# Chapter 6

# Recommendations for Technology in Teacher Preparation

Technology has revolutionized many jobs and substantially increased the mathematical skills needed across the workforce. In contrast, its impact on instructional practices has been more modest and varies greatly from classroom to classroom. During the careers of the prospective teachers now in college classes, new technologies now unimaginable are likely to enter classrooms. Hence prospective teachers' most important need with regard to technology in college mathematics classes is in building a framework that will aid them in teaching with technology throughout their careers.

This chapter briefly discusses three general aspects of technology's role in school mathematics classrooms: (i) computation, (ii) new computer tools, and (iii) mathematical content. More specific uses of technology in school mathematics instruction and in college mathematics courses for prospective teachers are described in Part 2 of this report. It is assumed that all prospective teachers will use the Internet to access information sources and use e-mail to foster professional development discussions. It is beyond the scope of this report to discuss various types of computer-based instruction and distance learning.

**Computation.** First, prospective teachers need to understand the differences among the three most common types of computation in mathematics classrooms: (a) electronic computation to advance learning, (b) human computation to advance learning, and (c) electronic computation as a practical expedient.

*Electronic computation.* Electronic computation allows students to explore more complicated applications than would be possible in its absence and to work problems with realistic data. Students can use technology to visually study mathematical patterns, e.g., comparing the graphs of $y = 2x$ and $y = x^2$, and to approximate the value of complex expressions, e.g., arc-length integrals. The pervasive use of statistics in the modern world would be impossible without computers, and likewise it is natural in the classroom to use technology for virtually all statistical computations.

*Human computation.* When elementary grade students are learning arithmetic, they need extensive pencil-and-paper experience to develop fluency and accuracy with basic arithmetic procedures. They also need experience doing mental calculations. These arithmetic skills provide a critical foundation for subsequent learning about decimals, fractions, algebra, and more.

*Practical expedient.* By high school and continuing throughout their lives, people use calculators (or mental arithmetic) as an expedient way to obtain answers in arithmetic calculations.

Second, prospective teachers need to understand that the use of technology for complicated computation does not eliminate the need for mathematical thinking but rather often raises a different set of mathematical problems. Students should be shown that brute force computation often takes excessive time, even with modern computers. Considerable mathematical planning and theoretical insights may be needed to structure efficient computation.

**New computer tools.** Spreadsheets and modern programming languages open up new avenues of problem solving and reasoning. There is a growing array of educational software, such as *Geometer's Sketchpad*, *FunctionProbe*, or *Fathom*, designed to enhance students' understanding of mathematical concepts and their reasoning skills. Mathematicians, mathematics education researchers, and mathematics teachers have been exploring how such computer tools can support new types of pedagogy.

Prospective teachers at all levels need experience in using spreadsheets, ideally in several quantitatively based courses across the undergraduate curriculum. Prospective high school teachers need experience writing in computer programs in a high-level language, such as C++. Prospective high school teachers should also have experience with a computer algebra system, dynamic geometry software, and a statistical software package. These experiences should be designed with two goals in mind: the short-term goal of helping prospective teachers to effectively use current technology in teaching; and the long-term goal of enabling them to become thoughtful and effective in choosing and using educational technology.

**Mathematical content.** The mathematical topics and reasoning underlying computer science and information technology seem likely to play a larger role in future school mathematics curricula. Computer-related mathematics involves new facets of traditional topics, such as number theory for encryption, as well as new fields, such as discrete mathematics. Moreover, technology-related workplace and scientific needs may cause curricular changes. For example, because of the important role that analytic geometry plays in computer graphics and visualization, more attention may be given in the future to two-dimensional analytic geometry, and three-dimensional analytic geometry may re-enter high school curricula. Computer-related mathematics also involves different emphases in reasoning, such as more definitions by recursion. Mathematics faculty need to stay abreast of changes as school mathematics curricula evolve to address the mathematical needs of computer science and quantitative social sciences, along with the longstanding needs of the physical sciences.