Games/Drill and Practice in Grades K-2

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Many people, including teachers, may automatically assume that screen-based technologies will benefit student learning more than traditional paper-and-pencil methods. Recently, researchers have found this to be the case in using mathematics computer programs that focus on learning discipline-specific concepts such as fractions, geometry, or place value. In addition, features such as text-to-speech offered in a digital environment can be invaluable for students who otherwise might not have access to a lesson's content.

However, when researchers do not consider the importance of accessibility, and the only goal is for students to engage in lower-order thinking—specifically, drill and practice—the value of computers seems limited. In previous research from the 1980s, the central finding was that computers do not appear to be more effective than traditional paper-and-pencil instruction as a means for helping students engage in lower-order thinking. In this respect, however, the research highlighted below from the 1980s seems more dated in the technology used and instructional practices emphasized—namely, drill and practice. Yet these findings, coupled with the suggestions Garofalo & Sharp (2003), offer for ways to successfully implement technology into the mathematics classroom, are important to keep in mind when purchasing mathematics software.

Curriculum studies

Axelrod, McGregor, Sherman, & Hamlet (1987) wanted to determine the effects of reinforcement on student learning. They observed four second-graders practice addition problems on "Math Machine" in three different conditions: 1) a "high reinforcement" condition that involved the opportunity to play a short computer game after each correct answer, 2) a "medium reinforcement" condition that included fewer opportunities to play these games, and 3) a "no reinforcement" condition. Not surprisingly, these researchers found that students spent more time playing games than practicing addition. Since drill and practice as an instructional approach focuses on the importance of the number of opportunities to practice, it is also not surprising that
students' scores improved when they did not have the option to play a game as reinforcement. The value of reinforcement, however, should not be dismissed, and these researchers suggest that drill and practice computer programs could still motivate students by reporting their previous scores and encouraging them to surpass that score.

Fuson & Brinko (1985) found similar results when comparing the effects of computer-based drill and practice software to the (non-digital) use of flash cards. In their study, 84 second- and fourth-grade students participated in either the flash card or computer group. When comparing these students' scores on weekly timed tests, there appeared to be no significant difference in achievement. Though they conclude that their results "call into question the use of microcomputers in the classroom for drill that involves the retrieval of facts," they do admit that the computer "was crucial in the design of the drill procedure" (p. 231). Both conditions' procedures included a limited number of facts that could be individualized for specific needs, provided immediate feedback on student's accuracy with the correct answer stated, and offered immediate feedback on the speed of the students' responses.

Overall, it appears that a digital environment is a more effective means of instruction for accessibility to the content, engagement in that content, and conceptual learning. With these ideas in mind, Garofalo and Sharp (2003) offer the following suggestions for successfully implementing technology in the mathematics classroom:

1. **Introduce technology in the context of the learning.** Focus on learning with technology, not just technology.

2. **Address worthwhile mathematics with appropriate technology.** As illustrated in the research above, computer programs have not been shown to be more effective for drill and practice approaches to learning.

3. **Take advantage of technology.** Consider ways that technology can enrich learning.

4. **Connect mathematics topics.** Consider computer programs that can help students link mathematics concepts to real-world applications.
5. **Incorporate multiple representations.** Use technology that presents mathematics concepts in myriad ways, including pictorial, numerical, graphical, and verbal, among others.

To illustrate these principles, Garofalo and Sharp (2003) describe a computer program, "Kids and Cookies." Though the effectiveness of this program has not been adequately researched, the principles used to guide its development have, offering a helpful representation of how a computer program can facilitate elementary students' learning of fraction concepts, vocabulary, and symbols, and apply these skills to real-world situations.

**References**

