How Many Computers Are Enough?


A 1995 report from the U.S. Office of Technology Assessment indicated that K-12 schools in the United States had an average of one microcomputer per nine students. This ratio has been steadily improving; therefore, one microcomputer per eight students might be a good current estimate. (Unfortunately, a large number of these computers are relatively old machines.)

Where are we headed in making computers more available to students? What is an appropriate goal? Many people feel that a good target ratio is one microcomputer for every two students. This ratio would ensure that schools could have a number of computer labs as well as "pods" of machines in each classroom.

A Goal for the Next 10 Years

Personally, I feel that a 1:2 computer-to-student ratio is far too low. Instead, I believe that our goal should be to achieve a ratio of about 1.5 computers per student within the next 10 years. A substantial part of this supply of machines should be portable computers that students could use both at school and at home. These portable machines could be easily connected to networks from home and from locations throughout the school. They would also allow students to have access to powerful personal productivity tools, such as those included in ClarisWorks and Microsoft Works. In addition, all students should have easy access to hand-held calculators.

The essence of the argument for a 1.5 computer-to-student ratio is simple enough. In the past, we have shown willingness to build a large part of the curriculum on the ready availability of certain types of technology, and we will continue to do so in the future. Because technology changes, the curriculum changes.

Mathematics and Technology—An Example

Let's consider the current technology used in mathematics as an example. (Other subject areas could be used just as effectively to make the argument.) Our mathematics curriculum is built on the assumption that students almost always have paper and pencils available for doing mathematics. Although students can do a great deal of mathematics mentally, they often use paper-and-pencil technology to overcome various mental limitations.

For example, although students can mentally learn to estimate the quotient of two large numbers, they usually learn to use a paper-and-pencil algorithm for long division. Very few people have the type of memory and persistence needed to mentally do long division involving large numbers. Therefore, paper-and-pencil technology has become inextricably woven into the long-division aspect of the mathematics curriculum.

The same holds true for solving equations, proving theorems, graphing functions, and analyzing statistical data. Learning how to solve math problems and actually solving them both depend on paper-and-pencil technology. The algorithms and problem-solving processes students learn are based on an appropriate balance between their mental capabilities and the capabilities
of the technology. Thus, it is assumed that students have the necessary technology available when they do homework and take tests.

Paper-and-pencil technology is a passive form of technology. This type of technological aid for representing and solving math problems is not very "intelligent." Of course, paper-and-pencil technology becomes less passive if we allow the use of books and student notes in homework and test-taking situations. It is interesting that we allow open books and open notes when students do homework, but typically not when they take tests. Open books and open notes are certainly more authentic in terms of how students solve problems outside of school settings. Contrast the passiveness of paper and pencil with the active "intelligence" of a calculator or computer. An inexpensive calculator "knows" how to do long division or compute a square root. A computer (with appropriate software) "knows" how to solve equations, carry out statistical analyses of data, and graph functions.

Our educational system has made relatively slow progress toward having a mathematics curriculum that assumes all students have a calculator (much less a computer) to use whenever they want. This is despite the fact that hand-held solar calculators have been available for about three dollars for many years.

However, some progress is occurring. Many high school math courses now assume that students have a graphing calculator. The content of the curriculum has been modified to assume such access. Moreover, the power of these calculators is steadily growing. Some calculators have computing power and built-in software that rival the capabilities of the mainframe computers of just 20 years ago.

**Using Technology Authentically**

The trend of intertwining technology tools into the content of the curriculum is continuing, strongly supported by continuing improvements in computer technology. "Knowing" will increasingly mean that "I and my information technologies know."

On a personal note, it is I and my information-technology support structure that solve problems and accomplish tasks as I work. I cannot function effectively without access to information technologies such as a computer, e-mail, telephone, voice mail, fax, the World Wide Web, a printer, a copier, and so on. Moreover, there is no expectation that I will function without such access to these information technologies. The same can be said for millions of adults.

For education to be authentic, students must have access to information technologies whenever they need them. That is the reason that we should move rapidly toward providing every student with a portable machine. These portables do not need to be state of the art; they should be rugged, reliable, and user friendly. They will need to be supported by more powerful multimedia machines (closer to state of the art), as well as servers for network connectivity. Every teacher will need both a portable machine and access to a more powerful machine. Every classroom will need multimedia presentation stations for students and teachers to use. This is why achieving a 1.5 computer-to-student ratio is essential if we want our students to succeed.

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