MATERIALS AND TECHNOLOGY

Life in the 21st century will require personal competence with technology, information processing, communication, and decision making. With the integration of technology into every aspect of the workplace, the integration of technology in teaching and learning is essential. New technologies offer increasingly versatile tools that can supplement and reinforce, not replace, student learning.

What Materials and Technology Are Being Used and Are They Effective?

- Print materials have been and remain mainstays of U.S. elementary and secondary education.[1] Textbooks that present, explain, and summarize dominate the introduction of new material. Workbooks and dittos dominate practice.

- Recent research suggests strongly that students perform better when working more with original materials rather than with the routine summaries typically provided in textbooks, workbooks, or worksheets.[2]

- Better understanding of arithmetic can be developed in students with a curriculum that emphasizes estimation, mental arithmetic, and calculator use, with reduced instruction on paper-and-pencil calculation. Indeed, some evidence suggests that over-emphasis on manual skills hinders children's learning of when and how to use those skills.[3]

- Students using exploratory computer graphics programs may perform as well as or better than students using traditional criteria.[4] For mathematical concepts such as data analysis or functions, appropriate use of the computer and software enhances student interest in and understanding of important ideas.

- Computers and other electronic technologies are readily available in Ohio's classrooms:

  - By early 1999, 88 percent of Ohio public classrooms had access to the Internet, slightly below the national average of 90 percent.[5]

  - CD-ROM technology is available in Ohio at a ratio of one CD-ROM drive to every 6.9 students. This figure ranks eighth among all U.S. states.[6]

- However, computers are rarely used in Ohio's math and science classes:

  - Fifty percent or more of Ohio's math and science teachers reported that they never used computers to do exercises or solve problems in 1998-99.[7]

  - Nevertheless, comparable data for the U.S. suggest that Ohio's teachers are slightly *more* apt to use computers in math and science instruction.[8]

A number of the features of new technologies are consistent with the principles of learning: direct experience, rapid feedback, and original materials. Consider the following:[9]

- The interactivity of new technologies makes it easier to create environments in which students can learn by doing, get feedback, and refine their understanding with less dependence on the teacher.

- Using technology, students can better visualize difficult-to-understand concepts, such as differentiating heat from temperature. Working with real-world software applications in school will only benefit students when they encounter the same applications outside the classroom.

- The Internet, CD-ROMs, and other digital technologies give students and teachers instant access to millions of pages of information, libraries, and other reference sources, real-world data, and the ability to communicate with other people.

With successful local, state, and federal governmental efforts to get computers into schools, it brings up the critical question of use. Is the technology being used? How is it being used? What kinds of additional training do teachers need to take full advantage of the technology's capabilities?[10] How can the technology be used to facilitate teacher learning?

For example, the technology exists to link world-class physics researchers with local classroom physics teachers. The benefits of such a link are virtually unlimited:[11]

- Researchers may gain a greater understanding of why learners fail to grasp core concepts of the field.

- Teachers may gain a better understanding of theories and relationships of concepts they teach.

- Students may gain a better understanding of the relationship of concepts learned in the classroom to their application in the real world.

The potential for the use of technology in the classroom is exciting.[12] However, without properly trained teachers to guide the way for student users, an expensive new computer in a school classroom has as much educational value as a dusty textbook on a shelf.

Endnotes

1. C. F. Kaestle, *Pillars of the Republic: Common Schools and American Society,* National Research Council, Washington, DC, 1996. Attempts to digitize textbooks have so far been unsuccessful, despite pressure from states as large as Texas.

2. National Research Council, *National Science Education Standards,* National Academy Press, Washington, DC, 1996.

3. Mathematics Sciences Education Board (MSEB), *Reshaping School Mathematics: A Philosophy and Framework for Curriculum,* National Academy Press, Washington, DC, 1990.

4. Ibid.

5. *Technology in Education: A Comprehensive Report on the State of Technology in the K-12 Market,* Market Data Retrieval, Shelton, CT, 1999.

6. Ibid.

7. NCREL analysis. The single exception was in 12th-grade science classes, where just over half of the teachers said they used computers in some lessons.

8. I. Mullis, M. Martin, A. Beaton, et al., *Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study,* Boston College, TIMSS International Study Center, Chestnut Hill, MA, 1997; and A. Beaton, I. Mullis, M. Martin et al., *Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study,* Boston College, TIMSS International Study Center, Chestnut Hill, MA, 1996.

9. J. Bransford, A. Brown, and R. Cocking, *How People Learn: Brain, Mind, Experience, and School,* National Academy Press, Washington, DC, 1999.

10. Teachers need to learn how to use and manipulate technology, how to integrate it into classwork productively, and how to locate or build useful technologies. These skills require time and other resources. Please see *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States,* Executive Office of the President of the United States, Washington, DC, March 1997.

11. Bransford, Brown, and Cocking

12. B. Means and K. Olson, *Technology's Role in Education Reform: Findings from a National Study of Innovating Schools,* SRI International, Menlo Park, CA, 1995.

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