr. Franklin and Ms. Anderson. Although she was a resource room teacher, she had a group of seven students who spent the entire morning with her, as well as a few students who came in the morning for language arts or math and several regularly scheduled groups in the afternoon. She also spent one afternoon in interdisciplinary team meetings, and varying amounts of time in testing. The case study focused on the group of students that remained with her all morning, because she used the computer most extensively with them. This group included 4 fourth-grade and 3 sixth-grade students (four boys and three girls).

Ms. Baker faced serious scheduling problems, which she felt interfered with the continuity of the program she provided to her students. The students were expected to join their regular classes for opening exercises, PE, art, and music, and many of the students had counseling or speech therapy to attend. For the entire month of December, the fourth graders left at 10:30 for a swimming program. Further, Ms. Baker herself was out of school about 1 day a week in November and December for various activities. She also shared her room with the speech teacher, who worked with students behind a moveable partition in one corner of the room, and with the half-time curriculum specialist. Ms. Baker complained frequently about the constant disruption, commenting in December about how "my program is disintegrating before my eyes." The disruption clearly had an impact on her instructional program, including computer use.

The school had one computer for every two teachers, and Ms. Baker had a computer full-time in her class. Just the year before, the school had added a half-time curriculum specialist, whose responsibilities included helping teachers make effective use of computers. However, Ms. Baker was acknowledged by the curriculum specialist, as well as the principal and other teachers, as the computer expert in the school. The principal described Ms. Baker's computer knowledge as "nine-and-a-half on a scale of ten."

Ms. Baker described herself as a "mostly self-taught computer bug." A few years earlier she had taken a workshop and a programming course provided by the district, and more recently she had attended a conference on computers in special education. She actively sought out software to review, with the help of the media specialist and a friend in a computer business, and was familiar with a wide range of software. Together with the curriculum specialist, she had taught an inservice workshop on computers in the school, and she had given a number of workshops and demonstrations outside of the school.

Educational Goals and Program. In discussing her educational goals for her students, Ms. Baker stressed acquiring strategies for learning and problem solving. "I work a lot trying to help kids develop their own sort of inner-languages and strategies for solving problems. . . . I just don't see a lot of carry over on teaching specific skills here . . . so I feel that some general strategies for doing a task are more useful." She gave as an example a strategy for students to monitor their own behavior: "What do I do first? Now, what can I do? Now I have to put a date on it, and so forth." When asked about specific academic goals, she said she tried to improve their basic reading and functional math skills, but, more than that, she wanted them to develop "strategies to deal with what you are going to be faced with in the outside world. . . . If they can't read it, what do they do?" Thus, she saw the development of problem-solving and organizational strategies as important means of compensating for their disabilities.

She also placed great emphasis on self-esteem. "Maybe the only thing people remember about school is how they felt about themselves while they were there." She thought her students saw themselves as failures academically, and she wanted to help turn that around by "helping them to see themselves as learners by achieving some academic goals."

Ms. Baker relied heavily on individualized instruction kits—the SRA and CLOZE series in reading, and a set of math word problem cards and audiotaped timed tests for math facts. All of the students worked on these kits daily. Ms. Baker assisted students when they had difficulty, but she provided little direct instruction in reading or math. The individualized instruction materials provided the basic routine for instructional planning in Ms. Baker's class. She described herself as a "manager," responsible for managing learning activities. She tried to make the students independent and gave them the responsibility of getting the next card in the kit, checking their work, and graphing their performance. She monitored their on-task performance closely and, when they were off task, directed them to refer to the chart of class rules or to ask themselves, "What am I supposed to be doing?" She

checked their work regularly and sometimes directed them to begin work on a new level in the materials.

In addition, students also wrote in their journals most days on general topics suggested by Ms. Baker. She responded very briefly in writing to the content and did not make any corrections. Another regular writing activity was to use their spelling words in stories. The major writing activity was the Aladdin project, which integrally involved word processing and is described below.

Ms. Baker encouraged students to work together on their academic assignments. For example, she assigned them to work in pairs reading their SRA cards or practicing their math facts. She regularly asked one of the sixth graders to help the younger students or to check their work. Students were generally on task during these independent work times, although their behavior varied with disruptions in the schedule.

Computer Beliefs and Goals. Ms. Baker's goals and beliefs about computers reflected her enthusiasm about computers and her general educational goals. In discussing her goals for using computers, she mentioned (a) computer literacy, (b) self-esteem, (c) compensation for disabilities, and (d) motivation. Regarding computer literacy, she thought that "society is becoming a databased society and computers are coming into every kind of career and occupation," and that to be "successful in life, you have to know what a computer is, [and have] a basic knowledge of how to deal with it. . . ." Second, she believed that computers could be "a great vehicle for building the self-concept of special kids," because they could learn how to do something that their peers did not know. "I want them to be able to go back to their class and say, 'Oh, I learned how to do that,' and for the teacher to use them as a resource. . . .' Could you show so and so how to do that?'" She sometimes took one or two students with her when she did workshops on computer applications, "to show what special education kids can do." She also had one or two students assist teachers with computer activities, such as making crossword puzzles.

Third, she saw word processing, in particular, as a "tool to help them circumvent their disability." She saw word processing as the most important application of computers because the attractive product was motivating to students with handwriting problems, and the spelling checker would help all of them. Finally, she noted that the computer was a motivating tool for instruction because the students liked to use it. She commented that they would do anything on the computer, even if it was not well designed instructionally.

Ms. Baker also stressed the importance of integrating the computer with academic goals and activities. "I don't do anything with the computer for the sake of computer skills. I do it in the service of an academic skill."

Computer Use and Planning. The computer was used in three primary ways: First, spelling drill-and-practice games were used throughout the week. Students went to the computer when they had finished their other work. This routine was inefficient, because the group of students around the computer grew as more students finished their work. It also created management problems when the students

argued about turn taking. Before using the spelling drill programs, students used the teacher utility to enter their spelling words for the week. Ms. Baker said this gave them one more chance to practice their words. However, it also created inefficiency and some frustration, because the students often made mistakes in entering the words and had to reenter them. In contrast to the careful self-recording by students and teacher monitoring on the noncomputer individualized instruction kits, no records of student performance were kept on the spelling drill. Ms. Baker did monitor on-task behavior and provided assistance if students asked for help.

Second, every Friday for 2 hours, in an activity called "Fun Friday," the students were free to choose from a variety of educational software, including math drill games, logic games, and, occasionally, software that Ms. Baker had obtained for review. Although students were also free to choose other activities, they most often chose the computer. For Fun Friday, Ms. Baker sent her students around the school to collect additional computers, so there were usually four to six computers in the room. There was little or no correspondence between the educational tasks on these programs and the rest of the curriculum, despite her insistence in interviews on the importance of integrating the computer with the curriculum. Ms. Baker gave two reasons for this activity: It built on the motivational power of the computer to provide practice in a way that was fun; in addition, it reduced the management problems created when there is one computer in the room and the teacher is repeatedly called on to help with technical problems.

The third use of computers was for collaborative writing activities using the word processor. In the first month, the two sixth graders worked collaboratively on a couple of stories, and the fourth graders worked collaboratively once, with Ms. Baker's help, to write a story on the computer using their spelling words. Ms. Baker helped guide the writing process and interactions and did the actual typing.

From mid-October to mid-January, students worked collaboratively 2 or 3 days a week on a major writing project centered on the story of Aladdin. Ms. Baker had done two similar projects the year before, based on a series of "classic coloring books." The procedure was based on her belief in the value of multisensory repetition. She showed them a filmstrip and then read the story to them. The students acted out the story; then they sequenced the pictures taken from the coloring book and retold the story to accompany the pictures. The younger students dictated to Ms. Baker in a group, copied the story by hand from a chart, and, finally, copied it onto the word processor. The older students composed their versions directly on the word processor. Whether copying or composing, the students worked in pairs at the computer, with one student typing and the other "proofreading." The final product was a published book with covers made by using the software program *Print Shop*.

Initially, the students appeared excited about the Aladdin project and enjoyed working on the word processor. However, after a couple of weeks, they began to show signs of frustration, openly complaining about the typing and proofreading. The students' typing skills were poor, and Ms. Baker felt that she could not justify taking their instructional time to practice typing. In addition, the transcrip-

tion task required looking back and forth between their handwritten copy, the keyboard, and the screen. Ms. Baker believed that the copying, recopying, and proofreading would reinforce reading and writing skills. She recognized that the unit was taking too long but attributed it to disruptions in her schedule as well as to typing. She planned to do a similar unit again later in the year following the same procedures. At the end, the students were pleased with the books they had produced.

At the start of the year, Ms. Baker had general plans to use special software to publish a class newspaper and an idea about using the modem to allow her students to communicate with another class in the district. Neither of these plans materialized. It is quite possible that Ms. Baker would have followed through more and would have completed the Aladdin project more quickly if she had had her class for the full day and had not had to deal with so many disruptions in her schedule.

Ms. Carpenter

Context. Ms. Carpenter taught in a resource room program in a small elementary school in an upper middle class neighborhood. The parents had lobbied hard to keep the school open despite declining enrollment and were, in general, actively involved with the school. Ms. Carpenter had a small caseload of eight students with LD, including one Indian and two Hispanic students with limited English proficiency and five white students. Mornings, she worked with groups of two to five students, and afternoons she assisted in mainstream classes.

Ms. Carpenter had taken an inservice course on computers and had used computers with her students for 3 years. However, one of the sixth-grade teachers was generally seen as the school computer expert. Ms. Carpenter wanted to make more extensive use of the two computers in her classroom, and she agreed to participate in the study, in part, to push herself to do so. The school also had a computer lab with 17 Commodore computers and 40 to 50 software programs purchased by the PTA, which her students used with their mainstream classes. Unfortunately, the experienced teacher who had initiated the lab had left a year ago, and it was run by an aide who admitted having little experience or interest. The lab was seen by many teachers as limited in value.

Educational Goals and Program. In discussing her goals for her students, Ms. Carpenter explained that over the years her primary emphasis had changed from affective growth to academics, because she realized that development of skill in reading, in particular, was critical to self-acceptance. "Children spend six or seven hours of their day in school and when they can handle their academics and feel good about it, then it blossoms into other areas, blossoms into social interactions, friendships. I guess it's teaching them to have self-acceptance." She also stressed the importance of being "well planned" so that things ran smoothly and the children worked productively. She described a good day as one that "flows. The children have a good idea of what they're doing and what's expected of them, and they don't have a lot of snags and questions and a lot of feelings of 'I can't' and 'I don't know how' and 'leave me alone.' And it usually comes from good planning."

Ms. Carpenter had one group for math and reading, one group for reading, and one for spelling instruction in the morning. Groups ranged in size from two to five and had overlapping membership. In addition, for the entire morning she had a low functioning student who was of second-grade age but working on early kindergarten concepts of letter recognition and counting.

Ms. Carpenter divided her time between small group instruction and helping students with their independent work. Nearly all of the materials for independent work were made by the teacher for individual students. She often made these materials during her morning planning period (this was possible because she had so few students). The math period typically included a brief timed drill on math facts, a small group lesson, and independent work on the assignment begun in the group or on the computer. Reading groups were less organized and varied more from day to day. Tasks included small group lessons from the basal readers, proofreading assignments and other teacher-made worksheets, and word processing for writing assignments from the mainstream class. Ms. Carpenter helped students as they worked and checked their assignments immediately.

Computer Beliefs and Goals. Although convinced of the value of computers, Ms. Carpenter was somewhat less enthusiastic about them than the other teachers. In the initial interview, she focused on specific benefits of computers and gave equal attention to the practical problems in using them. Like the other teachers, she mentioned motivation and student enthusiasm about computers, but she made no mention of computer literacy as a goal, or of any impact on students' self-esteem from learning about computers. She believed that drill-and-practice was a motivating way of providing independent practice while the teacher worked with other students; the computer "can act as another set of hands. . . ." At the same time, she thought computer drill should be limited to regular practice with basic material, such as math facts and spelling, and occasional review of other material already taught by the teacher. In addition, she mentioned several practical problems with CAI, including the problem of students needing help with the computer software when the teacher was busy with other students, and the demands on teacher time for reviewing software and preparing to use it in class. She also brought up the problem of "not getting feedback." She felt that a final score of number correct was not adequate. "You get a tremendous amount of information about how a child is doing his work by looking at the child's work yourself and seeing what kind of mistakes he makes. The final score doesn't mean anything. It's the process of the brain that's important and then you can make corrections and steer your style of teaching or material presented according to how they've done."

Similarly, she thought that word processing was "extremely important" for students with LD, but mentioned problems as well as specific benefits. Word processing would help students with LD compensate for their difficulties with the physical process of writing and produce papers that make a good first impression. "For a lot of LD children, the whole mechanical aspect of writing is painful, and [word processing] eliminates 90% of that." On the other hand, she noted that it takes students a very long time to type their papers, and that they often need help with the software.

Ms. Carpenter agreed to participate in the project, in part, to make herself focus on these "logistical" problems and thus use computers more effectively. "One of the reasons I agreed to be in this project is because I thought it would kind of help me iron out some of these kinks."

Computer Use and Planning. Ms. Carpenter began the year using computers for word processing and math drill and, in mid-October, introduced a spelling drill program. On a few occasions, other language arts software was used.

Word processing was used in a fairly limited way. Except for one language arts exercise made by Ms. Carpenter, word processing was used only to help students complete writing assignments from their regular classes. When students worked on the word processor, they usually devoted their entire class period to it. In the 4 months of the study, four students wrote one or two papers each on the word processor. The students' typing skills were poor, and they had difficulty with basic word-processing operations, including basic text editing and filing. Although Ms. Carpenter was skilled with the word processor herself, she was sometimes unaware of the difficulties that students were having. She emphasized mechanical corrections to her students' texts. At the start of the year, she was aware of the problem of typing skills, but she did not feel justified in taking students' time to learn typing. By the final interview in January, she had decided that she would teach typing to one group of students who had very poor handwriting and could benefit most from word processing.

Math drill was used regularly by the math class as part of the independent practice time. Ms. Carpenter knew that students would need help with operating the software at first, and she set a goal of helping them become independent so that she could work with others. Initially, she spent considerable time with individual students showing them how to operate the software, and she was interrupted frequently to help out. After about a month, the students were able to work independently. A similar pattern was observed for the spelling software, except that it was used much less regularly and students never developed independence.

Ms. Carpenter also developed an assignment and record-keeping sheet so that she could give them a computer assignment and they could record their performance independently. In fact, she developed three different sheets over the 4 months of the study; however, none of them were used regularly. She generally made computer assignments on the spot rather than using the sheet to plan them in advance, and the students did not record their performance unless reminded. Furthermore, Ms. Carpenter seldom checked to see how students were doing on the computer. This infrequent monitoring of performance on the computer was in marked contrast to paper-and-pencil tasks, which she corrected and discussed immediately.

When asked, she admitted that she had not used the record-keeping sheets regularly. She said that teachers *should* keep records if they were "using the computer right," but went on to explain that she only used the computer for review. "I know their level anyway; I don't need the computer to tell me." She thought the students would call for help if they needed it. In addition, she said that some teachers

did not keep records because the computer was "filler" and that sometimes it was filler for her, too.

The idea that computer tasks receive less time and planning because they are less important than other learning tasks came up in other ways as well. Computer use began to decline in her class in late November and December. She explained that the decline was due, in part, to her small class size: "The computer is secondary. If I only have 2 or 3 students and I can work with them myself, I don't use the computer." Again, in the final interview, she discussed the time required to review software as being a barrier to greater use. If time was pressing, she would not take the time to review software because CAI was "decoration on the cake. That's an attitude of mine, I guess, that computers are decoration." She hastened to add that there was an exception to this attitude. She had a group of students with very poor handwriting who really needed typing instruction and word processing. That was to be her next focus; she planned to begin typing instruction with that group at midyear. Though she had not managed to "iron out the kinks" in computer use, she continued to look for an application of computers that would have a specific benefit for her students.

CROSS-CASE CONCLUSIONS

Beliefs About and Goals for Computer Use

The teachers in the study were enthusiastic about the potential of computers in special education. Several beliefs about the positive effects of computers were mentioned by all or nearly all of the teachers, including improving self-esteem, increasing motivation, compensating for disabilities, and fostering computer literacy.

The teachers' goals for computer use were consistent in several ways with their overall educational goals. First, some of the computer beliefs were directly related to their expressed educational goals. In the initial interview, three of the teachers mentioned developing self-esteem and learning to compensate for their disabilities as important goals for their students. Computers were seen as important tools for achieving these goals. Second, all teachers expressed an intent to integrate computer use with the rest of the curriculum. The major applications were word processing and drill-and-practice. Applications not directly related to the academic curriculum (in particular, programming) were rejected or omitted.

Finally, the contrasts among cases show how overall educational goals were related to computer use. Ms. Anderson's emphasis on structure and academics was consistent with her high degree of structure in planning, organizing, and teaching with computers. Mr. Franklin's emphasis on self-esteem and social interaction was related to his cooperative uses of computers and his focus on word processing as a way of producing attractive final copies of written work. Ms. Baker's theory about multisensory repetition greatly influenced her use of word processing for repeated copying and editing.

On the other hand, the teachers' beliefs about the unique potential of computers were also important influences on how computers were used in their classrooms.

The teachers believed that development of computer skills would increase their students' self-esteem, even though the teachers differed in the importance they placed on computer literacy itself (e.g., Ms. Anderson doubted that her students would need computer knowledge in their jobs). But all of the teachers, with the exception of Ms. Carpenter, emphasized quite strongly their belief that computer skills would give their students a competitive edge over other students and help their self-esteem.

The teachers' emphasis on improving students' self-esteem had an interesting parallel in the teachers' own personal and professional motivation for using computers. Ms. Anderson's comments about impressing her superiors illustrate the importance of computers for the teachers' own professional self-esteem. These teachers did in fact receive recognition for their efforts. Most were recognized as computer experts in their schools. One teacher was occasionally given release time to attend computer conferences. Two of the teachers (Franklin and Baker) were known by administrators and other teachers in the district for their involvement with computers.

It is commonly recognized that computers are motivating and hardly surprising that these particular teachers mentioned motivation, given their own enthusiasm for computers. However, this belief had some interesting effects on teachers' decisions about using computers. Three of the teachers provided regular free choice time, during which students could select from a variety of instructional games and other software. Ms. Baker had Fun Friday; Mr. Franklin often let students choose software. Even Ms. Anderson, the most structured and skill-focused of the teachers, devoted two of five weekly sessions to free choice activities. In addition, although all of the teachers devoted some computer time to drill-and-practice, some of them viewed it as an instructional frill rather than as a serious method for providing needed instruction. Mr. Franklin described drill, at one point, as "entertainment," and Ms. Carpenter called it "decoration." Drill was seen as a way of letting students have fun while still getting some instruction.

Classroom Organization

The teachers' normal routines for organizing their classrooms were important determinants of how computers were used. The teachers attempted to fit computers into their organizational structures. All of the teachers relied heavily on individualized, independent seatwork and attempted to fit the computer into that schedule. Teachers' basic plans for organizing computer use were determined in the first few weeks of school. Variations across cases in how teachers managed computer use and how they resolved management problems were consistent with their overall classroom organization. Ms. Anderson's high degree of structure in scheduling, assignments, and accountability, and the absence of cooperative work, was evident in both computer and noncomputer tasks. Even word processing was fit into her schedule of short blocks of computer time. In contrast, Mr. Franklin's more casual scheduling and greater emphasis on social interaction were consistent with his pattern of computer use. He also had the advantage of access to a computer lab. Computers did not fit well in Ms. Carpenter's class because she had few students at a time and had organized her class around personal tutoring.

Ms. Baker was an exception. Although her basic academic instruction in reading and math was organized around independent practice activities, she made limited use of computer drill-and-practice during normal class time. Instead, she organized Fun Friday, in part, to avoid the management problems associated with using drill during class. Her major use of computers for the Aladdin project was organized quite differently from other instruction as a long-term group project.

Planning for Specific Instructional Applications

The predominant applications of computers were word processing and drill-and-practice, which were both used to some extent by all teachers. Since the issues of integration with the curriculum and planning and monitoring instruction are different for these two applications, they are discussed separately.

Word Processing. The global, long-range plans at the beginning of the year for all teachers featured word processing as a major application. However, actual use varied from minimal (Ms. Carpenter) to weekly (Ms. Anderson and Mr. Franklin) to more extensive (Ms. Baker). For the three teachers who used it regularly, word processing was relatively well integrated with overall writing instruction. Ms. Anderson's instructional emphasis was on the mechanics of writing, and her students used word processing to produce an error-free final copy after thorough editing by the teacher. Mr. Franklin emphasized fluency and motivation for writing; he allowed students to choose their topics and accepted their work with praise and few requests for corrections. He emphasized the motivational impact of a neat printed copy. Ms. Baker used word processing as a means of providing the multisensory repetition that she thought was important, as well as a way to get students to work collaboratively and publish a book that they could be proud of. Although these three teachers might have integrated the computer further by having students compose at the keyboard and revise more (MacArthur, 1988), their use of word processing enhanced their writing programs.

In terms of management, both Ms. Anderson's and Mr. Franklin's programs ran smoothly. Ms. Anderson provided explicit instruction in word processing and practice in keyboarding. Mr. Franklin had more students with word processing experience, access to a lab, and a computer-using aide to help out. Ms. Baker had more difficulties, in part, because of limited computer access and, in part, due to not providing keyboarding practice. Ms. Carpenter seldom used word processing despite her initial intentions, because she spent her time with students in tutoring. When she did have students use the word processor, they often had operational difficulties of which she was unaware.

Drill-and-Practice. In most of the classrooms, drill-and-practice on the computer was not well integrated with other instruction. All of the teachers used drill-and-practice software in one or more areas, most often math, spelling, and keyboarding. However, only Ms. Anderson had a well-organized system for making assignments and monitoring and evaluating student performance. Even in her class, computer drill was not monitored and evaluated as closely as paper-and-pencil seatwork.

However, she did ensure that students worked at the appropriate level on the keyboarding drill and put students' individual spelling words into the spelling drill program; and her students recorded what tasks they had worked on.

In other classes, drill-and-practice computer activities were not carefully assigned and monitored, and students often worked on inappropriate content. In Mr. Franklin's class, students were usually free to pick the software they wanted, and the form for recording completed assignments was seldom used. In contrast, paper-and-pencil seatwork was monitored while students worked and was corrected and assigned daily. Ms. Baker assigned appropriate content for computerized spelling drill, but the drill was inefficient, and the drill-and-practice software used on Fridays was unrelated to the curriculum. As in Mr. Franklin's class, paper-and-pencil seatwork was systematically checked and assigned.

How can one explain the teachers' failure to make appropriate assignments and monitor student performance systematically? After all, the computer's ability to manage instruction is often cited as a major benefit. It appears that microcomputer-based drill-and-practice activities create different requirements for planning and monitoring instruction than traditional seatwork. The routines that teachers are familiar with for planning instructional tasks and monitoring and evaluating student performance cannot be simply transferred to microcomputer activities. Microcomputers present new problems in planning and monitoring instructional activities.

The first planning problem mentioned by the teachers was getting access to software for review. The software owned by individual schools ranged from 10 to 40 titles. The district had a procedure for requesting software for review, but the titles were limited and teachers found the process slow and burdensome. Only Ms. Baker had a broad familiarity with available educational software. Ms. Anderson actively sought out new software through a local software store and by reading computer magazines, but the other two teachers made no systematic attempts to learn about software.

In addition to the problem of access, teachers mentioned the time required to preview software in preparation for using it in class. When programs required, or permitted, teachers to modify the content for individual students, additional planning time was necessary. Observers noted that the teachers were not always familiar with the software they used. In some cases, teachers understood how the student portion of a program worked but had not figured out how the record-keeping portion worked. The problems teachers faced in reviewing software and preparing to use it in class were due, in part, to resource constraints. In addition, the inherent characteristics of software and the fragmented nature of most available microcomputer software contributed to the problem. If drill-and-practice software is compared to student workbooks or worksheets, which serve a similar function, it is clear that it is quicker and easier to glance at a workbook and determine the content level than to sit at a computer and run through a program. In addition, textbooks and workbooks contain a substantial range of levels arranged in sequence, whereas many computer drills are restricted to a rather narrow range of content and level.

Monitoring student performance on computer drill is also different from and more cumbersome than monitoring paper-and-pencil seatwork. A completed worksheet can be corrected at a glance during or after school, whereas checking CAI work requires watching the screen, using record-keeping programs if available, or training students to self-record. Even when record-keeping facilities are present, the process of using them on a regular basis for several separate programs can be quite time-consuming. Teachers in the current study typically monitored paper-and-pencil seatwork by circulating as students worked, in addition to correcting completed work. By making in-class monitoring of performance difficult, the computer may actually reduce the teacher's awareness of student performance.

Another explanation for not monitoring computer work that was presented by one teacher was that she knew students' performance levels from their other work, so she did not need to check each day's computer work. Another factor was that teachers thought that computers should be fun. The common idea that computers could provide practice in a motivating and nonthreatening way militated against grading and performance measures. The idea that computer instruction should be motivating and fun was more salient to these teachers than the idea that computers could present systematic instruction.

RECOMMENDATIONS

Many factors are important in determining how computers are used in special education settings. Access to hardware and quality software, training and expert support for teachers, administrative policies, and research on specific instructional applications are all critical factors that operate outside of the classroom and form the context in which teachers make decisions about computers. The current study is a beginning examination of how teachers' beliefs and planning processes affect computer implementation. Teachers' overall educational goals, their approaches to classroom organization and management, the amount and type of instructional planning, and their specific beliefs about computers and knowledge of educational applications greatly influence how effectively they use computers. A few practical recommendations for teacher training and program development can be made.

The first recommendation, applicable to any educational innovation, is that, because teachers differ widely in their goals and educational approaches, they need to be actively involved in planning how they will use computers with their classes. Second, the inadequate planning and monitoring of drill-and-practice activities by most of the teachers indicates that teachers need greater support in this area. One way they can gain this support is by using integrated software that provides more comprehensive coverage of the material in a subject area and provides some automatic support for assigning lessons and monitoring performance together with periodic reporting to the teacher. A second way is to develop systematic support for teachers in selecting software for particular objectives and develop and train teachers in classroom systems for recording and monitoring student performance.

When teachers spoke about the benefits of computers, they emphasized global, affective outcomes, such as increased motivation and self-esteem, rather than specific academic outcomes. In the research and development community, in contrast, the consensus is that any impact of computers on learning is due to effective instructional design (Clark, 1985) or to taking advantage of the capabilities of computer tools to develop specific cognitive skills, as in the use of word processing in teaching revision (MacArthur, 1988). Thus, the final recommendation is to provide teachers with training that focuses on instructional design and the specific ways that computers can support effective instruction.

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