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Computers in the Teaching and Learning of Mathematics

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A personal perspective on research on the impact of computer use on pupil learning and achievement

International seminar on *New trends in mathematics education research: a European perspective*
l'Istituto Regionale di Ricerca Educativa dell'Emilia-Romagna (IRRE-Emilia Romagna)
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ICT in schools = big business

Education spending on information and communications technology (ICT) is big business.

UK Government spending on computers (and related items) for schools during 1998–2004:

£1.8 billion (2.65 billion Euro)

ImpaCT2 – impact on pupil learning and attainment

- Major research study involving 60 schools in England over 3 years (1999 -2002)
- One of the most comprehensive investigations into the impact of information and communications technology (ICT) on educational attainment so far conducted in the United Kingdom.

Source: Harrison, C. et al (2002). *ImpaCT2: The impact of information and communication technologies on pupil learning and attainment*. BECTA.

ImpaCT2 findings for school mathematics

- For primary school pupils (aged 5-11):
  A positive association between ICT use and National Test scores at age 11 was found for mathematics, although it was not statistically significant.
- For lower secondary school pupils (aged 11-14):
  A positive association between ICT use and National Test scores at age 14 was found for mathematics, although it was not statistically significant.
- For upper secondary school pupils (aged 14-16):
  A positive association between ICT use and National Test scores at age 16 was found for mathematics, although it was not statistically significant.

Findings from other countries

Israel

Between 1994 and 1996, about 10 percent of Israel's elementary school pupils and about 45 percent of middle school pupils were in schools that received new computers (about 35,000 machines).

Angrist and Victor (2001) found no evidence that increased use of computers raised pupil test scores. If anything, the mathematics scores of pupils in schools that received new computers actually went down.

Source: Angrist, J., & Lavy, V. (2002). New evidence on classroom computers and pupil learning. *The Economic Journal*, 112(482), 735-765.

Findings from other countries

USA: Analysis of data from the 1996 National Assessment of Educational Progress (NAEP) in mathematics, consisting of national samples of 6,227 fourth grade pupils and 7,146 eighth-grade pupils.

Fourth grade

General school computer use is negatively related to mathematics achievement.

Pupils who used computers to play learning games showed gains in achievement, as did those with a teacher who had received professional development on using computers.

Eighth grade

General school computer use is negatively related to mathematics achievement.

Pupils who used computers for higher-order thinking tasks showed gains in achievement, as did those with a teacher who had received professional development on using computers. These gains were larger than those made by fourth grade pupils.

Source: Wenglinsky, H. (1998). *Does it compute? The relationship between educational technology and student achievement in mathematics*. Princeton, NJ: ETS.

Are computers worth it?

"For a relatively small number of children with certain disabilities, technology offers benefits. But for the majority, computers pose health hazards and potentially serious developmental problems. Of particular concern is the growing incidence of disabling repetitive stress injuries among students who began using computers in childhood."

Source: Cordes, Colleen and Miller, Edward (2000), *Fool's Gold: A Critical Look at Computers in Childhood*. College Park, MD: Alliance for Childhood.

Are computers worth it?

"It is premature to call the investment in computers in schools a failure because of lack of evidence for increased productivity and transformed teaching and learning. As the infrastructure matures and teachers' beliefs about teaching and learning evolve, more and more teachers will change their practices and become serious users of computers."

Source: Cuban, Larry (2001), *Oversold and Underused: Computers in the classroom*. Cambridge, MA: Harvard University Press. (p179)

Reasons suggested for ImpaCT2 findings

For primary school pupils (aged 5-11):

Less use of ICT in mathematics lessons than in other lessons - over half the sample of pupils (52%) reporting never or hardly ever using ICT in their mathematics lessons.

75% of primary school pupils never or hardly ever used ICT to support their learning of mathematics in school outside mathematics lessons.

Use of ICT for mathematics at home was less than for other subjects, with 39% never using ICT at home for mathematics.

Reasons suggested for ImpaCT2 findings

For lower secondary school pupils (aged 11-14):

67% of lower secondary school reported never or hardly ever using ICT at school in mathematics (less often than in some other subjects).

81% of lower secondary school pupils never or hardly ever used ICT to support their learning of mathematics in school outside mathematics lessons.

Some 44% never used ICT at home for mathematics work

Reasons suggested for ImpaCT2 findings

For upper secondary school pupils (aged 14-16):

Nearly 82% of such pupils report never or hardly ever using ICT in mathematics lessons.

Almost 90% report never or hardly ever using ICT to support their learning of mathematics in school outside mathematics lessons, and a similar proportion report never or hardly ever using ICT to support their learning of mathematics at home.

Other UK findings

- primary schools with good ICT resources tend to have better achievement results than schools with unsatisfactory ICT resources, even when benchmarked with schools of a similar type
- schools that have good ICT resources and use them well tend to have better results than schools where good ICT resources are not well used ;
- primary schools that use ICT to support a subject tend to have better achievement in that subject than schools that do not make such use
- schools that made good use of ICT generally have high quality teaching of ICT, a favourable school ethos in relation to ICT, good pupil access to ICT resources, high pupils ICT skills, and have developed in their pupils a positive attitude to ICT;

BECTa (2001), *Primary Schools of the Future: achieving today*. Coventry: BECTa.

Need for more research

"Learning gains using ICT appear to be more likely when supported by effective pedagogical approaches and effective teaching strategies.

Research would suggest that a number of factors need to be in place in order to reach a threshold above which ICT is more likely to have a significant impact and support education and learning effectively. However, it is unclear at this stage which ones are the most significant and how many are required in order to reach the threshold."

BECTa (2001), *Primary Schools of the Future: achieving today*. Coventry: BECTa.

Need for more research

Little research data has yet emerged on how ICT might contribute to effective pedagogy, though plenty of speculation is available.

An unresolved question is whether ICT initiatives should aim to support current pedagogy and improve attainment within the frameworks that schools already have, or whether new pedagogies will emerge replacing the old.

Need for better research?

Research into the effects of using computers on student achievement "is often on small samples, rarely controls out the effects of things other than ICT, and is rarely rigorous enough in its methodology, or its search for explanations of findings, to support the weight that has been put on it."

David Reynolds, writing in the Preface to BECTa (2001), *Primary Schools of the Future: achieving today*. Coventry: BECTa.

Need for better research?

Only 31 out of 195 studies "used designs that met our minimum requirements for methodological criteria":

- the use of a comparison group,
- large enough samples,
- reliable measures of achievement, and
- sufficient information for estimating an effect size.

An additional limitation "is the almost total lack of documentation of the implementation of the programs, with a few exceptions. Thus, the evaluations reviewed fail to provide evidence of *why* particular results were obtained."

Murphy, Robert F., *et al* (2002), *A Review of Recent Evidence On the Effectiveness of Educational Software*. Menlo Park, CA: SRI International.

Problems to monitor in studies of ICT effectiveness

Selecting a special group of students, teachers, and/or classrooms

Selecting an inappropriate test of student achievement

Using too small a sample

Not documenting the duration of students' exposure to the software

Studying effectiveness too early in a software program's use

Failing to maintain an independent perspective

Confounding the effect of software use with the effect of other changes in the school

Some current UK research

- *InterActive Education: Teaching and Learning in the Information Age* Ros Sutherland, Susan Robertson and Peter John (University of Bristol)

  Design and evaluation of longitudinal teaching and learning initiatives using new technologies
- *Eliciting situated expertise in ICT-integrated mathematics and science teaching* Ken Ruthven & Sara Hennessy (Cambridge)

  Teachers' and students' views on successful (or promising) uses of ICT
- *Innovative pedagogical practices using ICT* Sue Harris and Alison Kington, NFER

  Case studies of ways in which ICT is being used in schools.

An English saying

You can lead a horse to water but you cannot make it drink.

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Thank you!

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