The Effectiveness of Educational Technology Applications for Enhancing Mathematics Achievement: A Meta-Analysis

Educator's Summary

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This review summarises research on the effects of technology use on mathematics achievement in primary and secondary school classrooms.

The main research questions included:

1. Do educational technology applications improve mathematics achievement compared to traditional teaching methods without technology?

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

Over 700 potential studies were identified for preliminary review in an extensive search of previous studies and a comprehensive literature search of articles written between 1970 and 2011. Producers and developers of educational technology programmes 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 primary and secondary pupils.

The three major categories of education technology reviewed were:

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

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

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

The full report (which this review summarises) is available at www.bestevidence.org.uk

Key Findings

The overall effect size weighted by sample size was +0.16, a modest effect. Outcomes were broken down by types of intervention, year levels, programme intensity, and socio-economic status. Key findings were as follows:

Types of intervention The 55 studies of supplemental technology programmes produced the largest effect size, +0.18, and the 10 studies of computer-managed learning programmes 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.

Year levels Studies were divided into primary (N=45) and secondary (N=29) school classrooms. The effect size for primary (ES=+0.17) was higher than for secondary (ES=+0.14).

Programme intensity Programme 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, programmes 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 pupils 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 pupils, 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.

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 maths achievement in primary and secondary school classrooms.

2. Compare pupils taught in classes using a given technology-assisted mathematics programme against randomly-assigned or well-matched control groups using alternative or standard programmes.

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 standardised 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 programmes which were replicable in realistic school settings.

The Full Report

The full report, which this review summarises, is Cheung A, and Slavin RE (2011), *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.uk