Computer Use by Teachers: Are Cuban's Predictions Correct?

Henry Jay Becker
University of California, Irvine

Jason L. Ravitz
SRI International

March, 2001

Paper presented at the 2001 Annual Meeting of the American Educational Research Association, Seattle.

Abstract

Are computers playing a significant role in teachers' instructional practices? Larry Cuban continues to argue that they are not (Cuban, 2000; Cuban, 2001). Using data from a national survey of 4,100 teachers' pedagogy, computer use, and teaching environment, we show that while Cuban is correct in a statistical sense, he draws incorrect implications regarding the place of computers in American K-12 schooling over the next decade. In particular, where teachers have reasonable expertise in using computers themselves, where they have clusters of 5 to 8 computers in their own classroom, and where they believe more strongly in a constructivist pedagogy that attends to making learning activities meaningful to students (rather than just transmitting content), a clear majority of teachers have students use computers regularly in their academic classes. Moreover, teachers who are most broadly engaged with their teacher peers in collaborative and leadership roles, and who thus influence their peers more than most, are much more likely than the average teacher to have their students exploit computer resources during class. These findings, along with the continued exponential increase in the technical capacities of computer and network technologies, make Cuban's assertions of minimal impact likely to be out-of-date in the near future.

For about 15 years, Larry Cuban has argued that computers, as a medium of instruction and as a tool for student learning, are largely incompatible with the requirements of teaching. Cuban points out that teachers have so many students to teach (or, in the elementary grades, so many different subjects to cover) that, along with the increasing accountability demanded of them, it is simply too hard for most teachers to incorporate student computer use as a regular part of their instructional practice. Moreover, computers are hard to master, hard to use, and often break down; therefore, investing effort into having students use them frequently is hardly worthwhile, and we should not expect many teachers to make this effort (Cuban, 1986; Cuban, 2001).

Yet, although Cuban's argument may have applied in the mid-1980's, is it correct today? The capabilities and functionality of what we call personal computers have changed by orders of magnitude since Cuban first wrote about desktop microcomputer technology. What passed for classroom computers fifteen years ago seem like primitive toys today. For example, software applications that in earlier years were frustratingly slow or markedly limited in their functionality are far more powerful yet provide much more help for student users. New applications have evolved that hardly existed ten or fifteen years ago—electronic mail, the World Wide Web, software for presenting digital slide shows, student-created multimedia authoring environments, and digital video-editing. These new applications constitute learning resources of a totally different sort from the computers of 15 years ago.

So have computers become more compatible with the conditions of teaching? Have their greater capabilities made them more relevant to teaching objectives? Or is Cuban right even today: Are computers really a mismatch with the requirements and conditions of teaching?

This paper addresses the question of the presumed mismatch between computers and the requirements of teaching by asking what conditions are necessary for frequent, high-quality use of computers to become a normal part of most teachers' instructional practices. By looking at the confluence of several conditions—a reasonable amount of technical expertise in handling computer technology, convenient (classroom) access to enough computers to incorporate their everyday use by small groups of students or individuals taking turns, and a teaching philosophy

that favors a constructivist-oriented (e.g., project-based, inquiry-based) teaching practice—we can see whether most teachers use computers in a substantial and intellectually fruitful way. In addition, we can examine the computer use practices of teachers who are most active in their profession—who regularly communicate with and observe other teachers, who work on committees and attend workshops, and who take leadership roles such as mentoring, presenting at workshops, teaching, and publishing. We can determine whether these "professionally engaged teachers," whose influence on other teachers extends much further than is typically the case, are themselves exemplary computer-using teachers. If so, that suggests that their points of view, and in particular, their approach to using computers, may over time be influential in how other teachers come to view and use this technology.

Methods and Data Source

In a Spring, 1998 NSF-OERI-sponsored survey directed by the senior author, more than 4,100 teachers in over 1,100 schools across the U.S. described their educational philosophies and characteristic teaching practices, their uses of computers in teaching, and various aspects of their teaching environment. The survey included a national probability sample of 2,251 4th through 12th grade teachers as well as 1,832 other teachers from two "purposive" samples of schools—schools with the greatest presence of computer technology and schools that participate in one of more than 50 identified national or regional educational reform programs. Roughly 75% of the schools sampled for the study participated and nearly 70% of the teachers sampled within those schools completed 20-page survey questionnaires (http://www.crito.uci.edu/TLC). Because teachers were sampled with unequal probabilities (teachers reputed to be computer users and constructivist teachers were oversampled), all analysis uses weighted cases with weights assigned inversely proportional to a teacher's probability of selection. Descriptive results make use of the national probability sample of schools only; certain analytic findings employ cases from both the probability and the purposive samples.

From among the many questions answered by responding teachers, this paper makes use of several particular sets of questions. Some variables were constructed from single-item measures; e.g., after determining that the teacher uses computers with students during a particular class

period, they are asked "Where do students use computers during this class and how many computers are available in each room?" Other variables were constructed from combining the evidence supplied by many different survey questions. For example, our measure of a teacher's teaching philosophy comes from 13 different survey prompts that produced an alpha reliability coefficient of .83. Most of the items used in the philosophy measure had previously been validated using in-depth interview and observational data on 72 teachers. (See Ravitz, Becker, and Wong, 2000, for a complete description of the philosophy index.) The measure of teacher role orientation that led to the designation of some teachers as "Teacher Leaders" was derived from 15 different prompts. In this case, simple index construction was not used; instead, a typology of different types of professional involvement was created and cut-scores were used for each element in the typology to establish a standard for teacher leadership (Riel and Becker, 2000). Frequent Computer Use was operationalized using a single question asking "On how many days since September has a typical student in this particular class used a computer while you were teaching their class?" with an answer of "21-40 times (weekly)" or "41+ (twice/weekly)" being considered "frequent use." The more complex designation of "Exemplary Computer User" was the result of a factor analysis of many different survey questions including, not only how frequently students used each of 10 types of software during class, but how frequently the teacher herself used computers for 6 different professional functions, a sub-index providing a self-report measure of technical expertise in using computers, measures of access to basic electronic technologies for teaching at home and at school, and a sub-index measuring how much more the teacher feels she is using computers in the classroom and professionally compared to five years ago. The factor analysis of all of the different indicators of computer use produced three dimensions of teacher computer involvement, which we labeled "student tool use," "frequent simple use," and "teacher use and expertise." These three dimensions were combined to identify a group of teachers (10%) as Exemplary Computer Users.

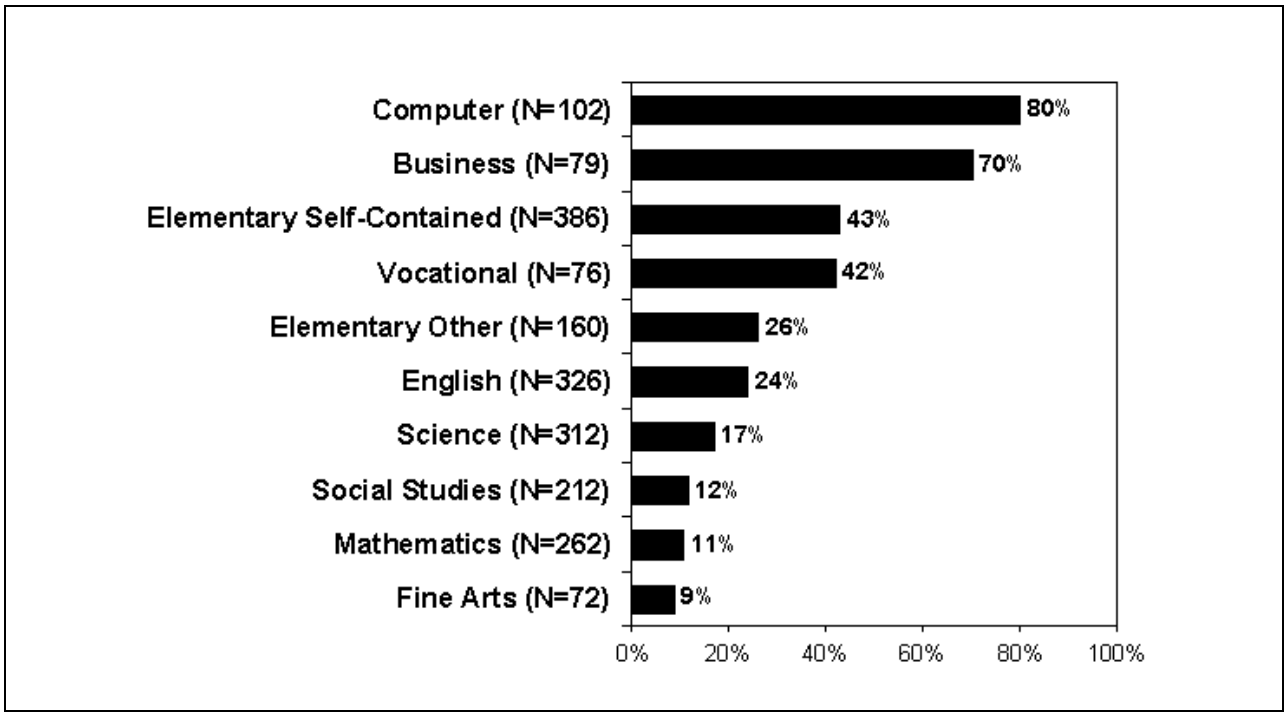
Results

Cuban's claim about limited impact of in-class computers is supported by a substantial body of our survey data. Only 1/4 of secondary English teachers, 1/6 of science teachers, 1/8 of social

studies teachers, and 1/9 of math teachers said that a typical student in their classes used computers on approximately a weekly basis during class time. (See Figure 1.)

Figure 1

Frequent Student Use of Computers by Subject (i.e., Typical Student Used Computers in Class More Than 20 Times Over Most of School Year)



Sample: National probability sample. Three groups of teachers omitted: secondary foreign language teachers (N less than 50), secondary teachers of mixed academic subjects (no subject taught for a majority of the school week), and secondary teachers of other applied subjects.

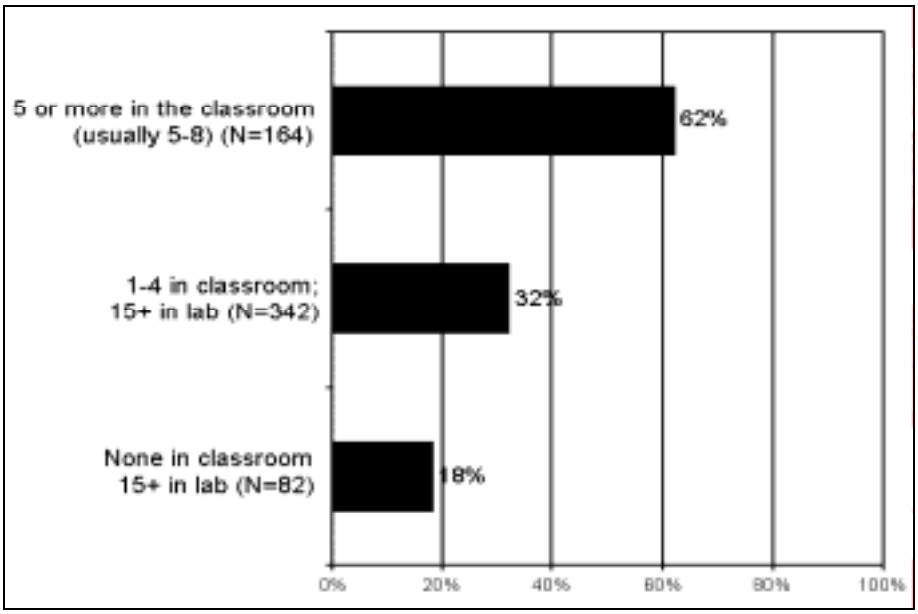
However, certain factors make teachers more likely to give frequent assignments involving computer work. Among secondary (middle and high school) teachers of academic subjects in our sample, those teaching on block-schedules (long class periods) were more likely to do so (19% vs. 15%), even though they met their classes on perhaps half the number of days as teachers who taught in traditional 50-minute periods. We also found that the relatively few academic teachers whose pedagogy involved "a small number [of topics] covered in great depth" (only one out of every thirteen academic secondary teachers in the study) were twice as likely as

those who reported covering "a large number of topics" to assign computer activities to their students on a frequent basis (29% vs. 14%).

Third, teachers with 5 to 8 computers in their classroom were twice as likely to give students frequent computer experience during class than teachers of the same subjects whose classes use computers in a lab with 15+ computers. (See Figure 2.) This may seem counter-intuitive since being in a lab with three times as many computers as these classrooms have would seem to be preferable. However, the scheduling of whole classes of students to use computers, at wide intervals determined well in advance of need (i.e., weekly or every-other-week use scheduled weeks in advance) makes it almost impossible for computers to be integrated as research, analytic, and communicative tools in the context of the central academic work of an academic class.

Figure 2

Frequent Computer Use by Location and Number of Computers Available (Selected Combinations), For Secondary Academic Teachers



Sample: 50% random subsample of teachers who used computers with their selected class in both probability and purposive samples. A fourth access category is not shown—teachers with 0-4 computers in classroom and under 15 in a lab or other outside location, if available.

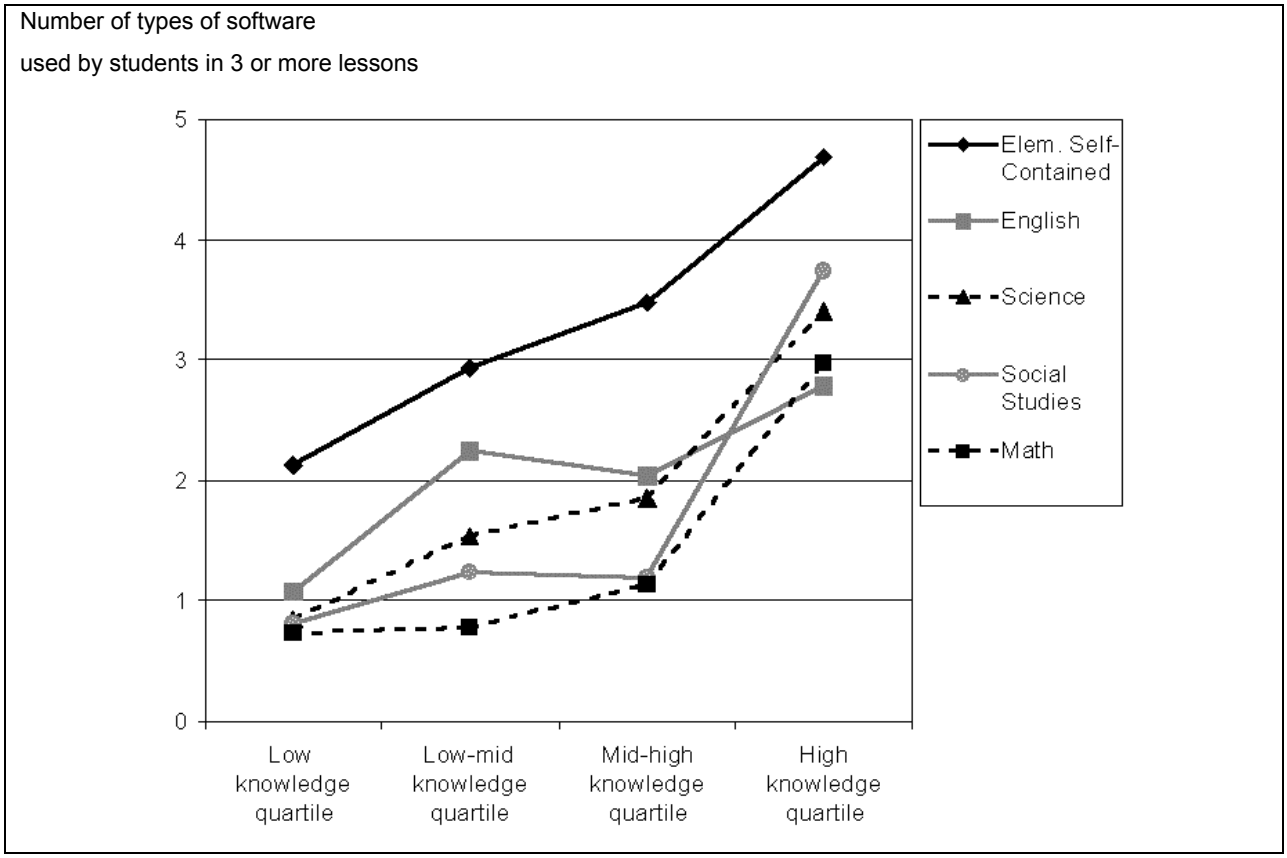
Our fourth finding is that teachers with greater technical knowledge use computers more. To conduct this analysis, we divided teachers into equal-sized groups using an index measuring (a) the variety of their self-reported computer skills, (b) the different ways they used computers professionally, and (c) how extensive their experience was on different computer platforms.[1] The teachers in the top 25% on that Computer Knowledge index, on average, had students use three times the number of types of software as did teachers in the bottom 25%. Figure 3 shows that the pattern is even stronger for teachers of individual secondary academic subjects. The biggest difference is between teachers in the upper 25% and the rest of the teachers; that is, the math, science, English, and social studies teachers who are most skilled and involved in using computers themselves account for most of the situations where students use a variety of software to do work for their academic classes.

[1] Three sub-indices contributed equally to this index of computer knowledge (by standardizing the variance of each one). One measured the number of technical computing skills a teacher reported having (out of seven skills; for example, copying files from one disk to another, preparing a slide show using presentation software, using a Web search engine). The second measured the number of ways the teacher reported using computers for professional functions (out of eight, including corresponding with parents, exchanging computer files with other teachers, and making handouts for students). The third reported the teachers' self-assessments of the level of their experience with each of the two major computer platforms—Macintosh and Windows/DOS. The correlations among the three subindices ranged from r=.43 (professional uses with platform experience) to r=.60 (technical computing skills with platform experience).

Figure 3

Breadth of Student Software Use

by Teacher's Computer Knowledge by Subject Taught



Sample: All teachers in probability sample.

Vertical axis indicates the mean number of different types of software (out of 10) which the teacher reported having students in her selected class use in at least 10 lessons during the school year.

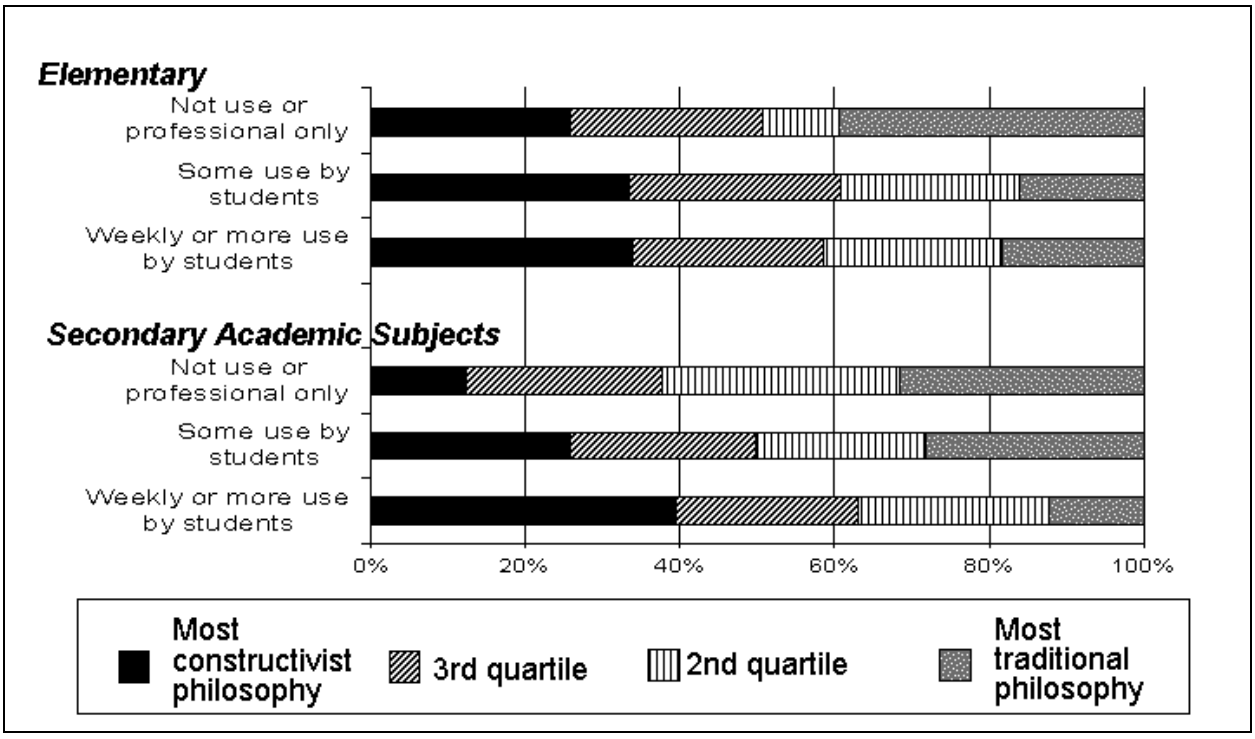
Finally, one of the strongest and most widespread findings of the study has been that teachers who avoid computers are also the ones who seem to be most "traditional" in their teaching philosophy; teachers who believe that their role is to transmit to students an externally mandated curriculum by means of a highly controlled pedagogy. In contrast, teachers who value students doing group projects and working on topics of personal interest—an approach compatible with belief in constructivist learning principles—are among the most frequent computer-using

teachers. For example, among secondary academic subject teachers, those who were in the highest quartile on an index of constructivist teaching philosophy were 3 times as likely as teachers in the bottom quartile to report giving each student more than 20 opportunities to use computers during about 6 months of class. (Constructivist elementary grade 4-6 teachers were twice as likely as transmission-oriented teachers to do so.) (See Figure 4.)

Figure 4

Frequency of Computer Use by Teacher Philosophy

By General Teaching Responsibility



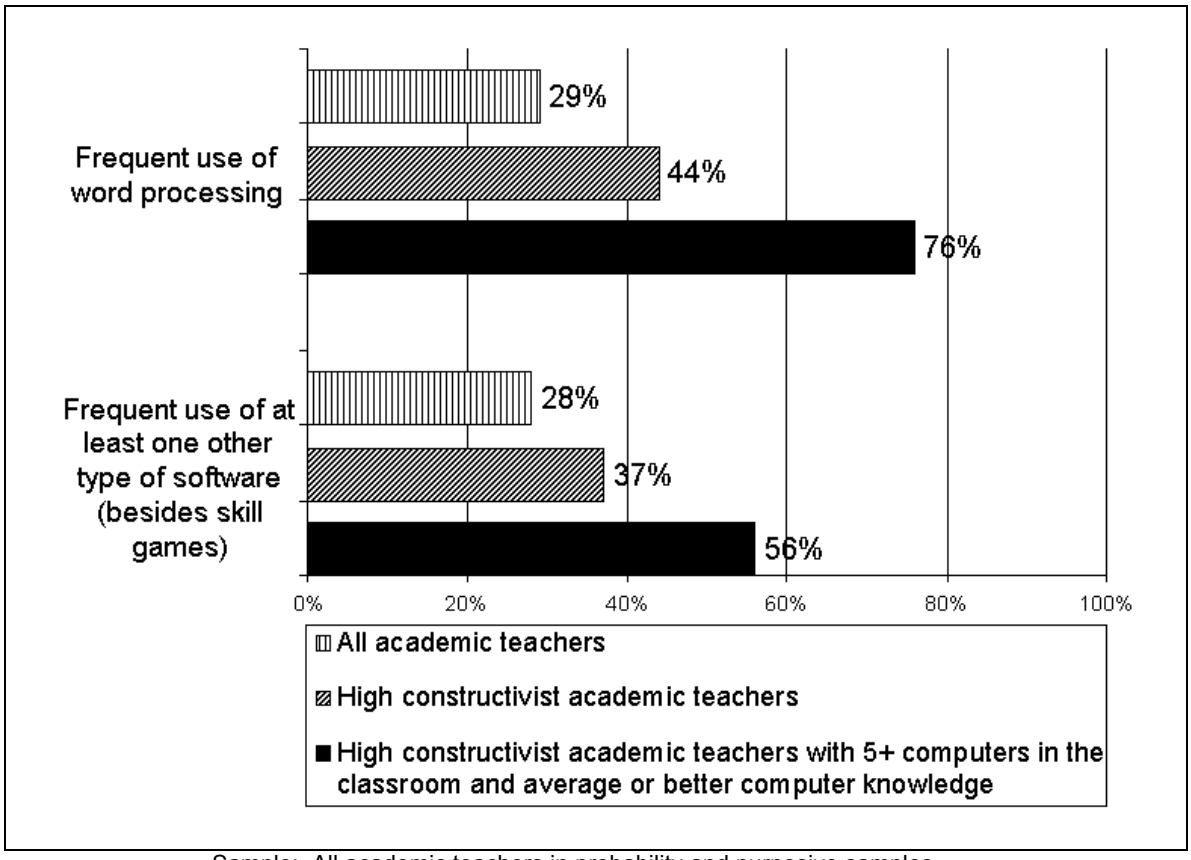
The Result of Combining All Indicators of Frequent Computer Use

When we combined the last three conditions mentioned—(1) where the teacher had at least 5 computers present in their own classroom, (2) where the teacher had at least moderate computer expertise, and (3) where the teacher was in the "top quartile" in terms of constructivist philosophy—we found that 3/4 of grade 4-12 academic teachers had their students use word

processing software often during class (10+ times), and they were roughly 3 times as likely as all academic teachers to do so. In addition, a majority (56%) of these "favorable condition" teachers had their students use another type of software that often (besides skill-related games and drills), twice as high as the rate for all academic teachers (see Figure 5).

Figure 5

Frequent Use of Software by Facilitating Condition



Sample: All academic teachers in probability and purposive samples.

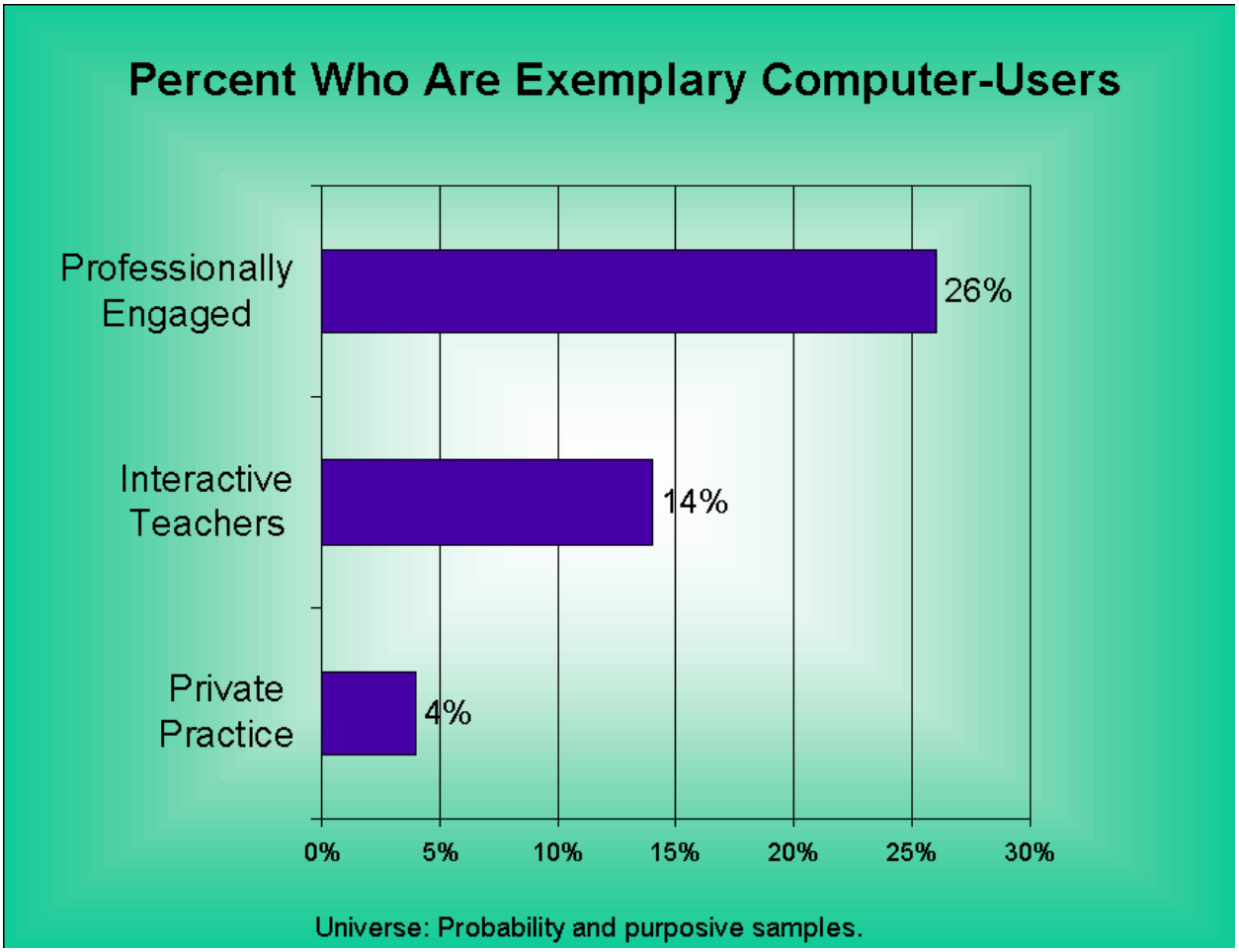
Teacher Professional Engagement

Finally, we found that, nationally, the 12% of teachers who were most professionally engaged of all teachers (e.g., in frequent substantive conversation and classroom observation with peers, frequently participating on committees, mentoring and giving workshops) were more likely to

have their students use all kinds of software (particularly presentation software, multimedia authoring software, and electronic mail), and they were also more likely to be active users of computers themselves. When we incorporated into our concept of "strong computer use" not only frequently assigning computer work and having students do fairly complex types of activities such as suggested by presentation and multimedia authoring software, but also the teacher's own growing experience and expertise in using technology, we found that the most professionally engaged teachers were more than 6 times as likely to meet our designation as an Exemplary Computer User as were the teachers whom we titled "Private Practice" teachers because of their limited involvement with other teachers at their school or elsewhere. (See Figure 6.)

Figure 6

Exemplary Computer Use by Professional Engagement



Discussion

In response to Larry Cuban's projection that computers are likely to continue to play a minor role in student learning of academic subjects in elementary and secondary schools, this paper has presented an examination of related evidence.

On the issue of whether computers are generally a central vehicle of instructional activities in classrooms, the data suggest that Cuban remains correct up to the present time. Although a substantial fraction of teachers are having students do word processing during class time, most in-class use of computers occurs as part of separate skills-based instruction about computers, in occupationally-oriented courses such as business and vocational education, and as one of many explorations of different learning modalities that occur in the 6-hour-long days of self-contained elementary classes.

We have also found that the teachers who have students use non-skills-oriented computer software in academic classes have fairly distinctive teaching philosophies, being disproportionately supportive of constructivist pedagogies such as developing student responsibility for selecting and carrying out learning tasks, emphasizing group work involving discourse, and the use of projects, products, and performances for outside audiences.

However, this data also suggests that when constructivist-oriented teachers have sufficient resources in their classroom (i.e., clusters of 5 or more computers in a typical sized class) and have come to have a reasonable level of experience and skill in using computers themselves, a *majority* of such teachers will have their students make active and regular use of computers during their class period. That use will be principally word processing but will typically involve at least one other type of software as well, most often either CD-ROM or Internet-based information retrieval or exploratory simulation software. Other facilitating factors, such as extending the secondary classroom period from 50 minutes to significantly longer blocks of time and not only removing curriculum coverage mandates from teachers but encouraging them to

teach fewer subjects in depth also can increase the number of teachers who make frequent use of computers in their plans for student class work.

Thus, although Cuban is correct when he claims that most teachers do not have computers play a very large role in their organization of student classroom learning, under certain conditions that is not true—where teachers have adequate technical expertise, adequate classroom access to computers, and a philosophy that supports meaningful learning around group projects, most of them do have students use computers frequently during class. Moreover, the most professionally active teachers, in a position to provide leadership with their teacher peers, are the most active computer users of all.

Over time, with increasing technical expertise, increasing numbers of classrooms having substantial computer and Internet access, and potentially increasing numbers of teachers believing in and employing project-based methods (admittedly, the least likely change to occur; however, with the large number of retirements approaching, we could see a change in teacher pedagogical philosophy), computers are quite likely to take on greater importance in school-based learning within the next 10 years. The issues about computers being hard to use, inconvenient, and subject to frequent breakdowns all seem likely to recede in significance over time. Their exponentially increasing capacities, combined with smaller size, simpler networking, more powerful software, and their clear relevance to a constructivist approach to teaching make it very likely that computers will become as central to academic education in K-12 settings as they are essential to the productive lives of adults and college students today. This paper provides important evidence that such a future is, in fact, more likely than the one which Cuban foresees.

References

Cuban, L. (1986). *Teachers and Machines: The Classroom Use of Technology Since 1920.* New York: Teachers College Press.

Cuban, L. (2000, January). So Much High-Tech Money Invested, So Little Use And Change In Practice: How Come? Paper prepared for the Council of Chief State School Officers' annual Technology Leadership Conference. Washington, D.C.

Cuban, L. (2001). *Oversold and Underused: Reforming Schools Through Technology, 1980-2000.* Cambridge MA: Harvard University Press.

Ravitz, J. L., Becker, H. J., & Wong, Y-T (2000, July). *Constructivist-Compatible Beliefs and Practices Among U.S. Teachers.* Teaching, Learning, and Computing: 1998 National Survey, Report 4. Center for Research on Information Technology and Organizations, University of California, Irvine. (On-line at http://WWW.CRITO.UCI.EDU/TLC/FINDINGS/REPORT4/startpage.html.)

Riel, M. M. and Becker, H. J. (2000, July). The Beliefs, Practices, and Computer Use of Teacher Leaders. Revised version of a paper presented at the 2000 meetings of the American Educational Research Association. (May,2001 version on-line at http://www.crito.uci.edu/tlc/findings/aera/startpage.html.)