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ABSTRACT

National survey data are used to address questions about the centralization and decentralization of decision making about computer use in American schools. Settings in which centralization and decentralization in decisions about computers are greatest are considered. The consequences of alternative decision-making structures are also considered, using data from the U.S. administration of the 1989 International Education Association Computers-in-Education survey involving a national probability sample of teachers and administrators from approximately 1,400 schools, with more than 5,500 respondents, including over 3,000 teachers. In the United States, the development of instruction-related computer activities has proceeded in a very decentralized pattern, although administrators and districts have come to take on more importance. Most teachers still use computers with relatively few constraints on their independent decision making. Nevertheless, the outcomes valued by leaders in computer-based education including teachers are related to active district-level involvement and the leadership of a school-level computer coordinator. It appears that reliance on district and school-based computer experts can coexist with the trend toward decentralized site management and increased teacher authority. Increasing top-down decision making can produce better results in instructional computer use. Three figures and nine tables present study data. (SLD)

Top-Down Versus Grass Roots Decision Making About Computer Acquisition and Use In American Schools

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How should schools make decisions about using computers for instruction and learning? Should each teacher have the freedom and responsibility to determine how computers should be used by her own classes? Should school administrators, department committees, and computer coordinators establish policies and provide direction to influence how teachers use those resources? Or should school districts set policies that systematize teacher practices in the district in order to optimize the use of computers throughout their domain? All three of these approaches sound reasonable, and to some extent they are mutually compatible. But only to a point. Increasing teacher autonomy limits the ability of teaching staffs, departments, and school administrators to develop a coherent program for using computer resources. School-level decision-making to the exclusion of district involvement ignores the value of specialized expertise and jointly owned resources--for example, it limits a school's ability to take advantage of economies of scale in purchasing software and hardware. Schools and school systems do have to make choices about where decision-making authority concerning computer acquisition, access, and use should reside. Given the other responsibilities that teachers, school administrators, and district administrators have and given their respective expertise about instruction, resource allocation, and technology, it is fair to ask, "On whose shoulders should be placed the added responsibilities for decisions related to instructional uses of computers?"

As with most issues in education about allocating decision-making authority, people have views about instructional computing that derive from basic assumptions they make about the appropriateness of teacher autonomy and the proper functioning of educational organizations.

For some people, schooling is a complex organization in which teachers and other professionals each occupy important but specialized roles. From this perspective, teachers contribute most to the educational enterprise when they present externally mandated curricula in a motivational way, orchestrating effective activities with classes of 30 or more active children or adolescents, largely using materials such as textbooks and computer programs that have been provided for them. Most teachers, having daily detailed responsibilities for as many as five classes of students or the curriculum for five subject-areas, may not have the time, interest, or perspective for making school-wide decisions about optimizing investments in technology nor perhaps even for making some curriculum and resource decisions for their own classroom. In this view, the challenges of deciding what the best technological resources are in a given situation and deciding how to optimally arrange their use throughout the school is part of the specialized province of administrators--including *line* administrators such as superintendents and principals, who manage the time of subordinates, and the more technically qualified *staff* administrators such as curriculum coordinators and media specialists.

For other people, teaching is a craft that is optimally practiced when teachers have control over resource allocation and curriculum materials that directly affect their own classroom teaching. To optimally select from among alternative resources for instruction requires simultaneous consideration of many factors, and like other front-line professionals, teachers may be in a better position to make appropriate judgments about how technology resources can best be used than administrators who lack knowledge of the climate and context of a specific class. In addition, using complex computer software itself requires a high degree of

implicit context-bound knowledge, and together the situation almost demands context-specific experience for effective decision-making. Thus, from this second perspective, optimal use of technology is not likely to occur unless teachers have as great a control as possible over the kinds of technological resources they can use and the circumstances and methods of their use.

Both viewpoints certainly have some merit. Under this circumstance it may be useful to examine empirical data about the degree of centralization or decentralization of decision-making about computer use in American schools. This paper uses national survey data to address two general categories of questions about the centralization and decentralization of decision-making about computer use in American schools:

- First, in what settings will centralization and decentralization each be the greatest? That is, where will we find schools where teachers have the greatest control over computer utilization and where will we find schools where higher levels of administrative authority retain prerogatives to make these decisions or set policies for teachers or schools to follow?

- What consequences derive from alternative decision-making structures? How are computers used differently and with what result because of the way decisions about computers are handled? The organization of decision-making might affect schooling and learning in a number of ways. For example,

    - Decision-making organization might affect how deeply involved the school becomes in using computers for instruction--how much equipment and software is present and how up-to-date is it, how broadly is it used across the school, and how much is it used?

    - It might influence the distribution of computer resources within the school--how equitable is its allocation and utilization--for instance, do different subject uses or different categories of students dominate school computer activity when different decision-making patterns emerge?

    - And it might affect the intellectual focus of computer use--whether computers are used largely for skill practice and remediation or as tools for intellectual discovery, analysis, and exposition.

Data Source

To answer these questions, data were analyzed from the United States administration of the 1989 I.E.A. Computers-in-Education survey. This survey was conducted in 20 countries to determine the pattern of computer use in elementary and secondary schools in those countries (Pelgrum and Plomp, 1991). The United States portion of that survey involved a national probability sample of teachers and administrators in roughly 1,400 U.S. schools. In the sampled schools, questionnaires were completed by the principal, by the school-level computer coordinator (or the staff member most knowledgeable about computer use), and by two samples of teachers, each of which included both computer-using and non-using teachers. The teachers

included elementary teachers, and, in middle schools and high schools, those who taught mathematics, science, English, or computer education. One teacher sample focused primarily on grades 5, 8, and 12; the other (smaller) sample included teachers throughout the grade range of 3 to 12. Altogether, more than 5,500 respondents, including more than 3,000 teachers, participated in the survey.

The response rate to the U.S. national survey was very good. About 69% of the principals, 76% of the school-level computer coordinators, and 79% of the teacher samples responded by mail. Most of the remaining principals, coordinators, and teachers participated in an abbreviated telephone interview, so we actually have some data on 91% of the sampled respondents.

Actors and Actions

There are several places in a school system where decision-making authority may reside. To simplify, we can imagine different schools in which each of the following actors are critical in making relevant decisions:

- Each teacher acting alone for his or her own classroom needs
- Groups of teachers or a committee of teachers making decisions for the school or a department as a whole
- A school-wide computer coordinator taking actions that affect how individual teachers will use computers
- The school's principal or other administrators setting policy or making decisions for the school
- District-level coordinators or administrators setting policy or taking actions affecting the school's computer use
- Higher-level authorities' actions or policies that affect individual schools

Secondly, there are several types of actions or policies that affect access and utilization:

- The acquisition of hardware and software.
- Policies restricting or mandating *how* computers should or should not be used, *where* they should be used (and located), and *who* should or should not use them.
- Decisions about the content of courses or the specific software to be used in classes where computers are taught about or used.
- The existence and the locus of training, support and encouragement for teachers' computer use.

An analysis of decision-making must take both dimensions into account--the actors involved and the types of actions or policies affecting computer access and utilization.

Descriptive Data About the Locus of Policy- and Decision-Making

The survey incorporated questions concerning each of the four types of actions, policies, decisions, and support structures affecting access and utilization and at the same time inquired about the most critical actors involved. Specifically, for this paper, we looked at six sets of survey questions:

(1) The principal's report about which actors (e.g., district-level or school-level professionals, clients, or outsiders) were most responsible for the school's first involvement in using computers for instruction.

(2) The principal's report of whether district or state policy, school policy, or "no policy" governed 12 aspects of computer use including mandating or allocating student access to computer education or computer-using instruction, the content of instruction in computer education courses, school and teacher selection of hardware and software, and training prerequisites for computer-using teachers.

(3) The school-level computer coordinator's identification of the major decision-makers concerning several decision areas--computer and software acquisitions; allocation of computer access by physical location, courses, subjects, and types of uses; the content of computer literacy classes, and software selected for each teacher's use. The categories used to identify decision-makers were (a) district administrators; (2) school administrators; (3) the school-level computer coordinator (if any); (4) a group of teachers at the school; or (5) each teacher acting individually for her own use.

(4) The coordinator's judgment concerning whether "by policy" there was little variation between teachers' use of computers in terms of the topics for which they used computers, the specific programs that they used, or the way that they organized their classes for computer use.

(5) Survey responses indicating that the school's computer coordinator was in fact a district-level administrator or another outside person, or whether the role was occupied by a full-time or part-time school-level coordinator, a teacher formally acting in that role, a teacher *in*formally taking on coordination activities, or no coordinator at all.

(6) Reports by computer-using teachers at each school about whether it was their choice to use computers in their teaching of other subject-matter or whether they were "expected" to do so by their school or department. In addition, some teachers were also asked to identify who, if anyone, first got them to use computers in their teaching.

These six aspects of the organization of computer use collectively reveal a great deal about the pattern of administrative, collegueal, and individual decision-making that occurs in schools with respect to computers.

(1) First acquisition of computers--who led the effort?

Principals were asked to name the person or group responsible for their school's first acquisition of computers for instruction. They could name one or two such prime movers. In most cases (about 60%), they named themselves (or their predecessor). But about two-fifths of the principals selected (in addition or instead) "district or state administrators". Those responses indicate at least some "top-down" involvement with respect to origination of the school's computer program. District initiation was most common among elementary schools and least common at the high school level.

A "bottom-up" pattern also prevailed in nearly one-half of the schools. In those schools, the principal named one or more department heads, teachers, parents, or students as responsible for the school's first computer acquisition. Those persons were named more often in high schools (65%) than at lower school levels (40%).

Overall, the schools divide into three groups of nearly equal size: one group where the initiative for first getting involved with computers was taken by the district, one where it was taken by the school administrative staff, and one where it was taken by the teachers or parents.

(2) Principal's reports about existence of state, district, and school policies that constrain or prescribe action of subordinates:

Most schools are relatively independent of higher authority in regard to their instructional use of computers. Out of 12 policy areas suggested to principals--from requiring that all students have computer experience to maintaining lists of "approved" hardware or software to mandating equity of access for different groups of students--for no single area did a majority of principals report that their school was governed by a district or statewide policy regarding that issue. (See Table 1.) Only 11% of principals reported district or statewide policies governing a majority of the areas asked about.

Even fewer principals reported school-level policies than reported state or district policies. For no policy area did as many as one-third of schools report having initiated rules or policies themselves. Overall, in the typical (median) school, only 3 or 4 of the 12 policy areas brought restrictions of any kind to teacher prerogative--most commonly, that all students should have computer experience before graduation and curriculum prescriptions for the content of computer literacy and programming courses.

Table 1: Presence of School, District, or State Policies Regarding Computers

Survey Item	% with District or State policy	% with school policy but not higher level	% "No policy"
Policy that all students should have computer experiences	50	13	37
Policy prescribing the content of computer literacy units	45	18	37
Policy prescribing the content of programming classes	36	15	48
Hardware purchases must be on approved list	34	11	54
Policy requiring computer training for certification	24	3	73
Limits on which students may use certain computers	20	10	70
Policy requiring computer use for specific grade level or subject	18	9	73
Software purchases must be on approved list	18	11	71
Policy prescribing the types of software to be used	17	12	71
Priorities among alternative uses of computer	12	12	76
Other policies to assure equity in access to computers	9	9	82
Rules about game playing on computers	2	28	69

(3) The locus of decision-making about computers:

The school-level computer coordinator (the person nominated by the principal as the person most knowledgeable about how the school uses computers) was an important source of information about the locus of decision-making regarding computers at their own school. The coordinator was presented with six areas of decision-making (similar to several of the policy areas about which the principal responded) and asked to identify who at their school makes most of each type of decision--district administrators, school administrators, the school's own computer coordinator (i.e., herself), a group of teachers acting together, or each teacher deciding separately.

There was *some* consensus concerning three of the six areas. In most schools, school-level administrators made decisions regarding acquisition of computers and their location within the school, and teachers (more often than not) chose which of the available computer programs to use in their own classes. But for three other areas--acquiring software, allocating computer time among classes and subjects, and determining the content of courses and units dealing with

general computer education--different schools handled decision-making in different ways. (See Table 2.)

For example, two-thirds of coordinators reported that each computer-using teacher made decisions about which software to use in their own class (and in 56% of the schools, individual teachers was the only category named). On the other hand, decisions about *which* software the school would acquire in the first place was influenced by different actors in different schools and was more often the prerogative of school administrators or the school's computer coordinator. Only at the high school level did individual teachers make the critical decisions in a substantial proportion of schools.

Table 2: The Locus of Major Computer-Related Decisions at Each School

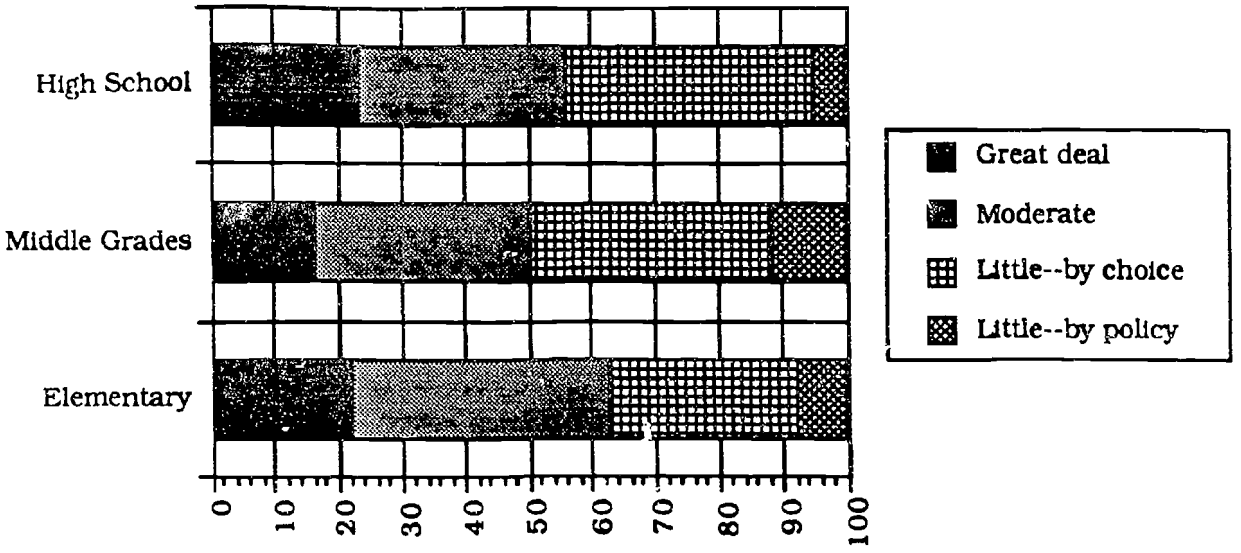
	Who Makes Major Decisions at This School[1]				
Type of Decision	District	School Admin.	Comp. Coord.	Group of Tchrs	Each Teacher
Computer acquisitions	32% 32%	58% 49%	19% 9%	11% 6%	4% 2%
Location of computers in school	9% 9%	69% 66%	21% 9%	19% 11%	5% 3%
Software acquisitions	13% 13%	24% 22%	38% 30%	30% 16%	24% 16%
Content of computer literacy classes	22% 22%	16% 15%	27% 21%	16% 12%	34% 27%
Allocation of time to classes and uses	5% 5%	34% 33%	26% 20%	23% 15%	32% 25%
Software to be used in a class	6% 6%	6% 6%	21% 19%	17% 12%	69% 56%

[1] The first number shown is the percent giving this response. The second number shown is the percent who gave this response *and no higher level of authority*.

(4) The variability of computer use patterns across teachers:

A fourth attribute about computer-related decision patterns comes from the computer coordinator's estimate of how much teachers vary in the way they use computers--and, more central to our purposes here, whether similarity in the use of computers is "by policy" or from teachers having "chosen" to do things the same way. In general, coordinators in somewhat more than one-half of the schools indicate that teachers vary from one another either "moderately" or "a great deal" in the topics for which they use computers, the specific programs that they use, or the way they organize their classes for computer use. (See Figure 1.) Around 40-45% of the coordinators report that there is "little variation" in these matters. And only about 10% report that the similar patterns of computer use that teachers display is due to school policy. Reports from middle-level schools are somewhat more likely to suggest the presence of planned uniformity in teacher computer-use patterns, whereas such constraints are least common at the high school level.

Figure 1: Variations among Teachers in Software Used



(5) Who performs the computer coordinator function?

In about one-half of the schools, someone functions as a formal computer coordinator. A full-time, non-teaching, school-level coordinator is very rare--only 4% of schools reported having someone like that. But fully one-fourth had a teacher who was formally designated as the school's computer coordinator. And in other schools, a school administrator or a part-time teacher or a district-level coordinator acted in that role.

In the other half of the schools, the only coordination regarding computers was informal. In 33% of the schools, one person informally took on that role. And in another 16% no one at all coordinated school-level computing. Elementary, middle, and high schools all showed similar distributions.

The computer coordinator's job is largely one of supervising students and teaching classes. There is time for very little instructional leadership and coordination. On average, the computer coordinator spends only one hour per week training teachers to use computers, 1.5 hours selecting instructional materials, and two hours keeping hardware and software in working order. Even less time is spent writing model lesson plans that integrate computer activities into curricular objectives or writing or adapting instructional software. Only among the 4% of schools with full-time computer coordinators are some of those tasks are being done. In schools with full-time computer coordinators, the coordinator spends 3 hours per week training teachers, 3 hours maintaining equipment and software, and 7 hours per week selecting software and providing materials to teachers. But even that group does not spend appreciable time in curriculum development or producing lesson plans as examples for other teachers to build on. And even 3 hours per week training teachers is not likely to be nearly enough to produce

important changes in teaching practice that take advantage of the potential of computer-based activities.

(6) Teachers' reports about influence over first and current computer use:

Two groups of teachers sampled in the survey were asked questions about the source of their involvement in using computers. One group was asked merely whether it was their own idea to use computers. The other group was asked who suggested that they use computers; second, whether at the time they began using computers they were "expected" to do so; and third, whether at the present time they were expected to use computers in their teaching.

The overwhelming majority of teachers said that it had been their choice to use computers--particularly among secondary school subject-matter teachers. At the same time, a substantial fraction said that, in addition, they had been expected to do so. Altogether roughly one-half of the teachers said that they started using computers either because they were expected to or that it was both personal preference *and* expectations of others that led them to do so. Elementary-level teachers were the most likely to report that expectations governed their use of computers (37% giving that as the main reason; another 20% reporting "both" reasons). Fewer teachers reported expectations governing their current use of computers than reported that as the main reason for their initiating computer use as shown in Figures 2 and 3 below.

Figure 2: Motivation for Teacher's First Use of Computers

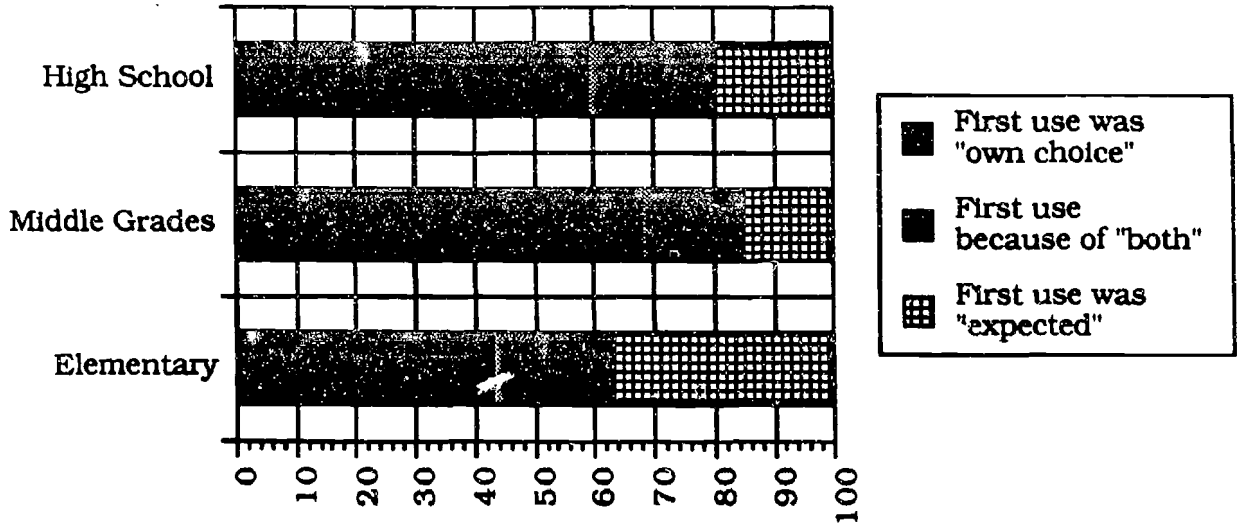
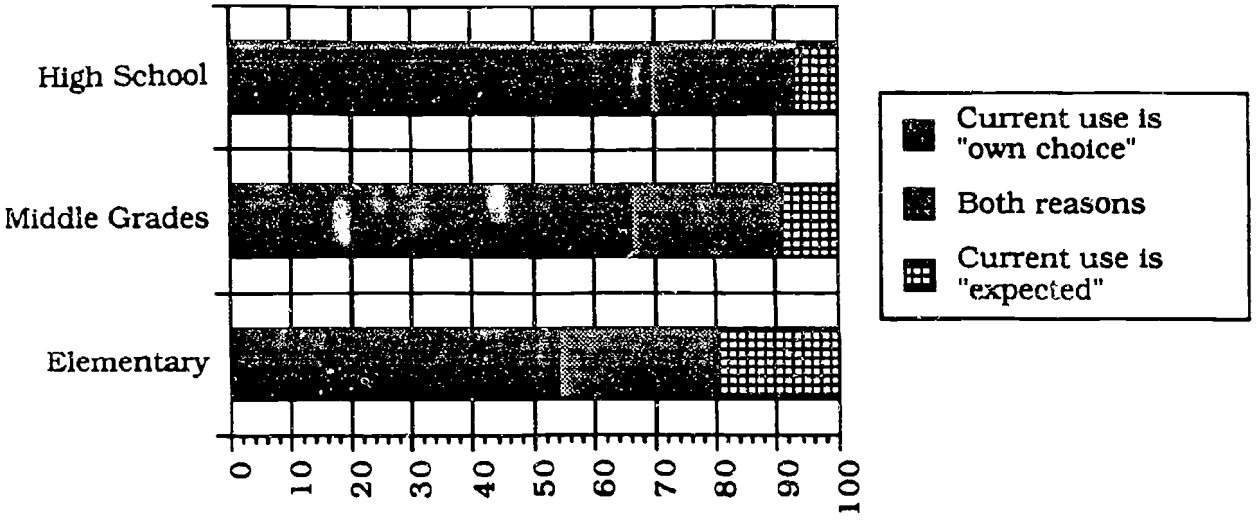


Figure 3: Motivation for Teacher's Current Use of Computers



For some teachers, using computers was their own idea. For others, it was at the suggestion of another teacher, a school administrator, or a school or district computer coordinator. Among our sample, about 1/3 started on their own; another one-fourth at the suggestion of a teacher, department head, or school computer person; another 1/4 at the suggestion of their principal or other administrator, and the rest at the urging of a district level individual.

District, School, and Computer-Using Teacher Levels of Control

One way of summarizing this descriptive data is to combine the responses to each of the survey question about these six policy and decision-making issues into an index of overall involvement of three groups of actors and actions:

- District-level administrators and computer-coordinators and district- and state-level policies
- School-level actors and actions providing organizational direction such as school administrators and computer coordinators and department- and school-level policies. We also include "a group of teachers acting together" for actions that might be taken *for* other teachers, such as influencing the content of a teacher's course or the types of software a teacher would use.
- Teachers acting on their own behalf, or acting collectively to influence school-level acquisitions or allocation decisions within the school (such as where computers would be located).

Based on this categorization of actors and actions, three indices were developed by counting reports indicating the involvement of each of the three groups in computer-related decisions and policies at their school.[1] To standardize across schools, each index was converted to a percentage of the total count recorded for that school. Thus each school's pattern of decision-making is allocated among the three categories--District, School, and Teacher.

Across the 1,105 schools and the six groups of survey questions used, teacher autonomy and organized school influence over teacher practice were both much more powerful than district personnel and policies. The Teacher index averaged 46 percent of all attributions of decision-making influence, the School index averaged 38, and the District index averaged 16. (See Table 3.) Thus, for the kinds of computer-related activities we looked at (e.g., influences on acquisition, first and continued use, selection of materials, allocation of resources, etc.), districts play a much smaller role than schools in providing direction to teachers, and a great deal of teacher autonomy exists in deciding how to use computers for instruction.

Nevertheless, some schools were substantially different from the typical pattern. At 12% of the schools, for example, the district percentage of the decision-making actions tabulated was greater than 33 (indicating that one-third or more was district-originated). At 14% of the schools, the District percentage was larger than the Teacher percentage, and at another 14%, it was larger than the School percentage. But at most schools, districts were less important than schools in determining how individual teachers used computers.

This was particularly true in high schools and, of course, in non-public schools, many of which have little administration above the school level. School size also matters. For example, high schools over 1,000 in student enrollment (most of which are in large districts) have greater district-level involvement and less teacher-level independence than smaller high schools. Similar differences were observed for elementary (K-6) schools over 200 students versus smaller ones. Regional differences were apparent also, with schools in the Northeast and Southern states somewhat less inclined to provide teachers with independent decision-making authority than schools in the Midwest and West.

Table 3 also illustrates that variations among types of schools (e.g., large vs. small, east coast vs. midwest, etc.) are greater for District and Teacher shares of decision-making than for School-level influences. In fact, except for non-public K-8 schools, school-level shares remain between 35 and 40 percent for each entry in Table 3.

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[1] The index-construction process was complex because each relevant survey question had a different structure, different number of items (thus data points), different reliability, and different relevance to each of the three categories. Some weighting of individual item components was done and some responses were split between two indices (where district or school influence could not be distinguished). Further details on index construction are available from the author.

Table 3: District, School, and Teacher Share of Computer-Related Decision-Making

Type of School	District	School	Teacher	Total
All Schools	16	38	46	100
Elementary (K-6)	20	37	42	100
Middle/Junior High	20	38	43	100
High School	13	39	47	100
Public K-8	17	36	48	100
Non-public K-8	7	46	47	100
Public 7-12, K-12	12	35	53	100
Non-public 7-12, K-12	3	40	57	100
High schools:				
Over 1,000 students	19	38	43	100
Under 1,000 students	11	40	49	100
Elementary				
Over 200 students	22	37	41	100
Under 200 students	12	36	52	100
Northeast	16	40	44	100
South	19	39	42	100
Midwest	12	38	50	100
West	14	37	49	100

Consistent with this pattern are the results of multiple regression procedures which modeled each of the three indices as outcomes of eleven demographic and school structural variables--school type (elementary, middle, high); location in the eastern or southern U.S. versus the midwest-far west; large city sites; rural sites; size of metropolitan area; public vs. non-public control; district poverty rate; number of students enrolled at the school; and percent of students at the school who were from minority backgrounds. The regression procedure found that there was greater variability in District and Teacher level influences across demographic and school structural conditions than there was in School level influences. The multiple regression coefficient was .50 for the District percent outcome, .30 for Teacher percent, but only .19 for School percent. In addition, there were seven statistically significant predictors of variations in District percent and four significant predictors of Teacher percent but only one significant predictor (public vs. non-public school status) of School percent. (See Table 4.)

Table 4: Multiple Regression Predictions of District, School, and Teacher Indices Using Demographic and School Structural Variables
(standardized beta coefficients)

Independent variable	District percent	School percent	Teacher percent
Elementary (K,1-5,6)	+.13*	+.03 (note)	-.12*
Middle (5,6,7-8,9)	+.05	+.05 (note)	-.07
High School (9,10-12)	-.13*	+.08 (note)	+.02
Eastern or Southern U.S.	+.17*	+.03	-.14*
Central city (over 200,000 in metro area bigger than 250,000)	-.02	+.04	-.02
Rural (outside metropolitan area or rural portion within metro area)	-.18*	-.09	+.20*
Size rank of metropolitan area	+.06	+.07	-.10
Public (versus non-public)	+.29*	-.17*	-.05
Poverty rate (1980) for public school district where located	-.01	+.06	-.05
Number of students enrolled in the school	+.12*	-.00	-.08*
Percent minority among student body	+.13*	-.04	-.05
Multiple regression coefficient	R=.50	R=.19	R=.30

* Beta coefficient significant at p<.05.

note: All three school type variables shown (elementary, middle, and high school) had positive coefficients. This is accounted for by the fact that multi-level schools (K-8, 7-12, and K-12 schools) have smaller school percent indices than any of those three school types, even controlling on differences in their public vs. non-public organization.

The Underlying Decision-Making Dimension: Top-Down vs. Grass Roots

We can account for the lesser predictability and overall lower variability of the School percent index by positing an underlying dimension of decision-making authority which I will refer to as the "top-down vs. grass-roots" dimension. Under this model, school-level policies and decision-making influence (i.e., by principals, department heads, computer coordinators, and formal teacher committees) constitutes an intermediate level of control over teacher practices compared to outside district influence at one extreme and complete discretionary authority for computer-using teachers at the other. It is true that school-level policies and control may result in *distinct* computer-use practices and other outcomes that are not simply intermediate in effect between district-dominated situations and individual teacher discretion. But for some outcomes, it may simplify discussion and analysis to treat level of control as a single dimension and school-level influence over computer-use practices as an intermediate position between top-down and grass-roots decision-making.

To operationalize this "top down vs. grass roots" dimension, a new variable was defined as the net difference between the District percentage of decision-making involvement and the

Teacher percentage. The value of this variable was most often negative (the mean was -30 on a scale that ranged from -100 to +100). In a comparable regression equation to those in Table 3, the "top down/grass roots" variable had an R = .43 and a vary similar pattern of significant predictors as the District percentage variable by itself. Six of the seven statistically significant predictors remained, and the seventh barely missed p<.05). The most sizeable predictor of grass-roots decision-making was being a rural school (beta=.22). Next-largest coefficients were those for national region (beta=.18; western and midwestern schools were most grass-roots; eastern and southern were more top-down) and public versus non-public control (beta=.17). It is mainly district versus school decision-making that distinguishes public from non-public schools. On average, both sets of schools allocate similar degrees of autonomy to individual teachers.

The top-down index is also higher in schools with a larger proportion of minority students in the student body and in schools with a larger student body overall. Again, it is in the degree of district-level decision-making where the greatest differences arise. In addition, smaller schools provide greater autonomy to computer-using teachers. (See Table 4.)

But how do top-down decision-making sites, grass-roots teacher-autonomy sites, and school-level leadership sites contrast with one another in terms of how computers are used at their schools? And more directly, what consequences for schools flow from alternative decision-making practices? Our data permit us to answer these questions in part--particularly in a descriptive way--but these particular questionnaire instruments and survey research in general limit how far we can assess differences, and in particular, ***consequences***, of alternative decision-making structures. Without longitudinally collected data, it is difficult to know, for example, whether decision-making structure impacts teacher practice or vice versa or even whether the character and characteristics of the school determines both decision-making practices and the way that teachers use computers. Nevertheless, multiple regression procedures allow us to make some tentative judgments about the causal impact of decision-making on computer use practices.

This remainder of this paper examines the empirical association between the locus of computer-related decision-making and (a) the amount of computer-based instructional activity, (b) how computer time is allocated across subject-matter uses, and (c) how the intellectual climate of a school might differ as a result of decision-making practices.

Decision-Making Patterns and the Amount of Computer Activity at School

1. Number of Computer-Using Teachers and District Staff Development re Computers

Schools with greater district involvement in decision-making about computers have more computer-using teachers. In this survey, schools with a low District score (only 0 to 9 percent of all attributed decision-making) averaged 5.2 computer-using teachers, but those with a relatively high District score (25 percent or higher) averaged 8.2 users--60% more. There were two-thirds more computer-using teachers in "high district-involved" elementary schools than in

"low district" ones, one-third more at the high school level, and more than double the number in middle schools.

The question of whether district involvement *leads to* a greater number of users is more complicated. District-level decision-making involvement occurs more often in larger-than-average schools, which, as one would expect, have more computer-using teachers. Controlling on the number of students enrolled and also on whether the school is public or non-public completely eliminates the association between district decision-making involvement and number of teacher computer-users *at the high school level*, but leaves the association substantially intact for elementary and middle schools. At those levels, a change of 30 percentage points in the district's share of decision-making translates into an increase of 2 computer-using teachers per school--a substantial increase.

One way that district decision-making involvement increases the number of computer-using teachers at a school is by causing the district to provide a greater variety of staff development activities. Six types of training activities related to using computers were reported in our survey: introductory courses in using computers; how to use application programs; how to use computers in specific subjects; computer programming instruction; computer electronics instruction; and other. The correlation between district decision-making involvement and the breadth of district-supplied computer training was +.35 (or +.31 if we exclude non-public schools which are largely independent of districts). And breadth of district-supplied computer training had a clear connection to the number of computer-using teachers. Schools that reported 3 or more district-provided training activities had one-third more computer-users, on average, than those with one or two activities (8.4 vs. 6.3) and 50% more than those with no district-led training (5.5).

District-sponsored computer training helps to account for the relationship between district decision-making involvement and number of computer-using teachers--particularly at the middle school level. For middle schools, incorporating district training into the regression model reduces the independent contribution of district involvement as a predictor of number of users (beta reduced from +.09 to +.04). At the elementary level, district decision-making involvement leads to a greater number of teacher users independently of its role as an agent of staff development. The beta is reduced only slightly (from +.18 to +.16) when the training variable is used as a control.

2. Outside Support for School's Computer Activities

Besides directly affecting the provision of computer-related training, district decision-making involvement spills over into other forms of assistance to individual schools, not only by districts but by other external groups such as businesses, teacher associations, colleges, etc. Our survey asked about four areas of support that external agents such as these might supply to computer-using schools--financial support, technical expertise, teacher training, and instructional support. We found that schools having a greater involvement of district policy and personnel in computer decisions also experienced greater support from non-district, external sources in three of these areas--technical expertise, training, and instruction. Greater support

came to district-involved schools from U.S. and state governments, teacher unions, teachers at other schools, businesses, and computer and software vendors than to schools with only internal computer decision-making.

High schools are much more likely than middle schools or elementary schools to receive external support for their computer activities. But an involved district gives *elementary and middle schools* greater access to outside support. From the survey responses of the school's computer coordinator, we built a simple index of the number of indicators of external support (other than support from the district itself). High schools averaged 6.4 supports, regardless of how much district decision-making involvement there was. Middle schools with low levels of district involvement had only 3.8 supports, but those with high levels of district involvement averaged 6.6 supports--as many as the high schools did. And for elementary schools, the difference between low- and high- involved districts was 3.7 versus 5.5 supports--a 50% increase.

Furthermore, a regression equation incorporating District score, school level (elementary, middle, and high school contrasts), public/non-public control, city/suburban/town/rural location, number of students enrolled, district poverty level, district racial composition, and principal-estimated school socio-economic status found that top-down decision-making involvement was one of only two statistically significant predictors of greater external support for school computer programs. (The other was "high school"; see Table 5--Section 1.)

Table 5 on next page

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3. Strength of Computer Equipment at the School

Schools with more top-down decision-making are also more likely to have computers that are networked (r=+.10), computer labs that are used during more hours of the day (r=+.14), computers that are more powerful (e.g., 16-bit) (r=+.07), and a higher proportion of computers obtained in the two years just prior to the survey (r=+.09). Along with having a greater number of computer-using teachers and greater support by outside groups, these variables suggest a more active computer life at schools with more district involvement in decision-making.

Multiple regression calculations confirm that top-down decision-making through district involvement makes a significant contribution to the technical up-to-dateness and usability of school computers. Table 5 shows that, along with the number of students enrolled and "high school," only the top-down index is a statistically significant predictor of as many as three of the four outcomes just mentioned. Among 11 predictors, it is one of four significantly related to having a higher proportion of 16-bit computers, one of only two predictors of the proportion of computers that are networked, and one of four predictors of the amount of time that each computer is used. (See Table 5--section 2.)

Table 5: Decision-Making Patterns Compared to Demographic and Structural Variables for Predicting Extent of Computer Activity (standardized beta coefficients shown where p<.05)

	Section 1			Section 2				Section 3			
	# of Computer Using Teachers	District Staff Develpmt. for Comp.	External Support for Schl. Computing	16-bit Computers as % of Total	Networkd. Computers as % of Total	Mean Hours of Daily Use (in labs)	Obtained Recently as % of Total	Computer Density (Comp / Student)	School Staff Develmpt. for Comp.	% of Computers Used Daily	Computer Use by School Club
Top-Down Decision-Making*	+.12	+.19	+.09	+.07	+.10	+.09					
School-Level Decision-Making*								+.12	+.15	+.16	+.15
Elementary (K-6)	+.11	+.12		-.11				-.20			
Middle/Junior High						+.09					+.16
High School**	+.14		+.14	+.16		+.11	+.08	+.11		+.13	
Public School		+.13					+.16	+.14			
Enrollment Size	+.26	+.10		+.11	+.11	+.18		-.24	+.11	+.08	
District Poverty Rate	-.07	-.07									
School socio-econ-status											+.07
% Non-Minority enrollment								+.13			
City Location		+.25									
Suburban or Town		+.11									

* Only one decision-making variables was included in each regression equation. The regression shown is the one with the strongest decision-making predictor.

** Three of the four school level dummy variables were in each regression equation. The omitted school level variable was "mixed," incorporating K-8, K-12, and 7-12 school types.

4. Density of Computers and Computer Use

Although district involvement leads schools to be stronger technically and more up-to-date, the volume of overall computer use seems more tied to the school's own collective decision-making involvement rather than the district's. (Of course, the causality may work the other way, in that schools with a lot of computer activity may lead to more involvement by the school staff in making collective decisions about computer use.) The proportion of decision-making done by school personnel (apart from teachers individually or collectively deciding for themselves) is positively associated with the following three quantity-of-use variables: the density of computers per 100 students (r=+.11), the percent of computers that are used every day (r=+.14), and the use of computers for a computer club (r=+.15). This was true for bivariate associations and in the multiple regression framework (see Table 5--section 3). Of the eleven predictors in the Table, school-level decision-making was the only one to be a statistically significant predictor of greater quantity-of-use for all three variables.

Finally, just as district-level decision-making was associated with the breadth of district staff development activity, school-level decision-making is associated with school-provided staff development activity. But in this case, the staff development does not even partly explain the relationship between decision-making involvement and outcome variables as it did for districts.

5. Autonomous Teacher Decision-Making and Computer Activity

The converse of top-down district-led decision-making--namely, teachers deciding on their own how they wished to use computers--was not associated in a positive direction with *any* of the variables in the survey that are indicative of active computer use. That finding does not mean that teacher expertise about computer use is not valuable. Teacher expertise is critical. But for an effective program, knowledgeable teacher experts must be co-opted on behalf of the school as an organization--through formal collective decision-making, promotion to a leadership position (i.e., computer coordinator), or influence over administrators' decisions.

Decision-Making Patterns and Allocating Among Alternative Computer Uses

The computer coordinator respondent at each school completed one question designed to roughly measure how all computer time was allocated among alternative uses and functions at the school. They answered about the relatively level of computer use for each of 13 areas including (a) keyboarding instruction; (b) instruction in using word-processing programs; (c) instruction in other computer applications such as spreadsheets and database programs; (d) instruction in computer programming; (e) use of computers for learning mathematics skills and concepts; (f) for learning English skills, writing, and reading; (g) for learning science; (h) for social studies learning; (i) for foreign languages; (j) for music and art; (k) for business education (other than keyboarding or word processing); (l) for industrial arts; and (m) for recreation. Responses were standardized so that all of the answers for one person summed to 100. For this analysis, we combined responses into four categories: computer education (a through d); basic

subjects (e and f); other academic subjects (g through j); practical skills (k and l); and recreation (m). Table 6 shows the mean time allocations to these four categories for elementary (K-6), middle, and high schools. Schools covering more than one school level are omitted from these analyses.

Table 6: Average Allocation of Computer Uses by School Level, 1989

School Level	Computer Education	Basic Subjects (Math,Engl.)	Other Academic Subjects	Practical Skills	Recreation	All Uses
Elementary (K-6)	29	39	18	1	12	100
Middle /junior high	47	21	15	6	9	100
High School	53	15	13	13	5	100

The computer coordinator's answers were gross estimates of time allocation across all student use at their school, so for specific schools the data contains a large amount of essentially random error. Even so, there were some distinct associations between the proportion of computer time going to different uses and the proportion of decision-making attributable to districts, schools, and individual teachers. The distinctions, if anything, were stronger once we controlled on demographic and structural factors such as socio-economic-status and number of students enrolled. Effects were most clearly observed at the elementary level. Table 7 shows results for elementary schools with the "practical skills" column omitted because the overall fraction of time for business or industrial arts education at the elementary level is so small.

Among elementary schools, high levels of teacher autonomy for using computers is associated with activities requiring the least computer expertise--recreational uses and programs for practicing basic math and language arts skills. School-level and district decision-making involvement are both associated with less of that type of computer activity and more with using computers to teach about computers themselves. As shown in Table 7, decision-making patterns are more related to how computers are used than are any of the other structural or demographic variables examined except for district poverty level--high levels of poverty are associated with less computer education and more basic skills uses of computers.

At the high school level, school-level decision-making is associated with more time spent on computer education (beta=+.17), but district-level decision-making involvement is associated (beta=+.13) with academic subjects *other than* math and English and with occupationally related uses such as for business and industrial arts education (beta=+.09). For schools serving these older students, as opposed to elementary and middle schools, more district involvement leads to using computers in other ways besides computer education (beta=-.18).

For middle schools, decision-making patterns were not generally associated with distinctions in use except that decision-making at the school-level was associated with more basic skills use than when teachers were more autonomous. District influence tended to be more in the direction of greater computer education, but the effect was small.

Table 7: Decision-making Patterns and Alternative Uses of Computers: Elementary Schools (standardized beta coefficients)**

Computer-related decisions and policies	Computer Education	Basic Subjects	Other Academic Subjects	Recreation
District share	+.14*	-.07	+.01	-.15*
School share	+.11*	-.08	+.07	-.15*
Teacher share	-.19*	+.12*	-.06	+.23*
Other variables where p<.20				
school socio-economic-status (principal estimate)				
district poverty level	-.22*	+.24*		
public control		-.10	+.20*	-.09
city location			+.11	
suburban/town location				
enrollment size				
% non-minority students				

* p<.10

** Beta-coefficients for the three decision-making variables reflect equations with all other variables and that *one* decision-making variable alone entered. Beta-coefficients for the other variables are for equations prior to the entry of any of the three decision-making variables.

Because the measure of time allocation across alternative uses was so weak, the magnitude of the measured relationships between computer uses and decision-making pattern are fairly small. But in a large fraction of the regression equations calculated, a decision-making variable had a larger coefficient than any other predictor. Out of 15 allocation outcomes studied (three school levels times five types of uses), a decision-making variable (either district share, school share, or teacher share) had the largest or second-largest beta coefficient in ten of them.

The Intellectual Climate for Computer Use in District-Led, School-Led, and Teacher-Autonomous Schools

Computers have tended to be used in pedestrian ways in schools. Most often they substitute for paper-and-pencil individual worksheet activity or they are used as the object of instruction as part of an "enrichment" emphasis on "computer literacy." But the largest potential impact of computers on learning in elementary and secondary schools may well be *neither* improving basic skills nor computer literacy but through engaging students in written communication, thinking, and problem-solving.

In this survey, computer coordinators were asked several questions about software and computer activities at the school. Answers to these questions were combined to form an index used here to estimate the attention being given at the school to computer activities requiring integration of higher order skills for communications and problem-solving. The index is quite limited for our purpose because most items do not clearly distinguish between routine activities employing potentially valuable software used for simple skill-based computer literacy training and activities using the same software but that are structured to actually challenge students to think and solve problems in subject-matter contexts.

One question dealt simply with the presence or absence of different types of software. We counted the presence of the following types of software as indicative that computers might have been used for higher-order thinking: music composition software, simulations, spreadsheets, graphing programs, statistics programs, database programs, science lab interfacing software, robotic control software, video control software, computer-assisted drawing, computer communications programs, and pre-writing software. Of these 12 types of software, the typical elementary school reported having only 2 present (on *any* computers) and the typical middle school and the typical high school had only 4 of these types. But some schools at all levels had as many as 10 types of potentially thought-provoking software present.

In this data, the presence of "higher-order" software is associated with school-level or district-level decision-making rather than teachers deciding on their own how to use computers, particularly at the elementary level. Elementary schools with relatively high teacher-level decision-making had significantly fewer types of software in this list (on average, 1.9) than those with high proportions of school-level decision-making (3.1) or those with relatively high district involvement (2.9).

Regression models were used to compare the strength of the decision-making dimension and various school background factors in predicting greater or lesser presence of higher-order software. The regression analyses were run for public schools only because non-public schools--particularly elementary schools--lack district administrative staffs and also have much less higher-order software present than public schools. (For example, non-public elementary schools have only one-fifth as many types of higher-order software as public elementary schools, on average--0.5 vs. 2.5; non-public high schools have only two-thirds as many as public high schools--2.3 vs. 3.5.) Separate regressions were run for elementary, middle, and high schools and are shown on the left side of Table 8.

Table 8: Decision-Making Patterns and Intellectual Content of Computer Activities--"Higher-Order" Software and Using Software Tools for Accomplishing Academic Tasks (standardized beta coefficients)**

	Types of Higher-Order Software Present			Best Uses of School's Computers: A Tool for Accomplishing Academic Tasks		
Computer-related decisions and policies	Element.	Middle School	High School	Element.	Middle School	High School
District share	+.14*	+.04	+.15*	+.08	+.01	-.02
School share	+.14*	-.19*	+.08	+.16*	+.02	+.16*
Teacher share	-.23*	+.13	-.15*	-.20*	-.02	-.14*
Other variables where p<.20						
school socio-economic-status (principal estimate)		+.24*				+.18*
district poverty level		-.15*	-.26*	-.19*		-.16*
city location						
suburban/town location						
enrollment size			+.17*			
% non-minority students						

* p<.10

** Beta-coefficients for the three decision-making variables reflect equations with all other variables and that*one* decision-making variable alone entered. Beta-coefficients for the other variables are for equations prior to the entry of any of the three decision-making variables.

Generally speaking, the only background characteristic that distinguished the presence of higher order software as much as decision-making practices was socio-economic-status (school and/or district-level indicators). For elementary and high schools, the regression results confirmed the simpler analysis that schools where decisions were made primarily at district or school levels had more variety of higher-order software present than where teachers made a larger share of the computer-related decisions. But school-level decision making and teacher-led decisions had the reverse relationship in middle schools; at that level, a higher teacher share of attributed decision-making influence was associated with more software variety, and vice-versa for school-level share. I have no explanation for that reversal.

The second variable featured in Table 8 comes from a single survey question asked of school-level computer coordinators. They were asked to choose among three functions that their school's computers played: (a) a method of improving students' basic skills; (b) a resource for students to learn more about computers; or (c) a tool for students to accomplish an academic task--such as in writing, analyzing data, or solving problems. The table shows the regression coefficients for response (c)--using computers as tools for academic tasks. At elementary and high school levels, this "tools" response was associated with a higher share of decision-making at the school level, and it was associated with a lower proportion of teacher-level decision-making.

Comparing the various predictors of the computer coordinator's choice of "tools for academic tasks" as the primary function of school computers, decision-making style was as important as socio-economic-status and more important than any other background variable examined in the regression model.

School-Level Decision-Making: Administrator or Computer Coordinator Leadership?

Our choice to simplify decision-making practices into three levels of action--district-level, school-level, and teacher-level--inevitably mixed different "sub-types" of decision-making into broader categories. For example, teachers acting collectively to make group decisions about acquiring software was mixed with each teacher acting independently to make decisions for their own classes. (Groups of teachers making decisions about how *other* teachers were to use computers in their classes was put with *school*-level decisions like those made by principals.) Similarly, the school-level decision-making category combined decision-making by principals and other strictly administrative personnel with decision-making by instructional leaders like department chairs and school-level computer coordinators or lead teachers. In this section, we disaggregate some of the data on school-level decision-making to see whether decision-making by administrators is associated with different consequences than decision-making by school computer coordinators. We compare these two patterns against most of the outcomes examined in this study--number of teacher users, outside support for school computer programs, density of computers, amount of use of computer facilities, school-level staff development, technical up-to-dateness, alternative subject-matter uses of computers, presence of higher-order software, and belief in the value of computers as tools for academic tasks. Only one of the six sources of decision-making data was used in this analysis--the computer coordinator's report of decision-making concerning hardware and software acquisition, location of computers in the school, allocation of computer time across classes, the content of computer literacy units, and the software to be used in a particular class. Table 9 contains results of regression equations which examined the answers indicating principal decision-making and computer-coordinator decision-making controlling on the background variables used in Table 5.

For none of the 14 outcome variables examined did both school administrator decision-making and school computer coordinator decision-making point significantly in the same direction. In fact, for three outcomes administrator and computer coordinator decision-making were significantly associated with outcomes in the *opposite* direction from each other. Computer coordinator decision-making was positively associated with (1) what fraction of computer time was used for academic subjects other than math or language arts, (2) the presence of a variety of higher order software, and (3) the coordinator's choice of tool uses of computers as being more important than basic skills or computer literacy. In each case, the extent of school administrator involvement in decision-making was *negatively* associated with those three outcomes. Computer coordinator decision-making involvement was also associated with six outcomes that administrator decision-making involvement had no relevance for--a higher proportion of computers being used every day, use by a computer club, school-level staff development activities, more computers per capita, *a smaller* proportion of computer time for math and English, and a greater number of computer-using teachers.

Table 9: School Administrator and School Computer Coordinator Decision-Making and Computer Use Outcomes
(standardized regression coefficients with background variable controls from Table 5)

Computer Use Outcomes	School Administrator Decision-Making	School-level Computer Coordinator Decision-Making
Number of Computer-Using Teachers	-.02	+.07*
External Support for School's Computer Prog.	-.04	+.04
Proportion of Computers Used Daily	+.05	+.11*
School-Level Staff Development Activities	+.01	+.15*
Computer Density	-.01	+.12*
Use by a Computer Club	-.02	+.17*
% of Computer Time for Computer Education (literacy & programming)	+.05	+.05
% of Computer Time for Math and English	+.03	-.08*
% of Computer Time for Other Academic Subjects	-.07*	+.08*
% of Computer Time for Recreational Activities	-.06	-.05
Types of Higher-Order Software Present	-.12*	+.17*
Computer Coordinator: Most Important Use: Tool for Academic Tasks	-.09*	+.11*

* $p<.05$

Thus, each of the positive results that our earlier analysis associated with school-level leadership in computer-related decision-making (i.e., from Table 5--school-level staff development, frequent use of computer equipment, and presence of a computer club; and from Table 8--presence of higher-order comptuer software and valuing computers as academic tools) are more specifically associated with decision-making leadership by the computer coordinator and not with decision-making by school administrators (at least as the coordinator herself assessed how decisions were made).

Conclusion

In United States schools, the development of instruction-related computer activities has proceeded in a very decentralized fashion. Computers were first acquired primarily by individual schools rather than districts and often through actions of individual teachers and parents. As schools have acquired more computers and more software to work with them, school and district administrators have come to take on more important roles. But most teachers use computers with relatively little constraint on their independent decision-making. Policies mandating computer use by all students or laying out the content of computer literacy and programming classes do exist in a majority of schools, but constraints rarely go beyond that--for example largely leaving individual teachers to choose the kinds of software and the specific products to be used. Priorities among users or types of uses are also rarely explicit.

Yet, when we looked at outcomes valued by leaders in computer-based education--that many teachers at the school use computers, that a variety of district-led and school-led staff development activities occur, that there is widespread outside support for school computer activities, that computer programs remain up-to-date, that there is heavy use of computer equipment, that curricular programs rather than recreational use dominate computer time, that software for higher-order thinking, communicating, and problem-solving is widely available, and that using computers as academic tools rather than basic skills practice is the major focus of computer use--in every case it is *not* independent teacher decision-making that is related to these outcomes but (a) substantial district-level involvement in school-level decision-making and (b) the active presence and leadership of a school-level computer coordinator.

Moreover, our conclusions flow not solely from bi-variate cross-tabular analysis, but from multiple regression procedures that held constant other contributing influences such as grade span, public vs. non-public control, enrollment size and ethnicity, school and district socio-economic-status, and size of community.

It was not anticipated that the results would be so totally one-sided. In the United States, the current direction of most reform efforts is to *decentralize* decision-making authority--giving more responsibilities to school principals and allowing teachers to collectively have greater input and even greater authority over decisions that affect their teaching. Such responsibilities, it is felt, will professionalize the teaching profession, result in more informed decision-making, and eventually improve academic outcomes for students.

Yet if improved teaching and learning are to follow from decentralization, this study shows that knowledgeable district administrators and school-based computer coordinators must be called upon to lead and make decisions regarding school computer-use efforts. My impression is that reliance on district and school-based computer experts can coexist with decentralized site-based management and increased teacher authority. But decentralization accompanied by a hands-off "do your own thing" attitude will not produce the kinds of decisions that will make best use of computer resources. There are just too many things to learn about using computers effectively and creatively for schools to succeed in using computers without active involvement of district-level experts and without investing in an on-site, full-time curriculum development and staff development computer coordinator. Knowing

when to cede autonomy and when to demand it is one of the hardest issues in managing organizations. Our data suggest that a policy of incorporating top-down decision-making involvement may produce better results than enthusiasts for independent and autonomous teachers are likely to believe.