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# Teaching, Learning & Computing

## Computer Presence in U.S. Schools

This article is an excerpt from the report, *The Presence of Computers in American Schools*. To order the full report, see page 7.

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Computers are increasingly taking on a significant role in American schools. This is only partly due to continued increases in the sheer numbers of computers available to students. The computer's role is larger also because more and more teachers are learning how to take advantage of new applications such as sophisticated writing and presentation software, multimedia authoring environments, analytic tools, and the World Wide Web.

Our study of teachers' use of computer technology has begun by examining the presence of computer hardware and software in different types of American schools, as of Spring, 1998.

### **Increased Computer Density**

Only a year earlier, in the Spring of 1997, the White House Panel on Educational Technology had deemed the amount of computer and networking equipment available for instruction in schools to be "sub-optimal" and concluded that a large share was "obsolete and of very limited utility." TLC's survey shows that schools have been making headway both in the per-capita presence of computers and in the recency of their hardware.

In 1998, there were about 8.6 million school computers used by teachers or students, or approximately one computer for every 6 students. In 1995, when the White House Panel

report was written, there had been only one computer for every 9.2 students, and three years before that, in 1992, there had been only one computer for every 13.7 students. This represents an annual rate of increase of more than 15% per year, and an even faster rate of increase over the past three years. As the prices of computers fall and as the Internet in particular gains more and more special attention, it is reasonable to believe the quantity of computers will continue to escalate over the next several years.

### **Racing Obsolescence**

Moreover, in spite of the pace at which new computer technologies get introduced into the marketplace, it appears that schools are doing a better job at keeping up with technology than they had done earlier. In 1992, only 22% of instructional computers were based on central processing units (CPUs) that were developed in the previous decade. The remainder would have to be considered "old" under anyone's definition. In 1998, in contrast, almost one-half of school inventories were computers whose CPUs (Pentiums and Power Macintoshes) had been introduced within the past five years!

Considering the fact that the life cycle of a computer has been shrinking down to as few as 3 to 4 years, by those standards, at least 30% of computers in American schools are still "new" – that *continued on page 3...*

# Patterns of Constructivist Practice Among Teachers of Different Subjects

## Percent of Teachers Assigning Various Activities Weekly or More Often

	Answer questions from textbook or worksheet	Hands-on or laboratory activities	Work in small groups	Journal writing	Essay writing	Long projects	Problems with no obvious method of solution	Students suggest and help plan class activities
Elem. Self-Contained	69%	65%	61%	61%	36%	22%	23%	18%
Elementary Other	64%	59%	49%	27%	26%	19%	21%	5%
English	37%	34%	36%	45%	35%	21%	19%	9%
Social Studies	40%	32%	33%	14%	22%	7%	12%	7%
Science	45%	66%	42%	16%	16%	11%	17%	4%
Math	79%	21%	51%	8%	9%	3%	18%	5%
Comp./Business/Vocational	35%	86%	35%	12%	7%	40%	14%	5%
Other Secondary	47%	51%	39%	24%	18%	30%	14%	9%
All teachers	53%	51%	44%	28%	22%	19%	17%	8%

Source: Teaching, Learning and Computing – 1998, "Internet Use by Teachers," <http://www.crito.uci.edu/TLC>.

How “constructivist” in practice are American teachers? An initial step in answering this question is to ask how often teachers have students perform certain activities that seem more consistent with a constructivist pedagogy than the more “skill-and-fact transmission-oriented” approach of having students simply answer questions from a textbook or worksheet. Of the seven “constructivist” activities we asked about, the following were the most frequently reported as occurring at least weekly:

- Hands-on or Laboratory Activities
- Students Working Together in Small Groups
- Journal Writing
- Essay Writing

Across the full population of 4<sup>th</sup> to 12<sup>th</sup> grade teachers, we found that **none** of those activities is more common in teachers’ practices than traditional textbook seatwork.

Nevertheless, there are major differences by subject-matter in the tasks that are most commonly assigned, and in particular the role that seatwork plays. Seatwork is most common in secondary mathematics classes – even

more often experienced than in elementary classrooms. It is *least* commonly used where the focus is on preparing students for adult work roles – i.e., in computer classes, business education classes, and vocational classes—and is less common in secondary English classes.

Correspondingly, hands-on or laboratory activities are least common in secondary math classes and most common in the applied adult-work-role preparation classes (and in science classes). However, it is not the case that one substitutes for the other. Most elementary teachers report using both seatwork and hands-on activities at least weekly and fewer than half of secondary English or social studies teachers use either one that often.

Math teachers, however, do use one constructivist-compatible practice more often than teachers of other subjects – having students work in small groups to solve a problem or complete a task together. One half of math teachers said they did this at least weekly, compared to only one-third of English and social studies teachers or teachers in the applied subjects.

Journal-writing is most commonly employed by elementary teachers of self-contained classes, even more than in secondary English classes. Indeed only one-third of secondary English teachers have their students, on roughly a weekly basis, write essays “in which they are expected to explain their thinking or reasoning at some length.”

Fewer than 20% of all teachers have students work on long-term projects at some time during most weeks, although this is twice as common in computer, business, and vocational courses, most likely because they are less constrained by curricular requirements of subject-matter coverage. For the most part, only elementary teachers in self-contained classes frequently have students help plan class activities.

This article is an excerpt from the special report, *Report to Participants*. To view or download the full report, please visit our web site.

*continued from page 1...*

is they were acquired on or after July of 1996. Of all computers in schools, 24% are Pentiums, 21% are Power Macintoshes, and 70% are capable of running Windows or Mac operating systems.

Secondary schools' inventories appear to be more modern than those of elementary schools. For example, using a definition of "technology-intensive" schools based on per-capita computer presence, the fraction of CD-ROM-equipped computers, and presence of a direct (rather than dial-up) Internet connection, 31% of high schools compared to only 22% of elementary schools were technology intensive as of 1998.

**Software**

School computers have access to a wide variety of software. At least 80% of computers are able to run word processing, spreadsheet, database, and drawing/painting software. And at least 40% can run desktop publishing programs, keyboarding practice software, and reference software on CD-ROMs, and can access the World Wide Web. Math and language arts specific software are present on a majority of computers only at the elementary level while Internet access is much more common on secondary school computers.

**Social Inequalities**

A question often asked is whether or not schools with poorer students or a higher percentage of students from minority backgrounds have less technology than schools with wealthier or more Anglo student bodies. The most significant finding is that the computer density gap has narrowed compared to 5 to 10 years earlier.

Nevertheless, certain inequalities do remain, particularly in upper-end computer equipment and in Internet connectivity. However, the patterns are uneven and the relationships are generally not very smooth, or even monotonic.



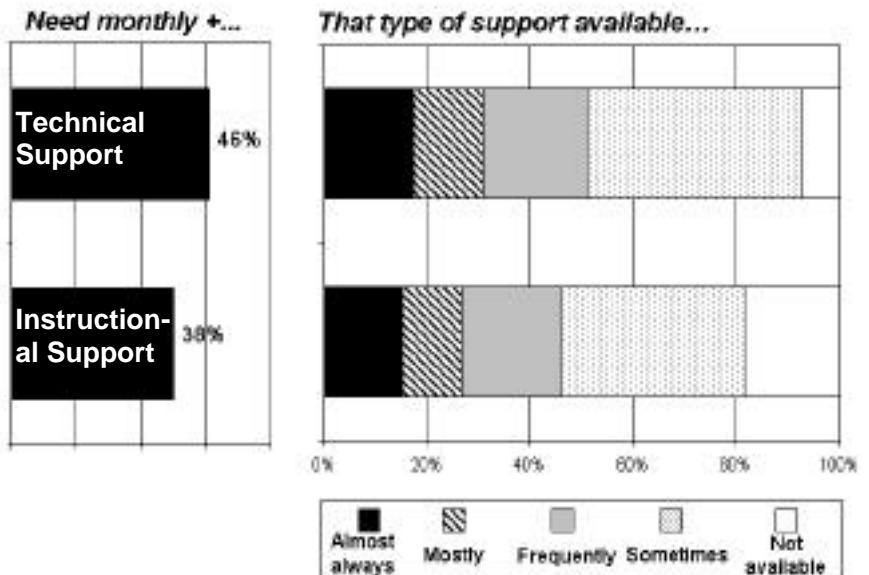
## Support For Teachers' Computer Use

Are teachers getting the support they need to regularly use computers with students? Can they rely on computers and software to not only be available, but reliable and working when they need it? More than half of teachers asked say they don't need help with the technology that they or their students use. However, almost half do report that they need technical support at least once a month. More significantly, of those who do need technical support, more than two-thirds say it isn't available when they need it—at least not in most circumstances. For almost half of those who need technical help, it's at best available only "sometimes."

The story for instructional support for computer use—that is, help in integrating technology into teaching practice—is similar. Somewhat fewer teachers report needing this kind of help (only 38% say they need it monthly). However, of those who do need help in integrating technology with their lessons, even fewer (26%) say it is available on most occasions when they need it.

A future report from TLC:1998 will show which types of teachers most often say they need support for technology use and which teachers are getting the help they need.

### Need and Availability of Support



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This article is an excerpt from the future report, *Computer and Software Use by Teachers* to be issued next month.

## Computer and Software Use in U.S. Schools

Every year, teachers and their students are gaining greater access to more powerful computers at school. By last Spring (1998), more than 3/5 of teachers had a desktop computer provided by their school for their own use. The number of computers available to students has grown as well from one computer for every 19.2 students a decade ago to one computer for every 6 students in 1998. Almost all teachers (88%) use computers for professional purposes involving classroom management, lesson plans, and communication with other teachers and parents, yet fewer teachers use computers frequently with students. Though 70% have exposed students to computers by using them during class on one occasion, only a little over a quarter of teachers have had students use computers more extensively -- that is, more than 20 times during the school year. TLC has been studying which teachers in particular have greater access than others, to what degree access determines use for different groups and which teachers are actually using computers more with students.

### Access

Although 43% of all teachers have at least one computer in their classroom for student use, only one out of fifteen has 8 or more computers in their own classroom and about the same number of teachers have between 4 and 7 computers. We also looked at access

by subject and found that those teachers who teach classes related to applying computers in adult work roles (computer, business, vocational classes) have by far the greatest number of computers available in the classroom. A majority of those teachers (56%) have at least one computer for every four students in their class. In contrast, only 8% of secondary teachers of academic subjects have that level of classroom computer availability.

In spite of having so few computers, most teachers of academic subjects have their students use computers at least on some occasions. However, without sufficient computers in their classroom, teachers must either settle with what they have or opt to have their students work in a computer lab or media center. Looking at those teachers who have fewer than 4 computers in the classroom, we find that most teachers choose to move their students outside the classroom to take advantage of the greater number of computers present.

### Classroom Access Versus Access Elsewhere

While one might think that the large number of computers available in a computer lab (the typical lab has 21 computers) would facilitate more extensive computer use, we find this

## Technology Resources and Uses at High-Tech and Reforming Schools

TLC not only studied a nationally representative sample of U.S. teachers, but also examined a selected group of schools that are either making major investments in technology or schools involved in reforms where in some cases, technology plays a large role. Some of these programs are school wide, while others focus on individual teachers. Individual teachers involved in reform activities and those in high-end technology schools have more technology resources than teachers in our representative sample, and they use them toward different objectives. We have only started to examine differences between these groups of teachers and can present some initial findings.

### Teacher Pedagogy

We are finding that pedagogy in schools participating in school wide reform programs is somewhat more constructivist, on average, than in the nationally representative schools. However, both representative school faculties and those in school wide reform programs look similar compared to the very strong constructivist pedagogy of individual teachers who participate in reform programs which focus on *single teachers* rather than whole schools.

On the other hand, the "one-teacher-focused" programs themselves exhibit no discernible spillover in pedagogy from the program participants to the other teachers at their own school. Thus, when measured in school-level terms, only school wide reform *appears* to be having any impact at all on pedagogy. *continued on page 5...*

assumption to be problematic. Even though fewer computers are available to students in the classroom, those teachers who have students use them in the classroom are almost twice as likely to be frequent users (having students use computers 20 or more times during the school year) than those whose students use computers in a lab or media center. Our findings indicate that 50% of the teachers whose students use computers in their own classroom are frequent users compared to only 31% of teachers whose students use computers only in a lab or media center.

When a sufficient number of computers are available in the classroom, teachers can more easily integrate material currently being covered in the classroom in a way that scheduled use of a common facility does not permit. We have found large correlations between the number of *classroom* computers and frequency of use. That relationship is strongest among vocational education classes and in classes of “other” academic subjects (interdisciplinary classes). However, the relationship is also significant among teachers of major academic subjects. They tend to use computers to a greater extent when more are available in the classroom. There seems to be less of an advantage to elementary teachers in having more classroom-located computers, most likely because they can more easily orchestrate student use of a small number of classroom computers over the entire school day rather than the abbreviated class periods with which secondary teachers have to work.

**Who uses computers with students more?**

As with access to computers, teachers of different subjects vary widely in terms of how many of them use computers with students on a frequent (e.g., weekly) basis. Apart from computer teachers, who of course would be expected to have students use computers frequently, the range for weekly student experience goes from 69% of business education classes to only 5% of foreign language classes. In between are 42% of vocational teachers and teachers of self-

contained classes, 32% of English classes and 15% or fewer of science, math, social studies and fine arts classes. The fact that students are more likely to use computers frequently in English class than in other academic classes is probably due to the predominance of word processing among school-based computer activities.

**What kind of software is most commonly used?**

The focus of computer use is slowly shifting from having students practice skills and gain “computer literacy” (e.g. “how to use” computer programs) to an orientation towards applying computer skills to do real work: for example, finding information and communicating ideas. This shift is reflected in the software we see teachers using.

Word processing by far is the most commonly used software, not only among English teachers, but among science, social studies and elementary teachers. Among elementary classes, games for practicing basic math and language skills are still common. However in middle schools, drills and games are used less frequently than CD-ROM reference software and Web browsers. In high school, drills and game software are also less common than graphics software, spreadsheets, simulation or exploratory software and computer-aided presentation software. Math teachers, however, use skills-practice games more than any other type of software (except perhaps graphing software which we didn’t ask about).

Relatively few teachers have incorporated some of the more creative and analytical applications of computers in their teaching. Less than a quarter use simulation or “exploratory environments” software, and even fewer have students use presentation software, multi-media authoring software or e-mail. These types of software are more often used by teachers of elective classes who are less constrained by curricular standards. They tend to have greater flexibility to explore new possibilities for computer use.

*continued from page 4...*

**Technology Resources**

Individual program participants tend to make greater use of computer resources than other teachers at their own school, regardless of whether their school’s program emphasizes technology or doesn’t. Moreover, individual teachers who participate in reform programs even if they’re not technology based, have objectives for computer use and patterns of use that are primarily constructivist.

However, teachers in schools involved in school wide reform that don’t emphasize technology do not use computers very much nor do they have very constructivist objectives for their use. The problem is simply that the high cost of the other elements of school wide reform leaves very little money available for computers or for the development of teachers’ understandings of how to use computers to fulfill reform goals – except in those programs where technology is explicitly emphasized. Without that explicit emphasis, educational technology is not likely to be a facilitator of constructivist pedagogy. This exception, as noted, is in those reform settings that involve only an individual teacher or a small handful of program participants.

**High-End Technology Schools**

Interestingly, the teachers in schools we studied that had a great deal of technology (relative to the size of the school) but which were not part of reform programs were still rather constructivist in their approach to using computers. Because of a high level of technology presence, teachers in these schools actually implemented a relatively constructivist program with their computers, despite the lack of a formal program providing a theoretical basis for instructional reform.

This article is based on preliminary analysis that will contribute to the future report, *Computer Use in Reform and High-End Technology Settings* to be issued later this year.



# Teacher Role Orientation

## Classroom Focus Versus Collaborative Professional Practice

This article is an excerpt from the special research study, *Teacher Professionalism, School Work Culture and the Emergence of Constructivist-Compatible Pedagogies*. To view or download the report, please visit our web site.

Do teachers who are involved with other teachers' practices (as supportive colleagues or by taking on leadership tasks) teach their own classes in a different way than teachers who are focused solely on their classroom responsibilities? Hank Becker and Margaret Riel are examining this question along with the possible influence on teaching practices of the presence of a collaborative professional working culture. In a research paper presented at AERA in April, Becker and Riel compared how teachers who had discussions with other teachers about pedagogical and subject-matter issues differed in classroom practices from teachers who kept to themselves. They found that teachers who had many professional contacts with other teachers at their school (that is, discussions and classroom observations) were 3 1/2 times as likely to employ a strong "knowledge construction" approach in their teaching than were teachers who had few such contacts. Conversely, low-contact teachers were 3 1/2 times as likely to focus on information transmission and skills practice as high contact teachers.

In examining role orientation more broadly, they examined three types of professional contacts: discussions with

and classroom observations among teachers at their own school; involvement with teachers elsewhere such as by workshop attendance, district committees, and e-mail discussions; and leadership activity, including mentoring another teacher, teaching peers at workshops or conferences, teaching a college class, or publishing articles on education. They then classified teachers according to the breadth and depth of their involvement in these activities into four groups: the 3% with the most extensive collaborative professional practice (professional teacher-leaders); 12% who could be classified as professionally oriented, but not so strongly (professionally active); 30% with a "mixed practice," above the mean on collaborative contacts, but not outstandingly so (collaborative classroom teachers); and 55% who are classroom focused in their own practice (own-classroom oriented teachers).

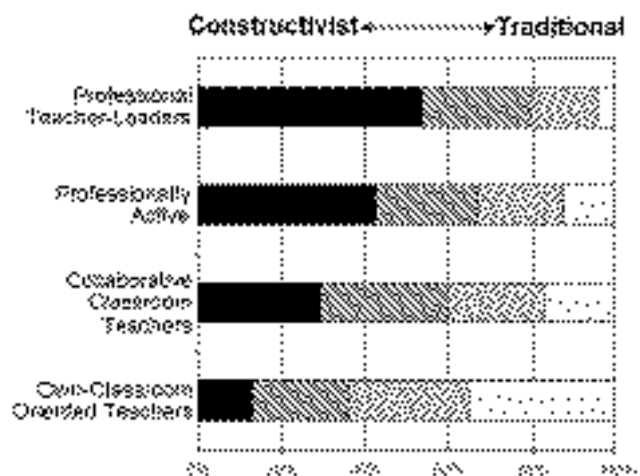
Then, these four groups of teachers were compared on a wide variety of aspects of their teaching practice, including how salient group and individual projects were in their teaching, how much they engaged students in complex problems and gave students substantial freedom to undertake investigations around those problems, and how much reflective writing and

self-assessment they required of their students. Answers to about 20 indicators of teaching practice were combined into an index that contrasts an information and skills approach to teaching with a constructivist one.

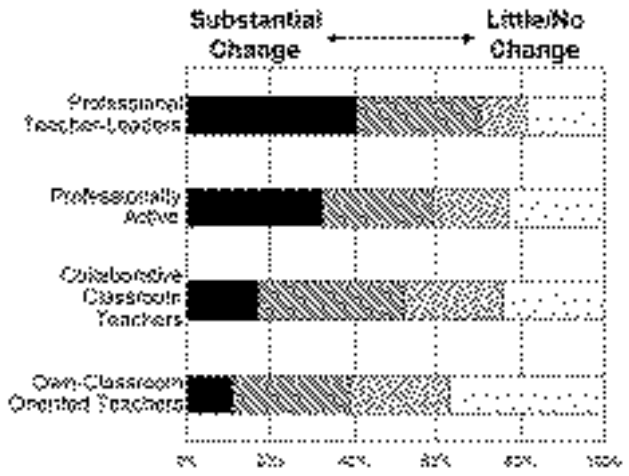
The accompanying figures show that the more that teachers orient themselves in professional activity beyond the classroom, the more constructivist their teaching practice. Becker and Riel propose that, consciously or unconsciously, teachers' instructional styles mirror their own interaction patterns. That is, teachers who learn from their peers, lead their peers, and present their ideas and opinions to their peers are more likely to have their students do the same in the classroom. They conduct their classes in a manner similar to the way they conduct their professional activities.

The researchers also found that the more teachers orient their professional practice beyond the classroom, the more likely they are to report substantial change of pedagogy in a constructivist direction in recent years. Be on the look out for the complete report from Becker and Riel at our web site.

**Teacher Practice by Role Orientation**



**Change in Pedagogy in a Constructivist Direction, by Role Orientation**



## Reports

## TLC Staff

### TLC's 12 Report Series

(A tentative list of titles.)

1. *Internet Use by Teachers* - Currently available.
2. *The Presence of Computers in American Schools* - Currently available.
3. *Computer and Software Use by Teachers*
4. *School Decision-Making on Technology*
5. *Staff Development and School Support for Teachers' Computer Use*
6. *Pedagogical Beliefs and Practices Among American Teachers*
7. *School Technology Investment Alternatives*
8. *Teacher Pedagogy and their Use of Computers*
9. *School Context and Personal Factors in Teachers' Use of Computers*
10. *Computer Use in Reform and High-End Technology Settings*
11. *Dynamic Relationships Between Pedagogy and Computer Use*
12. *A Summary of Teaching, Learning, & Computing-1998*

### Special Reports and Research Studies

(These reports and studies are not for sale and are only available for viewing and downloading at TLC's web site.)

- *Report to Participants – (Summary of findings to date written for TLC-1998 survey participants.)*
- *Teacher Professionalism, School Work Culture and the Emergence of Constructivist-Compatible Pedagogies*
- *A National Study of Teacher Technology Use and Pedagogy: Implications for Teacher Education and Integrating Technology Use Into Schools*

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# Computers and Constructivist Practice

The more a teacher uses computers, the more likely he or she is to be a strong constructivist. (See figure below.) This pattern is strong among English teachers, social studies teachers, to a lesser extent, science teachers, and non-existent among math teachers since few are strongly constructivist to begin with.

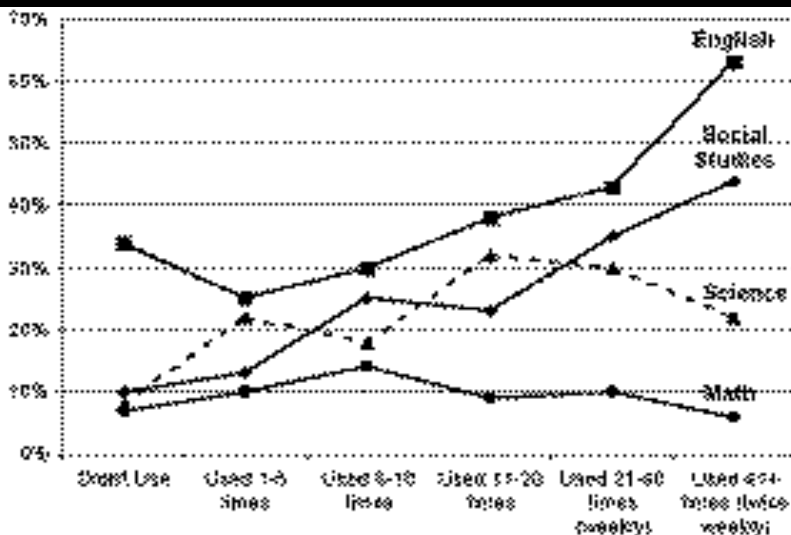
This relationship is perhaps due to the fact that technology provides students with almost unlimited access to information that they need in order to do research and test their ideas. It facilitates communication, allowing students to present their beliefs and products to broader audiences and also exposes them to the opinions of a more diverse group of people in the real world beyond the classroom, school, and local community – all conditions optimal for constructivist learning.

It is not surprising that a constructivist learning environment would evolve given the presence of computers. In fact, we are finding that the more important, and the

longer teachers have regarded computers as important to their practice, the more likely they are to be strong constructivists.

View or download the related special report, *A National Study of Teacher Technology Use and Pedagogy: Implications for Teacher Education and Integrating Technology Into Schools* from our web site.

**Percent of Teachers in the Top Quartile of Constructivist Practice by Frequency of Computer Use**



**Teaching, Learning & Computing**

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