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- key research evidence about network technologies
- examples of effective use
- bibliography and further reading.

Summary

The amount of available research evidence regarding networks varies - it is extensive for computer mediated communications (CMC) but more limited for wireless and broadband.

Key benefits

- communication beyond school boundaries
- support for collaboration
- flexible access through wireless networks
- positive effects on student motivation.

How teachers can maximise the impact of network technologies

- being aware of the range of applications available
- applying their teaching expertise.

What the research says about network technologies in teaching and learning

This report is based on an analysis of available research about the uses made of network technologies and their impacts on teaching and learning. It summarises the key findings and suggests resources for further reading.

What are network technologies?

Many types of networks exist, but essentially a network is a group of linked computers. Within a school, connecting up computers with cables creates a network. This allows them to communicate with each other through applications such as email, or to access resources which may be hosted on a network server. The school network may be connected to the internet, itself a huge collection of networks, to communicate and share resources beyond the school. Recent advances in technology have led to the introduction of wireless networks, which liberate networked computers from the need to be connected together by cables. A broadband internet connection enables faster use of the internet than that provided by an Integrated Services Digital Network (ISDN) or conventional dial-up line.

Topics which have been reviewed include:

- collaboration between students by electronic means
- impact of CMC (computer mediated communications) on the classroom
- effects of networks on student motivation
- implementation of wireless networking in schools
- use of networks to support learning in distributed courses.

Key research evidence about network technologies in teaching and learning

On the basis of Becta's analysis, network technologies can have positive effects in the areas outlined below (there are references for further reading supplied alongside most of the findings).

General benefits

- learning to use the internet, developing communication skills by using electronic tools such as email, and the sharing of online resources are all dependent on computer networking
- wireless networking reduces the physical constraints associated with computer use
- networks open up access to tools and resources which can have a strong motivational effect on students.

Benefits for students

- videoconferencing with schools and people in other countries
- broadband technology supports the reliable and uninterrupted downloading of web-hosted educational multimedia resources
- positive effects in areas such as self-esteem, motivation, interest and focus (Reaux 1998)
- opportunities to address their work to an external audience (Allen 1995)
- opportunities to collaborate on assignments with people outside or inside school (Chiu 2002; Lipponen 2000; Willinsky 2000)
- access to online course resources (Chiu 2002).

Benefits for teachers

- an alternative medium such as CMC for interaction and discussion with students, which can encourage contributions from those hesitant to participate in the normal classroom environment (Cooney 1998)
- forming partnerships with peers around the world, while collaborating to complete tasks, through such programmes as Learning Circles, which are based around cross-classroom collaboration, or telecollaboration (Riel 1998)
- access to curriculum software and internet applications which have a strong motivational effect on students (Mistler-Jackson, 2000; Wishart 1999)
- wireless networks can encourage students in the use of social computing tools such as email and messaging by supporting flexibility in access, and hence extending collaboration (Gay 2001)
- wireless connectivity enables work with ICT to take place whenever and wherever suits the teacher, leading to improved access to ICT and consequently increased use (Perry 2002)
- confidence in innovating with ICT is increased if a teacher, supported by wireless networking, can use ICT in their own classroom (Perry 2002)

- courses may be designed along principles of either distance or distributed education. A wholly distributed course can be highly motivating for students, who tend to take on responsibility for their own learning (Adanes 1998).

Benefits for parents

- home access to school records, reports and resources.

However, these benefits do not occur universally. Other factors influence whether these benefits will be realised.

Factors for effective use

- provision of models, support and practice for teachers integrating network technology into their teaching (Stuhlmann 1998)
- a vision which shapes the way teachers combine technology with pedagogical aims (Cooney 1998)
- reliable and modern school infrastructure, which does not place barriers between teachers and ICT.

About Becta's 'What the Research Says...' series

This series of briefing papers is designed in particular for teachers, ICT co-ordinators and school managers, in order to provide an initial idea of the available research evidence for the use of Information and Communications Technology (ICT) in schools and colleges. We welcome feedback and suggestions for further titles in the series (contact details can be found at the end of this briefing).

Networks in practice

Telford and Wrekin LEA has built a wide-area broadband network, provided free as a service to schools. The Blessed Robert Johnson secondary school is one of the schools in the area to be linked to the network and is using group videoconferencing to teach subjects such as modern foreign languages. A-level history students are able to talk regularly to professors at Lancaster University. The speed and quality of the videoconferencing has allowed for individual tuition, specialist lectures and simultaneous broadcast lessons to all Telford schools. Headteacher John Martin is using videoconferencing projected onto a whiteboard for whole class teaching of subjects he is unable to offer, such as psychology. He also believes that videoconferencing is useful for slow learners as well as for 'catch-up' lessons for pupils who have missed lessons.

The high-speed connection can deliver streamed educational media and broadcast video-on-demand. Teachers are able to plug into interactive broadcasts at their own convenience, rather than having to schedule lessons to coincide with traditional television broadcasts. They can also choose digital material and modify it for the needs of particular classes or individuals. Students can go forwards, pause or rewind, stop for discussion, bring in material from the internet, engage in exercises or respond to questions which can be emailed to a tutor. The network has been used by the BBC to trial its online learning resources.

Explanation of findings

As with ICT more generally, direct causal effects are not always easily identifiable. Drawing clear conclusions on the effects of ICT from the range of research evidence and reports available can be problematic. There are a number of factors that limit effective comparisons, such as differences in sample sizes, methodologies and effects, and the extent and purpose of ICT use involved.

Positive impacts depend on the ways in which the technology is used and benefits will inevitably be reliant on the capacity of teachers and students to use ICT as an effective pedagogical tool in the pursuit of particular learning objectives.

Why is broadband significant?

Broadband is a general term used to describe high-speed networking services, and does not specify the speed. Targets announced in January 2003 are for connections to primary schools of two megabits per second (mbps) and secondary schools of 8mbps. Extensive simultaneous usage by students could slow response times significantly however, and in 2002 the E-envoy Andrew Pinder suggested that the target speed for broadband could be 10 mbps.

Educational websites increasingly are offering audio and video, and low speed connections limit the use of these. With the improvements in infrastructure associated with broadband developments, the opportunity to exploit to the full some of the more exciting, interactive and advanced elements of products becomes a reality for more educational institutions. Teachers responding to the Fischer Family Trust report of 2002 reported that the internet was invaluable for research, enabling pupils to explore independently and to achieve their own goals, and that the impact of broadband had been huge (*Fischer Family Trust 2002*). Slow and unreliable connections to the internet in schools, and time wasted by pupils waiting to download information, have been highlighted by Ofsted (*Ofsted 2001*).

Anecdotal evidence demonstrates the effectiveness of broadband in removing barriers to access to ICT. Case studies from the Yorkshire and Humberside Grid for Learning (YHGfL) show the impact of greater speed, both for students and teachers, resulting in greater use of ICT. Speed means less frustration for users, and the reliability of the connection encourages teachers to plan use of ICT where before they were deterred by the erratic nature of the technology (*YHGfL 2002*).

Broadband also enables a use of web-based resources which were previously unavailable: a South East Grid for Learning (SEGfL) case study describes the use of webcams, real-time satellite images and BBC News broadcasts at Paulsgrove Primary School (*Smith 2001*). Once broadband is available, it seems that on the whole teachers and students are quick to take advantage of its benefits. Indeed, the final NGfL Pathfinders report states that 'secondary schools are becoming dependent on broadband to meet their increasing needs' (*DfES 2002, p.11*).

Computer mediated communications (CMC)

Email and the related tools of discussions groups and chat rooms are widely used tools, and the research literature reflects this popularity. Although these are relatively simple forms of ICT they have many potential uses in the education world. Studies of classroom application suggest their effectiveness in several areas:

- communication skills: when 16 year olds were paired up with local employees, about whom they had to write a profile based on knowledge gleaned from electronic discussions only, they received an excellent lesson in how to ensure effective and well-received communication (*Willinsky 2000*)
- creative skills: a class of nine year olds engaged in role playing, taking on the parts of characters from a children's book and answering questions received by email from the other classes. The participants showed great imagination and identification with the characters (*Stuhlmann 1998*)
- motivation: ten year olds who submitted their essays by email to an external audience for feedback showed a strong positive attitude and produced better quality writing than those handing in work to their teacher in the normal fashion (*Allen 1995*).

Key areas for further research

- school-based research into the effects of the types of ICT use which are enabled by the new network technologies. These include multimedia resources, video conferencing, and searching the internet
- isolating the impact of wireless networking on a school from the general effects of using ICT, identifying the particular types of use enabled and their pedagogical effect.

About the research literature

When searching for relevant literature it is necessary to focus on types of use: there is a good sized body of research into the use of applications such as CMC or video conferencing which are dependent on network technologies. However, there is a very limited amount of research into the pedagogical impacts of implementing specific network technologies such as wireless or broadband.

Current research

The Learning how to Learn project (part of the ESRC Teaching and Learning Research Programme), includes a study into educational networks. A number of schools are being used to inform its findings, which are due for dissemination in late 2004. Amongst the issues being investigated are:

- teachers' levels of competence and confidence in using network technologies
- variations in network operations and technologies in ICT-rich environments
- policies and practices which affect the development of networks.

The schools involved in the project are regarded as being at the leading edge in the use of ICT for networking between schools. The project also seeks to document what is involved in best-practice use of networks. The networks strand is managed by the School of Education at Reading University (<http://www.learntolearn.ac.uk/home.php3>).

Key questions for schools

- Are decisions regarding network technologies part of a comprehensive ICT development plan?
- Are teachers likely to be able to exploit fully the learning possibilities offered by new networks?
- Is there sufficient technical support for these networks?

Bibliography and further reading

The research referred to in this briefing represents a selection from the rapidly growing field of ICT research, and should not be regarded as a definitive list of the 'most important' research in this area.

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For further technical information see the ICT Advice site: www.ictadvice.org.uk

Becta's ICT Research Network

If you're interested in research on the use of ICT in education, you can join Becta's ICT Research Network.

The ICT Research Network seeks to encourage the exchange of information in order to inform the national agenda and professional practice.

Membership is free and is open to:

- teachers
- ICT co-ordinators
- ICT advisors
- school managers
- researchers
- policy makers
- research sponsors
- industry.

The Network provides them with an opportunity to:

- exchange information on current research
- develop partnerships
- discuss priorities for further investigation
- focus research on issues of importance to practitioners and policy makers.

They can do this via:

- an e-mail discussion list
- publications
- conferences and events.

More information on Becta's ICT Research Network can be found at:

www.becta.org.uk/research/ictrn

Alternatively, e-mail:

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About Becta

Becta is the Government's lead agency for information and communications technology (ICT) in education and supports UK Government, national organisations, schools and colleges in the use and development of ICT in education to raise standards, widen access, improve skills and encourage effective management.

About the ICT in Schools Programme

The ICT in Schools Programme is the Government's key initiative to stimulate and support the use of information and communications technology (ICT) to improve standards and to encourage new ways of teaching and learning. The enormous potential of ICT means that for the first time it is becoming possible for each child to be educated in a way and at a pace which suits them, recognising that each is different, with different abilities, interests and needs. The challenge over the next four years will be to successfully embed ICT in every facet of teaching and learning where it can directly impact on raising standards of attainment. A vision for the future of ICT in schools is provided in the paper *Transforming the Way We Learn*, available at: www.dfes.gov.uk/ictfutures

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