The Pedagogy of Educational Technology and Technology Education: Data from Teaching, Learning, and Computing—1998: A National Survey of Computer Technology and Instructional Reform

Statement by
Henry Jay Becker
Professor of Education
University of California, Irvine

September, 1999

Teachers can use computers in almost an infinite variety of ways to help children learn, and for their own professional needs. Computers are…

?? A way to make repetitive practice of algorithmic skills more enjoyable
?? A means of accessing a rich variety of information about a topic
?? A powerful tool for data analysis, for creative expression, and for perfecting articulate verbal expression
?? A vehicle for synchronous and asynchronous communication with persons known and unknown.
?? And they provide an ability to publish one's ideas, in visually attractive ways, before both local and worldwide audiences.

Because of this large variety of applications of computers, to understand why a given teacher uses computers as he or she does, one has to understand not only the teacher's subject-matter and grade level responsibilities, but her basic philosophical approach to teaching and how that teacher conceives of the teaching role.

In the Spring of 1998, researchers at the University of California, Irvine and the University of Minnesota fielded a national survey of teachers to learn the place of computers in their instructional practice. Over 4,000 teachers participated, 70% of those who were sampled. A majority of the teachers (55%) represented a national probability sample of teachers in 4th through 12th grades; the rest came from schools specially selected because of their involvement in reform or because of the presence of substantial technology at their school. When I refer to teachers' practices in general (N=4,000), or practices of science teachers (N=330), I'll be using data only from the national probability sample. However, when I refer to results for teachers of the following groups—

(a) technology education (including tech prep, engineering, design, and video production; but NOT computer education); and
(b) vocational education (including career ed, industrial arts, health occupations, and agriculture; but NOT business education)—

I will pull in the teachers from the reform and high-tech schools, in order to raise the reliability of statistics for these relatively small groups of teachers (N=50 technology education; N=70 vocational education).

One approach our data analysis has taken contrasts teachers who emphasize skill and knowledge transmission approaches to teaching with those who emphasize either or both of the following: (1) complex reasoning and critical thinking competencies; and (2) making instructional tasks meaningful to students—project activities connected to their individual interests or experience—rather than focusing on coverage of a specific and comprehensive curriculum. Both of those emphases are associated with current efforts to improve teachers' effectiveness, and in combination these pedagogies are associated with the theory of learning called "constructivism." Constructivist pedagogy has two dimensions: (1) a philosophical one—what teachers believe is good practice—and a practice dimension—how they actually organize learning and instruction for classes of students.

We found fairly consistent differences in how teachers with constructivist approaches to teaching had students use computers compared to teachers with a transmission orientation, overall and within most school subject specializations. There are many complexities in the analysis, but to simplify I will use the contrast between the 50% of teachers who score highest on our measure of constructivist philosophy with the 50% of teachers who are more skill-and-concept transmission-oriented, according to our indicators.

Most teachers have students use computers, but typically they do so only on an occasional basis. That is particularly true for teachers in academic subjects like science, math, and social studies. However, in almost every subject, constructivist teachers are more likely to have students use computers frequently (i.e., more than 20 times during the school year). Across all subjects, 33% of the constructivist teachers do, compared to 21% of the transmission-oriented teachers. Constructivist science teachers are four times as likely to assign computer work frequently as transmission-oriented teachers in that subject (20% vs. 5%). Similarly, vocational education teachers are four times as likely to use computers frequently if they have a constructivist orientation than if they are transmission-oriented (56% vs. 14%). The constructivist-transmission-oriented distinction breaks down, though, for technology education. A majority of teachers in those subjects have students use computers frequently regardless of whether they are in the constructivist or transmission-oriented half of our sample (66% and 50%, respectively). [Note that the labelling of teachers is for a single class that they teach; and also that computer education classes are not included in the technology education label.]

Computer Use in Science Classes

In secondary school science, two of the three most common categories of software used by students are not science-specific: word processing programs and World Wide Web browser software, along with science-oriented reference materials on CD-ROM. These were the same three most commonly used types of software in our survey across all teachers (with different subject-matter for the CD-ROMs of course). Still, compared to

their other subjects, students have somewhat less experience with word processing software in science class and make more use of the World Wide Web than elsewhere. But, compared to other types of software that might have more specifically analytic functions in science—simulation programs and spreadsheet software in particular—word processing, along with researching on the Web and on CD-ROMs are the most common applications of computers in science class. For example, twice as many science teachers reported three occasions of World Wide Web use by students during the year as reported spreadsheet or database use (34% vs. 16%). Simulations were used by more science teachers (24%) than those who used spreadsheets but by fewer than those who had students look up information on CD-ROMs (38%). The impression one gets with these figures is that most science teachers do not have students use computers in ways that build their understanding of known science through the analysis of raw data. In fact, except for the presence of word processing, it seems that relatively little analytic work is done using computers across science classes as a whole. And it is not clear that even the word processing effort reflects an articulation of analysis as much as students documenting the work they did in order to receive appropriate credit.

Limiting ourselves now to those science teachers who have their students use computers during class, there are some distinctions between constructivist-oriented teachers and those whose philosophy is more transmission-oriented. However, the principal distinction is just that the constructivist teachers had students use every type of software more frequently than transmission-oriented science teachers, particularly the more commonly used types of software such as word processors, Web browsers and CD-ROMs. Proportionally, though, among the greatest differences between constructivist and transmission-oriented teachers were in having students use electronic mail (a difference of 10 to 1 on an index of frequency of use), presentation software (4:1), and multimedia authoring software (3:1). It is also interesting to note that constructivist science teachers had students use skills-practice software including games more than transmission-oriented teachers (4:1). Again, it appears that basic philosophical distinctions among teachers shows up primarily as a difference in how much class time they allocate to student computer use.

The previous results concerning types of software used in science class are paralleled by teachers' answers to questions about their major instructional objectives in having students use computers. Among science teachers who use computers with their students, the most frequently mentioned objective for computer use is to have students do library-type research, using Web or CD-ROM-based information. That is true of both traditional and constructivist science teachers. Using computers to analyze information is also important for both traditional and constructivist science teachers. However, science teachers with a constructivist philosophy have some objectives for student computer use that are different from ones that transmission-oriented science teachers have. They are more likely to value computers for improving students' writing, for having students present their findings before an audience, and to learn to work collaboratively. Transmission-oriented science teachers more often have as objectives for student computer use things like helping them practice skills and remediation. This is true

despite the fact that science teachers with transmission teaching philosophies actually teach classes that are, on average, of somewhat higher student ability levels.

Overall, for science teachers, the linkages are reasonably clear between their objectives for using computers, their general teaching philosophy, and their teaching practices (such as to what extent they emphasize integrative long-term projects and activities that challenge students conceptually and analytically). [The correlations among these three are about the same for science teachers who use computers as they are for English teachers, fine arts teachers, elementary teachers, computer teachers, and math teachers. They are higher for social studies teachers for some reason.] However, for vocational and technical education teachers, these correlations are quite weak, and, in fact, the objectives reported by constructivist voc-tech teachers and those reported by more transmission-oriented teachers didn't match our expectations at all.

Computer Use in Technology Education and Industrial Arts Education

We found that "analyzing information" was the most frequently mentioned objective—not of constructivist voc-tech teachers (it was only the 7th most frequent for them)—but of vocational and technology education teachers (considered together) who had traditional teaching philosophies. And, on the other hand, the most valued computer use objective of constructivist voc-tech teachers was helping students to "master skills just taught." The skills results are exactly contrary to the pattern for every other subject-area: generally, skill-mastery is usually one of the top three objectives for the traditional-believing teachers and not in the top three for the constructivist-leaning ones.