The Effectiveness of Educational Technology Applications for Enhancing Mathematics Achievement in K-12 Classrooms: A Meta-Analysis

Educator's Summary
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This review summarizes research on the effects of technology use on mathematics achievement in K-12 classrooms.

The main research questions included:

1. Do education technology applications improve mathematics achievement in K-12 classrooms as compared to traditional teaching methods without education technology?

2. What study and research features moderate the effects of education technology applications on students' mathematics achievement?

Over 700 potential studies were identified for preliminary review in an extensive search of previous studies, which included a comprehensive literature search of articles written between 1970 and 2011. Producers and developers of educational technology programs were also contacted to check whether they knew of any studies that had been missed. After applying consistent inclusion standards, a total of 74 studies met the inclusion criteria and were included in the final review. These had a total sample size of 56,886 K-12 students.

The three major categories of education technology reviewed were:

1. **Computer-managed learning**, which included only Accelerated Math. This program uses computers to assess students' mathematics levels, assign mathematics materials at appropriate levels, score tests on this material, and chart students' progress.

2. **Comprehensive models**, such as Cognitive Tutor and I Can Learn, use computer-assisted teaching along with non-computer activities as the students' core approach to mathematics.

3. **Supplemental CAI technology**, which consists of individualized computer-assisted instruction (CAI). Supplemental CAI programs, such as Jostens, PLATO, Larson Pre-Algebra, and SRA Drill and Practice, provide instruction at students' assessed levels of need to supplement traditional classroom instruction.

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Key Findings

The overall effect size weighted by sample size was +0.16, a modest effect. Outcomes were broken down by type of intervention, grade level, program intensity, and socio-economic status.

Key findings were as follows:

Types of intervention The 55 studies of supplemental technology programs produced the largest effect size, +0.18, and the 10 studies of computer-managed learning programs and the nine studies of comprehensive models produced similar small effect sizes of +0.09 and +0.06, respectively. The results of the analyses of computer-managed learning and the comprehensive models must be interpreted with caution, however, due to the small number of studies in these two categories.

Grade level Studies were divided into elementary (N=45) and secondary (N=29) schools. The effect size for elementary (ES=+0.17) was higher than for secondary (ES=+0.14).

Program intensity Program intensity was divided into three categories: low intensity (the use of technology for less than 30 minutes a week), medium intensity (between 30 and 75 minutes a week), and high intensity (over 75 minutes a week). The effect sizes for low, medium, and high intensity were +0.06, +0.20, and +0.14, respectively. These results suggest that, in general, programs that were used for more than 30 minutes a week had a bigger effect than those that were used for less than 30 minutes a week.

Socio-economic status (SES) Effect sizes were similar in schools serving children of low and high SES. Low SES refers to studies in which 40% or more students received free and reduced-price lunches, and high SES less than 40%. The 13 studies that involved a diverse population, including both low- and high-SES students, and the 10 studies that had no SES information, were excluded in these analyses. The effect sizes for low and high SES were +0.12 and +0.25, respectively.

Conclusions

Findings of this review suggest that educational technology applications produce a positive but small effect (ES=+0.16) on mathematics achievement. Supplemental CAI technology had the largest effect, with an effect size of +0.19. The other two categories, computer-managed learning and comprehensive models, had much smaller effect sizes, +0.09 and +0.06, respectively.

Educational technology is making a modest difference in mathematics learning. The evidence to date, however, does not support complacency. New and better tools are needed to harness the power of technology to enhance mathematics achievement for all children.

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Review Methods

To be included in this review, a number of criteria had to be met. The studies had to:

1. Evaluate any type of education technology which was intended to improve math achievement in grades K-12.

2. Compare students taught in classes using a given technology-assisted mathematics program against randomly assigned or well-matched control groups using alternative or standard programs.

3. Be written in English, but could have been conducted in any country.

4. Use random assignment or matching with appropriate adjustments for pretest differences. Studies in which students selected themselves into treatments, or were specially selected into treatments, were excluded.

5. Provide pretest data, unless studies used random assignment of at least 30 units (individuals, classes, or schools) and there were no indications of initial inequality. Studies with pretest differences of more than 50% of a standard deviation were excluded.

6. Have dependent measures that included quantitative measures of mathematics performance, such as standardized mathematics measures.

7. Have a study duration of at least 12 weeks.

8. Have at least two teachers in each treatment group to avoid the confounding of treatment effects with teacher effects.

9. Use programs which were replicable in realistic school settings.

Full Report

Cheung, A., Slavin, R.E. (2011, July). *The Effectiveness of Educational Technology Applications for Enhancing Mathematics Achievement in K-12 Classrooms: A Meta-Analysis*. Baltimore, MD: Johns Hopkins University, Center for Research and Reform in Education.

The full report can be downloaded at www.bestevidence.org/math/tech/tech_math.htm

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