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ABSTRACT

This paper utilizes case study findings of the implementation of educational computing in two schools, one elementary school and one fifth- through sixth-grade school, to reflect on recurrent patterns that account for the slow pace of change in instruction. In particular the study focused on the structural arrangements of teachers' work and the way in which teachers made sense of their world. The administration at both schools aimed its support of instructional computing at providing in-service training for teachers and purchasing hardware and software, neither of which is enough to create conditions for extensive and systematic instructional computing in the classrooms. A computer literate staff alone does not produce generalized computer use. Command over technical and social resources is a necessary but not sufficient condition for the systematic implementation of instructional computer activities. In the sites studied, one of the strongest determinants of how extensively and in which ways computers were used was the structure of the schools. Another strong influence on educational computing was the staff's occupational culture, their perceptions of the student body and what constitutes legitimate school knowledge. The analysis is based on an ethnographic study conducted in the 1984-85 school year, 3 to 4 years after computers had been introduced in these schools. (Contains 26 references.) (Author/JB)

Research Report #4

The Impact of School Wide and Classroom Elements on Instructional Computing: A Case Study

by

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Abstract

This paper utilizes case study findings of the implementation of educational computing in two schools to reflect on recurrent patterns that account for the slow pace of change in instruction. In the case study reported in this paper, the administration at both schools aimed its support of instructional computing at providing in-service training for teachers and purchasing hardware and software, neither approach enough to create the conditions for extensive and systematic instructional computing in the classrooms. A computer literate staff alone does not produce generalized computer use. Command over technical and social resources is a necessary but not sufficient condition for the systematic implementation of instructional computer activities. In the sites studied, one of the strongest determinants of how extensively and in which ways computers were used was the structure of the schools. Another strong influence on educational computing was the staff's occupational culture, their perceptions of the student body and what constitutes legitir.. .te school knowledge. The analysis is based on an ethnographic study conducted in the 1984-85 school year, three to four years after computers had been introduced in these schools.

Introduction

The findings reported in this paper challenge the usual accounts of why classroom instruction has changed so little over the years. A case study of the introduction of educational computing in two schools illuminates the gap between courses of study and classroom instruction. The case study shows the effect of school structure and culture on the process of implementing educational computing.

The introduction of computers in schools has been promoted as an effective means to accomplish every educational aim for every group. It would provide remedial assistance to underachieving students and opportunities for enrichment to gifted students; it would free teachers from routine tasks and allow them to focus on creative teaching. Empirical evidence, however, does not support the effectiveness of computers to provide either effective remediation or enrichment (DeVillar & Faltis, 1991).

In the last decade schools have acquired computers in large numbers, and predictions of the impact computers can have on instruction hastened even more the pace of adoption of the new technology. These predictions have been based almost exclusively on the technological capabilities of computers. There is, however, evidence that the social and political relationships that prevail in an organization influence the utilization of computers (Kling & Scacchi, 1980). Sheingold and her associates found that in four school districts microcomputer innovations were highly consistent with each school district's "needs, values, and ways of operating" (Sheingold, Kane, & Endreweit, 1983).

The way shared meanings have shaped the implementation of educational computing in unanticipated ways is consistent with findings in the field of educational change. Michael Fullan (1991) argues that,

> One of the most fundamental problems in education today is that people do not have a clear, coherent sense of *meaning* about what educational change is for, what it is, and how it proceeds. Thus, there is much faddism, superficiality, confusion, failure, and misunderstood reform. What we need is a more coherent picture that people who are involved in or affected by educational change can use to *make* sense of what they and others are doing (p. 4).

This paper contributes to an understanding of why teachers have been reluctant to use computers as an instructional tool by analyzing the ways in which distinctive features of two schools—one K-6 grade school and one 5-6 grade school—conditioned the extent of computer use and shaped the form and substance of educational computing. The paper focuses on the structural arrangements of teachers' work and the ways in which teachers made sense of their world, particularly how they defined the student body and what constituted legitimate school knowledge.

Research Background

Recent studies of educational computing have described how aspects of the structural, symbolic, and political dimensions of schools have affected the implementation of instructional computing (Sheingold et al., 1983; Kling & Scacchi, 1980). Typically, however, these studies have not included an integrated analysis of these dimensions. This study attempts to do such an analysis by looking both at structure and at the way actors create, recreate, and interpret it. In using the term *structure* I refer on the one hand to the organizational framework of schools, the differentiation of positions, the rules, the procedures and the prescriptions of authority; and on the other, to the emergent patterns of interaction, to the ways in which "actors actually transact their work, formulate policy, and allocate resources" (Ranson, Hinings & Greenwood, 1980). I will focus on the organizational framework in which teachers work, their ways of making sense of the world, and the patterned regularities that they create and recreate (Bartunek, 1984; Ranson et al., 1980). I will then examine the interpretive schemes of teachers that map their experience of the world and identify and interpret its relevant aspects (Ranson et al., 1980). Finally, I will draw attention to those relations of power that enable some organizational actors to shape and constitute structure according to their understandings of reality (Ranson et al., 1980).

Recent research literature has singled out lack of technical and social resources as a major structural constraint to developing teacher commitment to educational computing. The issue is not only the number of computers available, but also computer capability, computer allocation, and software purchased. To begin with, the majority of schools that have computers have fewer than ten (Becker, 1985). Furthermore, decisions about computer allocation can enhance or limit access to the hardware, expand or reduce time for computer activities (Becker, 1985), and affect the degree to which instructional computing remains peripheral to school work (Sheingold, Hawkins, & Char, 1984). At most elementary schools, teachers have access to one or two computers at best. Some schools have a computer lab, and teachers have to schedule their class to use the lab. In addition, only a few teachers design and implement computer activities suitable to their curricular needs while most rely on prepackaged curricular units (Jungck, 1985). The kinds and amount of software available in the schools shapes the range of activities that can be implemented (Sheingold et al., 1983), and teachers complain that their choices are limited. In effect, most of the software available in elementary schools is for drill and practice, particularly in math and the language arts (Becker, 1985). Finally, a relatively small number of teachers are competent computer users.

Research suggests that two other structural elements shape the implementation of educational computing. First, different patterns of interaction between teachers create different channels of access to those with computer knowledge. Regular interaction between teachers fosters the creation of support groups for learning and experimenting with computers while little contact between them limits the ability of isolated innovators to influence their peers (Sheingold et al., 1983). Second, established styles of teacher-student interaction set limits on what can be done with computers. Instructional computer activities adapt to the style of existing classroom practice instead of radically changing it (Chandra, 1984; de Acosta, 1993).

In and by themselves these structural elements do not determine how educational computing is implemented. Teachers' perception of their students' needs, of how organizational arrangements constrain or enhance their work (Chandra, 1984; Jungck, 1985), their confidence about their computer expertise (Chandra, 1984), and their assessment of the pay-offs for carrying out instructional computing in their classrooms affect their commitment to the new technology (de Acosta, 1993). Teachers are the ones who have to figure out how to integrate computers into the curriculum (Sheingold et al., 1984). Their understanding of what type of instruction would benefit their students influences the kind of software they select and the extent to which they use computers (Becker, 1985). Whether an elementary school provides drill and practice software and microcomputers to lower-achieving or to better-prepared students reflects different assumptions about the role of personal interaction in helping students to master basic skills (Becker, 1985).

Teachers' notions about the extent to which computers should be used and what they should be used for are influenced not only by their understanding of the curriculum they have to teach but also by their views about classroom management (Chandra, 1984). Teachers who think that they should be an authority figure in the classroom often disapprove of the use of computers. Finally, understandings about educational computing are affected by teachers' conception about computers (de Acosta, 1993).

Studies about the salient aspects of the structural arrangements of the schools have shown that their organizational framework (Lortie, 1975), available resources (Gross, Giacquinta, & Bernstein, 1975) and the patterns of work in the classroom (Doyle, 1981) shape teachers' planning and work. Lortie (1975) has shown how the cellular form of school organization and the way space and time are patterned work against teacher interaction and, as a result, foster individual solutions to shared problems. Gross et al., (1975) found that lack of two basic resources (skilled staff and adequate tools and materials) accounted to a large extent for a failed innovation.

In their research on classroom context, Cohen, Intili, and Robbins (1979) have found that different kinds of activity structure demand different kinds of student supervision. When the teacher organizes the class so that several tasks take place simultaneously, the opportunity to give individualized assistance increases and control of student behavior is less visible than during whole class instruction (Bossert, 1979). Small group and individualized instruction increase the complexity of the activity structure and demand the replacement of direct control by bureaucratic forms of control (Cohen et al., 1979).

Although research on classroom management has shown the connection between activity structure and management style, it has not taken notice of how teachers' understandings about their work affect their selection of activities. This has been done in studies of how teachers make sense of their reality, particularly in studies of faculty culture. The principles and beliefs expressed in the faculty culture are translated into teachers' perspectives which are constituted by rules for work that they negotiate daily with colleagues, administrators, and students (Page, 1984). Assumptions about subject matter, their students, and work underlie teachers' selection of instructional activities. Different perspectives lead to different definitions of the reality of work and the classrooms which lead, in turn, to different practices (Popkewitz, 1978).

The power relations prevailing in a school enhance the ability of some school members to make their interpretations of reality heard. The control exercised over teachers' work is a salient aspect of these power relations. This control can be personal, bureaucratic or, as Gitlin (1980) found, technical control embedded in a curriculum that specifies behavioral objectives and classroom activities sets a pace for work and evaluates students according to the number of objectives the students have accomplished. At the informal level, interpersonal politics allows teachers to use power strategically to protect their own behavior and to influence that of others (Blase, 1987).

This paper goes beyond current research on educational computing by giving an account of how the definition of educational computing at each of the schools in the case study was socially constructed. Furthermore, it analyzes the specific conditions set by the structural framework of the school and the power relations between the teachers at each school that patterned the construction of the meaning and the implementation of educational computing.

Research Design

This paper is based on an ethnography in two suburban schools, one a K-6 grade school and the other a 5-6 grade cluster school. The schools, located in the suburbs of a large metropolitan area, were selected because they were identified by the local educational computer users' group as the most advanced in their implementation of educational innovation. If educational computing was having positive effects on teaching and learning, I could expect to find them at these schools.

I spent the entire 1984-1985 academic year in the schools. I observed a wide range of settings, most of the time in classrooms. I attended classes daily, spending a few weeks in each of the classrooms. In some classrooms, the teacher asked me to help; in others, I sat in the back and blended in with the students. The classes ranged from social studies to language arts and math.

I offered to help teachers in the classroom as long as it did not interfere with my need to observe and take notes. In most of the classrooms I was just an observer, but in six classrooms I assisted teachers. My activities increased the number of students who received help, but I thought that "the cost of altered events was far less than the benefit of greater understanding. Although I influenced events observed by participating, my involvement deepened my insight" (Hart, 1982, p. 415) . By participating I gained a closer rapport with students and teachers. I was able to observe closely the interaction between students. In addition, collaboration created more opportunities for teachers to describe their activities and rationales.

I also observed in the hallways and backstage areas (Goffman, 1959) such as teachers' lounges. I attended staff meetings and open houses. I regularly ate lunch with the teachers and with the students. Through informal conversation and open-ended interviews, I gathered participants' accounts of their activities. I read documents to gather additional classroom and school information. After an initial period of guardedness, teachers and students began to treat me as just one more member of the staff.

The results of this study were presented to the teachers and principals who gave their time and trusted the researcher with their perspectives and concerns. The findings were presented at staff meetings at both of the schools. Many teachers acknowledged descriptions and analyses that applied to them but other teachers, and at times the principals, indicated it was the first time they had thought of some issues in the way presented. The presentation generated animated discussions. The results were also presented at two state meetings for teachers. In these meetings teachers told me how, in their schools, they had faced situations similar to the ones I described. These presentations of research findings to teachers and principals afforded them an opportunity to reflect on their working conditions and on the role of the new technology in their classroom.

The Schools

The two schools in this study were located in the suburban belt of a large metropolis. Oakgrove[1] was located in one suburb, Elmway in another. Although similar in some respects, the communities differed in significant ways. The communities were similar in that they both had well-financed schools and, in both, staff and students felt they were performing well. They were different in the ethnic composition and socioeconomic level of their student bodies: one district was more diverse in its racial and socioeconomic composition.

Oakgrove was situated in a predominantly black neighborhood of an ethnically diverse district with a substantially lower income than the district's median. Oakgrove was an elementary school with an unbalanced racial composition—almost 80% of its students were black—located in a relatively low-income neighborhood. At a time when educational computing was being touted as the new wave in educational innovation, Oakgrove was transformed into a computer magnet school[2] in an attempt to attract white students. The school was unable to draw large numbers of white students even though it had won several excellence awards and had strong support among the parents of its students.

Elmway, which was located in a more homogeneous district in both respects, had a student body constituted by predominantly white middle-class students. Elmway, was a cluster school characterized by team teaching for grades five and six. As a result of parental pressure the school had gone through several changes in its history from an open classroom setting to a mixed setting with some open and several self-enclosed classrooms. The school combined what are usually referred to as "child-centered' and "subject-centered" teaching styles.

The structure of the two schools was different. Their patterns of division of labor set them apart. At Oakgrove, teachers were responsible for a class in self-enclosed classrooms, at Elmway that responsibility was shared with a team. The typical pattern of interaction between teachers was shaped, in part, by the schools' structure and also by informal processes that created various degrees of solidarity and support. At Oakgrove, self-enclosed classrooms isolated teachers, but monthly staff meetings and the personal, close style of supervision of the principal created a sense of participation in a common enterprise. Teachers accepted the principal's tight control because they considered it necessary to bring out the dedication their students required. Over and over, teachers described the school as family. At Elmway, teamwork facilitated interaction between team members, but hindered contact with members of other teams. The principal's style of coordination at Elmway was very different from that at Oakgrove. The latter was based on the assumption that teachers were professional experts; therefore, it was unnecessary to supervise them closely.

Not only did the school differ in their structures, they differed in their faculty cultures in a number of ways as well. First, each faculty had distinct images of its role derived, to a large extent, from their perception of its students. At Oakgrove teachers thought that students, given the low socioeconomic status of their families, lacked many of the skills required to succeed in school; at Elmway, teachers assumed that the parents—many of whom are professionals, managers, and small entrepreneurs—had taught their children the skills needed to succeed in school. The differences found in faculty cultures at these schools are consistent with those found between faculty cultures at other middle-class and working-class schools. Different prescriptions for effective teaching ensued from different attributions of student needs. While much attention was given at Oakgrove to a caring relationship with students and developing their trust and commitment, at Elmway much attention was given to students' individual differences. Second, while the faculty at the two schools described themselves as professionals, they valued different dimensions of professionalism. At Oakgrove, they valued dedication to their work; at Elmway, they valued their autonomy and accompanying discretion to define a teaching style.

The Educational Computing Programs

The K-6 course of study written for Oakgrove and the course of study written for Elmway (and other schools in that district) shared common goals. Both were aimed at teaching programming and enhancing students' learning in various areas by the use of prepared programs. In the words of the developer of the course of study for Oakgrove, there was a lot of agreement about what educational computing should be,

> The big question is whether computer literacy is using a computer or programming a computer. Set that aside and there is agreement. So we did both of them.

The time that lapsed between the installation of computers in the classrooms and the writing of courses of study ranged from one year at Oakgrove to three years at Elmway; consequently, a lot of things were being tried before teachers knew what the course of study specified. Moreover, because the course of study was not followed by curriculum development, questions about when educational computing was going to be taught, where, by whom, and how, were left to teachers.

Oakgrove had forty-four computers at the time of the study. Sixteen were housed in the lab and the rest in classrooms and resource rooms. But, as is the case with many elementary schools, the capacity of a large number of the classroom computers was limited. Teachers who were interested in using computers systematically competed for eight computers with more capability. The summer before the computers were brought to the school, teachers were trained to use them as was customary at the time; they learned how computers work and they learned some elementary programming. Several teachers took courses on their own about specific applications and a few about how to integrate educational computing into the curriculum.

Three different kinds of settings were used for computer activities at Oakgrove. One was the computer lab, where a computer teacher taught programming in BASIC and less frequently, supervised drill and practice programs. All students attended the lab for one period each week. In addition, students in grades four to six went to the computer lab with their own teachers for math drill once a week. A second place where computers were used was in the special classrooms—a resource room to teach all students observational skills and a math classroom for gifted students. In each of these classrooms, which had one or two computers, students used LOGO, a database management program and problem-solving software to teach students about classification and patterns. A third place where computers were used was in the classrooms. In most of them, there was one computer; in a few, two. Most teachers, provided drill and practice programs for their students after they had finished their work. They made no effort to give all students access to the computer nor to supervise work in the computer corner. When they selected software, most of these teachers chose one that was tightly connected to something they had recently taught. Less than a third of the teachers used computers regularly for projects which were integrated with learning activities in math, science, or language arts.

Elmway had thirteen computers. The staff experienced no problem in terms of their capacity, and there was plenty of software for them. Each team had two computers, the rest were in the media center. Computer use varied from team to team. In one team all students took turns at the computer around the clock, usually for drill and practice and occasionally for what teachers labeled "problem solving." In two other teams, computers were used predominantly before school by motivated students who volunteered to come. In the last team, computers were used mostly for games during free time.

Teachers at Elmway had been trained in the use of computers along similar lines to those at Oakgrove. They learned something about how computers worked and a little bit of programming. Later, some teachers took additional courses on authoring systems to develop their own lessons. The computer "buffs" at Elmway had learned about computers by playing with them for many hours on their own time.

Patterns Common to the Two Schools

Administration Views and Resulting Behavior

The first characteristic common to the two schools was that the administration viewed inadequate resources as the main obstacle to the expansion of educational computing. Consequently, their policy was to improve and expand the available hardware and to carry out teacher training. However, many of the teachers were computer literate; they did use computers for grade management, word processing, and the printing of banners and invitations. They did not need to know how to use computers, but how to use computers in the classroom and to have administrative support to do so. One of the most active computer users at Oakgrove said,

> What is needed is total school commitment; every teacher has to understand that she has to use computers as educational tools and that is not happening now.

In her view school commitment and integrating computers into the curriculum were two central elements of educational computing innovation that were absent in her school.

Schools' Inflexible Structural Arrangements

A second characteristic common to the two schools was that, to a large extent, computer practices reproduced and legitimated the schools' structural arrangements. At the school level, there was little evidence that the school structure adjusted to educational computing. At Oakgrove, the bulk of systematic computer activities took place in the computer lab, and, although Elmway did not have a lab, the staff was looking forward to having one. At both schools the majority of the staff expressed a preference for placing computers in a separate setting and setting predetermined times for computer activities, as well as hiring a special teacher to oversee them. Inadequacy of resources was offered as the reason for preferring a lab. Adding onto programs is a common strategy for educational reform because it minimizes the need for structural changes, but, at the same time, it isolates the new practice from the rest of the curriculum. Only one or, at best, two computers for a large group of students in each classroom created classroom management problems for many teachers. In addition, several teachers felt they did not have the expertise to select software and implement projects that were suitable to their instructional goals.

Although space and time were found for computer education at Oakgrove—in the way of a computer lab and a resource room—the same did not happen in the classrooms. Although the principals at both schools told teachers that they wanted to see an expansion of computer use, they did not encourage it either by their assignment of responsibilities or by their reward system. While teachers were expected to meet certain well-defined goals in areas, such as math or science, the goal for educational computing seemed to be reduced to exposure to computers, or time spent at the computer. At the classroom level, teachers did not modify ingrained practices regarding the organization of time and space, nor their ways of setting up instruction to carry out computer activities in a systematic manner. Instructional computing adapted to existing practice. If existing practice conflicted with instructional computing, the latter was dropped after a trial period.

Usually, computer activities flourished in classrooms where small group or individualized styles of teaching prevailed (dc Acosta, 1993).

Absence of Outcome Evaluation

A third characteristic of the implementation of educational computing common to these two schools was the absence of evaluation of computer activities. This resulted in limited computer activities in many classroom. As this teacher explains,

> We have eleven subjects to teach this year. We had to teach a political science unit because of the elections...then comes a dental hygiene unit, and you have to drop everything else to teach that. And, on top of all that, we have "computers" which isn't even graded. When are you going to teach that? If they took something out, then you could do computers. That's why we push it aside.

The lack of clearly specified expectations and the absence of teacher-student interaction about the work that was being carried out at the computer contributed to crystallize an abstract characterization of computer activities as "time spent at the computer" which was used by many teachers. When I asked one teacher whether there was pressure from the principal that she implement educational computing in her classroom she answered,

> Not that I do something with computers, but that the children get to use the computer more; the pressure is about time.

Principals and many of the teachers discussed educational computing, not in terms of what the students were learning, but of abstract time at the computer.

Lack of formal evaluation also resulted in scant teacher supervision of computer activities, and an almost complete absence of student feedback about what was going on in the computer corner. In most classrooms teachers did not know what was going on in the computer corner. Students working diligently, students frustrated by their inability to solve problems, students hitting keys at random, students playing with a classmate at the computer corner, were ignored in most classrooms by their teachers.

Support Among Computer Users

Teachers who were active computer users shared information with each other and gave assistance to those learning new software or running into difficulties. They also liked to share their little triumphs.

> *Field Notes*. Oakgrove. When Mrs. Parker finished printing the forms with the information from the children who had been working on a data base project on animals, she said to me: "Mrs. Moore (the computer teacher) will be pleased to see the printed forms."

Different Patterns in the Two Schools

Structural Arrangements and Educational Computing

School Wide Structural Patterns

In the previous section, I discussed the inflexible nature of both schools' structural arrangements. It is true the structures did not adapt to educational computing, but because there were differences in the structural patterns at each of the schools, the way in which educational computing was implemented differed.

The ways in which teachers' work was structured at these two schools created a set of conditions to which educational computing adapted. At Oakgrove teachers worked in self-enclosed classrooms and engaged in few collaborative projects with their colleagues. When one teacher in the resource room implemented a data base project that required that students do library research during regular classroom time, she found that, given Oakgrove's structure and the fact that there was no precedent for collaboration across classrooms, it was difficult to gain teacher support.

> *Field Notes*. Mrs. Parker has printed a data base form with the information one student has collected about one animal. She is planning to take it to the girl, who she says will be thrilled. But another reason for taking it is, according to Mrs. Parker, that the girl's teacher has not given her students time to do research during school hours. This student has done all her research at home. Mrs. Parker wants to use this opportunity to exert some pressure on the teacher.

Classroom Structural Patterns

The activity structures and style of student supervision that prevailed in a classroom strongly influenced the extent of computer use. A majority of the teachers at Oakgrove and Elmway favored whole group instruction and had a direct, personal style of supervision of student work. These teachers did not use computers regularly. Because they disfavored learning activities over which they had little control, such as individualized learning activities, their efforts to use computers were shortlived. Those among them who continued to give their students access to computers, did so either during free time—after students had finished their assigned work, during recesses or during lunch periods. Most of these teachers expressed a desire to move all educational computing to a computer lab.

As a matter of fact, at Oakgrove a few teachers who rarely turned on the computer in their classroom did take their students once a week to computer lab for math drill. They preferred the lab for educational computing because all the students were doing the same task simultaneously; therefore, they could respond to requests for assistance and could inspect the work of each student. Many of the teachers who favored small group instruction or individualized work scheduled computer activities regularly. Interestingly, although these teachers had established mechanisms to assist students and monitor their work, few among them did the same thing for those students engaged in computer activities. They only inspected the output of students' work when the software allowed them to do so at their convenience. As I will discuss later, this was due to the fact that even in these classrooms, computers were often considered a marginal teaching resource.

Power Gained by Computer Experts

Pay-offs for becoming regular computer users were not limited to the classroom; those who became visible computer users increased their ability to have access to scarce resources. At Oakgrove they had a virtual monopoly on the hardware with more capacity. Furthermore, regular computer users were the ones who suggested what software to buy. The new influence gained by the computer experts, informal and not sanctioned by the principal, was welcomed by some teachers and perceived as a threat by others according to how they thought it affected their autonomy. Teachers who did not use computers interpreted the influence of the computer buffs as a threat to their ability to define what went on in their classroom.

So, while most teachers used school-established practices and rules as an explanation for why they did not engage in educational computing, others proved that it could be done under those circumstances. It is clear, however, that the cost was high in terms of commitment, and only those who perceived some pay-offs were willing to do it. Some teachers saw their role enhanced by their ability to teach in new ways, others discussed how they saw their influence in the school grow, and still others indicated that they anticipated career moves; two teachers indicated that they thought they could move to other positions because of their knowledge of educational software.

Faculty Perspectives and Educational Computing

Faculties develop customary ways of thinking about the problematic situations they face at school and behave accordingly. Teachers develop group perspectives on a large number of situations; thus, they typify those features of their work setting and of the students they will attend to.

Work environment

Teachers portrayed their work environments as something fixed and resistant to change. In particular, most of the teachers who did not use computers argued that it was impossible to use computers given their working conditions. These teachers described the constraints imposed by a skewed distribution of resources, by the schedule, and by the lack of released time to develop computer projects. They also indicated that the prevailing definition of teachers' roles restricted their ability to develop instructional computing projects for their students. Typically, teachers listed activities they were accountable for and their responsibilities outside the school to demonstrate how little time they had to look for software or develop ways of integrating it to the curriculum. This is how two teachers described it,

> *Mr. Martin*: The amount of work we have to do every year is greater... progress reports for students who are having problems, lesson plans for those who take a vacation, paperwork you find every time you look in your mailbox.
>
> *Mrs. Coles*: When I had the baby, I stopped taking school work home.

Both at school and at home, competing demands limited the time teachers can spend learning about computers, experimenting and finding ways to integrate them into the curriculum.

Nevertheless, at each of the schools a small group of innovators was able to work around those structural conditions and implement instructional computing as a regular feature in their classrooms. In the beginning, these teachers were not more knowledgeable about computers than their peers. Knowledge was not why they became committed to computers in the first place. These teachers thought that they could enhance their teaching by integrating instructional computing with other learning activities. One teacher, for instance, developed a LOGO unit to teach a lesson about polygons; another used a data base system to teach students how to compare drugs; a third one taught students about patterns and attributes with the assistance of educational software packages.

These teachers interpreted school rules differently from their peers. Rules did not constrain them—they found ways of getting around them. When it was not possible for students to complete their assignments at the computer during regular periods, these teachers asked students to work at the computer during their lunch break, before and after school. At Oakgrove students came after school to work in the LOGO projects, and at Elmway one teacher offered courses before school for interested students in word processing, problem solving, and BASIC.

Students

Teachers' diverse characterizations of their students was at the base of divergent ways of teaching. Although perspectives about students were grounded in the culture of each school, they did develop in different directions at the classroom level. At Oakgrove the socioeconomic level of the students was a salient element in teachers' characterization of their students. Teachers thought that the relative low income of the students' families created poor grounds to prepare them for academic success. (The small percentage of students who were bussed in for the magnet program did not alter the image created by the presence of a large proportion of neighborhood students.) Hence, a large number of school activities were aimed at engaging the students in learning, making them feel that they belonged in school, and challenging them to do serious work. In order to do this, the staff imposed strict discipline and high expectations, but at the same time showed a lot of warmth and caring for the students. According to students and teachers, this behavior on the part of the staff created a feeling of being "part of a big proud family."

This characterization of students and their needs had two implications for educational computing. First, it was often assigned a marginal role in the classrooms. Teachers thought that mastering the core curriculum was more important than computing. In addition, in their view, what students could accomplish drilling at a computer came a distant second to what they could learn from the personal help given by a teacher. Second, the notion that the school was a place for "serious work" implied that teachers were the sole definers of educationally legitimate computer uses. Programming in BASIC and LOGO, drill and practice, problem solving, simulations, and word processing were seen as legitimate educational uses of computers. Games were not. No adventure games or arcade-type games were used at Oakgrove, although nobody frowned upon drill and practice programs that rewarded students who had successfully solved a number of math problems with arcade-type screens.

Some teachers decided what role to assign to computers at the beginning of the year and followed through with no variations. Such was the case of the teachers in the lower grades. In previous years, the first grade had tested relatively low in reading compared to other schools in the district. Therefore, these teachers felt that their priority was to improve students' reading skills. They committed themselves to the implementation of a new reading and writing program relegating computer activities to free time. Other teachers periodically reassessed how much time should be assigned to computers and when students should use them on the basis of their continuous monitoring of students' progress. A case in point was one sixth grade teacher who had planned simulations and data bases, LOGO, and word processing projects for her students. At the beginning of the school year, the one computer in her classroom was used around the clock, but when she felt students were not keeping pace with their work, she would turn it off for a few days. She even dropped the LOGO projects after a few months in order to concentrate on the math required for the students' grade level.

At Elmway, the central feature in the staff's characterization of students was their diverse learning styles. Teachers thought that, given the students' socioeconomic status, they had been well prepared for school; furthermore, they thought that students had diverse learning needs. In fact, the desirability of having teams with divergent teaching styles was a central theme of the school's ethos. This diversity in teaching colored the implementation of educational computing. Indeed, there was more diversity at Elmway in the way teachers set up computer activities and in the kind of software they gave their students than that described at Oakgrove. The software ranged from drill and practice and word processing to "problem solving" and games. The issue of what type of software could be construed as problem solving and which were strictly games was controversial at Elmway. On the one hand, the majority of teachers who rarely used computers thought that unless the software dealt explicitly with school topics it should be considered a game. On the other hand, a few teachers defined any software that demanded thinking and analysis as "problem solving software." This category encompassed mathematical pieces such as "Puzzle Tanks" and adventure games such as "Mask in the Sun." Only one teacher argued that arcade-type games had educational benefits such as improving eye-hand coordination. Attributing educational benefits to adventure-type and arcade-type software legitimized their use during school hours.

Aside from differing in the extent of computer use and the kind of software selected, teachers at Elmway differed in the degree to which they allowed students to participate in the selection of software. Teachers with a direct style of control decided by themselves what software their students would use. Teachers with a delegated style of control negotiated with students what software to use. Some even allowed students to bring games from home.

Conclusion

The previous discussion shows that the impact of various structural and symbolic elements on educational computing is not linear. It is impossible to assert, for example, that the larger the number of computers in a school, the greater their use. Structural and symbolic elements affect the implementation of education computing in more complex ways. Some, such as command over resources, operate mostly to create the conditions that enhance or inhibit computer use, while others, such as faculty culture, influence the selection of software and who has access to it. Furthermore, these elements do not operate independently from one another. For example, power and command over resources are related. Those who are more influential are also those who are often able to gain command over some critically scarce resources.

This case study draws our attention to some of the pitfalls of developing curriculum in the direction of what Kliebard (1977) has called the bureaucratic model of curriculum development. Early in this century, school administrators applied the principles of scientific industrial management to school management and later the bureaucratic model was applied to curriculum development. The bureaucratic model of curriculum development values the efficient production of standardized outcomes. A central tenet of such a style of curriculum development is the need to acquire those resources that will allow more efficient production. At both Oakgrove and Elmway, principals were focusing their energy on purchasing hardware and software, and they were investing in teacher training. At the same time, the relevance of computer education to various areas of the curriculum went unquestioned. This case study reaffirms Sheingold et al.'s (1984) finding that teachers are left to consider whether the software is educational and relevant to curriculum goals. Moreover, given that hardware is still scarce and that teachers are being urged to integrate computers to all areas of the curriculum, it is to be expected that computer activities will typically consist of one or two students working at the computer.

Teachers should not be asked to implement educational computing with little administrative support and blamed for not accomplishing it. Computers can be empowering to those who learn how to use them. Pappert's (1980) accounts of what students can achieve through programming in LOGO and Turkle's (1984) description of the role of computers in improving students' writing are among the many that illustrate this point. One must ask whether we are providing learning experiences with computers that lead to gaining command of the technology in such a way. At present the answer is that we are not.

The implementation of computer activities in schools has been tackled as a technical task of identifying skills to be taught and purchasing the necessary hardware and software. Taken-for-granted conceptions of knowledge, of students, and of organizational constraints have gone uncriticized. As a result, computer activities in the classrooms have been usually limited to drill and practice. The implementation of computer activities at Oakgrove and Elmway was pushed forward by the assumptions that computer literacy and different kinds of software applications would improve students' logic skills and achievement in various subject areas. A few teachers reflected on the relevance of computer activities for students' learning, but it was an individual not a group process; hence, it did not carry on to other faculty members. A majority of teachers arrived at an abstract definition of computer activities that took into account only the time spent at the computer. Other teachers who harbored doubts about the relevance of computer activities simply became non-users.

The difficulty of adapting to the new technology within existing organizational and teaching arrangements was not recognized by the administration. When the findings of this study were reported at faculty meetings at these schools, the principals and those teachers who were computer users expressed surprise at finding that non-systematic users experienced structural constraints to educational computing or that teachers did not see the use of educational computing in terms of their instructional goals. Those meetings revealed the limited dialogue regarding educational computing that had taken place in these schools, the limited awareness of contextual constraints, and the extent to which the implementation of educational computing had been conceptualized as a technical task.

This case study has shown how meanings about teaching and learning are contextualized. Often, educators who want to set up computing arrangements in their schools search for the solution that works. They seem to think that some solutions are better than others, irrespective of a school's structure and culture. As a result, they copy solutions because they worked elsewhere. This case study alerts us to the pitfalls hidden in such an approach by showing how differences in structural arrangements and faculty culture between the two schools affected the way in which instructional activities were carried out. The weight of practices that had existed before the introduction of computer activities in the classrooms shaped them so that they could fit into certain time slots, and address the needs of different kinds of students. Fullan (1991) has noted that the neglect of "how people actually experience change as distinct from what it might have been intended—is at the heart of the spectacular lack of success of most social reforms" (p. 4).

Notes

1. The names of the schools and teachers used in this paper are not the real names of the schools and teachers involved.

2. The magnet program was conceived as an enrichment of the regular curriculum, not as an exclusive concentration on particular areas.

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