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THE DIGITAL DIVIDE IN SCHOOLS:

AN EXAMINATION OF THE PATTERNS OF ADOPTION AND USAGE OF ICT IN IRISH SCHOOLS DURING A NATIONAL ICT INITIATIVE, 1998 - 2000

Volume 1 of 2

by

Aidan Mulkeen

A thesis submitted to the School of Education at Trinity College, the University of Dublin, in fulfilment of the requirements for the award of the Degree of Doctor in Philosophy

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Summary

Many countries, including Ireland, have invested substantial sums in Information and Communications Technology (ICT) in schools in recent years. While such investments may aim to ensure that all learners benefit equally from ICT, there have been suggestions that variations in within-school use of ICT may mirror the existing inequalities in ICT in society. In-school use of ICT may therefore serve to reinforce rather than reduce the *digital divide*.

This study is an examination of the patterns of adoption and usage of ICT in Irish schools in the period 1998 to 2000, during a national initiative aimed at developing the use of ICT in schools. The study is based on large-scale surveys of schools, conducted at the beginning and end of the period under study. All of the schools involved in the national initiative were surveyed, and high response rates were achieved. In addition a more detailed examination, based on interviews and school-wide teacher surveys, was conducted in a small sample of schools.

The thesis is organised around three central themes. The first is the question of whether school use of ICT mirrored existing social patterns. In this analysis the survey data is used to examine whether schools serving disadvantaged groups in society were different from other schools in either their amount or their type of use of ICT. The second major theme is concerned with gender, examining whether girls had different experiences of ICT from boys, particularly in single-sex schools. The third theme may be termed the adoption of ICT in schools. This examines how the conventional theory of adoption of innovations may be applied to ICT in schools, and seeks to identify the factors associated both with presence of computer equipment, and with high use of ICT within subject areas.

The groups that are traditionally associated with lower use of ICT, the socially disadvantaged, and to lesser extent girls, were not found to be at a disadvantage in terms of the equipment in their schools. However there were indications that these groups received a qualitatively different experience of ICT, with less emphasis on the "information age" skills, and on the use of ICT in support of "emergent practices" in teaching and learning. Thus the practices in schools are neither neutral nor acting to reduce the digital divide. In fact, the practices recorded in 2000 leave grounds for

serious concern that schools may reinforce existing inequalities by offering the highest level ICT experience to the groups already associated with high ICT use.

The existence of these differences in the use of ICT suggests that the quality of use of ICT, and the variation with socio-economic status and gender, were not determined by central policy, but constructed at school level. A series of factors was found to be associated with the type of use of ICT. Teacher participation in postgraduate courses focused on ICT in education and in short courses specifically focused in integration were associated with use of ICT within subjects. These findings suggest that the provision of basic skills is not sufficient to ensure integration of ICT, and that courses that develop a pedagogical understanding are important. The study also highlighted the importance of some school level factors, including the role of the school principal, school planning for ICT, the status of the ICT co-ordinator, and the location of computers in classrooms.

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I would like to thank the people who have helped and encouraged me in the course of this project.

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Abbreviations

BECTa	The British Educational Communications and Technology Agency (UK)
COMPED	Computers in Education Survey (IEA)
ECDL	European Computer Driving License
ICT	Information and Communications Technology
IEA	International Association for the Evaluation of Educational Achievement
LCA	Leaving Certificate Applied
LCVP	Leaving Certificate Vocational Programme
NCTE	National Centre for Technology in Education (Ireland)
PLC	Post Leaving Certificate Courses
SES	Socio-Economic Status
SESE	Social, Environmental and Scientific Education
SIP	Schools Integration Project (NCTE, Ireland)
SITES	Second Information Technology in Education Study (IEA)

CHAPTER 1

INTRODUCTION

In most developed countries, the use of Information and Communications Technology (ICT) in education has become a significant part of education policy, and has resulted in substantial expenditure. In 1999, OECD countries invested $16 billion in ICT in education, representing 1% to 2% of total education spending.[1] In the US, annual expenditure on technology by schools reached $4.34 billion by 1996-97.[2] By 1999, expenditure on ICT in education in the US had exceeded that on textbooks.[3]

In many countries, explicit programmes to support ICT in schools were announced. In the US in 1996, President Clinton announced a plan to connect all schools to the 'information highway' by the year 2000, and similar policies were adopted in Denmark, Finland, the Netherlands, Portugal and Spain.[4] In the UK, the government announced the *National Grid for Learning* and it set aside funding to develop the ICT skills of teachers.[5]

ICT skills have also been identified as a priority for the EU, where the following targets were set in June 2000:

- *Every citizen be equipped with the skills needed to live and work in the new information society*
- *Member States ensure that all schools in the Union have access to the Internet and multimedia resources by the end of 2001*
- *Member States ensure that all the teachers needed are skilled in the use of the Internet and multimedia resources by the end of 2002*

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[1] OECD. *E-Learning, The Partnership Challenge*, (Paris: OECD 2001), p19.

[2] Jane M Healy, *Failure to Connect*, (New York: Simon and Schuster, 1998), p80.

[3] OECD, *Education Policy Analysis 1999,* (Paris: OECD, 1999), p49.

[4] Willem Pelgrum and Ronald Anderson, *ICT and the Emerging Paradigm for Life Long Learning: A Worldwide Educational Assessment of Infrastructure, Goals and practices,* (Amsterdam: International Association for the Evaluation of Educational Achievement, 1999), p2.

[5] Marilyn Leask and Norbert Pachler, eds. *Learning to Teach Using ICT in The Secondary School,* (London and New York: Routledge, 1999), pxvii.

- *Schools are progressively linked to the very high-speed trans-European network for electronic scientific communications to be created by the end of 2001*
- *Europe's education and training systems must adapt to the knowledge society.*[1]

In response to these needs, the EU embarked on the eEurope 2002 plan, which will seek to ensure that all pupils are digitally literate by the time they leave school.[2]

Ireland was no exception to this trend, and in November 1997 launched an Education Technology Investment Fund of £250 million,[3] with the aim of "developing our education system....to meet the needs of a rapidly growing knowledge-based economy".[4] One part of this investment was a programme aimed at developing the use of ICT in primary and post-primary schools. This programme, known as *Schools IT 2000*, involved public expenditure of £40 million over 3 years, with additional funding from private enterprises.[5]

The programme activities focused on four main areas, which can be summarised as infrastructure, training, pilot projects and support services. The programme issued direct grants to schools to purchase equipment, totalling £15 million in 1998. In a parallel action the national telecommunications company, Telecom Eireann, provided each school with one computer, Internet access, and a telephone or ISDN

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[1] Lisbon European Council, 2000. (Reported at http://europa.eu.int/comm/information_society/eeurope/actionplan/actionlines_en.htm)

[2] European Commission. *eEurope 2002: An Information Society for All* (Draft Action Plan 2000), p14.

[3] Jerome Morrissey, "The Schools IT 2000 Initiative in the Republic of Ireland", in *Dissolving Boundaries, ICT and Learning in the Information Age,* proceedings of a conference in Dublin (Ireland: NCTE, May 1999).

[4] Minister Micheál Martin, speaking at the launch of the Education Technology Investment fund, cited in Jerome Morrissey. "The Schools IT 2000 Initiative in the Republic of Ireland". In *Dissolving Boundaries, ICT and Learning in the Information Age*, proceedings of a conference in Dublin (Ireland: NCTE, May 1999).

[5] An Roinn Oideachais agus Eolaíochta, *Schools IT 2000, A Policy Framework for the New Millenium* (1997).

line with 5 hours of free usage per week.[1] Short courses were developed and provided free to teachers in locations throughout the country. Further funding of £3.5 million was distributed to schools participating in pilot projects known as *Schools Integration Projects* (SIPs) aimed at developing good practice and experimenting with innovation in ICT. In total these involved 228 schools in 48 different projects.[2] In addition a website named ScoilNet was developed to support teachers and provide on-line resources.[3]

This study is an examination of the changes in ICT in Irish schools during the first two years of the *Schools IT 2000* programme. Based on surveys of schools before and after the initial part of the programme, it examines how patterns of ICT in schools changed during the period. This study does not attempt to demonstrate the educational value of ICT, nor does it attempt to evaluate the *Schools IT 2000* programme. Instead it is focused on the patterns of adoption of ICT, asking which schools had the most and least ICT.

Measurement of ICT in schools is relatively unproblematic when it is confined to measurement of the amount of equipment. However, when this is extended into consideration of the usage of the equipment, the picture becomes more complex. The value assigned to usage of ICT is dependent on the viewer's perception of the purpose of having ICT in schools. This purpose is not always clear or agreed and therefore deserves some consideration.

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[1] An Roinn Oideachais agus Eolaíochta, *Schools IT 2000 Achievements to Date,* published on the Department website at www.irlgov.ie/educ/it2000/it2000update.htm (1998).

[2] Jerome Morrissey, "The Schools IT 2000 Initiative in the Republic of Ireland", in *Dissolving Boundaries, ICT and Learning in the Information Age.* Proceedings of a conference in Dublin, (Ireland: NCTE, May 1999), p51.

[3] Ibid.

1.1 Rationale for the Use of ICT in schools

The investment in ICT in education has been justified using a variety of arguments. Hawkridge has distinguished four major rationales for the introduction of computers into education, which he has named the vocational, social, pedagogical and catalytic rationales.[1] The first two of these are concerned with learning about the technology, while the latter two are concerned with the use of technology in support of other learning.

The vocational rationale is concerned with the use of ICT in schools to develop ICT skills needed for employment. The social rationale involves a broader view of ICT skills, making the argument that ICT skill is becoming an essential life-skill, and therefore that it is important that schools ensure universal access to ICT skill.

The pedagogical rationale centres on the belief that ICT can be used to improve the quality of teaching and learning, other than learning about ICT. This may include the use of ICT in many kinds of roles, but the thinking has often focused on the use of ICT to facilitate a move towards constructivist or project-based learning. The catalytic rationale is a further extension of this thinking, making the argument that the introduction of ICT into schools can act as a catalyst for a broader educational change.

These rationales carry logical implications for the type of use of ICT in schools. If the purpose of ICT in schools is to ensure universal ICT skills, then it is important that schools provide skills to all, and particularly to those who would otherwise not acquire them. Likewise, if the purpose of ICT is to support learning of other subjects, then it is important that ICT be used in support of other subjects, rather than as a separate discipline. Two of these rationales, the social and the pedagogical, are of particular relevance to this study, and are examined in more detail below.

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[1] D. Hawkridge, "Computers in Third World Schools: the example of China", *British Journal of Educational Technology*, Vol. 21 No. 2 (1990), pp4-20.

1.1a The social rationale - ICT as a life skill

ICT literacy has often been identified as "a key skill in today's world, alongside literacy and numeracy."[1] This view of ICT skill as an essential life-skill is supported by the increasing pervasiveness of technology in many areas of life.

During the 1990s there was a sharp increase in the number of computers in developed countries,[2] and they became cheaper and more powerful. The nature of the technology also changed during the decade, with the growth of the Internet. By 2001 US Internet users spent more time online than reading newspapers or magazines, and 45% of Internet users even reported a reduction in their time watching TV as a result of their Internet usage.[3]

The importance of technology may continue to grow with the development of 'pervasive computing', where small computing devices connected via wireless links move computers into areas of life not at present using technology.[4] The Internet is also likely to become increasingly important. In 2000 the Internet was estimated to comprise 3.6 million websites, and to be doubling in size every year.[5] The quality of Internet access may also improve, as an increasing proportion of Internet users in the US have broadband access to the Internet, and the cost of bandwidth is falling.[6]

Negroponte has argued that the development of digital technology will have as dramatic an impact on economic and social structures as the development of railways, steam-power or the other technological drivers of the industrial

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[1] Dr Kim Howells, Foreword to *Preparing for the Information Age, Synoptic Report of the Education Departments' Superhighways Initiative.* (DFEE 1997).

[2] OECD, *E-Learning, The Partnership Challenge* (Paris: OECD 2001), pp12-13.

[3] Jupiter Communications Survey, cited in OECD, *E-Learning, The Partnership Challenge.* (Paris: OECD 2001), p14.

[4] OECD, *E-Learning, The Partnership Challenge.* (Paris: OECD 2001), p15.

[5] Ibid., p25.

[6] Ibid., pp15-16.

revolution.[1] The idea that developments in ICT might have a significant impact on the way we live has been abbreviated into the concept of an "information society". As such a society develops "digital literacy" will become increasingly important.

Digital literacy is not confined to the operation of the technology. To be able to function in an information society will require skills of handling large quantities of information, and the associated skills of synthesis and evaluation of information. As the technology changes rapidly, simply learning to operate the technology is likely to have a short useful life. An understanding of the potential of the technology, and the confidence and skill to comprehend and adopt the emerging technology appropriately will prove more useful.

This broader view of digital literacy has been reflected in some national ICT strategies. In the US for example, it was noted that:

> *... it is widely believed that workers in the next century will require not just a larger set of facts or a larger repertoire of specific skills, but the capacity to readily acquire new knowledge, to solve new problems, and to employ creativity and critical thinking in the design of new approaches to existing problems.*[2]

Similar thinking can be seen in the Australian national goals for schooling in the twenty-first century, which place emphasis on problem solving skills.[3]

These higher-order skills of analysis, synthesis and problem solving and learning to learn can be described as 'meta-cognitive skills'.[4] While these skills have always been of importance, the greater volume of information available and the increased pace of change may make these skills more significant.

As more people achieve digital literacy, there is greater disadvantage for those without it. The same may be said of conventional literacy. In a society where there

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[1] Nicholas Negroponte, *Being Digital* (London: Hodder and Stoughton, 1995).

[2] President's Committee of Advisors on Science and Technology. Panel on Educational Technology, (March 97), summary.

[3] The Adelaide Declaration on National Goals for Schooling in the Twenty-First Century, (Available on-line at http://www.curriculum.edu.au/mceetya/nationalgoals/, 1999)

[4] Roy Pea, *New directions for Child Development*. 1985, pp75-96, cited in Jane M Healy, *Failure to Connect* (Simon and Schuster 1998), p138.

are very low levels of literacy, very few things are written and people experience little need for literacy. As the need for literacy appears, typically through the needs of commerce, law or interaction with government, those who are literate are at an advantage. As more people become literate the extent to which literacy is assumed increases, more services and interactions require literacy, and the people who are not literate are further marginalised.

Digital literacy may follow the same pattern. As the proportion who are digitally literate increases, those who are not digitally literate may be increasingly disadvantaged both in economic terms and in terms of participation in society generally. The belief that lack of ICT skill may become a significant barrier in the future has led to concerns about the social groups who may be excluded from access to ICT. As Alexander notes,

> *...there are profound concerns now about the gaps opening up between the ICT 'haves' and 'have-nots', between those who reinforce their access to, and use of ICT in education what they have and do at home, and those who have little of either. The gaps may become every bit as profound as earlier forms of rigid social and education selection.*[1]

1.1b The pedagogical rationale

The use of ICT in schools is also justified by the pedagogic rationale, which envisages the use of ICT to support improvements in the quality of teaching and learning, separate from learning about the technology. ICT may be used to support learning in a variety of ways. Some researchers have reported the benefits of automated teaching systems such as Integrated Learning Systems (ILSs), which provide individualised learning.[2] Such systems have demonstrated marked gains in

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[1] Tom Alexander, "New OECD Initiatives on ICT, Education and Learning", in *Dissolving Boundaries, ICT and Learning in the Information Age,* proceedings of a conference in Dublin (Ireland: NCTE, May 1999), p11.

[2] National Centre for Educational Technology, *ILS Phase II Evaluation report.* (NCET, 1996).

performance in some studies,[1] but the evidence for their value is neither consistent nor uncontroversial.[2]

Others have seen the potential of ICT in the development of more open learning environments where exploratory learning could be facilitated. Examples include the seminal LOGO programme, designed to provide an environment for learning mathematical and logical skills.[3] This constructivist approach to learning may also be facilitated by use of "content free" software such as word processors.[4] Use of such software has been reported to increase motivation and result in student work that is longer, better presented and of better quality.[5] It may also be used to facilitate collaborative writing activities in the context of a more project-oriented approach.[6]

The use of content free ICT applications in support of exploratory project work is exemplified by a case from the UK portables pilot project. Year 6 pupils in a primary school began to carry out a comparative study of the weathering of different types of rock, using the gravestones in two cemeteries. They entered information about the types and age of the stones used, and graded each entry according to how weathered it looked. Subsequently this information was transferred to a spreadsheet and plotted as graphs and charts for comparison with local headstones. While collecting data on the field trip some pupils noticed the predominance of certain family names on the headstones. This led to a discussion

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[1] Jean Underwood and Jenny Brown, *Integrated learning Systems: Potential into Practice.* (NCET, 1997).

[2] David Wood, Jean Underwood and Peter Avis. 'Integrated Learning Systems in the Classroom'. *Computers and Education.* Vol. 33, (1999), pp91-108.

[3] Seymour Papert, *Mindstorms: Children, Computers and Powerful Ideas.* (Basic Books, 1980).

[4] Jean D.M. Underwood and Geoffrey Underwood, *Computers and Learning : Helping Children Acquire Thinking Skills* (Oxford: Blackwell Publishers, 1991), Chapter 6, 'Reading Writing and the Wordprocessor'.

[5] Bob Stradling, David Simms and Jim Jamison. *Portable Computers Pilot Evaluation Report.* National Foundation for Educational Research, (NCET, 1994).

[6] Apple Computers, *Apple K-12 Effectiveness Report No 5, High School Writing*, published on the Web at www.apple.com/education/k12/leadership/effect5.html, (last accessed April 2002).

about how to organise databases in order to facilitate searching and sorting. This project went on to involve an exploration of the impact of industrial pollution (by communicating with students in other regions) and an analysis of the age at death, which led to an exploration of social history.[1]

The development of the World Wide Web has brought additional possibilities for education. The vast range of resources available online may allow the development of more 'fluid' curriculum content, where learners have increasingly easy independent access to information.[2] Some have even developed approaches that use the Web resources as the basis for constructivist learning activities.[3]

The Web also provides schools with a publication forum where work can be produced at a very low cost, and yet be accessible both to parents and to a global audience. Web publication may be used to provide authentic tasks that are highly motivating for learners. There are numerous competitions that encourage Web publication by schools. One such scheme is ThinkQuest, a non-commercial organisation that organises a competition and exhibition of Web projects produced by students.[4]

The benefits of use of ICT in these constructivist ways may go beyond the learning of the topic. In the Second Information Technology in Education Study (SITES), schools using ICT reported gains in knowledge and skills, motivation, responsibility and independence.[5] While this kind of open-ended project-based work can allow able learners to perform to their limits, there is also evidence that

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1 Bob Stradling, David Simms and Jim Jamison, *Portable Computers Pilot Evaluation Report*, (National Foundation for Educational Research, NCET 1994).

[2] OECD, *E-Learning, The Partnership Challenge* (Paris: OECD 2001), p22.

[3] One example is the webquest, a model developed in San Diego State University. Details are available at http://edweb.sdsu.edu/webquest/

[4] See www.thinkquest.org

5 Willem Pelgrum and Ronald Anderson, *ICT and the Emerging Paradigm for Life Long Learning: A Worldwide Educational Assessment of Infrastructure, Goals and practices* (Amsterdam: International Association for the Evaluation of Educational Achievement, 1999), p223.

ICT can attract and empower weaker and disadvantaged learners.[1] In the one of the Apple Classroom of Tomorrow (ACOT) projects, learners from disadvantaged backgrounds were found to benefit in terms of motivation, confidence and attitudes to learning following prolonged high access to computers.[2]

1.2 The promise of ICT

The previous two sections have outlined some of the thinking involved in the social and pedagogical views of the role of ICT in education. These two may be seen as complementary rationales, in that the kind of education required in the information society may be facilitated by the pedagogical use of ICT.

The information society will, it is argued, place a greater value on higher-order thinking skills than on memory of facts. People will be expected to be able to source, evaluate and synthesise the vast quantities of information available to them. They will be expected to interact through the metaphors and virtual representations provided by technology.[3] They will be expected to be able to adapt quickly as economic and social life changes and new structures and opportunities emerge. In addition to ensuring that these skills are developed in young people, the education system is also expected to ensure that those without home access are not disadvantaged, thus preventing the emergence of a digital divide.

While the changes in technology and the growth of an information society generate need for changes in the curriculum, they also drive change by undermining some aspects of existing curricula. The young people who inhabit a technology-rich information society may question the relevance of a traditional curriculum that

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[1] Bob Stradling, David Simms and Jim Jamison, *Portable Computers Pilot Evaluation Report* (National Foundation for Educational Research, NCET 1994).

[2] Robert J. Tierney, Ronald. Kieffer, Laurie Stowell, Laura Desai., Kathleen Whalin and Antonia Moss. *Computer Acquisition: A longitudinal study of the influence of High Computer Access on Students Thinking, Learning and Interactions*. (Apple Research report No 16, published on the Web at: http://www.apple.com/education/k12/leadership/acot/library.html, last accessed April 2002)

[3] Daniel Burstein and David Kline, *Road Warriors,* Penguin. 1996, cited in Jane M Healy, *Failure to Connect*, (New York: Simon and Schuster, 1998), p105.

relies heavily on recall of facts. School may appear uninteresting and sterile for those familiar with interactive and highly visual media. These issues of mismatch between school and life outside school present challenges to educators.

> *It is not too much of an exaggeration to say that American adolescents live in a world defined by their age-peers and that they visit the alien adult world during their time in teachers' classrooms.*[1]

While the technological advances prevent these challenges to education, they also promise opportunities to help meet the challenges. The advocates of the "information society" argument stress "the role that ICT has to play in supporting learning in the Information Age context".[2] The use of technology in education may help to develop ICT skills and promote the development of meta-cognitive skills through the use of more open and constructivist learning methods. In addition ICT may help to make education accessible and attractive to some of the groups most alienated from the existing school provision.

1.2a Criticisms of current use of ICT in schools

This utopian view of ICT as both the driver and facilitator of educational change is not without its critics. Zhao and Conway, in an analysis of US State technology plans, argue that although most technology plans call for equality of access to ICT, they do little to cause it.[3]

Other critics have questioned the impact of ICT as used in schools at present. Much of the use of computers in schools is in teaching computer applications. This may be irrelevant to real world applications, particularly when it is focused on learning the operation of an individual package, rather than learning general principles that can be transferred to other packages. Further, some of the material taught is not very challenging and may be displacing more valuable school

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[1] CRITO Center for Research on IT and Organizations, *Pedagogical motivations for Student Computer Use that Lead to Student Engagement*. (Special Report, undated).

[2] Bryn Holmes, Tim Savage and Brendan Tangney, *Innovation in Learning in the Information Society: A Comparative International Study*, a report by the Centre for Research in I.T. in Education for the Lifelong Learning Group of the Information Society Commission. (2000), p5.

[3] Yong Zhao and Paul Conway, "What's In, What's Out – An Analysis of State Educational Technology Plans", *Teachers College Record* (January 2001).

activities.[1] In any case the teaching of computer applications represents a shift in the fundamental aims of the education system to a more vocational focus, where subjects are taught for their utility rather than for any sense of their intrinsic value.[2]

Healy argues that while meta-cognitive skills may be increasingly important for the information age, many of our existing applications of ICT retard the development of meta-cognitive skills, by allowing the child little time for self-reflection.[3] Healy also expresses concern that one of the areas that may be displaced by ICT is working with real objects, or "concrete play".[4]

1.3 The study – ICT in Irish schools

The preceding sections have identified two areas for concern with regard to ICT and education. The first is the question of equality. While the social rationale is concerned with ensuring that all citizens have the opportunity to develop digital literacy while at school, there is a need to examine whether existing policies are ensuring that this occurs. The second issue is a question of quality. While the pedagogical argument for use of ICT rests on the potential of ICT in improving the quality of teaching and learning, it seems clear that not all uses of ICT are of equal educational value. The critics have pointed that much of the use of ICT in schools involves operational learning and may be displacing more valuable educational activities.

It is against the background of these two issues that this study examines the place of ICT in Irish schools. This study is an exploration of the changes that occurred in the place of ICT in Irish schools during the first two years of the *Schools IT 2000* programme. While the study takes 1998 as its starting point, it must be recognised

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[1] Clifford Stoll, *High Tech Heretic,* (New York: Doubleday 1999), p4.

[2] Bryn Holmes, Tim Savage and Brendan Tangney, *Innovation in Learning in the Information Society: A Comparative International Study.* A report by the Centre for Research in I.T. in Education for the Lifelong Learning Group of the Information Society Commission, (2000), p8.

[3] Jane M Healy, *Failure to Connect*, (New York: Simon and Schuster, 1998), p190.

[4] Ibid., pp220-221.

that the story of ICT in Irish schools began long before that, and dedicated teachers had been working in this area since the 1970s. Indeed, by 1998 there were 36,000 computers in Irish schools,[1] most post-primary schools had a computer room, and most also had timetabled access to ICT. However 1998 marked a change of pace for ICT, as it saw the start of a government programme specifically aimed at developing the place of ICT in schools. The *Schools IT 2000* programme provided ICT grants for all schools,[2] which for many primary schools provided the first computers in the school.[3] It also involved a large-scale programme of ICT training for teachers and the development of a dedicated support unit for ICT in education. Hence, 1998 can be seen as marking the change from a *laissez faire* system where ICT was adopted at the discretion of the school, to a more organised government programme aimed at mass adoption of ICT.

This study examines the changes from an equality perspective. Thus its central question is whether all schools were providing similar ICT experiences for their students. If schools were providing different ICT experiences, it is important to ask whether these patterns were associated with existing patterns of ICT skill in society. In the light of the social rationale for the provision of ICT, it is important to ask whether ICT patterns in schools seem likely to reduce or enhance the inequalities in ICT skill in society.

The focus on equality also involves the pedagogic view of ICT. Demonstration of the pedagogic benefits of ICT, and the impact of Internet usage on meta-cognitive skills, are beyond the scope of this study. However, if there are genuine benefits to be derived from pedagogical usage of ICT, then it is important to ask whether such usage was found equally in all schools, or whether patterns of pedagogical usage could be identified. Similarly if Internet usage has an impact on the development of meta-cognitive skills, and if these skills are increasingly important determinants

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[1] Figure taken from the 1998 survey, appendix E, Table 2.2.

[2] With the exception of some 37 fee-paying Catholic schools which were excluded from the programme.

[3] See the 1998 survey in Chapter 6 and appendix E.

of life chances, then it is appropriate to examine which types of schools were engaging in such activities.

Thus, the question of equality is examined at two levels. Firstly, by examining which schools have ICT equipment and provide access to ICT, the study considers the relationship between school ICT and the goal of universal ICT skills. Secondly, by examining the use of ICT in support of teaching in other curricular areas, and Internet use, the study explores whether, assuming the claims for the role of ICT are well founded, the higher-order benefits will be equally distributed.

The study then examines the characteristics of teachers and schools that were associated with the adoption of ICT in the school. In particular it considers the characteristics of the schools where ICT was used in ways that could support learning in other curricular areas, or could be argued to be associated with the development of "information age" meta-cognitive skills.

The study is organised around three themes, which can be stated in the form of the following three questions:

1) Were there social patterns in ICT in schools?
2) Was there a gender pattern in ICT in schools?
3) Were there any school or teacher characteristics that were associated with adoption of ICT in schools?

These three themes can be seen throughout the structure of this thesis. Chapters 2, 3 and 4 review the relevant literature. Chapter 2 examines the literature concerned with social patterns and ICT, first examining the social patterns in ICT in society generally, and then examining the social patterns within schools. Chapter 3 examines the literature about gender ICT. As before, it begins with an examination of the patterns in society, and then considers whether these are reflected in schools. Chapter 4 considers the literature relating to the adoption of ICT in schools. It examines the general theories of the adoption of innovations and the specific material concerned with innovation in schools, and especially ICT in schools.

These three review chapters set the scene for this study. Chapter 5 describes the methodology used and examines some of the limitations to this approach. Chapter

6 then outlines briefly the main changes in the state of ICT in schools revealed by the surveys.

The following three chapters (7,8 and 9), are concerned with the analysis of the data. This analysis is organised into the three main themes. Chapter 7 explores the social patterns, looking at socio-economic status, school type and school location. Chapter 8 examines the evidence of gender patterns in ICT in schools. Comparing the single-sex boys' and girls' schools it examines whether the boys' schools were better equipped, provided more access to ICT, or made different use of ICT. Chapter 9 is concerned with the features of schools that were associated with adoption of ICT. It seeks to answer the question of "what types of schools have best adopted ICT?"

These three strands are drawn together in a general consideration of the issues in Chapter 10. In this chapter, the common elements of the three analyses are highlighted and some tentative explanations are suggested. Chapter 11 then considers the implications of this material, both for education policy and for our understanding of ICT in schools.

CHAPTER 2

LITERATURE RELATED TO SOCIAL PATTERNS IN ICT

One of the reasons presented in the previous chapter for the investment in ICT in schools is the aim of ensuring that all learners have the opportunity to acquire appropriate ICT skills, thus avoiding the emergence of an inequality in society. There are real concerns that ICT may become such a source of inequality. There is increasing evidence that those with ICT skills are at an advantage in both their working lives and in terms of their participation in society.

It is clear that an increasing number of jobs and professions require the regular use of ICT. More fundamentally, the globalisation of patterns of production and distribution is dependent on sophisticated information technology, and it is the ability to enter into transactions with customers located anywhere that facilitates much of our economic well being.[1] ICT is also expected to have a broad impact on social patterns. These are illustrated in the Delphi surveys conducted in Spain, France, UK and Japan, which predict increased incorporation of ICT in the home, providing the basis for delivering a range of services to families.[2]

As the importance of technology increases, so does the concern that those without ICT skills may be at a disadvantage. This concern is described in the phrase "digital divide". However this divide can be seen at different levels. At its simplest, the divide may be seen as that separating those with Internet connectivity from those without. It may also be argued that the issue goes beyond mere access and that access to information is enriching only to people who have the higher level skills required to assess, interpret and apply this information.[3] Others have suggested that

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[1] Nolan A. Bowie, "The Digital Divide: Making Knowledge Available in a Global Context" in *Learning to Bridge the Digital Divide* (Paris: OECD, 2000), p38.

[2] Jose Antonio Diaz Martinez, "Social trends of the information and communication technologies in Spain". *Futures,* Vol. 32 (2000), p677.

[3] Ingrid Burkett, "Beyond the 'information rich and poor': futures understandings of inequalities in globalising informational economies." *Futures* Vol. 32 (2000), p686.

working with ICT involves dealing with abstract symbols, and that those with high analytical skills will gain significant economic advantages over those without.[1]

This chapter explores the nature of the digital divide, and the relationship between it and the ICT provision in schools. It is concerned with two central questions. Firstly, it examines the evidence of a digital divide in society. Secondly, it asks whether the existing patterns of ICT in schools are likely to reinforce or counter that divide. The first part of the chapter (section 2.1) is concerned with the existing patterns of ICT access and skill in society. It examines the divide between rich and poor countries, and the patterns of socio-economic status, ethnicity, and location within countries. The following section (2.2) considers the role of schools in addressing the divide. It begins with the policy statements of governments, and then examines the available information about the level of ICT equipment in schools. Section 2.3 then considers the indications that ICT may be used in different ways in some schools.

2.1 The Digital Divide

One dimension to the digital divide is the marked variation in levels of access to the Internet between countries. The variations between countries are dramatic. In 1997 Finland had the highest proportion of Internet users with 244 users per 1,000 of population. The world-wide average in the same year was only 16.9 users per 1,000 people. Differences exist even within Europe. In 1997 the European average was 44 users per 1,000 people, but individual countries had much higher levels of use. The UK for example had 99.5, while Sweden had 147.3.

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[1] Katherine Sarikakis and George Terzis, "Pleonastic exclusion in the European Information Society". *Telematics and Informatics,* Vol. 17 (2000), p122.

TABLE 2. 1: INTERNET USERS PER 1000 PEOPLE, TOP 5 COUNTRIES (1997)[1]

Rank	Country	Internet users per 1,000 people
1	Finland	244.5
2	Norway	231.1
3	Iceland	227.3
4	US	203.4
5	Australia	178.0
Average	Top 15 countries	148.5
Average	Europe	44.1
Average	Worldwide	16.9

Internationally the levels of ICT, and particularly Internet, access are related to general educational levels and general levels of economic development.[2]

TABLE 2. 2: DIGITAL DIVIDE BETWEEN RICH AND POOR COUNTRIES[3]

	Less-developed regions	More-developed regions
Population	5,000 million	885 million
Education expenditure US$	248 billion	1,100 billion
Higher education enrolment	8.8%	59.6%
Number of R and D scientists and engineers per million of population	Nigeria 15 El Salvador 19	United States 3,732 Japan 6,309
Computers per 10,000 of population	120	2,690
Internet hosts per 10,000 of population.	3	470

However the international pattern is not determined solely by the wealth of countries. Cultural factors may also play a part in assisting the development of an information gap. For example in Greece only 4% of the population chose the Internet as a preferred source of information.[4] In part this may be a result of the dominant culture of the Internet, which is based on the English language and Latin

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[1] Ibid., p109.

[2] Guillermo Kelley-Salinas, "Different Educational Inequalities: ICT an Option to Close the Gaps" in *Learning to Bridge the Digital Divide* (Paris: OECD, 2000), p24.

[3] Adapted from Guillermo Kelley-Salinas, "Different Educational Inequalities: ICT an Option to Close the Gaps" in *Learning to Bridge the Digital Divide* (Paris: OECD, 2000), p24 and 25. Data from UNESCO 1998 and World Bank 1999.

[4] Katherine Sarikakis and George Terzis, "Pleonastic exclusion in the European Information Society". *Telematics and Informatics* Vol. 17 (2000), p114.

script.[1] There is also evidence that choices made within countries can change the levels of access. The Internet was developed in the US and much of the Internet content is American in origin, yet in July 1999 only 53% of US households had a computer and there was a marked social pattern in access to the Internet. By contrast in Finland there is almost universal access, and electronic access is being seen as an integral part of the democratic process.[2]

2.1a Digital divides within countries

A second dimension to the digital divide is the pattern within countries. There is evidence from a number of countries that the socially disadvantaged are least likely to have access to computers and the Internet.

A recent survey in the UK has recorded a strong social pattern in use of computers and the Internet. In 2001 only 25% of people living in council estates with high unemployment had ever used the Internet, compared with 60% of "white collar workers" and 61% of "prosperous professionals".[3] Similarly in the US households where one of the adults has a high level of education are far more likely to own computers and have Internet access than those with lower adult levels of education.[4]

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[1] Ibid., p116.

[2] Nolan A. Bowie, "The Digital Divide: Making Knowledge Available in a Global Context" in *Learning to Bridge the Digital Divide* (Paris: OECD, 2000), pp39-40.

[3] Neil Russell and Nick Drew, *ICT Access and Use. Research Surveys of Great Britain.* DFEE Research Brief No252 (January 2001).

[4] Lynda Ginsburg, John Sabatini and Daniel A. Wagner ."Basic Skills in Adult Education and the Digital Divide" in *Learning to Bridge the Digital Divide* (Paris: OECD, 2000), p78.

TABLE 2. 3: HOME PC OWNERSHIP AND ADULT LEVEL OF EDUCATION, US 1999[1]

Household level of education among adults.	% of households possessing a personal computer.
No more than elementary education	8
Some high school education	16
High school diploma or equivalent	31

In Ireland the Information Society Commission has reported that ICT users are divided along social lines. The groups over-represented among Internet users are young, urban, employed, professional, and have a high income and high level of educational attainment. People who are older, who live in rural or deprived urban areas, who are outside the workforce, are non-professional, or have a lower income and lower level of educational attainment are under-represented. Thus, the people most unlikely to have access to ICT are also those identified in the *National Anti Poverty Strategy* as the most marginalised generally within society.[2]

The report showed that 64% of people in the workforce were familiar with PCs, while only 30% of those not working were. Even within the workforce there were social patterns, with only half of skilled manual workers, but 87% of office and support staff familiar with PCs.[3]

Such variations in access are not surprising, as many innovations, especially expensive ones, are often acquired first by the wealthiest people. Such gaps might be expected to be temporary, as the bulk of the population catches up on the wealthy early innovators. However the US surveys show that some of the inequalities are being sustained and even growing as Internet access rates rise.

The 2000 report on the digital divide recorded that Internet access in the US had increased dramatically since 1998. In December 1998 26% of US households had

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[1] Data from NTIA 1999, cited in Lynda Ginsburg, John Sabatini and Daniel A. Wagner ."Basic Skills in Adult Education and the Digital Divide" in *Learning to Bridge the Digital Divide*, (Paris: OECD, 2000), pp77-89.

[2] Information Society Commission, *Information Society Ireland. Third Report of Ireland's Information Society Commission* (Ireland: ISC, December 2000), p68.

[3] Ibid., p68.

been connected to the Internet, and this had risen to 41.5% in August 2000. In this rise some of the previously reported "digital divides" had narrowed. In particular rural families had narrowed the gap with urban and suburban families. By 2000 38.9% of rural households had Internet access, compared with the national average of 41.5%.[1]

However some ethnic groups were still considerably less connected. Black and Hispanic households had lower levels of connectivity than average, with 23.5% of black households and 23.6% of Hispanic households connected. Although these two groups had considerably increased their connectivity since 1998, the gap between these groups and the US national average had increased slightly in the two years from 1998 to 2000.[2]

2.1b Interest in the Internet by disadvantaged groups

The pattern of Internet use is not determined solely by the cost of access. Research in the UK noted that only 30% of non-users of the Internet said that they were "fairly interested" in using it in the near future.[3] Also in the UK, attempts to provide ICT access to the most disadvantaged through community level ICT learning centres have achieved mixed results. Although the majority of users of the centres were drawn from the target groups, the most disadvantaged were under-represented among the users. Interestingly, those who had a computer at home but were unable to use it were over-represented.[4]

A similar pattern was reported in Ireland where the MRBI data prepared for the Information Society Commission in 2000 showed that non-users of the Internet included disproportionate numbers of the less educated and unskilled workers. In addition the data showed that non-use of the Internet was often linked to personal

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[1] National Telecommunications and Information Administration (NTIA), *Falling Through the Net: Toward Digital Inclusion.* Fourth report in the Falling through the Net series, (2000).

[2] Ibid.

[3] Neil Russell and Nick Drew, *ICT Access and Use. Research Surveys of Great Britain.* DFEE Research Brief No252 (January 2001).

[4] Hall Aitken Associates, *ICT Learning Centres. Formative Evaluation of Pioneer and Pathfinder projects.* Final Report to DFEE (February 2001), p72.

choice and perceptions of utility, rather than access to the equipment.[1] Only 33% of those without Internet access expressed an interest in having Internet access, compared with 58% of others. Those with Internet access also showed a higher interest in public access points such as Internet cafes or libraries. This pattern of those with existing access having the greatest interest in public access points, calls into question the usefulness of initiatives focused on physical access alone. This finding led the study to conclude that

> *support and training is important to promote and encourage the use of information and communications technology among those currently unfamiliar with them, to stimulate knowledge and interest.*[2]

This pattern reported in the UK and Ireland of lower interest in the Internet, even when free, among the most disadvantaged may reflect deeper issues than lack of awareness of its potential. Lonergan argues that a series of features of the content, targeting, language and culture of the material available on the Web may make it less attractive to the most disadvantaged. He suggests that the communities under-served by Internet may not find it to be as valuable as others do because it provides little local information of relevance to the most disadvantaged. Secondly the majority of the material on the Internet is written for an audience with an average or advanced literacy level, and therefore the 22% of adults in the US with below average literacy levels may find the material available difficult and inaccessible. In addition the material on the Internet is predominantly in English, and heavily biased towards certain ethnic groups.[3]

These findings suggest that the reasons for low use of the Internet within some social groups may be only partly to do with the cost of access, and partly a result of varied perceptions of the value of the Internet. While assessing the value of the

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[1] Susan O'Donnell. "Closing the Digital Divide". Computimes, *The Irish Times* 9th October 2000.

[2] Information Society Commission, *Early and late Adopters of New Technology 1999 Research into General Public Attitudes towards Information and Communications Technology.* (Ireland: ISC, February 2000), pp3-4.

[3] James M. Lonergan, *Internet Access and Content of Urban Schools and Communities.* ERIC digest Number 157, (2000).

Internet for different social groups is beyond the scope of this study, it is clear that if the technology fails to attract the social groups already identified as lower users, the potential for a divide is increased.

2.1c Children's home access to ICT

Social patterns in access to ICT have an impact on the education system. As parents' income is related to home computer access, this leads to unequal access in homes and provides the children of the better-off with an advantage in school.[1]

In the US the 1997 report to the President on ICT concludes that:

> *Because certain segments of the American population have a far lower level of computer ownership than others, home access may now be one of the most significant sources of educational inequality in the United States*[2]

Home access to computers is likely to play a major role in students' ICT contact. In the US in 1995 computers were found in approximately half of the households with children. Students having access to a computer at home used them for on average one hour per week for purposes which were broadly educational in nature, roughly equivalent to the typical amount of computer time provided at school.[3]

Later studies in the UK revealed even greater advantages for home users. Mumtaz, in a study of 360 pupils in years 3 and 5 in the UK, found a growing gap between the exposure to computers at home and in schools. In all 39% of children in the sample used a computer at home every day, but only 2% used the computer at school daily. This suggests that for the average students, much of their computer experience is gained at home.[4]

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[1] OECD, *Education Policy Analysis 1999,* (Paris: OECD, 2000), 1999, p56.

[2] President's Committee of Advisors on Science and Technology, *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States,* (March 1997), Section 7.1.

[3] Ibid.

[4] Shazia Mumtaz, "Children's enjoyment and perception of computer use in the home and the school". *Computers and Education,* Vol. 36 (2001), p356.

Part of the reason for this may lie in children with computers at home having a greater level of access at home than they do at school. In a typical home situation children have to share a computer with one or two family members, but in a school context children often have a few computers to share among a whole class.[1]

2.1d Quality of home use

Mumtaz also found differences between the quality of computer time at home and that at school. Almost 70% of the children preferred to use a computer at home to using one at school, citing choice of activity, control over their time, working by themselves, and the less restricted access they had at home as the main reasons. By contrast the children found school use of computers "tame", and mainly centred on use of word-processors.[2]

The perception of home computer access as less restrictive than school access may lead to more favourable attitudes to computers among those with home access. Selwyn reports that students using a computer at home were consistently found to have more favourable attitudes towards computers than others do.[3] Those with access to a home computer also preferred to do their work at home, emphasising the freedom to experiment. As one student reported:

> *You just build up a general knowledge of computers at home. I mean if you sit at home and you mess it up or something goes wrong ..... I suppose there is no one sitting beside you to laugh for starters so you can explore. When you're in school you just get given a sheet and you load it up and follow the instructions. 'Type this type that'. It's a waste of time*[4]

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[1] Henry J Becker, *Who's Wired and Who's Not.* Report from the 1998 TLC survey published on the Web at http://www.crito.uci.edu/tlc/html/findings.html p7.

[2] Shazia Mumtaz, "Children's enjoyment and perception of computer use in the home and the school". *Computers and Education,* Vol. 36 (2001), p349.

[3] Neil Selwyn, "The effect of using a home computer on students' educational use of IT", *Computers and Education*, Vol. 31 (1998), p216.

[4] Ibid., p220.

Students with computers at home used a broader range of applications of ICT at school than their colleagues without a home machine. In particular students using a home computer made more use of the Internet and email at school, but reported the same level of use of basic applications like word-processing. This pattern suggests that those students using home computers were more actively seeking out the "optional" applications of ICT that they had experienced at home.[1] Selwyn suggests that these differences may be fostering advantages that continue to be felt long after the individual has left school.[2]

2.1e Home access variation with socio-economic status

Given the importance of home access in determining children's access to ICT, socio-economic variations in level of access have important implications for the digital divide. As might be expected, children's access to computers at home follows the same pattern as adult ICT use, that is, the most disadvantaged groups have less access and the most advantaged have more.

Becker reports that socio-economic differences in home computer access were of "gigantic magnitude".[3] In the US in 1998 only 16% of children living with parents who did not graduate from high school had home access to a computer, compared with 91% of children with a parent having at least a Master's degree.[4] The tables below show the groups of children with the lowest levels of access at home, and the groups with the highest rates of home access.

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[1] Ibid., p216.

[2] Ibid., p225.

[3] Henry J Becker, *Who's Wired and Who's Not.* Report from the 1998 TLC survey published on the Web at http://www.crito.uci.edu/tlc/html/findings.html p7.

[4] Ibid.

TABLE 2. 4: GROUPS WITH LOW ACCESS TO HOME COMPUTERS AND THE INTERNET, US 1998[1]

	% with home computer AND Internet access.
Maximum parent education: 10th grade.	4
Maximum parent education: 11th-12th grade dropout.	6
Household income under $20,000	8
Black children	12
Latino children	12
Parents employed in blue collar or service occupations	12
Not living in a 2 parent household	17

TABLE 2. 5: GROUPS WITH HIGH ACCESS TO HOME COMPUTERS AND THE INTERNET, US 1998[2]

	% with home computer AND Internet access.
Maximum parent education: Professional or doctorate degree	75
Household income over $75,000	70
Maximum parent education: MA degree	69
At least one parent in a managerial or professional occupation	55
Maximum parent education: BA degree	54
Household income $60,000 to $75,000	54
White, non-Hispanic children	44

The Cyberkids study in the UK reveals similar social patterns of home PC ownership. In the case study schools the proportion of students with home computers ranged from 55% to 73%, with the highest rates of home access in the schools in the most wealthy areas. However the study also noted that there were some working class parents who had gone to great lengths to purchase a PC in the belief that it would improve the life chances of their children.[3]

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[1] Ibid., p9.

[2] Ibid.

[3] G. Valentine, S. Holloway and N. Bingham, *"Children's social networks, Virtual Communities and On-line Spaces"*. Report of the Cyberkids research project, 1999. Published on-line at www.shef.ac.uk/~geog/staff/valentine_gill/about.htm

Kirkman[1] reported some variation in ICT skill and confidence with social class. This finding must be treated with some care, as the study was based on a small sample (199 students) and was conducted in 1990 when the technology was quite different. Nevertheless it does suggest that the current stratification of ICT along socio-economic grounds may be amenable to change, and indeed that ICT may prove particularly attractive to boys from some of the less advantaged backgrounds.

2.1f The influence of parents on type of home use

Students use of home computers is likely to be heavily influenced by parent attitudes. In an early small-scale study Giaquinta and Lane found that much of students use of home computers was for non-academic purposes. Where there was academic work it was linked with parent encouragement, parent orientation to help in school work generally and a school emphasis on the academic use of home computers.[2]

More recent work in developing countries has also underlined the key role played by parents. Kelley-Salinas argues that in the use of ICT in developing countries, parent involvement plays a crucial part. He suggests that parents, as the first teachers of children, have a large part to play in the education process. If ICT is to be used in an attempt to compensate for educational disadvantage, then providing skills and access for parents is a crucial part of the process.[3] A number of projects have already experimented with this approach, including the LINCOS project in Costa Rica, where Internet access and other ICT services are provided to small rural communities.[4]

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[1] C. Kirkman, "Computer experience and attitudes of 12-year-old students: implications for the UK National Curriculum". *Journal of Computer Assisted Learning,* Vol. 9 (1993), p55-6.

[2] Joseph Giaquinta and Peggy Lane, "Fifty-one Families with Computers: A Study of Children's Academic Uses of MicroComputers at Home", *Educational Technology Research and Development,* Vol. 38 (1990), pp27-37

[3] Guillermo Kelley-Salinas, "Different Educational Inequalities: ICT an Option to Close the Gaps" in *Learning to Bridge the Digital Divide*, Vol. 36 (2001), p29.

[4] Ibid., p30.

2.1g Different types of home use

Simply having a home computer does not ensure valuable educational experiences with it in the home. Data from the US records socio-economic variations in how the computers were used at home. Becker reports that data from a 1997 survey showed that of those who had computers at home, half of the high-SES children used word processing, but only 24% of low-SES children did. Given the differences in level of computer ownership, this means that 44% of high-SES children used word processing, but only 4% of low-SES children did. More of the high SES children used the computer for each activity recorded, including school assignments, e-mail, graphic design, educational programmes and games.[1]

In a small-scale study of home computer use in the UK, Sutherland *et al.* reported that what is done with the computer in the home is structured by family discourses, and that these discourses provide a context which frames the children's interactions with the technology. So for example a student's use of the computer as a tool for creative writing may be related to the parental use of the computer as a work object, for writing letters and for writing Open University assignments.[2] The researchers recorded examples of families specifically constructing the computer as a means of attaining educational and cultural capital to allow the child to benefit in the future. One parent described her thinking as follows:

> *Because I myself had no interest in school whatever. All I wanted to do was get out. And Gill {the older sister} I'm afraid followed me. But Samantha has more interest. She's more learning. She wants to do it. So I didn't want to hold her back and end up in a factory like me and you, love. She's got more going, more brains, she's inquisitive, she wants to know all the time. So that's why I bought it for her. (Mother of a 14 year old girl).*[3]

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[1] Henry J Becker, *Who's Wired and Who's Not.* Report from the 1998 TLC survey published on the Web at http://www.crito.uci.edu/tlc/html/findings.html p14-15.

[2] Rosamund Sutherland, Keri Facer, Ruth Furlong and John Furlong, "A new environment for education? The computer in the home". *Computers and Education,* Vol. 34 (2000), p210.

[3] Ibid., p202.

Another parent expressed similar motives:

> *He's into drawing a lot. So only a couple of months ago I said "Look, if you're into that and you feel that good about it, think about designing software and all that, technology". There's a lot of money in that kind of stuff. (Father of 14 year old boy).*[1]

By contrast in other homes the computer was constructed in different roles, as a games machine, or as a childminder:

> *At last I thought, why not? Why not. It's for the small ones as well, they use it as well. It's a good pastime, because I'm so busy I don't have time to take them out (Mother of a 14 year old girl).*[2]

The research presented above suggests a strongly divided pattern of access to ICT, with the most disadvantaged groups having less access to ICT than the advantaged groups. A series of dimensions of the divide were identified. Firstly, there is a division between countries, with some countries having much higher rates of Internet connectivity than others. Secondly, there are variations within countries, along the lines of SES, ethnicity and level of education. These differences may not be entirely attributable to differences in income, as there was some evidence that the technology was perceived as more relevant by some social groups.

2.1h Summary

The studies also suggest that differences in ICT skill and usage by social groups are reflected in home access to computers for the children of those groups, thus providing a mechanism for reproduction of the inequality. Home access to computers is seen as very important, and often accounts for more computer time than school computer use. Home access may also be seen as more interesting than school computer time, and have a major influence on attitudes to ICT. However, there is evidence that the families least likely to have ICT skills themselves are also

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[1] Ibid.

[2] Ibid.

least likely to have a home computer. In addition the quality of use of the computer may vary with the parents' expectations.

2.2 Schools as a means to bridge the gap

The previous section has examined the digital divide within society. This section now examines the role of schools in addressing that divide. The research presented above suggests a strongly divided pattern of access to ICT, with the most disadvantaged groups having less access to ICT than the advantaged groups. It also reveals a series of factors that may assist in reproduction of this pattern in the next generation, including variations in home access, different family discourses on the role of ICT, and different levels of parental ICT skill and modelling of good practice. The unequal access in homes provides the children of the better-off with an advantage in school. This results in "political pressure in many OECD countries to provide children from poor families with access to computers in schools....".[1] However this raises the question of whether the existing provision of ICT in schools is acting to narrow or widen the divide. As the US President's advisors on ICT noted:

> *On the one hand, it has frequently been noted that new computing and networking technologies have the potential to empower historically disadvantaged groups of Americans with greater access to the sorts of knowledge building and communication tools that might help them to overcome at least some of their respective disadvantages. While the Panel believes that this potential can scarcely be overstated, it also believes that the ways in which educational technologies are actually deployed and used will determine whether they serve to narrow these historical disparities or widen them even further.*[2]

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[1] OECD, *Education Policy Analysis 1999,* Vol. 36 (1999), p56.

[2] President's Committee of Advisors on Science and Technology, *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States.* (March 1997), section 7, Equitable Access, page 1.

Equality of access to ICT in schools is seen as a key aim for many national ICT strategies. In the UK for example, one of the key aims of the National Grid for Learning is to provide access to ICT for all, as the plan records:

> *Remove barriers to learning, ensuring opportunities for access for all, including those in isolated areas and those with special needs.*[1]

In the US specific action to ensure equality of access to the Internet was taken in 1997 with the introduction of the e-rate. This aimed to subsidise Internet access to schools libraries and rural healthcare providers. The initiative provided $2.5 billion annually to support low cost access for these organisations.[2]

The DENI Strategy for Education Technology in Northern Ireland recognises that home access to ICT is likely to favour the most economically fortunate, but suggests that large scale access at school can easily level any such advantage. To achieve this levelling, however, it suggests that schools must be aware of the need for equity, and seek to facilitate it. Possible mechanisms for facilitating equity suggested include out-of-hours access, home-work clubs and partnerships with libraries or other local services which could bridge the gap in provision.[3]

The strategy also suggests that there is scope for involving parents in addressing this inequity. Provision of computer classes for parents and advice on home computer purchase are possible actions which could encourage parents to see home use as an extension of school use. Another possible action is the provision of a pool of laptops for loan to those without the resources to buy a home computer. DENI also identifies intra-school strategies which could enhance equal access such as provision of equipment in common areas such as the library.[4]

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[1] *Connecting the Learning Society,* UK government consultation paper (1998), p3.

[2] James M. Lonergan, *Internet Access and Content of Urban Schools and Communities.* ERIC digest Number 157 (2000).

[3] Department of Education Northern Ireland, *A Strategy for Education Technology in Northern Ireland.* (DENI, 1997), p15.

[4] Ibid.

2.2a The digital divide in schools

Despite the intention that schools should ensure equal access to ICT, there is a considerable body of evidence suggesting that the social inequalities in ICT access are, at least in some places, reproduced in schools. As early as 1987 studies in the US were reporting higher levels of computer equipment in schools with better off students. Becker and Sterling reported that level of computer equipment correlated with socio-economic status in US elementary schools, and that schools with black students had fewer computers than those with white students.[1] By 1997 the US President's advisors on ICT reported that students from families classified as low in socio-economic status report 14% less usage of computers in schools than students from high SES families.[2]

The US National Center for Educational Statistics (NCES) has explored the relationship between schools ICT and the background of the students. The NCES data reveals patterns in ICT equipment related to student poverty, school size, metropolitan status and level of enrolment of minorities. Schools where a greater proportion of the students were eligible for a subsidised school lunch had fewer computers connected to the Internet per student than other schools.

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[1] Henry J. Becker and C. W. Sterling. "Equity in School Computer Use: National Data and Neglected Considerations", *Journal of Educational Computing Research,* Vol. 3 No. 3, (1987), pp289-311.

[2] President's Committee of Advisors on Science and Technology, *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States.* (March 1997), section 7.2.

TABLE 2. 6: COMPUTER EQUIPMENT AND STUDENT POVERTY, AUTUMN 1998[1]

Percentage of students eligible for a free or reduced-price school lunch.	Students per instructional computer with Internet access
Less than 11 %	10
11-30%	11
31-70%	12
71% or more	17

This pattern of schools located in richer areas having better ICT resources is confirmed by the separate TLC survey. This 1998 survey revealed a series of disparities in the level of ICT resource in schools.[2] Schools with a high proportion of students living in poverty, as indicated by eligibility for special federal funding known as "Chapter 1", were disadvantaged in terms of the numbers of computers, number of Internet connected computers, speed of Internet access and presence of a Web or email server. A parallel assessment of the relative poverty of the areas where the schools were located, based on data about average income levels in each zip code, reported similar patterns.

The study also reported other variations in schools technology infrastructure. Although there were few differences between public and private schools, public schools had greater bandwidth to the Internet, and Internet access on more of their computers and had CD-ROM facilities on more of their computers.[3] Within private schools there were also differences in level of equipment, with a large gap between Catholic and non-Catholic private schools. Many of the Catholic schools had no access to the Internet, and very few had high-speed access. By contrast the non-

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[1] National Center for Educational Statistics. *Internet Access in Public Schools and Classrooms 1994-98*, NCES 99-017 (February 1999), p3.

[2] R. E. Anderson and A. Ronnkvist, *The Presence of Computers in American Schools*. Teaching, Learning and Computing: 1998 National Survey Report #2. Center for Research on Information Technology and Organizations (June 1999).

[3] Ibid., p14.

Catholic private schools had high levels of Internet connectivity, even higher than the public schools.[1]

2.2b Variations over time

As the level of technology in schools changes the location of the gap between the richest and poorest schools may change. In the US in1994 the schools with the greatest proportion of poor students were least likely to have a connection to the Internet, but by 1998 this gap had narrowed as most schools of all types had connected to the Internet.

TABLE 2. 7: PERCENTAGE OF SCHOOLS WITH INTERNET CONNECTION AND PERCENTAGE OF STUDENTS CLASSIFIED AS ELIGIBLE FOR SUBSIDISED LUNCH, US 1998[2]

Percentage of students eligible for a free or reduced-price school lunch.	1994	1997	1998
Less than 11 %	40	88	87
11-30%	39	83	94
31-70%	33	78	91
71% or more	19	63	80

However in the same period a difference appeared in the percentage of classrooms with Internet connectivity. In 1994 very few schools had classrooms connected to the Internet. However between 1994 and 1998 the schools with the fewest poor students connected their classrooms to the Internet at a much greater pace than the schools with more poor students and in both 1997 and 1998 there was a substantial gap between rich and poor on this indicator.

TABLE 2. 8: PERCENTAGE OF CLASSROOMS WITH INTERNET CONNECTION AND PERCENTAGE OF STUDENTS CLASSIFIED AS ELIGIBLE FOR SUBSIDISED LUNCH, US 1998[3]

Percentage of students eligible for a free or reduced-price school lunch.	1994	1997	1998
Less than 11 %	4	36	62
11-30%	4	32	53
31-70%	3	27	52
71% or more	2	14	39

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[1] Ibid., p15.

[2] National Center for Educational Statistics. *Internet Access in Public Schools and Classrooms 1994-98*, NCES 99-017 (February 1999), p2.

[3] Ibid., p2.

While individual indicators may vary as the technology becomes more widespread, the basic gap in equipment level has not reduced. The NCES notes that although the ratio of US students per instructional computer with Internet access improved from 1998 to 1999, the differences between types of schools remained.[1]

2.2c Ethnicity and school ICT resources

The NCES also reports that ICT equipment was related to the presence of ethnic minorities in the school. Schools with a higher percentage of minorities had fewer Internet-connected computers per student.

TABLE 2. 9: COMPUTER EQUIPMENT AND PERCENT MINORITY ENROLMENT, AUTUMN 1998[2]

% minority enrolment.	Students per instructional computer	Students per instructional computer with Internet access
Less than 6%	6	10
6-20%	6	10
20-49%	7	12
50% or more	6	17

The variations in level of equipment with ethnic group may be related to socio-economic status, as the ethnic groups are over-represented in the poorest sectors of the population. However this data highlights an unequal provision of ICT in US schools, with those who are otherwise disadvantaged also having less access to ICT at school.

The parallel TLC survey also confirms this pattern, reporting that schools with high concentrations of students of racial minorities were also less well equipped, although the differences were smaller and uneven.[3]

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[1] U.S. Department of Education, National Center for Educational Statistics. *Stats in Brief: Internet access in US public schools and classrooms: 1994-99.*

[2] National Center for Educational Statistics, *Internet Access in Public Schools and Classrooms 1994-98*, NCES 99-017 (February 1999), p3.

[3] R. E. Anderson and A. Ronnkvist, *The Presence of Computers in American Schools.* Teaching, Learning and Computing: 1998 National Survey Report #2. Center for Research on Information Technology and Organizations (June 1999), p15.

2.2d Variations with location (rural/urban)

Another dimension of inequality is the location of the school. The NCES data reveals that rural schools had higher levels of equipment per student, both in terms of computers and Internet connected computers. In 1998 rural schools had an average of 9 students per internet-connected computer, compared with 12 in suburban schools and 14 in urban schools.

TABLE 2. 10: ICT EQUIPMENT AND METROPOLITAN STATUS, AUTUMN 1998[1]

Metropolitan status.	Students per instructional computer	Students per instructional computer with Internet access
City	7	14
Urban fringe	6	12
Town	6	12
Rural	5	9

The TLC survey also classified schools in terms of their metropolitan status using a four-point scale (City, suburban, Town and Rural). In general rural and town schools had more favourable computer student ratios than city and suburban schools, although this pattern was not very strong, and may have been due to variations in school size.[2]

The US President's advisors on ICT also noted that inner city schools were disadvantaged compared with suburban schools,[3] and suggested that there might be an additional disadvantage for rural schools if local "points of presence" or high speed access were not available.[4]

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[1] National Center for Educational Statistics. *Internet Access in Public Schools and Classrooms 1994-98*, NCES 99-017 (February 1999), p3.

[2] R. E. Anderson and A. Ronnkvist, *The Presence of Computers in American Schools.* Teaching, Learning and Computing: 1998 National Survey Report #2. Center for Research on Information Technology and Organizations. (June 1999), p16.

[3] President's Committee of Advisors on Science and Technology. *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States.* (March 1997), section 7.3.

[4] Ibid.

This concern was also raised in the 2001 Eurobarometer survey, which found that broadband technologies were better developed in metropolitan areas. It reported that ADSL was used by 9% of metropolitan schools, and only 2% of rural schools. Similarly cable modem technology was in use in 8% of metropolitan schools and 3% of rural schools.[1]

Data from the UK records a similar pattern at primary level. In 1998 rural primary schools had 13 students per computer, while the urban schools had 19. However this difference did not appear at secondary level, where the rural schools had 9 students per computer, and suburban and urban schools had 9 and 8 respectively.

TABLE 2. 11: UK SCHOOLS, ICT EQUIPMENT AND LOCATION, 1998.

English schools, data from 1998[2] statistical report.	Average computers per school Primary	Average computers per school Secondary	Average pupils per computer Primary	Average pupils per computer Secondary
Rural	9	89	13	9
Small town	14	99	18	9
Outer area of a large town or city	15	107	19	9
Inner area of a large town or city	15	103	19	8

TABLE 2. 12: UK SCHOOLS, EXPENDITURE ON ICT AND LOCATION, 1998.

English schools, data from 1998[3] statistical report.	Average expenditure on ICT for teaching and learning. Primary	Average expenditure on ICT for teaching and learning. Secondary	Expenditure per pupil on ICT for teaching and learning. Primary	Expenditure per pupil on ICT for teaching and learning. Secondary
Rural	1,606	29,849	14	37
Small town	2,685	31,424	10	35
Outer area of a large town or city	3,128	34,178	11	37
Inner area of a large town or city	3,328	35,963	12	42

[1] European Commission. *European youth in a Digital Age: eEurope 2002 Benchmarking.* Draft Working document of the Commission services Based on the Eurobarometer surveys of February 2001, p7.

[2] Department for Education and Employment. *Survey of Information and Communications Technology in Schools 1998.* Statistical Bulletin Number 11/98 (November 1998), section 20.

[3] Ibid.

2.2e School size and ICT equipment

There are also indications that small schools tend to be better equipped in terms of ICT than larger schools. In the US in 1998, smaller schools had more favourable levels of computer equipment, both in terms of numbers of computers and in terms of computers connected to the Internet.

TABLE 2. 13: ICT EQUIPMENT AND SCHOOL SIZE, US SCHOOLS, AUTUMN 1998[1]

School size, student numbers.	Students per instructional computer	Students per instructional computer with Internet access
Less than 300	4	9
300-999	6	12
1,000 or more	7	13

The TLC study also reported that smaller schools had more favourable student computer ratios. It found that more of their computers had printer access, and more had an Internet server.[2] The reasons for the technology deficit in larger schools was uncertain, but possible reasons suggested include the tendency of large schools to underestimate the resources and support services required to deal with large student numbers, and the difficulties that larger schools may face in attracting funding.[3]

This variation in equipment with school size may partly explain the higher levels of equipment found in rural schools. Data from the US indicates that although rural schools were better equipped than other schools, they were also smaller, and the difference in equipment diminished when controlled for school size.[4]

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[1] National Center for Educational Statistics. *Internet Access in Public Schools and Classrooms 1994-98*, NCES 99-017 (February 1999), p3.

[2] R. E. Anderson and A. Ronnkvist, *The Presence of Computers in American Schools.* Teaching, Learning and Computing: 1998 National Survey Report #2. Center for Research on Information Technology and Organizations (June 1999), p15.

[3] Ibid.

[4] President's Committee of Advisors on Science and Technology. *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States.* (March 1997), section 7.3.

2.2f Regional variations in ICT equipment in schools

The US data also revealed small regional disparities in the level of computer equipment in schools, but much greater disparities in the type of use of computers. Students in the Southern region were less likely to be heavy computer users, and less likely to use computers for higher order activities, than students in the Western region.[1]

The TLC survey also found some differences, albeit uneven, between regions. Schools in the South tended to be lower on most of the indicators of the presence of technology, while there was higher than average presence of technology in the Midwest and West.[2]

2.2g Explanations for the variation in ICT equipment

There are a number of factors which may contribute to the inter-school variation in levels of ICT provision, even in the UK where education is government funded. One possibility is that the more wealthy parents make more financial contributions to the school. This appears to be the case especially at primary level in the UK. In the 1996 UK survey of IT in schools it was recorded that parents' financial contribution varied very markedly with their wealth in primary schools, with parents in prosperous areas supplying 20% of the school's expenditure. The contributions to second level schools were much smaller, amounting to only 1% of the total.

TABLE 2. 14: PERCENTAGE OF EXPENDITURE PROVIDED BY PARENTS, UK 1996[3]

	Primary schools	Secondary schools
Relatively prosperous	20	1
Neither prosperous nor disadvantaged	10	0
Economically disadvantaged.	1	1

[1] Ibid.

[2] R. E. Anderson and A. Ronnkvist, *The Presence of Computers in American Schools.* Teaching, Learning and Computing: 1998 National Survey Report #2. Center for Research on Information Technology and Organizations. (June, 1999), p16.

[3] Department for Education and Employment. *Survey of Information technology in Schools 1996.* Statistical Bulletin no. 3 (March 1997), p11.

Parent contributions to primary schools were much more significant in rural areas, amounting to 29% of school expenditure in rural areas, compared with only 4 or 5% in urban areas.

TABLE 2. 15: PERCENTAGE OF EXPENDITURE PROVIDED BY PARENTS, UK 1996[1]

Location of school	Primary schools	Secondary schools
Rural	29	1
Small town	8	1
Outer area of large town or city	4	0
Inner area of a large town or city.	5	0

A similar trend was noted in the 2001 Eurobarometer survey which reported that more of the computer equipment in primary schools was provided through private donations. Overall one in five computers in primary schools came from private sources, compared with one in ten in secondary education.[2]

2.2h Summary

This section has examined the available data concerning the variation in level of ICT equipment in schools serving different social groups. In the US the surveys suggest that the level of ICT provision in schools varied with a number of factors, including:

- Socio-economic status of students.
- Ethnicity/race of students.
- Location (rural/urban)
- School size
- Regional location.

It is likely that these variables were inter-related. It is probable that ethnic minorities are over-represented in the lower socio-economic groups. It is also probable that both ethnic minorities and lower socio-economic groups were over-

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[1] Ibid.

[2] European Commission. *European youth in a Digital Age: eEurope 2002 Benchmarking.* Draft Working document of the Commission services Based on the Eurobarometer surveys of February 2001, p11.

represented in downtown urban locations, and that the schools in these areas were larger in size. Given this complex series of interrelationships it is difficult to attribute the difference to any one factor, although the NCES notes that, taking students per Internet-connected computer as an indicator, the largest difference was associated with the poverty level in the school.[1]

There were some indications that the nature of the equipment gap may have changed over time. As the schools with the poorer students caught up with the others in terms of numbers of computers, the other schools made advances in terms of classroom Internet connectivity.

These studies raise the possibility that at least in the US, the pattern of provision of ICT in schools may reinforce the existing digital divide. The one exception to this pattern was in the variation with location. In both in the US and the UK rural schools were better equipped than urban schools, contrary to the pattern of ICT skill in society. However this may have been a result of the smaller average size of rural schools, as smaller schools were generally better equipped than larger schools.

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[1] U.S. Department of Education, National Center for Educational Statistics. *Stats in Brief: Internet access in US public schools and classrooms: 1994-99.*

2.3 Type of use of ICT in schools

Another dimension to the inequality in use of ICT is the manner in which ICT is used. In the US the 1997 report to the President recognised that certain types of application of ICT support "higher-order" learning and problem solving activities, while others involve routine drill and practice activities. The report notes that if the former category is believed to have a special value, then "systematic differences in the character of technology usage may be as problematic as lack of access to computing and networking hardware".[1]

Sutton reports that numerous studies have revealed differences in the type of use of ICT.[2] Work by Becker as far back as the 1980s showed that schools that had owned computers for more than three years tended to do more programming and a wider range of activities with the computers, compared with those schools in their first year of computer ownership, which tended to concentrate on drill and practice applications.[3] Later work noted the move away from programming, and the emphasis on using the computer as a tool integrated into the curriculum.

Venezky suggests that the same applications may be used in different schools in ways that are very different educationally:

> *The role of school academic standards in student ICT skill acquisition has largely been ignored, yet looms as large as equipment differences in the skill acquisition equation. Schools that have high standards encourage their students to do more sophisticated learning with ICT than schools with lower standards. In the lower standards setting, students might use word processors and spreadsheets for mundane tasks, and occasionally search the World Wide Web for information, using simple searches and a single search engine. In schools with*

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[1] President's Committee of Advisors on Science and Technology. *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States.* (March 1997), section 7.1.

[2] Rosemary E Sutton, "Equity and Computers in the Schools: A Decade of Research", *Review of Educational Research,* Vol. 61, No. 4 (Winter 1991), p481.

[3] H. J. Becker. *School Uses of Microcomputers: Reports from a national Survey.* No 1 (1983), Cited in Sutton, Rosemary E. "Equity and Computers in the Schools: A Decade of Research", *Review of Educational Research,* Vol. 61, No. 4 (Winter 1991), p481.

> *higher standards, students use spreadsheets to simulate different planting options in agriculture or policy options in government, build their own web pages, and manage forums. When they search the WWW, they use complex searches and a variety of different search engines.*[1]

Becker has linked teachers' use of the Internet with the teachers' pedagogical beliefs, and particularly with the existence of a "constructivist" approach to teaching. The survey measured teacher belief by asking teachers to attach values to a series of classroom conditions and by asking teachers to identify practices within their own teaching. The constructivist teachers were identified by five factors:

1. Disagreement with traditional pedagogy and learning theory. This included opposition to statements about the value of a quiet classroom, the need for basic skills to be taught before 'meaningful instruction' and the need for problems or tasks with clear correct answers.
2. Agreement with constructivist values. This included the teacher as facilitator, multiple classroom activities, and student freedom of movement within the classroom.
3. Frequent use of projects or demonstrations.
4. Frequent practices involving student responsibility.
5. Frequently using practices such as student assessment of their own work, student journal writing, student debates, and student participation in planning class activities.[2]

Using these criteria, Becker records that the most constructivist teachers made most use of the Internet themselves, and also used it more frequently both for student research and for publication of student work.[3]

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[1] Richard L. Venezky, "The Digital Divide Within Formal School Education: Causes and Consequences" in *Learning to Bridge the Digital Divide* (Paris: OECD, 2000), p75.

[2] Henry J. Becker, *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use.* Teaching, Learning and Computing: 1998 National Survey Report #1. Center for Research on Information Technology and Organizations (February 1999), p22.

[3] Ibid., p23.

Thus both Venezky's view of "high standards" and Becker's view of "constructivist orientation" are associated with what might be termed higher-order uses of ICT. However, a number of studies have reported patterns suggesting that the higher-order uses of ICT are found less frequently in schools with disadvantaged students. Four distinct dimensions to this difference may be identified:

Firstly, the poorer students may spend more of their ICT time in learning the operation of the computer. In the US the President's committee concluded that:

> *Lower-SES high school students are also significantly more likely to be taught about computers than to use computers in the course of other learning. Moreover when high SES students are exposed to computers as a subject area, they are more likely to engage in computer programming (as opposed to lower level computer related tasks) than low-SES students.*[1]

Secondly, poor and minority students may spend more of their ICT time on drill and practice programmes. In 1981-82 only 7% of students in Title 1 (poor) schools had taken programming, compared with 14% of students in other schools.[2] In 1982-83 only 13% of schools with predominantly White and high SES students reported extensive use of drill and practice programmes, compared with 33% of predominantly minority schools.[3]

Thirdly, the use of ICT for poorer students may be concentrated in a smaller range of subject areas. In the US the 1998 TLC survey found that the use of ICT in subject areas varied with an indicator of the SES of the students. For three of the

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[1] President's Committee of Advisors on Science and Technology. *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States* (March 1997), section 7.2.

[2] R. E. Anderson, W. W. Welch and L.J Harris. "Inequities in opportunities for Computer Literacy." *The Computer Teacher* Vol. 11 (April 1984), pp10-12. Cited in Sutton, Rosemary E. "Equity and Computers in the Schools: A Decade of Research", *Review of Educational Research,* Vol. 61, No. 4 (Winter 1991), pp475-503.

[3] H. J. Becker. *School Uses of Microcomputers: Reports from a national Survey*. No 3. 1983, cited in Sutton, Rosemary E. "Equity and Computers in the Schools: A Decade of Research", *Review of Educational Research,* Vol. 61, No. 4 (Winter 1991), p482.

four main academic subjects, (i.e. English, Social Studies and Mathematics) frequent computer use was reported more often by teachers working in low income schools than by teachers in any other SES quartile.[1]

Fourthly, the teachers in schools with low SES students may have more limited objectives for their computer use. Becker has reported that teachers in high SES middle and high schools were more likely to report using computers to teach students to "present material to an audience" and to "analyse information". By contrast teachers in low SES schools were more likely to use computers for "remediation of skills", "mastering skills just taught" and "learning to work independently".[2]

Taken together, these suggest that for the schools with the lower SES students, more of the focus of ICT use is on teaching basic computer skills, and on use of ICT to rehearse basic skills in "core subjects". By contrast, in the schools with higher SES students, there was greater emphasis on the higher order uses of ICT, including presentation and analysis.

2.3a Explanations for the variation in type of use of ICT

A number of possible explanations for the variation in type of usage are suggested. One possible factor is suggested by the 1997 US report to the President on ICT, which suggests that teachers' ICT skills may vary with the SES of the school population. Although the report offers little direct evidence to support this, it records "anecdotal evidence" of such a pattern. Possible mechanisms for this proposed in the report include schools in wealthy districts offering higher salaries to teachers and thereby attracting the most skilled, or wealthy schools offering their teachers more training.[3]

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[1] Henry J. Becker, *Who's Wired and Who's Not.* Report from the 1998 TLC survey published on the Web at http://www.crito.uci.edu/tlc/html/findings.html, p5.

[2] Ibid., p6.

[3] President's Committee of Advisors on Science and Technology. *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States* (March 1997), section 7.2.

A second possible factor may be the ability of the students. As most of the material on the Web is in written form, those less comfortable with reading are likely to find it a less comfortable space. As Venezky suggests:

> *A less tractable problem is presented by those with low literacy and inadequate language skills..... Much of the value of the WWW rests in texts and technical diagrams that are at or above high school reading level. Students who enter secondary school still reading at a far lower level will gain little meaning from most of what they encounter on the WWW.*[1]

The issue of student ability may go beyond questions of literacy. Venezky has argued that capacity for self directed learning is "a critical factor that allows some students to profit more than other students from such open-ended resources as ICT".[2] He suggests that "many students lack the experience not only in technically-based skills but also in information handling and effective independent learning. For these students a range of skills need to be taught, including self-monitoring and time management, before computers and the Internet become intelligible".[3]

> *Unlike television and radio, the Internet requires active, autonomous engagement to realise its full benefits. Stored information is available, as well as connections to dynamic information sources, including real-time data (e.g. weather satellite transmissions) and advisors, tutors, mentors and the like. But all of these require active search, communication and information management skills, as well as constant monitoring to extract from the overwhelming bulk of texts, diagrams, tables, photographs and the like what is needed for a particular assignment. Those students who have good self-monitoring skills and are highly motivated to learn usually do better in independent learning than those who do not.*[4]

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[1] Richard L. Venezky, "The Digital Divide Within Formal School Education: Causes and Consequences" in *Learning to Bridge the Digital Divide* (Paris: OECD, 2000), pp72-73

[2] Ibid., p64.

[3] Ibid., p72.

[4] Ibid., p72.

However, while variation in student ability may result in different uses of ICT, it is important to note the dangers in the assumption of an association between student ability and SES or ethnicity.

A third possible explanation arises from Becker's work, in which he has suggested that teachers' use of ICT is associated with teachers' own beliefs and attitudes.[1] This raises the possibility that the variation in type of use of ICT may be a product of teacher thinking, rather than a response to student needs.

2.4 Conclusion

This chapter is concerned with social patterns in ICT skill and usage. The studies cited reveal a series of dimensions of inequality in ICT skills in society. The dimensions include SES, income, educational background, ethnicity and location. The general pattern is that those groups most marginalised in society are least likely to have access to ICT, and least likely to perceive it as valuable. Their children are also less likely to have access to a home computer, and even if they do, may not have the parental encouragement to use it in educational ways. Given that home use of ICT may vastly outweigh the use of ICT within school, there is cause for concern that the digital divide will continue into the next generation.

Schools are often identified as a mechanism for correcting this gap, and strategies have been suggested to provide greater access to ICT in school for disadvantaged students. However there is some evidence that schools themselves replicate the divide, with the schools attended by the poorest students having fewer facilities. There is particular evidence for this in the US, where the schools attended by the disadvantaged had lower levels of ICT equipment than other schools. However the level of ICT equipment in schools is obviously associated with the availability of funding, and this pattern may not necessarily occur in other countries.

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[1] Henry J. Becker, *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use.* Teaching, Learning and Computing: 1998 National Survey Report #1. Center for Research on Information Technology and Organizations (February 1999).

There was one area where the pattern of equipment in schools seemed the reverse of the pattern in society. In rural areas the level of Internet penetration was generally lower than in urban areas. However rural schools, both in the US and the UK were better equipped than other schools, perhaps because of their smaller size.

There is also some evidence of schools using ICT in different ways, with the schools attended by the poorest students being more focused on the lower order applications. US studies suggest that schools with a high proportion of disadvantaged students placed a greater emphasis on learning the operation of the computer, on drill and practice software, and on the use of ICT to reinforce basic material in core subjects. Thus it appears that the kinds of uses of ICT most likely to develop the broad meta-cognitive skills identified as a key part of digital literacy, may be less frequently experienced by the poorer students. The reasons for this difference in type of usage are uncertain, but possible explanations involving teacher skill, student ability and teacher beliefs and attitudes have been suggested.

These findings raise questions about whether existing pattern of school ICT provision will narrow the digital divide. Mumtaz has noted that children reported negative attitudes to computer use generated by school use of the computer, which was reported to be boring and time consuming. By contrast home computers generated positive attitudes to computers.[1] If the poorest students are least likely to have a home computer, least likely to have high access at school, and least likely to do the more interesting things with the computers at school, then their experiences at school are unlikely to reduce their negative images of ICT. Indeed these patterns raise the spectre of what Mumtaz terms a "Sesame Street effect", where an innovation which seems to offer the disadvantaged children the opportunity to catch up is in fact of greatest benefit to the most affluent children.[2]

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[1] Shazia Mumtaz. "Children's enjoyment and perception of computer use in the home and the school". *Computers and Education,* Vol. 36 (2001), p357.

[2] Ibid, p349.

CHAPTER 3

LITERATURE RELATED TO GENDER AND ICT

If, as discussed in chapter 1, digital literacy becomes important to effective participation in social and economic life, then the patterns that emerge in ICT skills are important concerns for society. The previous chapter has examined the possibility that different groups within society may have different exposure to ICT skills, both within and outside of school, potentially resulting in a damaging digital divide.

This chapter is concerned with another potential divide in ICT skills, namely that of gender. The gender divide is unique in that it may cross boundaries of socio-economic status and geography, and may exist even within households. In exploring this divide there is an underlying danger of representing gender as a binary distinction with dominant, competitive males contrasting with supportive, collaborative females. In considering gender issues it is important to stress the lack of fixity of girls' and boys' identities, and acknowledge the complex and variable nature of gender identity.[1] Thus throughout this chapter, while the discussion will consider the differences between boys and girls as a group, it must be recognised that these general comparisons mask very large differences between girls, and between boys.

Examination of the gender pattern is focused on two main areas. The first is concerned with the gender pattern in society generally, while the second is focused on schools and whether schools act to counter the existing pattern. This chapter begins in section 3.1 with the Irish educational system, and looks at some of the existing gender patterns, not specifically related to ICT. Section 3.2 then considers the gender pattern in ICT skill and interest, especially for young people. Section 3.3 examines some of the factors supporting the gender pattern, looking at home

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[1] Joan Swann, "Tinker Town: Reading and re-reading Children's Talk Around the Computer", in *Computers and Talk in the Primary Classroom,* ed. by Rupert Wegerif and Peter Scrimshaw (England: Multilingual Matters Ltd., 1997), p.135.

access to computers, parental encouragement and type of use of ICT. Finally section 3.4 asks whether there are also gender patterns within schools.

3.1 Gender patterns in the Irish Educational system

There are gender variations in participation and achievement in education in many countries. These variations may appear in the form of very visible differences in participation, retention and performance, or may be found in more subtle indicators, such as subject choice. In the Irish system, although many schools are single-sex, the boys' and girls' schools are funded in the same ways and operate the same curriculum. There were a series of gender inequalities within the Irish system, but some of the most obvious have reduced over time[1]. Historically, while girls' retention in the school system was higher than that for boys, this was attributed to lack of employment alternatives.

TABLE 3. 1: PARTICIPATION IN IRISH EDUCATION BY GENDER[2]

	Women 1978/9	Women 1995/6	Women as a % of total 1978/9	Women as a % of total 1995/6
Second level	151,177	190,157	51.6	50.9
Senior cycle	44,208	74,677	54.4	51.6

In terms of performance, boys historically scored higher in state examinations, particularly in some subjects, but this gap has narrowed over time. In 1979 only 35% of girls taking honours mathematics in the Leaving Certificate attained a grade C or higher, compared with 44% of boys. By 1996 the girls had exceeded the performance of boys, with 83% of girls attaining Grade C or higher, and 79% of boys.

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[1] Kathleen Lynch, *Equality in Education*. (Dublin: Gill and Macmillan, 1999), p140.

[2] Ibid., p141.

TABLE 3. 2: PERFORMANCE IN IRISH EDUCATION BY GENDER[1]

Figures are percentage attaining grade C or higher in Leaving Certificate.	1979 % girls	1979 % boys	1996 % girls	1996 % boys
Maths (higher)	35.1	44.1	82.9	79.4
Maths (ordinary)	33.5	40.4	69.3	62.1
English (higher)	50.7	49.4	68.5	61.0
English (ordinary)	37.0	34.5	64.5	49.1
Chemistry (higher)	55.6	56.3	64.2	63.9
Chemistry (ordinary)	49.5	37.9	60.7	47.2

While girls' participation and performance has equalled and exceeded that of boys, there are some subjects where there is a highly gendered take up pattern. Technical Drawing, Construction Studies and Physics are still studied mainly by boys, while Home Economics is studied mainly by girls.[2]

The gendered pattern of interest in subjects is apparent even at Junior cycle level. Materials Technology, Metalwork, Technical Graphics and Science all have higher percentages of males choosing them, while more females take Home Economics, Languages, Business Studies and Art.[3] These figures suggest that although girls have equalled boys in terms of participation and achievement in the second level school system, there remain significant gender patterns in the selection of subjects, along traditional gender lines.

Hannan *et al.*[4] argue that there are also gender difference in girls' performance within mixed schools. Their study noted significant differences between school types, both in term of intake and in terms of treatment of students after intake.

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[1] Ibid., p141.

[2] Ibid., p142.

[3] Damian Hannan,. Emer Smyth, John Mc Cullagh., Richard O'Leary and Dorren McMahon. *Coeducation and Gender Equality.* (Dublin: Oak Tree Press, 1996), p103.

[4] Ibid.

Mixed schools were less likely to be selective in intake, and were more likely to engage in streaming or banding of students. However, once the study had controlled for these differences, girls in mixed schools performed slightly less well than girls in single-sex schools. The difference was particularly marked in Mathematics, where girls in mixed schools perform substantially worse in Leaving Certificate than girls in single-sex schools, even controlling for Junior Certificate results.

These studies reveal that gender patterns remain within the Irish education system, both in terms of subject choice and in performance within subjects. There is also some evidence to suggest that these gender differences may continue and even be enhanced in mixed schools.

3.2 The gender pattern in ICT skill and use in young people

The previous section has considered the gender patterns within Irish education. This section now examines the possibility of a gender gap in ICT skill in society. While evidence from other countries points to a gender pattern, the differences reported were often small, elusive, and sometimes not statistically significant. Sutton[1] provides a comprehensive review of the research on the patterns relating to computers in education during the 1990s. Her meta-analysis of research on gender patterns in access to computers concluded that a number of studies reported small gender differences favouring boys, while other studies reported no significant difference. However no studies reported greater access for girls.

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[1] R. Sutton, "Equity and Computers in the Schools: A Decade of Research", *Review of Educational Research* Vol. 61, No 4 (Winter 1991), p479.

TABLE 3. 3: SUMMARY OF META-ANALYSIS FROM SUTTON[1]

Figures are numbers of studies.	Statistically significant advantage boys	Not significant advantage, boys	No difference	Advantage girls.
Access to computers at school	3	2	7	0
Access to computers at home	10	5	0	0
Interest in using computers	3	0	4	0
Confidence in using computers	3	0	4	0

However the lack of any studies showing an advantage for girls suggests that this pattern is worthy of further exploration. This analysis gives rise to two possible explanations. Either the gender pattern is very small and difficult to measure accurately, or the gender gap is variable, and exists in some cases and not others.

Some other studies support the latter possibility. Becker and Sterling[2] analysed the within-school pattern of ICT use, and reported a small average difference, but an asymmetric pattern where some schools appeared to have little gender difference, and others had a significant gender gap. In the US, a report to the president in 1997[3] noted that the gender gap in ICT access was small but significant.

3.2a Skill level

Data from the International Association for the Evaluation of Educational Achievement (IEA) Computers in Education project (COMPED), suggests that boys had higher levels of computer skill than girls. This major quantitative study, conducted in 20 countries in 1989 and in 10 in 1992, provides a substantial body of data collected under rigorous conditions. However discussion of its findings must

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[1] Ibid., p480, 487 and 488.

[2] H.J. Becker and C.W. Sterling, "Equity in School Computer Use: National Data and Neglected Considerations", *Journal of Educational Computing Research,* Vol. 3 No. 3 (1987), pp289-311.

[3] President's Committee of Advisors on Science and Technology. Report to the President on the Use of Technology to Strengthen K-12 Education in the United States (March 1997), section 7.5.

be prefaced by the warning that the study is now dated, and as the technology has changed in the interim, particularly with the development of the Web, the pattern of skills may also have changed.[1]

The COMPED study used a test of students' knowledge of information handling and simple computer use, known as the Functional Information Technology Test (FITT). In all of the participating countries, boys scored higher than girls, and the differences were statistically significant in all but three countries (Graph 3.1).[2]

3.2b Interest in IT

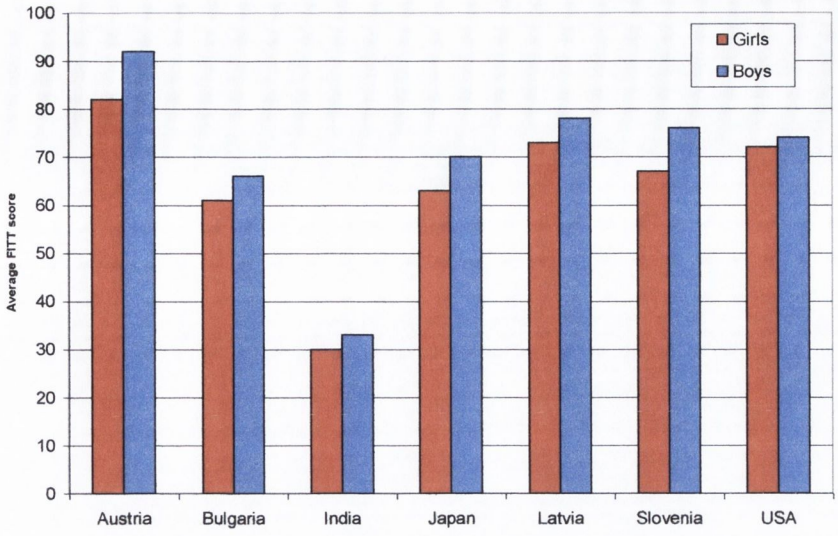
The COMPED study also administered a questionnaire survey to the sample students, aimed at measuring their belief in the "relevance" of computers, and their "enjoyment" of computers. In most countries there was no significant difference between male and female students on the "relevance" scale. In the three countries where there was a difference (Austria, the Netherlands and Latvia) males saw computers as more relevant. In almost all cases male students reported enjoying computers more than females. The exceptions were elementary students in the USA and Japan, and upper secondary students in India. Graph 3.2 shows the pattern of "enjoyment" of ICT for upper secondary students illustrating the wide variation in the gender gap.

The study attempted to measure the students' perception of the gender pattern in computer use. Students were asked to indicate whether they thought there was a gender pattern in each of four areas, as indicated by the following questions.

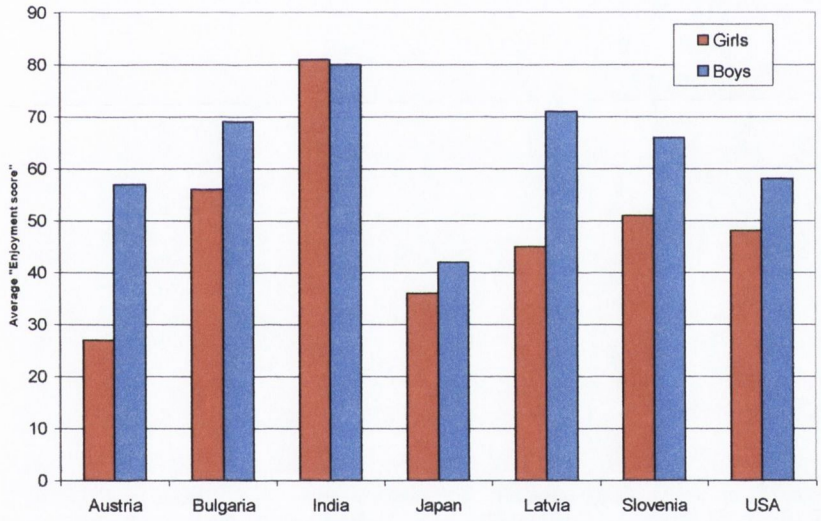
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[1] Ingeborg Janssen Reinen, and Tjeerd Plomp. "Information Technology and Gender Equality: A Contradiction in Terminis?", *Computers and Education*, Vol. 28 No 2 (1997), pp65-78.

[2] The differences were not statistically significant in the USA, Bulgaria and India.



GRAPH 3.1. SCORES ON FITT FOR UPPER SECONDARY STUDENTS (FITT IS A MEASURE OF FUNCTIONAL IT SKILLS)[1]



GRAPH 3.2 AVERAGE "ENJOYMENT SCORES" FOR UPPER SECONDARY STUDENTS[2]

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[1] Ingeborg Janssen Reinen and Tjeerd Plomp. "Information Technology and Gender Equality: A Contradiction in Terminis?", *Computers Education*, Vol 28 No 2, 1997, pp65-78.

[2] Ibid.

TABLE 3. 4: STUDENT PERCEPTION OF GENDER PATTERN, QUESTIONS USED[1]

Question	Allowed answers		
Who, do you think, is more likely to play computer games?	Boys	Equally boys and girls	Girls
Who, do you think, is more likely to enjoy using computers for practical jobs?	Boys	Equally boys and girls	Girls
Who, do you think, is more likely to get a job doing computer programming?	Boys	Equally boys and girls	Girls
Who, do you think, knows more about computers?	Boys	Equally boys and girls	Girls

Responses to these questions show some interesting patterns. Overall the students did not perceive that boys were more likely to enjoy using computers. Indeed in the US data, girls were seen as slightly more likely to enjoy using computers. This pattern seems to contradict that reported earlier, where students were asked to report their own personal level of enjoyment of computers. Janssen Reinen and Plomp suggest that this may be explained by the "We can, I can't" paradox. This phrase refers to the pattern of females describing gender equality for females in general, while declaring less skill when reporting their own personal performance.

Similar gender patterns in expectations have been recorded in other studies. Culley's[2] study, conducted in the UK in the mid 1980s, reported that working with computers was a career aspiration for a high proportion of boys, but played very little part in girls' hopes for their future. Kirkman's survey of Year 8 students (aged 12) in the UK in 1990, found strong gender patterns. The study revealed that boys

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[1] Extracted from table in Ingeborg Janssen Reinen, and Tjeerd Plomp. "Information Technology and Gender Equality: A Contradiction in Terminis?", *Computers and Education*, Vol. 28 No 2 (1997), p78.

[2] Lorraine Culley, "Girls, Boys and Computers", in *Computers and Learning*, ed. by Oliver Boyd-Barrett and Eileen Scanlon, (England: Addison Wesley, 1991), p84.

were significantly more enthusiastic about computers, were more confident using computers and considered themselves better at using computers.[1]

Another interesting pattern in the COMPED data is revealed by examining the pattern of responses at the different levels of schooling. In the US data extracted from the COMPED report, it is clear that girls' perceptions of the gender pattern are greater for the students in the upper levels. At elementary level 37% of girls felt that girls were most likely to enjoy using computers to do practical jobs, but by upper secondary level this had fallen to 24%. The same pattern appeared with the other questions. The girls further into the school system had less confidence in their enjoyment, skill and career prospects with computers.[2] Graph 3.3 shows the pattern of responses to the question about knowledge of computers. This shows that girls at elementary school level thought that girls knew more than boys, but that this pattern had reversed by upper secondary level.

These studies suggest that boys had more ICT skill than girls in many countries. Perhaps more importantly, they indicate that boys had more favourable attitudes to computers, both in terms of their confidence in using the technology, and in their belief in its relevance.

Burstyn argues that the lower rate of usage of IT by girls, as reported in numerous studies in the US, is partly due to the socialisation of girls. She suggests a number of different factors which may contribute to perception of computers as a male domain. IT is frequently associated with maths and science, which are, she suggests, also linked to males. In addition, she suggests that jobs in the IT industries are associated with particular genders, key personnel being typically male, and the production line staff being typically female. Thirdly, she argues that even the computer games are not gender neutral, both because of their emphasis on

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[1] C. Kirkman, "Computer experience and attitudes of 12-year-old students: implications for the UK National Curriculum". *Journal of Computer Assisted Learning* Vol. 9 (1993), p55-6.

[2] Extracted from table in Ingeborg Janssen Reinen, and Tjeerd Plomp. "Information Technology and Gender Equality: A Contradiction in Terminis?", *Computers and Education*, Vol 28 No 2 (1997), p78.

battle and because many include women as victims.[1] She quotes Provenzo[2] as reporting that 30% of Nintendo games contained scenarios where women were kidnapped or had to be rescued as part of the game.

There is some suggestion that this gender pattern may change as the technology evolves. The "Cyberkids" research project was a large-scale study of the impact of Internet connectivity on school age students. The study reported that both teachers and pupils held gender stereotypical attitudes to computers. Computers were frequently seen as "boys' toys", possibly because of their association with games. However Internet access appeared to be reducing this pattern, and to be making the computer "cool" for girls. In one of the schools studied e-mail significantly increased girls' use of computers. The study noted that "Interviews with teachers and female pupils indicated that this was because they enjoyed communicating with other people, but had little interest in computer games", and concluded that "for girls, provision of e-mail provides a way into computer use which does not undermine their femininity".[3]

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[1] Joan Burstyn, "Who Benefits and Who Suffers? Gender and Education at the Dawn of the Age of information Technology", in *Gender and Education*. Edited by Sari Knopp Biklen and Diane Pollard. (Chicago: University of Chicago Press, 1993).

[2] Eugene Provenzo, Video Kids: making Sense of Nintendo (Harvard University Press 1991), quoted in Joan Burstyn, " Who Benefits and Who Suffers? Gender and Education at the Dawn of the Age of information Technology". *Gender and Education*. Edited by Sari Knopp Biklen and Diane Pollard. (Chicago: University of Chicago Press, 1993), p116.

[3] Gill Valentine, Sarah Holloway and Nick Bingham, "Children's social networks, Virtual Communities and On-line Spaces". Report of the Cyberkids research project, published on-line (1999) at www.shef.ac.uk/~g/staff/valentine_gill/about.htm

3.3 Out-of-school use of ICT

The previous section has examined the suggestion that boys may tend to have greater ICT skills than girls, and that ICT may be perceived as a male activity by young people. This section is concerned with gender differences in access to ICT in the home, and the possibility that this may contribute to the skill pattern. A number of studies suggest that where females have the same experience of, and access to, computers, their skills[1] and attitudes[2] are similar to those of males. These findings suggest that the gender pattern may be partly a result of differential access to, or experience of, ICT. Levin and Gordon argue that girls with access to computers have similar attitudes to those of boys, and suggest that the issue is not one of gender but of access.[3]

3.3a Home access to IT

One major contribution to young people's experience of ICT is the access to a home computer. Home access to PCs seems likely to increase in the near future, and children's education appears to be a major factor in the decision to buy home computers. In the US a 1995 survey found that over 80% of families intending to buy a PC cited the educational value for their children as the primary reason for purchase.[4]

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[1] R. Anderson, "Females surpass males in computer problem solving: Findings from the Minnesota Computer Literacy Assessment", *Journal of Educational Computing,* Vol. 3 No. 1 (1987), pp39-51.

[2] J. Woodrow, "Development of computer related attitudes of secondary students" *Journal of Educational Computing Research*, Vol. 11 No. 4 (1994), pp307-338.

[3] T.Levin and C. Gordon "Effect of Gender and Computer Experience and Attitudes Towards Computers", *Journal of Educational Computing Research* , Vol. 5 No. 1 (1989), pp69-88.

[4] American Learning Household Survey, reported in "The Red Herring" December 1995. Cited in ISTE, *The Future of Information Technology in Education*. Published on the Web at: www.iste.org Publications/Books/Future 1999.

The IEA COMPED study noted that female students made up the majority of those who have computer access only at school.[1] Further analysis of this data revealed that males were more likely to have home access to PCs than females. This pattern was statistically significant in all of the countries studied except at some levels of schooling in the USA and India.[2]

Culley,[3] reporting on research she conducted in the UK in the mid 1980s, reported a similar strong gender pattern in home computer ownership. Of 974 pupils surveyed, 383 had a home computer, and only 107 of these were girls. Moreover, only 14% of the girls with a computer reported that the computer was bought for them, while 85% of the boys with a home computer reported that it had been bought either specifically for them, or for another male in the household. Hattie and Fitzgerald[4] also noted that where a family had a home computer, it was more likely that a male would use it regularly. In Kirkman's sample 70% of boys made use of a computer at home, compared with 38% of girls. Boys used a home computer for an average of 7.1 hours per week, compared with 4.2 hours per week for girls.[5]

More recently Selwyn's[6] study, based on a survey of 983 students aged 16-19 in Wales, confirmed that female students were less likely to have home access to a

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[1] Ingeborg Janssen Reinen and Tjeerd Plomp. "Gender and Computers: Another Area of Inequity in Education?". In *Schools, Teachers, Students and Computers: a Cross National Perspective* ed. by W.J. Pelgrum, I.A.M. Reinen Janssen and Tj. Plomp. (Amsterdam:IEA, December 1993), p108.

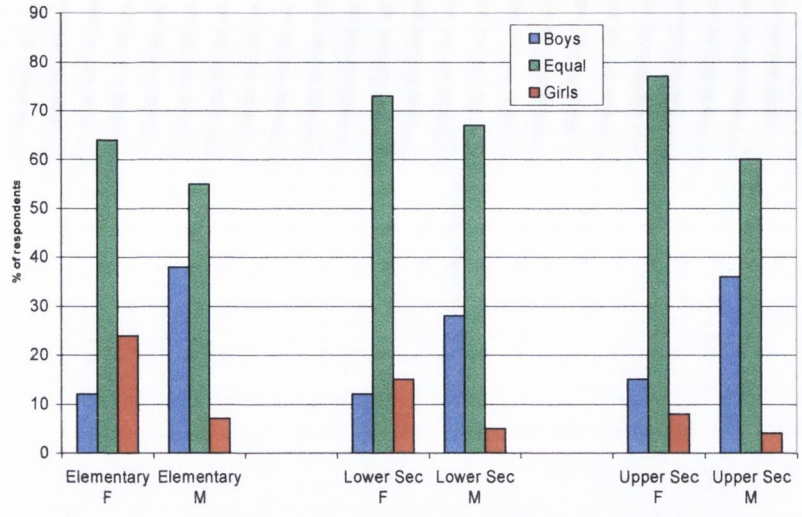
[2] Ibid., p107

[3] Lorraine Culley, "Girls, Boys and Computers", in *Computers and Learning*, ed. by Oliver Boyd-Barrett and Eileen Scanlon, (England: Addison Wesley, 1991), p84.

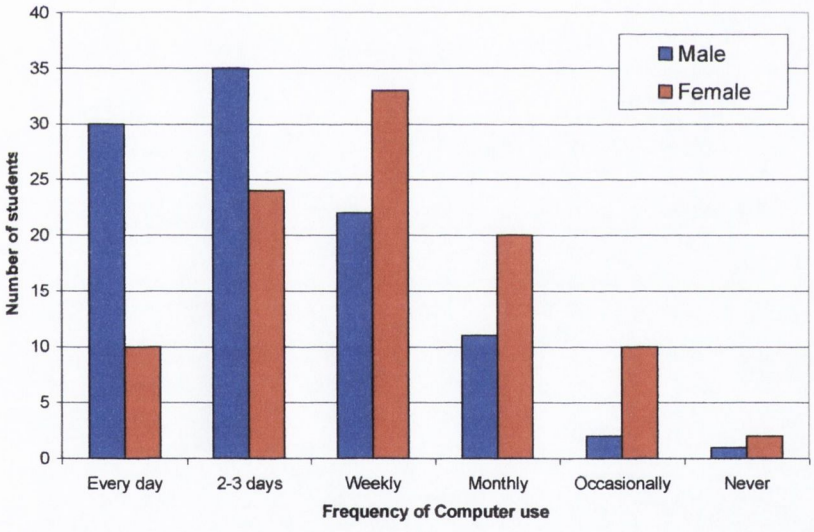
[4] T. Hattie and D Fitzgerald, "Sex Differences in Attitudes, Achievement and Use of Computers.", Australian Journal of Education, Vol. 31 No. 1 (1987), pp3-26.

[5] C. Kirkman, "Computer experience and attitudes of 12-year-old students: implications for the UK National Curriculum". Journal of Computer Assisted Learning Vol. 9 (1993), p55-6.

[6] N. Selwyn, "The effect of using a home computer on students' educational use of IT", *Computers and Education* Vol. 31 (1998), pp211-227.



GRAPH 3.3. "WHO, DO YOU THINK, KNOWS MORE ABOUT COMPUTERS?", ANSWERS BY US STUDENTS, CLASSIFIED BY LEVEL OF SCHOOL AND GENDER OF RESPONDENT[1]



GRAPH 3.4. FREQUENCY OF COMPUTER USE BY GENDER[2]

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[1] Ibid.

[2] Neil Selwyn,. "The effect of using a home computer on students' educational use of IT", *Computers and Education* 3, 1998, pp211-227.

computer. Even when they had access to a home computer, female students made less frequent use of it. On a six-point scale recording frequency of use, the modal value for male students was "every 2-3 days" while the modal value for female students was "weekly" (Graph 3.4).

3.3b Parent influence and encouragement

Although home computers may be bought with a view to their perceived educational value, it is likely that much home use of computers is not for educational purposes. A study by Giacquinta and Lane[1] followed 51 families and monitored their use of home computers over a two-year period. They reported that most use of home computers by children was not for academic or educational purposes. The study also identified a series of factors linked with non-use of home computers for academic purposes. Prominent among these were lack of parental support and encouragement for children.

Unfortunately Chen reports that parents encourage boys more than girls to take up computers, and to excel at using them.[2] Further support for the differential pattern of parent support is provided by the COMPED study. This asked students to indicate the level of encouragement they received from parents. In a number of countries (The Netherlands, Greece, Latvia and upper secondary schools in Bulgaria) boys reported higher levels of parental encouragement. In other countries there was no significant difference. The only exception was in Japan, where girls reported more parental encouragement.[3]

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[1] Joseph Giaquinta and Peggy Lane "Fifty-one Families with Computers: A Study of Children's Academic Uses of MicroComputers at Home", *Educational Technology Research and Development,* Vol. 38 (1990), pp27-37.

[2] M. Chen, "Gender and Computers: The beneficial effects of experience on attitudes", *Journal of Educational Computing Research*, Vol. 2 No 3 (1986), pp265-282.

[3] Ingeborg Janssen Reinen, and Tjeerd Plomp. "Information Technology and Gender Equality: A Contradiction in Terminis?", *Computers and Education*, Vol. 28 No 2 (1997), p69.

3.3c Type of home use

The findings cited above have pointed to gender patterns in the amount of use of ICT in the home. In addition there may be differences in the ways in which boys and girls use ICT. Sutton's[1] meta-analysis also reported a series of findings suggesting that there are gender differences in type of use of computers, from the US, Canada, Australia, New Zealand and Britain. Kirkman also noted that of those who reported using a computer at home, the boys were more likely to play games and do some programming, whereas the girls were more likely to use word processing.

TABLE 3. 5: STUDENTS' USE OF COMPUTERS AT HOME (FROM KIRKMAN)[2]

Types of use of computers	% of boys using computers for each type.	% of girls using computers for each type.
Games	100%	91%
Word processing	15%	43%
Art	12%	5%
Desk top publishing	3%	0%
Music	3%	0%
Programming	30%	10%

Selwyn's study also revealed a similar gender pattern in type of use of the computer. Relative to numbers using computers, boys were more likely to play games than use a word processor, while girls reversed this pattern. Girls were also more likely to use art packages and the Internet, while boys were more likely to use databases, spreadsheets, and programming.[3]

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[1] R. Sutton, "Equity and Computers in the Schools: A Decade of Research", *Review of Educational Research,* Vol. 61, No 4 (Winter 1991), p482.

[2] C. Kirkman, "Computer experience and attitudes of 12-year-old students: implications for the UK National Curriculum". *Journal of Computer Assisted Learning* Vol. 9 (1993), p56.

[3] N. Selwyn, "The effect of using a home computer on students' educational use of IT", *Computers and Education* Vol. 31 (1998), p218.

While there are some differences between these two studies in areas such as art, both of these studies found that more girls used word processing, while more boys used computers to play games and for programming. By the time of the second study in 1998 the Internet was more widely available in homes, and Selwyn reported that girls were making more use of it than boys. This seems consistent with Valentine's analysis of the Internet as a female friendly space.[1]

The gender differences in computer use may even extend to styles of programming. Turkle and Papert have considered the idea that girls might tend to approach programming in different ways in the context of Piaget's concept of a hierarchy of stages in an individual's approach to knowledge. They suggest that there may be people who use a "concrete" approach to programming. Normally programming begins with an abstract plan, but Turkle and Papert have suggested that the "concrete" thinkers, or "bricoleurs" may interact with the material around them to arrive at a product. They suggest that such people are:

> *not drawn to structured programming; their work at the computer is marked by a desire to play with the elements of the program , to move them around almost as though they were material elements - the words of a sentence, the notes in a musical composition, the elements of a collage.*[2]

3.3d Impact of home computer use

A number of studies indicate that the use of computers at home has a positive impact on the skills and attitudes of young people towards computers. The IEA COMPED study concluded that:

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[1] See section 3.2b.

[2] Sherry Turkle and Seymour Papert, "Epistemological Pluralism: Styles and Voices Within the Computer Culture", *Signs: Journal of Women in Culture and Society* Vol. 16, No. 1 (Autumn 1990), p136.

> *In most countries, across all three populations, females agree more on the relevance of computer use when they use the computer at home.*[1]

Kirkman reported that use of a home computer correlated with a more positive attitude to computers for boys and girls, but the difference was greater for girls, suggesting that use of a home computer seemed to have a stronger effect on attitude for girls.[2] By contrast Selwyn found that both male and female students with home access to computers had significantly more positive attitudes to ICT than those without. However, access to a home computer made a greater difference in attitudes for boys than for girls. He concluded that

> *.. using a home computer has a positive effect for both sexes, but that boys seem to be benefiting at greater levels from using a home computer than girls. So far from improving inequalities in students' attitudes towards computers, home computer use appears to be, if anything, increasing gender differences*[3]

A part of the explanation for this pattern may be the larger time that the boys spend playing games. Indeed Sanders suggests that computer games culture acts as an important agent for socialisation of boys into IT.[4] Similarly in Selwyn's focus groups, many male students reported that playing computer games served initially

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[1] Ingeborg Janssen Reinen and Tjeerd Plomp. "Gender and Computers: Another Area of Inequity in Education?". In *Schools, Teachers, Students and Computers: a Cross National Perspective,* ed. by W.J. Pelgrum, I.A.M. Reinen Janssen and Tj. Plomp. (Amsterdam:IEA, December 1993), p110.

[2] C. Kirkman, "Computer experience and attitudes of 12-year-old students: implications for the UK National Curriculum". *Journal of Computer Assisted Learning,* Vol. 9 (1993).

[3] N. Selwyn, "The effect of using a home computer on students' educational use of IT", *Computers and Education* Vol. 31 (1998), p219.

[4] J. Sanders, "The computer: Boy, Girl or Androgynous?" *The Computing Teacher*, Vol. 4 (1984), pp31-34. Quoted in C. Kirkman, "Computer experience and attitudes of 12-year-old students: implications for the UK National Curriculum". *Journal of Computer Assisted Learning,* Vol. 9 (1993), pp51-62.

as the attraction for using computers at home. Some male students felt that the competitive and sometimes violent nature of the games was part of their attraction. Many felt that their interest in games had developed into an interest in computers generally, and they had continued to use home computers for both work and leisure. By contrast few of the female students showed an interest in games, and many used the computer only when required to.

TABLE 3. 6: COMMENTS FROM MALE AND FEMALE STUDENTS ABOUT HOME COMPUTER USE AND GAMES.[1]

James	*I remember playing when I was very young.. with just a bat and a ball on the screen and went on from there*
Steve	*It probably does start from games when you were young and boys seem more wanting to beat each other and play each other and then eventually they play loads and then they want to know how the game works. So it like progresses and you interest gets bigger as you mature.*
Fiona	*it shouldn't be a male thing but it probably is. .... And the games are all rubbish now anyway aren't they?*
Alison	*I think we're more interested in what's happening in the world than what boys are*

3.3e Gender and social class

Thus far the discussion of home access to computers in the context of gender has centred on the differential access to and use made of the home computer by boys and girls. However Kathleen Lynch argues (not specifically about IT), that there is an inherent danger in researching social class and gender as separate issues, and in the process treating women as an undifferentiated social group. She argues that working class women may have different rates of take-up to middle class women.[2] In the context of IT, it may be that there are significant differences between working class boys and girls in their attitudes to IT, which are not apparent in middle class students.

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[1] N. Selwyn, "The effect of using a home computer on students' educational use of IT", *Computers and Education* Vol. 31 (1998), pp222-224.

[2] Kathleen Lynch, *Equality in Education*, (Dublin: Gill and Macmillan, 1999), p147.

Kirkman,[1] in his study in the UK, used daily newspapers read as a proxy for social class. Households taking the Telegraph, Times or Guardian were considered high, those taking the Express, Today or the Mail were classified as medium, and those reading the Sun and Star classified as low. This crude measure showed some variation in the gender pattern with social class. For girls the results showed that those in the high socio-economic group were more positive towards computers, followed by the middle socio-economic group. Those girls in the low socio-economic group had the least enthusiasm for computers. By contrast, with the boys the lowest socio-economic group were most enthusiastic about computers, with the high socio-economic group next, and the middle group showing the least enthusiasm. For boys, the low socio-economic group also rated themselves the most skilled with computers.

Kirkman expresses some surprise that the boys in the middle socio-economic group had the least positive attitude to computers, but confirms his finding by noting that they had the fewest computers at home, took the least interest in lunchtime clubs, spend least time on computers at home, and are least confident using computers.

3.3f Summary

The research cited above suggests a gender gap in ICT skills in many countries. In general boys appear to have a higher level of ICT skill than girls, and to be more confident both of their skills and the relevance of those skills. This pattern may be supported by the pattern of home use of ICT. The studies suggest that boys are more likely to have access to a computer at home, and when they have are likely to use it more frequently. In many cases the pattern is also supported by parental attitudes, with parents providing more encouragement for boys.

There were also indications from small scale studies that boys and girls might make different types of use of ICT. Boys seemed to make more use of games, and of the technical and mathematical parts of ICT, such as programming, database and

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[1] C. Kirkman, "Computer experience and attitudes of 12-year-old students: implications for the UK National Curriculum". *Journal of Computer Assisted Learning* Vol. 9 (1993), p58.

spreadsheets. By contrast, girls made more use of word processing. Although this suggests that boys may have a broader experience of ICT, the more recent studies suggest that the Internet may be particularly attractive to girls, and report more girls using the Internet than boys.

The pattern is made more complex by its interaction with social class patterns. Although there was limited research available on this topic, there was a suggestion from one study that the gender gap was more pronounced among low socio-economic status (SES) children than those from higher SES.

These findings make it difficult to avoid the conclusion of the COMPED study, that concern about the gender pattern is well founded.[1] The COMPED study suggested that school gender policies could be part of the strategy for tackling this gender gap. Similarly Selwyn viewed schools as agencies that could redress the gender imbalance, concluding that:

> *schools and colleges should strive to make IT experiences more positive so that females .... are not as disadvantaged as they currently are...*

3.4 In-school use of ICT

The research cited above has suggested that there are gender patterns in ICT skills in society, and that these patterns are reflected in different access to computers by boys and girls outside of school. This section turns the focus onto schools themselves, examining whether they too may provide different experiences of ICT to boys and girls. Given the gender gap in interest in ICT, home access and home use, combined with the importance of ICT for economic and social participation in adult life, it is reasonable to support Burstyn's argument that countering this trend

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[1] Ingeborg Janssen Reinen and Tjeerd Plomp. "Gender and Computers: Another Area of Inequity in Education?". In *Schools, Teachers, Students and Computers: a Cross National Perspective* ed. by W.J. Pelgrum, I.A.M. Reinen Janssen and Tj. Plomp. (Amsterdam:IEA, December 1993), p116.

presents a major challenge to schools.[1] However there are indications that, rather than reducing the inequity, schools may actually exacerbate it.

The COMPED study reported that computer use at school was more highly related to computer skill for female students. One possible explanation for this finding may be that the girls had less access to computers at home and so more of their computer use was at school.[2] Hence school access to ICT may be more important for girls than for boys. Despite this, there is some evidence to suggest that girls may get less access to ICT at school than boys.

In the US, as early as 1987, researchers were showing indications that there were gender differences within schools, both in the volume and type of use of computers. Becker and Sterling[3] conducted a series of national surveys on the use of computers in schools. The second survey in 1985 measured conditions in a sample of 2,101 schools across the US. Their study asked schools to report the percentage of females among students taking part in each computer activity. While most schools reported that 50% of the students using the computer were female, female students were under-represented in many of the computer activities. Girls were less likely to use computers before or after school hours, or to be involved in programming or game playing. Across three levels (k-6, Middle and High school), the only area where girls were more involved than boys was in word processing at high school. Their study concluded that

> *a school atypically low in computer use by girls had female participation of only 30 percent, while a school atypically high in use by girls still had no better than a 50-50 parity between girls and boys.*

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[1] Joan Burstyn, " Who Benefits and Who Suffers? Gender and Education at the Dawn of the Age of information Technology". *Gender and Education*. Edited by Sari Knopp Biklen and Diane Pollard. (Chicago: University of Chicago Press, 1993).

[2] Ingeborg Janssen Reinen, and Tjeerd Plomp. "Information Technology and Gender Equality: A Contradiction in Terminis?", *Computers and Education*, Vol. 28 No 2 (1997), p75

[3] H.J. Becker and C.W. Sterling, "Equity in School Computer Use: National Data and Neglected Considerations", *Journal of Educational Computing Research,* Vol. 3 No 3 (1987), pp289-311.

> ..... *Thus, in a substantial percentage of schools at all levels, boys dominate time on computers.*

A study by Culley[1] in 1986 explored the differential access of male and female students to computers in schools and at home. Although the context has changed considerably since the time of the study, some of the mechanisms are worthy or note. The study noted that girls accounted for less than 10% of computer users in optional school computer activities. It concluded that computer clubs were regarded as "male territory" and that girls frequently reported "being made to feel very uncomfortable by the attitudes and behaviour of boys".[2] Several schools in the study had recognised this problem and responded by reserving some time as "girls only" time. However this had tended to result in the remaining time becoming de facto "boys' time", thus further reinforcing the inequality of access.

A number of studies have considered the possibility of girls being less likely to take up computer related activities within school. Lockheed suggested that boys' enthusiasm for computers made them crowd into computer rooms, and as a result they were likely to be seen as a male domain.[3] Sanders suggested that the barrier to girls' participation was not the presence of the boys, but the absence of their female friends.[4]

3.4a Type of computer use at school

In addition to getting less time on computers in the school, it is likely that girls engage in a smaller range of activities on the computer. The COMPED study reported, female students were involved in a smaller number of activities with the computer. Note that this last finding is based on number of activities, rather than

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[1] Lorraine Culley, "Girls, Boys and Computers", in *Computers and Learning*, ed. by Oliver Boyd-Barrett and Eileen Scanlon, (England: Addison Wesley, 1991), p81.

[2] Ibid., p82.

[3] M. E. Lockheed, "Women, girls and computers: A first look at the evidence" *Sex Roles*, Vol. 13 (1985), pp115-122.

[4] J. S. Sanders, "Making the computer neuter", *The Computing Teacher*, Vol. 12 (1985), pp 23-27.

hours of computer use. Boys carried out a higher number of activities with the computer in all countries surveyed and at all school levels.[1] Janssen Reinen *et al.* concluded that:

> *It is clear that, on average, males students are engaged in a greater number of activities than females. In each activity type, it appears that male students engages more often. The only exceptions are word processing, where female students show a higher engagement in a small number of countries.*[2]

Becker and Sterling[3] reported a similar pattern in US schools. The examined the percentage of girls among the students involved in each kind of activity. As the population was roughly gender balanced, one might expect 50% of the students involved to be girls. Instead the girls showed slightly lower levels of overall use of the computer. More importantly, they showed markedly lower levels of use of the school computers outside of scheduled time. This use before and after school is voluntary, and therefore an indicator of interest in use. Girls also showed lower levels of use in game playing and elective programming work. The only area where the girls made up more than 50% of students involved was in word processing, and then only at high school level. This finding repeats the findings with relation to home use, reported earlier, suggesting that girls were more likely to spend their computer time on word processing.

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[1] Ingeborg Janssen Reinen, and Tjeerd Plomp. "Information Technology and Gender Equality: A Contradiction in Terminis?", *Computers and Education*, Vol. 28 No 2 (1997), p75

[2] Ingeborg Janssen Reinen and Tjeerd Plomp. "Gender and Computers: Another Area of Inequity in Education?". In *Schools, Teachers, Students and Computers: a Cross National Perspective* ed. by W.J. Pelgrum, I.A.M. Reinen Janssen and Tj. Plomp. (Amsterdam:IEA, December 1993), p114.

[3] H.J. Becker and C.W. Sterling, "Equity in School Computer Use: National Data and Neglected Considerations", *Journal of Educational Computing Research,* Vol.3 No 3 (1987), p302.

TABLE 3. 7: GENDER DIFFERENCES IN US IN-SCHOOL COMPUTER USE[1]

Figures are "percent girls" of the students involved.	K-6	Middle school	High School
Overall use Note that this refers to participation, not to level or frequency of participation.	48	45	45
Use before/after school	28	22	26
Word processing	36	40	60
Elective programming	22	38	41
Game playing	37	28	20

The type of computer use encouraged at school may have a further impact by influencing home computer use. Giacquinta and Lane found that school emphasis on programming was a deterrent to home use.[2]

3.4b Differential benefits from ICT in school

Even if students spend the same amount of time on computers and do the same tasks, it is possible that they may have a different experience of them. One of the frequently mentioned possibilities of the use of computers is that it could facilitate the use of group or collaborative work. A number of studies have explored the interactions between pupils working in small groups at computers. Many of these studies have reported gender patterns within groups, in the level and type of interaction.

One study reported by Swann[1] recorded the conversations between two children engaged in a collaborative writing activity at a word processor. The recorded

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[1] Ibid.

[2] Joseph Giaquinta and Peggy Lane "Fifty-one Families with Computers: A Study of Children's Academic Uses of MicroComputers at Home", *Educational Technology Research and Development,* Vol. 38 (1990), p35.

conversation reveals the gradual domination of the activity by the boy, in a mixed sex pair. While these two pupils engaged in a discussion and produced a collaborative document, Swann's analysis of the text reveals that the girl (Emma) accepted many more of the boy's (Craig's) suggestions than vice versa. In total 59% of Craig's suggestions were accepted, and 17% not accepted, while 44% of Emma's proposals were accepted and 30% not accepted. Although both made roughly the same number of suggestions, Emma suggested fewer novel ideas and more of her suggestions were adaptations of earlier proposals. Emma also ended more of her suggestions with intonation that sought confirmation, or with direct requests for approval. Craig was more likely to issue his suggestions as directives.[2]

Watson[3] conducted a similar textual analysis with a group of three, two boys and a girl. She reports that while all three were present, the girl (Diana) contributed proposals, but had none of her proposals accepted. This does not mean that she had no influence on the interaction, as she influenced decisions by giving her support, and by reminding the group of the task set by the teacher and of the need for discussion. The role Diana played in the group was highlighted by the change in the interaction when she left the boys for a time. In her absence Watson notes that the boys did not discuss proposals in depth, but simply restated ideas. She suggests that this finding supports earlier work reporting that all-boy groups have lowered levels of "total verbal activity".

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[1] Joan Swann, "Tinker Town: Reading and re-reading Children's Talk Around the Computer", in *Computers and Talk in the Primary Classroom,* ed. by Rupert Wegerif and Peter Scrimshaw (England: Multilingual Matters Ltd, 1997), p133.

[2] Ibid., p142.

[3] Madeline Watson, "The Gender Issue: Is What You See What You Get?", in *Computers and Talk in the Primary Classroom,* ed. by Rupert Wegerif and Peter Scrimshaw, (England: Multilingual Matters Ltd, 1997), p151.

Diskin and Close[1] report a similar study conducted in a primary school in Ireland. In this study pairs of students were observed as they worked through mathematical problems on the popular computer package "Maths Circus". Nine pairs of pupils were observed over a number of sessions with the computer. The types of interaction were recorded using a notation system, and some of the sessions were also recorded on video. As a general pattern it appeared that in the same sex male groups the boys worked together but with little real collaboration. One pair was described as follows:

> *Group 2 Boy/boy: Both boys in this group struggled to assert themselves as leaders. These boys were competitive and worked alone rather than as a team. There was much use of the word "I" but little use of the word "we". They did not seek assistance from each other, but freely gave unsolicited advice and suggestions. They paid little heed to each other's suggestions. One took control of the mouse and tended to dominate the proceedings. The other, however, was not happy with the status quo and consistently tried to re-assert himself. At one point the boys began to ridicule each other's efforts.*

By contrast the tone of the single-sex female groups was friendly and collaborative:

> *Group 8 Girl/girl - These girls were very talkative and chatty. At times the conversation was irrelevant to the task at hand. One girl was more competent than the other, with the latter, at times, less engaged in the task. There was a lot of social interaction. Failed attempts were followed by mock horror and exaggerated disappointment. These interactions involved squeals of delight and disappointment. There was no earnest competition but one girl did engage in mock bravado as she recounted her successes. They requested help from each other and responded verbally.*

In two of the three mixed sex groups the boy took control of the mouse and dominated the partnership. In the third, the girl was described as "bossy" and insisted on taking turns with the mouse. This last pair seemed to behave in the same competitive manner as the boy/boy groups. The more typical mixed groups were described as follows:

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[1] Maria Diskin and Sean Close, "A Study of the Role of Gender in group interaction in a Computer Supported learning Environment" in *Proceedings of the Third European Conference on Integrating Information and Communications Technology in the Curriculum.* Edited by Emily Banville, Maureen Mullery, Aine Ui Eigheartaigh, Tom Kendall and Larry Sheil. (DCU, August 1998).

> *Group 6 Boy/Girl - Again the boy positioned himself at the mouse and positioned it in such as way as to place it beyond the reach of his partner. He tended to give a lot of orders, constantly pointing to the screen, regardless of who was taking a turn. The girl partner behaved in a subservient manner from the beginning, seeking affirmation from the boy, who delivered a series of instructions in a monotone, but not bossy, voice. His dominance was clearly evident, but the girl remained interested throughout the session, although she appeared to have little confidence in her ability, and voiced her apprehensions at regular intervals. The boy did not respond to these declarations but continued to offer advice. She did not offer him advice.*

An analysis of the type of verbal interaction showed that the mixed sex groups had significantly fewer interactions classified as "comments" and the largest proportion of interactions classified as "disagreements". While these classifications present a generalised picture, the researchers concluded that girls were more likely to seek help from boys than vice versa, and that girls were more likely to express doubts about their ability than boys. Girls were more likely to support each other when working together, while boys were more likely to ridicule their partners' efforts.

This tendency for the boy to take control of the mouse in mixed pairs has been documented in other studies, and Barbieri and Light[1] have concluded that access to the mouse plays an important part in domination of group work at a computer.

The Minnesota study[2] offers another perspective on this pattern. In this study groups of 11-13 year old students worked on a Geographical simulation game involving a sailing voyage to collect gold. In some of the groups, the assessment was arranged on a collective basis, so that each person's grade depended on the group performance. In others the students were evaluated against each other. In a third series of groups, the students were evaluated individually. The performance of the students varied with the type of group. Co-operating groups performed better during the exercise and in the post-test.

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[1] M. Barbieri and P. Light. "Interaction, gender and performance on a computer based task". *Learning and Instruction,* Vol. 2 (1992), pp199-213.

[2] R.T. Johnson, D.W. Johnson and M.B. Stanne. "Effects of co-operative, competitive and individualistic goal structures on computer assisted instruction". *Journal of Educational Psychology*, Vol. 77 (1985), pp68-77.

In this study the girls in competitive groups, those where the group members were assessed against each other, did less well than boys. They completed fewer of the tasks and scored lower overall. Furthermore, the girls in competitive groups reported a level of liking for computers lower than that reported by the boys. By contrast girls in collaborative groups, where they were assessed as a group, reported liking computers slightly more than the boys. Similarly at the end of the exercise, the girls in the competitive groups reported liking geography less than their classmates in collaborative groups. Competition seemed to encourage task persistence for boys, and reduce it for girls. Conversely, in collaborative groups the girls were more persistent, and the boys less so.

These findings suggest that the gender impact of computers may depend more on the context in which they are used, and the nature of the task, rather than on computers or on group work per se.

A more recent study by Underwood and Underwood[1] suggests that girls may benefit more than boys from some activities. In this study the researchers organised 62 children aged 8 to work on an "Interactive Talking Book" CD ROM resource. The children were all attending the same primary school in a suburban area in the UK. The children worked in pairs on the story, some in boy/boy pairs, some girl/girl and some boy/girl. They worked through the story on two occasions for a period of 20 minutes on each occasion. A week after the second session, they did a comprehension test. Four weeks after the session they were asked to write a short story about the character in the CD book. These assessment tasks were done individually by the children involved.

In the use of the software, the composition of the pair made little difference. The number of clicks on words and animated characters were similar for each pairing type. In the boy/girl pairs, the boy frequently took control of the mouse, but the progress through the story was similar to that of other pairings.

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[1] Geoffrey Underwood and Jean Underwood, "Children's Interactions and Learning Outcomes with Interactive Talking Books", *Computers and Education,* Vol. 30 (1998), pp95-102.

In the comprehension test a week after the sessions, there was little gender variation. However, there was a significant difference in the level of recall of the talking book when writing the story 4 weeks later. Girls who had worked on the talking book in girl/girl pairings outperformed both girl/boy and boy/boy pairs. This finding is very interesting, in that it suggests that, in this study, the effect was caused not by the gender of the child, but by the composition of the pairing. Given that the tests were all performed by children working individually, the residual effect of the pairing seems to have been quite strong.

Not all studies at classroom level have found gender patterns. In the UK Portable Computers Pilot project, the evaluation found no gender difference in attitude to the portable computer. Girls were just as likely to use their portables for homework, with the exception of Music, and were just as likely to use the features of the computer. The one significant gender difference found was that boys were more likely to use the computer for purposes other than school work, such as playing computer games.[1]

Turkle[2] suggested that boys and girls might have different styles of computer programming. In the early 1980s, in analysing middle-school children learning LOGO, she described two styles of programming. In the first, which she called "hard mastery", sees the computer as a device to be controlled, and the pupil strives to control the computer to make it follow a pre-determined plan. In the second style, which she termed "soft mastery" the pupil and the computer interact in a looser way. The pupil tries something, looks at the result, and then tries something else. These two styles can both result in mastery. These two styles could be characterised as the approach of an engineer and that of an artist. Turkle suggests that the "soft mastery" is more typical of girls, while the "hard mastery" is more typical of boys. This research is now quite dated and patterns may have changed as

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[1] Bob Stradling, David Sims and Jim Jamison. *Portable Computers Pilot Evaluation Report.* (NFER, 1994), p17.

[2] Sherry Turkle. *The Second Self: Computers and the Human Spirit.* (New York: Simon and Schuster, 1984).

the technology evolved. Nevertheless this work provides some evidence to suggest that the gender pattern in computer use may go beyond home access and parent expectations.

3.4c Differences increase with age

In the study by Becker and Sterling[1] in the US, the under-representation of girls in all activities except word processing was noted earlier. In addition their data showed girls as under-represented in word processing until high school level. The COMPED study also reported that the difference in performance between boys and girls was more pronounced at secondary school.[2] This raises the possibility that the gender gap may increase during the years of school attendance. In Australia, Hattie and Fitzgerald[3] reported that girls become less frequent users of IT as they progress through secondary school, and develop negative attitudes towards computers.

Further evidence that the gender differences in attitude to computers develop during the period of formal schooling is provided by the Young Children's Computer Inventory Project (YCCI).[4] This study began in 1990 as an attempt to search for evidence on the impact of computer use on primary school children. The study was conducted in three countries, the USA, Japan and Mexico, and used a series of both quantitative and qualitative measures. It concluded that

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[1] H.J. Becker and C.W. Sterling, "Equity in School Computer Use: National Data and Neglected Considerations", *Journal of Educational Computing Research,* Vol.3 No 3 (1987), p302.

[2] Ingeborg Janssen Reinen and Tjeerd Plomp. "Gender and Computers: Another Area of Inequity in Education?". In *Schools, Teachers, Students and Computers: a Cross National Perspective* ed. by W.J. Pelgrum, I.A.M. Reinen Janssen and Tj. Plomp (Amsterdam: IEA, December 1993).

[3] T. Hattie and D Fitzgerald, "Sex Differences in Attitudes, Achievement and Use of Computers.", Australian Journal of Education,Vol. 31 No.1 (1987), pp3-26.

[4] Betty Collis *et al.*, *Children and Computers in School.* (New Jersey: Lawrence Erlbaum, 1996), p19.

> *gender differences with respect to attitudes towards computers do not generally exist at the first-grade level; they probably do not emerge until after Grade 3*[1]

The study found no gender differences in the children's perception of the importance of computers, or enjoyment of computers at first grade level, and no consistent gender pattern at second and third grade. This contrasts with the "empathy" measure, which showed significant and consistent gender differences at all three grades and in all three countries.[2]

A later study, using the same instruments, showed that the gender pattern was different in fourth and fifth grades, with girls showing higher levels of motivation and persistence than boys.[3] This data led the authors to conclude that the YCCI conclusion of little significant gender difference for grades 1-3, does not conflict with the significant gender differences found at older ages in other studies. They suggest that it is likely that the gender differences emerge as children progress through elementary school.

3.4d Role models

There are some indications suggesting that the perception of computers as a male domain could be unintentionally encouraged by schools. One mechanism for such an effect is the role models of computer use, and computer users, provided by teachers in schools. The COMPED study reported that in most countries the majority of staff teaching IT were male,[4] and suggested that stereotypical sex-

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[1] Ibid.

[2] Ibid., p90.

[3] G. Knezek, M. Lai, and J. Southworth,, "Psychological dispositions of children residing in Hawaii in the context of a multinational study on computing", in G. Knezek ed. *Studies on Children and Computers the 1993-94 Fulbright series*. (Denton: Texas Centre for Educational Technology, 1994), pp 39-60.

[4] Ingeborg Janssen Reinen and Tjeerd Plomp. "Gender and Computers: Another Area of Inequity in Education?". In *Schools, Teachers, Students and Computers: a Cross National Perspective* ed. by W.J. Pelgrum, I.A.M. Reinen Janssen and Tj. Plomp (Amsterdam: IEA, December 1993), p112.

specific roles were a possible factor contributing to the formation of attitudes to technology. Culley[1] noted that the majority of computer-using teachers were also male. Her study, conducted in the UK in the mid '80s, found that 70% of teachers using computers in their teaching were male.

The IEA data suggests that part of this difference may be due to the higher levels of technical confidence reported by male teachers. The 1989 COMPED data reveals that female teachers gave themselves a lower self-rating of computer skill than male teachers, especially in the area of programming.[2]

> *...male teachers have a significantly higher self confidence regarding computers. These findings might be an indication that the type of role model female teachers provide students with is different from the one male teachers provide.*[3]

Although in most countries the majority of computer co-ordinators were male, this imbalance reduced between 1989 and 1992. However even in 1992 female computer co-ordinators were significantly under-represented in most countries and at most levels of education.[4] The table below shows the figures for lower secondary education in a sample of countries.

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[1] Lorraine Culley, "Girls, Boys and Computers", in *Computers and Learning*, ed. by Oliver Boyd-Barrett and Eileen Scanlon. (England: Addison Wesley, 1991), p84.

[2] Reported in Ingeborg Janssen Reinen, and Tjeerd Plomp. "Information Technology and Gender Equality: A Contradiction in Terminis?", *Computers and Education*, Vol. 28 No 2 (1997), p67.

[3] Ingeborg Janssen Reinen and Tjeerd Plomp. "Gender and Computers: Another Area of Inequity in Education?". In *Schools, Teachers, Students and Computers: a Cross National Perspective* ed. by W.J. Pelgrum, I.A.M. Reinen Janssen and Tj. Plomp (Amsterdam: IEA, December 1993), p113.

[4] Ingeborg Janssen Reinen, and Tjeerd Plomp. "Information Technology and Gender Equality: A Contradiction in Terminis?", *Computers and Education*, Vol. 28 No. 2 (1997), p74.

TABLE 3. 8: FEMALE COMPUTER CO-ORDINATORS[1]

Lower Secondary schools	% female IT co-ordinators	% female teachers	Female IT co-ordinators as a percentage of expected number
Austria	13	57	23
Bulgaria	56	76	74
Germany	5	47	11
Greece	2	59	3
Japan	0	37	0
Netherlands	3	31	10
USA	64		Not reported

3.4e Association with Mathematics

Writing in 1993, Burstyn suggested some mechanisms by which IT can become a male activity within a school.

> *Children associate computers with science and mathematics, both subjects appealing more to males than to females. Boys in the United States do better than girls, and are more interested than girls in mathematics and science. Hence if computers are linked in peoples minds with mathematics and science, it follows that boys are more likely to "do better with computers" than girls.*[2]

Culley also reported a frequent strong linkage between computers and mathematics. At the time of the study the majority of teachers of computer studies were also teaching mathematics. In 37% of the schools surveyed, responsibility for computers was assigned to the mathematics department. In addition, the

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[1] Adapted from Ingeborg Janssen Reinen, and Tjeerd Plomp. "Information Technology and Gender Equality: A Contradiction in Terminis?", *Computers and Education*, Vol. 28 No. 2 (1997), pp74-75.

[2] Joan Burstyn, " Who Benefits and Who Suffers? Gender and Education at the Dawn of the Age of information Technology". *Gender and Education*. Edited by Sari Knopp Biklen and Diane Pollard. (Chicago: University of Chicago Press, 1993), p116.

mathematical background and interest of the teachers responsible for computers had an impact on the kind of work done.

> *Computer games and other programmes devised by teachers to demonstrate the capacities of computers were very often based on mathematical concepts, processes and examples. Word games, word processing and graphic design applications were much less commonly used.*[1]

In both cases these works are now dated, and it is possible that the association of computers with mathematics has reduced as other applications have become popular.

3.4f Teacher attitudes

Other possible causative factors are the attitudes and expectations of teachers. Sutton[2] highlighted the importance of teachers' attitudes in determining use in schools, but noted that reported attitudes and behaviours are not always the same, and that studies that examined both were rare, thus making accurate analysis difficult.

Other studies have noted contradictions in teacher attitudes. Knupfer[3] reported popular beliefs among teachers including both the belief that equal access to computers was important, and the belief that better-behaved students should have a better chance of using the computer. However Chen reported that school counsellors and teachers encouraged boys more than girls to take computer classes.[4] Even if not actively discouraging girls, some studies have noted that few

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[1] Lorraine Culley, "Girls, Boys and Computers", in *Computers and Learning*, ed. by Oliver Boyd-Barrett and Eileen Scanlon, (England: Addison Wesley, 1991), p83.

[2] R. Sutton, "Equity and Computers in the Schools: A Decade of Research", *Review of Educational Research* Vol. 61, No 4 (Winter 1991), p482.

[3] N.N. Knupfer, "Teachers beliefs about instructional computing: Implications for instructional designers", *Journal of Instructional Development*, Vol. 11 No. 4 (1988), pp29-38.

[4] M. Chen, "Gender and Computers: The beneficial effects of experience on attitudes", *Journal of Educational Computing Research*, Vol. 2 No 3 (1986), pp265-282.

teachers make positive efforts to encourage girls towards computers. The IEA study noted that very few schools had policies relating to gender and computers.[1]

Culley[2] reported that teachers seemed to make little effort to counteract the tendency of boys to dominate in the computer room. In observations of computer related lessons, it was noted that boys dominated the discussion, asking more questions and making more comments on the lesson contents. Boys also occupied more central positions in the computer room, with girls often seated at the back or the side. Moreover, boys frequently acquired the newest computers, and those with higher specifications and colour monitors.

Culley[3] also noted that teachers made little effort to accommodate girls' interest in computers when devising curricular materials. The emphasis of teaching activities was on programming and mathematical activities, and some teachers had a 'hobby' interest in programming, which ran parallel to that of some of the male pupils. The strength of the gendered expectations is highlighted by the finding that:

> *Boys were not always sufficiently motivated towards written presentation of work, but they were frequently regarded as more interested in computing, and more rewarding to teach than girls. Even when girls did all that was necessary, followed instructions carefully and presented their work well, they were still seen by some teachers as less interested and as having less 'flair' for computing.*

3.4g The impact of schools on the gender gap

There is some evidence that education policies and practices can have an impact on the gender gap. Jannsen Reinen and Plomp suggest some positive indications with relation to the gender question. In two countries, Bulgaria and the USA, the gender gap was narrower than in others. In Bulgaria there was a very high proportion of

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[1] Adapted from Ingeborg Janssen Reinen, and Tjeerd Plomp. "Information Technology and Gender Equality: A Contradiction in Terminis?", *Computers and Education*, Vol. 28 No 2 (1997), p77.

[2] Lorraine Culley, "Girls, Boys and Computers", in *Computers and Learning*, ed. by Oliver Boyd-Barrett and Eileen Scanlon, (England: Addison Wesley, 1991), p84.

[3] Ibid.

female IT co-ordinators, and in the USA there was a high level of home access to computers and parent encouragement for girls. This leads to the suggestion that these two factors might have a positive effect in encouraging girls' participation.[1]

There is some evidence that the gender pattern in use of computers is related to provision of equipment. Two studies reported that when the ratio of computers to students reached 1:1, girls were as likely to use computers as boys[2]. If this proves to be the case, the gender gap may tend to narrow as the level of equipment increases.

However waiting for the gap to narrow may not be enough. Policy makers have already recognised the need for more proactive intervention. The EU Study Group on Education and Training suggests that policy implementation must focus on, among other things, "bringing specific provision to girls and women, in order to equalise their IT access and skills".[3]

There are already examples of interventions which have demonstrated results. Kirkman noted that an IT induction course helped to get girls interested in computers. Following his survey of computer use and attitudes among 12-year-olds in the UK, he concluded that schools could act to reduce the gender gap:

> *.. schools themselves should lead the way in closing the gender gap. This study has shown that girls' enthusiasm and confidence rises with use. Therefore if schools ensure that girls receive a good IT education with adequate time on the computers we could expect great changes in their attitudes and patterns of use. A striking piece of evidence comes from the school in which this study was made. For many years the*

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[1] Ingeborg Janssen Reinen, and Tjeerd Plomp. "Information Technology and Gender Equality: A Contradiction in Terminis?", *Computers and Education*, Vol. 28 No 2 (1997), p77.

[2] R. Anderson, "Females surpass males in computer problem solving: Findings from the Minnesota Computer Literacy Assessment", *Journal of Educational Computing*, Vol. 3 No 1 (1987), pp39-51. And D. Ayersman, "Effects of computer instruction, learning style, gender and experience", *Computers in the Schools*, Vol. 12 No. 4 (1996), pp15-30.

[3] EU Study Group on Education and *Training Accomplishing Europe Through Education and Training*. Published on the Web at: europa.eu.int/comm.dg22/reflex/en/res-en.html

> *number of girls opting to take IT as a GCSE subject was less than 10%. This year was the first year when students who were opting to take GCSE IT had been through an IT induction course in their first year of secondary schooling. This year almost 40% of students who opted to take IT were girls.*[1]

Kirkpatrick and Cuban point out that the discrepancy between girls and boys increases through their years in school, and argue that "the early grades could be the target of attempts to remedy the later substantial inequalities".[2] They suggest, however, that the policy makers are not sufficiently concerned to invest the resources that such a strategy would require. They argue that, given the implications of ICT as a tool for social development, this is an issue of importance:

> *In an economic system where competition is prized, in a society where individual merit is highly esteemed and schooling is viewed as a consumer good that is necessary to raise one's social status, more must be done to ensure that half of the population has the chance to wield the powerful tools that computers literally put at their fingertips.*[3]

Strack, writing for UK schools preparing ICT strategies, suggests that schools should monitor equal opportunities by recording the access of each child to ICT, and to record the applications available to each child. He argues that

> *Most parents would expect their child, female or male, to have the same access to IT equipment as other children in the class and would expect someone in the school to have an overview of this.*[4]

To meet the expectation of a gender-fair school environment, he suggests scrutinising software for gender stereotypes, and a careful planning of the role

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[1] C. Kirkman, "Computer experience and attitudes of 12-year-old students: implications for the UK National Curriculum". *Journal of Computer Assisted Learning* Vol. 9, (1993), p61.

[2] Heather Kirkpatrick, and Larry Cuban, "Should We be Worried: What the Research Says About Gender Differences in Access, Use, Attitudes and Achievement with Computers", *Educational Technology*, (July-August 1998), p58.

[3] Ibid.

[4] Geoff Strack, "Curriculum Constraints and Opportunities", in *Developing a Whole School IT Policy*, ed. by Bill Tagg, (London: Pitman Publishing, 1995), p23.

models provided by the school, both in the selection and training of the staff who deliver IT, both teaching and ancillary staff.[1]

Other possible strategies could focus on the different kinds of computer use favoured by boys and girls. The Cyberkids report stressed the differences in type of use, and suggested the use of e-mail and other communication activities, as providing an attractive entry to computer use for girls.[2] Similar suggestions can be derived from Turkle's[3] suggestion that boys and girls might have different styles of computer programming. McGrath suggests strategies which could hook girls into programming, including;

- the early introduction of graphics,
- an emphasis on words and music as well as numbers,
- a context in which students need to know a command or concept
- acceptance of bottom up as well as top down programming styles, and
- encouragement of collaboration in projects.[4]

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[1] Ibid., p24.

[2] Gill Valentine, Sarah Holloway and Nick Bingham, "Children's social networks, Virtual Communities and On-line Spaces". Report of the Cyberkids research project, published on-line (1999) at www.shef.ac.uk/~g/staff/valentine_gill/about.htm

[3] Sherry Turkle. *The Second Self: Computers and the Human Spirit.* (New York: Simon and Schuster, 1984).

[4] Diane McGrath, "Eight Ways to Get Beginners Involved in programming", *Women and Computers* Vol. 2 No. 1 (January 1990), pp5-7.

3.4h Awareness of the gender issue

Despite the weight of research evidence, it seems that the importance of gender in IT is not widely recognised at school level. The IEA study reported that very few schools had policies relating to gender and computers.[1] Drury[2] reported a similar lack of awareness in Irish schools. In surveying a sample of Irish post-primary schools he sought views on many aspects of IT including gender. 254 schools were sampled and 67 responded. The study reported that the majority of computer co-ordinators felt that there was little difference between boys and girls in reaction to computers, and that gender was not an important factor in IT.

TABLE 3. 9: IT CO-ORDINATORS REACTIONS TO GENDER ISSUES[3]

Computer co-ordinators views.	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
There is little difference in the way boys and girls react to the use of computers	24%	28%	30%	16%	1%
Gender is an important factor in IT in education	6%	7%	25%	37%	24%

In summary it seems that there are demonstrable benefits from particular interventions, such as ensuring sufficient equipment to encourage equal access and organising "headstart" courses to bring girls to the skill levels that the boys may get from home. It is possible that a deliberate attempt by schools to encourage girls' participation, combined with modelling of this by female teaching staff, could have an impact.

There is also the potential for a much more profound change in kind of use of computers in schools, to make the area more aligned with the preferences of girls. Such changes might include more use of e-mail and communication, avoidance of

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[1] Adapted from Ingeborg Janssen Reinen, and Tjeerd Plomp. "Information Technology and Gender Equality: A Contradiction in Terminis?", *Computers and Education*, Vol. 28 No. 2 (1997), p77.

[2] Cyril Drury. *Implementing Change in Education.* Unpublished MSc Theses, University of Leicester 1995.

[3] Ibid.

gender biased games and competitive software, and a focus on collaborative activities. This approach could even be extended into the teaching of programming using collaborative groups and Turkle's "soft mastery" strategies. Unfortunately there are indications that there is little positive action of this type in schools, and little awareness of the gender issues regarding ICT.

3.5 Conclusion

The research described above suggests that there is a significant gender gap, with boys outperforming girls in ICT skills, and also displaying greater interest in computers. This gap is apparent in numerous studies, and while it does not appear in every country and at every level, there are very few recorded instances where girls outperform boys. The size of the gender gap is also varied. Analysis of multiple studies shows a mixed response, with some studies reporting no significant difference, and others showing an advantage for boys.

Evidence from the home indicates that boys are more likely to have a computer at home, and where there are multiple siblings, the computer is more likely to have been bought for a boy, or located in a boy's room. Boys in general spend longer working at the home computer, and perform a wider range of activities on it. The boys and girls seem to like different activities on the computer, with girls being attracted more by the communication potential (word processing, publishing and e-mail) and boys more by the games, activities and technical challenges. More recently there are suggestions that the Internet may be particularly attractive to girls.

Because of the differences in access and expectations, boys may begin school with more skill and confidence with ICT than girls. However, there is evidence that the gender gap increases through the period of schooling in many countries. This does not necessarily indicate that schools are enhancing the gender gap, as this is a period where out-of-school socialisation also take place. However there are some indications of gender differentiated experiences of ICT at school.

Within mixed schools some studies have shown boys receiving more access to the computers, both within scheduled hours and outside school times. Boys are also likely to make use of a broader range of computer applications at school. Even within small group activities and collaborative work, boys are likely to dominate and to take control of the computer. Gendered expectations about computers develop, and by the end of formal schooling in many countries, girls perceive that boys are more likely to get a job working with computers than they are.

Other studies have indicated that deliberate actions by schools aimed at ensuring girls' engagement with ICT have had some success. Possible actions have included additional access to ICT for girls, headstart courses, and deliberately choosing the types of ICT applications which may attract girls. However despite the success of such approaches, few schools appear to have adopted such strategies.

The lack of "positive discrimination" measures in favour of girls may stem from how equality is understood. Sutton[1] has suggested that much of the practice in schools is based on an equality model, which values equal access to ICT, rather than on an equity model, which would value social justice and therefore require unequal access. Lynch argues that much of the discussion about gender in education derives from what she terms the liberal paradigm. In this thinking, a high value is placed on individual freedoms, even at the cost of equality of outcomes. Much research derived from this paradigm has focused on equality of provision, or the opportunity of take up, rather than participation or outcomes. However, Lynch agues that there is a need for a model which goes beyond outcomes, and recognises the differences and cultures associated with gender[2].

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[1] R. Sutton, "Equity and Computers in the Schools: A Decade of Research", *Review of Educational Research* Vol. 61, No 4 (Winter 1991), p477.

[2] Kathleen Lynch, *Equality in Education*, (Dublin: Gill and Macmillan, 1999), pp135-137.

CHAPTER 4

LITERATURE RELATED TO THE ADOPTION OF ICT IN SCHOOLS

The adoption of technology in schools has often been seen as a matter of the amount of equipment available. Across a range of technological innovations, teachers and school principals frequently cited lack of equipment as the main barrier to greater use of technology.[1] The 1989 survey by the International Association for the Evaluation of Educational Achievement (IEA) also reported that lack of technical infrastructure was consistently reported as the most important barrier to the use of computers in schools.[2]

However it is clear that equipment is not the only barrier. Cuban points out that even when equipment was available in schools it was not always used.[3] The IEA study found that, despite expectations, the importance given to the problem of lack of equipment did not decline as equipment levels increased.[4] In the US the National Center for Educational Statistics (NCES) reported that only half of the US public school teachers who had computers or the Internet available in their schools used them in classroom teaching.[5] Similarly only 30% of teachers in California and the UK reckoned to make use of ICT in their teaching in spite of the increasing

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[1] Larry Cuban, *Teachers and Machines. The Classroom Use of Technology Since 1920,* (New York: Teachers College Press, 1986), p25.

[2] Dan Davis, "Implementation and Educational Uses of Computers", in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems*, (Oxford: Pergamon Press, 1993), p113.

[3] Larry Cuban, *Teachers and Machines. The Classroom Use of Technology Since 1920,* (New York: Teachers College Press, 1986), p51.

[4] Dan Davis, "Implementation and Educational Uses of Computers", in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems*, (Oxford: Pergamon Press, 1993), p113.

[5] National Center for Educational Statistics, *Teachers' Tools for the 21st Century: A report on teachers' use of technology, (2000).*

availability of resources.[1] These findings underline the complexity of the adoption of technological innovation in schools and point to the need to investigate further the factors related to adoption.

This chapter considers some of the literature concerning how innovations are adopted, both in schools and in society in general. Section 4.1 outlines some of the main features of conventional diffusion theory and considers some of the writings that suggest that innovation within schools may be more complex and differ from the conventional model.

Following this, section 4.2 examines the existing patterns of adoption of ICT in schools. It considers the importance of factors such as teacher age, home computer access, parent expectations and the location of computers within the school on the use of ICT. This is followed by an examination of the strategies that have been used by governments to encourage use of ICT in schools (section 4.3). However, the use of such strategies may run counter to the aim of ensuring equality of access to ICT. Section 4.4 considers the equality implications of the patterns of adoption and the strategies used to encourage adoption.

Some studies have attempted to measure the factors associated with adoption of ICT, thus allowing an assessment of their relative importance. These studies are considered in section 4.5. Section 4.6 considers the linkage between ICT and pedagogy. It examines the possibility that ICT in schools might be associated with an increased emphasis on constructivist or "emergent" practices in education. Together these issues provide a framework for the analysis of adoption of ICT in Irish schools in Chapter 9.

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[1] OECD/CERI, *ICT and the Quality of Learning.* Educational Multimedia Software Quality Group. Meeting of Experts, 15-16 April 1999.

4.1 Innovation

The adoption of ICT in schools can be seen as an innovation and may be hypothesised to follow the patterns associated with adoption of innovations. Rogers points out that:

> *Not all individuals in a social system adopt an innovation at the same time. Rather, they adopt in a time sequence, and they may be classified into adopter categories on the basis of when they first began using a new idea.*[1]

Research into adoption patterns has generally shown that the adoption of an innovation follows a normal distribution. Thus if the number of new adopters at any one time is plotted against time, the result is a bell-curve pattern. If cumulative numbers of adopters are plotted against time the result is an S-shaped curve.[2] Such a pattern would result from a diffusion effect, where each adopter influences a number of other contacts, but the number of contacts not already convinced declines over time as the innovation becomes widely adopted. However this simple model is rarely replicated in reality, as other factors such as unequal access to information or resources distort the pattern.[3]

Rogers proposes an idealised model of the diffusion process, where the normal distribution pattern is followed. In this model different types of adopters are distinguished by their position on the normal curve. Rogers suggests five general types, as follows:[4]

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[1] Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), p241.

[2] Ibid., p243.

[3] Ibid., p245.

[4] Simplified from Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), pp247-250.

TABLE 4. 1: ROGERS' MODEL OF ADOPTION OF INNOVATION.

Type of adopter.	Position on time curve	% of total population	Characteristics
Innovators	Mean - 2 SD	2.5%	Venturesome, eager to try new ideas. Happy to take risks. Not always respected in the community.
Early adopters	Mean - 1SD	13.5%	Respectable, opinion formers, the "people to check in with" before using an idea.
Early majority	Earlier than mean	34%	Deliberate. Follow with a deliberate willingness, but seldom lead.
Late majority	Later than mean	34%	Sceptical and cautious.
Laggards	Mean + 1 SD	16%	Traditional. Possess almost no opinion leadership, suspicious of change and change agents.

There has been particular research interest in the area of the diffusion curve after about 10% adoption, when the innovation "takes off". Rogers suggests that "after that point, it is probably impossible to stop the further diffusion of a new idea, even if one wishes to do so."[1]

Early innovation models viewed the diffusion process as a delivery system, seeing the media as delivering information to the people. Such models were challenged by research such as that on the 1940 US presidential election, which indicated that almost none of the voters had been influenced by the mass media.[2] Later models modelled diffusion as a two-stage process, with the media and central agencies having an influence on opinion leaders, who later influenced their peers.[3] Rogers points out that the two step model focuses attention on the communication between the adopters and others in the community.

Patterns of uptake of innovations may result from diffusion of innovations through interpersonal communication. "A fundamental principle of human communication is that the transfer of ideas occurs most frequently between individuals who are alike, or homophilous".[4] Such homophilous communication can act as a barrier to

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[1] Everett Rogers, *Diffusion of Innovations*, Third Edition, (New York: The Free Press, 1983), p245.

[2] Lazarfeld *et al.* 1944, cited in Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), p272.

[3] Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), p272.

[4] Ibid., p274.

the innovation, which may be confined to specific groups and may not "trickle down" to the entire population. Homophilous communication therefore tends to slow down the rate of diffusion.[1] In this context important agents of diffusion are the "weak ties" of casual meetings or contacts. People are likely to share many of the values and opinions of their circle of close contacts, and may have little new information to share. However the weaker links to people outside the immediate group may have an important impact in conveying new information. Granovetter has called this effect "the strength of weak ties".[2]

The pattern of homophilous communication is superimposed on a pattern of local communication. Rogers summarises these two factors as a single principle thus: "Individuals tend to be linked to others who are close to them in physical distance and who are relatively homophilous in social characteristics".[3]

Social learning theory suggests that diffusion of an idea can occur without direct contact of conversation between individuals. Bandura suggests that individuals can learn from one another by "observational modelling".[4]

Diffusion theorists also recognise that the individual does not necessarily mimic the model exactly. Instead the adopter may select parts of the innovation or generalise the information, thus modifying or "re-inventing" the innovation.[5]

4.1a Innovation in schools

Making real changes in the process of education is not an easy task. It is recognised that it is a slow process and that there are real and deep-rooted barriers to change. These barriers have been characterised as the "grammar of schools", and include

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[1] Ibid., p276.

[2] Mark S Granovetter, "The Strength of Weak Ties", *American Journal of Sociology*, Vol. 83 (1973), pp1420-1443, cited in Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), p272.

[3] Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), p299.

[4] Albert Bandura, *Social Learning Theory*, Prentice Hall 1977, cited in Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), p304.

[5] Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), p306.

structures, attitudes and values in schools that prevent educational change. Components of the "grammar of schools" include the linear structure of curriculum, and the separation of subjects. These features are larger than any individual teacher's approach, but do much to determine what happens in classrooms.[1]

The complexity of introducing an innovation such as ICT into schools has long been recognised. When designing the 1989 IEA study in the mid 1980s, the researchers acknowledged that many obstacles needed to be overcome before successful implementation could occur, and noted that although the numbers of computers in schools had increased considerably in previous years the numbers of teachers making use of them was low and there was poor integration into the curriculum.[2]

Although difficult, it is well recognised that the diffusion of ICT into schools has been rapid, and that at least computer access in schools is a rapidly changing phenomenon.[3] Indeed the IEA study noted that, given the complexity and cost of the innovation, the speed of investment in computers could be considered remarkable:

> *... in spite of the complexity of this innovation, educational practitioners and students are still very enthusiastic about this new technology. Although many school administrators and teachers feel they are overburdened due to budget cuts, it is remarkable that they are willing to invest additional time to get acquainted with this new technology or as one teacher worded it "It costs so much time. If students were not so enthusiastic we already would have given up*[4]

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[1] David Tyack and Larry Cuban, *Tinkering Towards Utopia: A Century of Public School Reform*, (Cambridge: Harvard University Press, 1995).

[2] I.A.M. Janssen Reinen and Tjeerd Plomp, "The Decision Phase: Starting to Use Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems*, (Oxford: Pergamon Press, 1993), p4.

[3] W. J.Pelgrum. "Hardware and Software Provision in relation to the Integrated Use of Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems*, (Oxford: Pergamon Press, 1993), p44.

[4] W. J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems*, (Oxford: Pergamon Press, 1993), p235.

Others have been less optimistic about the progress of ICT in schools. In 1993, Larry Cuban suggested that in the US, despite a decade of computers in schools the overall picture remained that of "an expanding but marginal activity in schools".[1]

The OECD has also recognised the complexity of the implementation of ICT in education describing it is as "a classic chicken and egg problem". The infrastructure must be in place for the innovation to work. However having the technology infrastructure in place without adequate content/software and training generates disappointment and discourages many teachers and learners. But it is difficult to generate the content/software in the absence of a ready market, and difficult to provide effective teacher training without existing material and infrastructure.[2]

Cuban argues that the complexity is more fundamental than simply the timing of technology and training. He argues that there are fundamental reasons within schools as institutions that make them qualitatively different from business, industries, and other organisations.[3]

Rogers' innovation theory also recognises that different types of systems may have different susceptibilities to change. He distinguishes three states of change in which a system can exist. Stable equilibrium exists when there is almost no change. Dynamic equilibrium exists when the rate of change is matched by the ability of the system to cope with change, and disequilibrium arises when the rate of change is two rapid for the system and has painful and inefficient consequences.[4]

Cuban's view that schools are in a more stable equilibrium than other systems derives from his analysis of a series of technological innovations and their impact on schools ranging from the early attempts to use radio and television in

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[1] Larry Cuban, "Computers Meet Classroom: Classroom Wins" *Teachers' College Record,* Vol. 95 No. 2, TCR ID 82 (1993), p2.

[2] OECD, *E-Learning, The Partnership Challenge*, (Paris: OECD, 2001), p25.

[3] Larry Cuban, "Computers Meet Classroom: Classroom Wins" Teachers' College Record, Vol. 95 No. 2, TCR ID 82 (1993), p1.

[4] Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), p391.

classrooms, to the use of microcomputers in schools in the 1980s.[1] He suggests that one of the consistent patterns in a series of technological innovations is that the use of the technology by teachers was lower than expected. For example three studies between 1970 and 1981 found that teachers in states that used educational television made use of the service for between 2 and 4 percent of instructional time. This means that students spent more time going and coming from the bathroom than watching televised lessons.[2] Educational radio received similarly disappointing reports, with one author concluding that radio was used regularly in only one classroom in twenty.[3] There were also geographical patterns to the adoption of the technology. In 1940-41 a study in Ohio found that the American School of the Air was used regularly in 18% of urban schools but only 3% of rural schools.[4] As a result, Cuban argues that technology in education has often been a tiny niche area, used mainly by a small band of enthusiastic teachers.[5]

Cuban's view is that those disappointed with the pace of adoption of ICT in schools have often taken simplistic views and ignored the complexities of the classroom. He suggests a series of issues that act as barriers to the use of a technology in the classroom, even when it is available in the school. Firstly, he suggests, having equipment in the school does not necessarily mean that appropriate hardware and software (e.g. radio and TV programmes) are accessible to the teacher.[6] Secondly the pattern of top-down implementation of an educational technology does not

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[1] Larry Cuban, *Teachers and Machines. The Classroom Use of Technology Since 1920,* (New York: Teachers College Press, 1986).

[2] Ibid., p39.

[3] William Levenson, *Teaching Through Radio.* Farrar and Reinhart 1945, p181. Quoted in Larry Cuban, *Teachers and Machines. The Classroom Use of Technology Since 1920,* (New York: Teachers College Press, 1986), p24.

[4] Norman Woelfel and Keith Tyler, *Radio and the School,* World Book Co 1945, pp60-61. Quoted in Larry Cuban, *Teachers and Machines. The Classroom Use of Technology Since 1920,* (New York: Teachers College Press, 1986), p23.

[5] Larry Cuban, *Teachers and Machines. The Classroom Use of Technology Since 1920,* (New York: Teachers College Press, 1986), p49.

[6] Ibid., p53.

always take into account the practical realities of the classroom, and may result in a token compliance.[1] Thirdly he agues that the "setting" of the classroom shapes the behaviour of the teachers with regard to technology.

Teachers, he argues, are faced with multiple and sometimes conflicting demands and are expected to "maintain control, teach a prescribed content, capture student interest in that content, match levels of instruction to differences among students and show tangible evidence that students have performed satisfactorily".[2] In this context, teachers have developed simple and efficient strategies, such as class routines for students, speaking only when allowed by the teacher and raising hands to seek permission to speak. These, he suggests are the visible evidence that teachers have evolved a "vocabulary to match the grammar of the classroom".[3] The technologies that teachers have adopted, such as the blackboard, are simple, flexible, and responsive to changed needs during the class. By contrast, technologies that require a rigid class structure planned from the start, such as television, film and radio, have had disappointing results.[4] Teachers have also, he argues, tended to adopt technologies that have reinforced their authority and not those that undermine it.[5]

In addition, Cuban argues that the nature of the teaching profession is conservative, because all those entering the profession have experienced years of the socialising effect of school, because the selection systems tend to select those who affirm rather than challenge the role of schools.[6] Student teachers learn the practice of their craft in an environment dominated by older teachers often with traditional values. More significantly, teachers' thinking values the general progression of a child more than knowledge of specific items, and therefore view technologies with a different lens from that used by researchers using objective tests. In addition,

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[1] Ibid., p55.

[2] Ibid., p57.

[3] Ibid., p58.

[4] Ibid., p58.

[5] Ibid., p65.

[6] Ibid., p58.

many teachers may view television and video as "filler" material, and a teacher using the media heavily may be under suspicion from colleagues.[1]

Cuban sees real educational reform as something much deeper than the introduction of a technology, and notes that the history of reform in schools records "that none were dependent on instructional technologies beyond teacher, blackboard, textbook and pen and paper".[2]

4.2 Factors related to adoption of ICT in schools

The research cited above has presented two possibilities. Firstly, Rogers and other writers on innovation have suggested general models of innovation that may be found in many different contexts. Secondly, other writers have suggested that schools are more complex and change resistant than other environments and so may not necessarily follow these patterns. This section is concerned with the question of whether the adoption of ICT in schools has been seen to follow the general pattern of adoption reported for other innovations. It begins with an examination of the characteristics of the "early adopters" of conventional innovations. These are then compared with the emerging evidence of adoption of ICT in schools.

The general research on adoption of innovations indicates that certain social, economic, personality and behaviour traits are associated with the innovators. In general the earlier adopters have more education and higher social status than later adopters, but there is no conclusive pattern with regard to age. In economic terms the earlier adopters are more wealthy and are likely to have larger units (e.g. larger farms), a more commercial (as opposed to subsistence) outlook, a more favourable attitude to credit and more specialised operations.[3]

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[1] Ibid., p61.

[2] Larry Cuban, "Computers Meet Classroom: Classroom Wins" Teachers' College Record, Vol. 95 No. 2, TCR ID 82 (1993), p3.

[3] Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), pp251-2.

This association of more wealthy people with early adoption may be partly explained by the risks involved in early adoption. These mean that early adopters must be wealthy enough to take the losses if the decision proves unwise. However there are clearly also other factors, as not all of the wealthy are the early adopters.[1] There is even some debate about the linearity of the relationship between wealth and innovation. An alternative model suggests that the wealth pattern is valid for the extremes, but that low-middle people are more likely to innovate than high middle, because they have more to gain and less to lose.[2]

There may also be personality traits associated with early adopters. Rogers concludes that early adopters probably have greater empathy, in the sense of being able to project himself/herself into other roles. They may also be less dogmatic, have a more favourable attitude towards change, and be less fatalistic. Early adopters are better able to deal with uncertainty, and have a greater ability to deal with abstractions. They also tend to have higher motivation and higher aspirations.[3]

The early adopters are also more highly "connected" than later adopters. They are likely to have more social participation, have greater exposure to mass media, and to seek information more actively than others.[4]

4.2a Teacher age

Rogers points out that the research on innovation in general has demonstrated no conclusive pattern with regard to age of innovators.[5] However some writers have associated innovation in schools with younger teachers, particularly when the innovations concern technology. Sikes argues that older teachers will have developed methods that they have found to work, and therefore may be more reluctant to change. This may be particularly true for technological innovations, where some may doubt their ability to learn about the technology and appear afraid

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[1] Ibid., p 254.

[2] Ibid., p255.

[3] Ibid., p258.

[4] Ibid., p259.

[5] Ibid., pp251-2.

of it.[1] There is some evidence to support this view. In the US, the NCES reported that teachers with the fewest years of experience were more likely to use ICT both in lesson preparation and creating instructional materials.[2]

It is possible that the age pattern that develops may be a temporary one, as ICT becomes an accepted part of the school, and is gradually adopted by all. For example in Norway officials believe that:

> *Initial differences between genders, age groups and subjects are disappearing. 'Young men' were the first ones to embark on the ICT vessel. Now female teachers are as eager as their male colleagues, and teachers at all ages are taking part - perhaps with a slight absence of those 'above 60'. Teachers from all subjects are gradually more involved as technology and bandwidths become more user friendly, making the offers more attractive to arts, music, language and sports teachers.*[3]

However there is also some evidence to suggest that while young teachers may be familiar with the technology, they may not be willing to experiment with it in their teaching. Becker found that although young teachers were more likely to have Internet skills, they were less likely to use the Internet in the classroom. Teachers with less than 4 years of teaching experience were less likely than other teachers to use the Internet with their students.[4] In Ireland a 1995 study of a sample of Irish post-primary schools declared that the "typical computer co-ordinator" was "a 40 year old male mathematics teacher".[5]

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[1] Patricia Sikes, "Imposed Change and the Experienced Teacher" in Fullan, Michael and Hargreaves, Andy, eds. *Teacher Development and Educational Change,* (New York: Falmer Press 1992), p47.

[2] National Center for Educational Statistics, *Teachers' Tools for the 21st Century: A report on teachers' use of technology, (2000).*

[3] Submission of the Norwegian Government to the OECD expert group on ICT and the Quality of Learning, 2000. Unpublished.

[4] Henry. J. Becker, *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use,* Teaching, Learning and Computing: 1998 National Survey Report #1. Center for Research on Information Technology and Organizations (February 1999), p16.

[5] Cyril Drury, *Implementing Change in Education: The Integration of Information Technology into Irish post-primary schools,* (Unpublished MSc Thesis, University of Leicester, 1995), Chapter 6.

Huberman, in a study of 160 second-level teachers in Switzerland in the 1980s suggests a model of teacher life cycle that may explain this pattern. The study found that for many young teachers the process of beginning teaching could be characterised in three phases:

- Painful beginnings.
- Stabilisation.
- Experimentation.

In the first of these phases many (but not all) teachers reported being overwhelmed, vacillating between different strategies, and being exhausted. Their position later stabilised, the teachers consolidated their repertoire and felt integrated into a peer group. This phase gave way to a period of experimentation, both within and outside the classroom, as teachers tried to improve educational outcomes.[1] This model suggests that even if the younger teachers had greater technical skill, the classroom innovation may occur most frequently in the classes of the mid-career teachers.

4.2b Teacher level of education

Early adopters and innovators are often more highly educated than average.[2] Similarly there is some indication that more highly educated teachers are more likely to adopt ICT. Becker has examined the relationship between teachers' own educational backgrounds and their use of and attitudes to the Internet. Four different measures of teacher educational background were used; the teachers undergraduate grade point average, the entry requirements of the teacher-education college attended, the degrees obtained beyond a BA, and the number of courses outside education since college. Using a composite of all of these, the teachers with lower scores, suggesting relatively limited educational experiences, were less

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[1] Michael Huberman, "Teacher Development and Instructional Mastery", in Hargreaves, Andy and Fullan Michael eds. *Understanding Teacher Development,* (New York: Teachers College Press, 1992), p129.

[2] Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), pp251-252.

convinced of the need for the Internet in the classroom, and less likely to use the Internet than the teachers with the higher scores. When these four indicators were analysed separately, advanced degrees and coursework beyond the BA were the most related to the teacher's view of the value of the Internet for classroom teaching.[1]

There may also be differences in the type of teacher. ICT may appeal more to teachers of particular subjects or to teachers of one gender. For example one study in Ireland in 1995 recorded that over two thirds of the co-ordinators were male, and most were from a mathematics/ science background. Only 13% taught humanities subjects.[2]

4.2c Teachers home access to computers/Internet

In the 1998 US TLC survey, Becker reported that in terms of teachers' professional use of the Internet, having a modem at home was almost as important as having Internet access in the classroom. The study found that teachers with a home modem but working in a school without Internet connectivity had an average Internet usage score that was twice that of teacher without a home modem but working in a school with Internet access. Further, teachers with home Internet access had stronger beliefs about the need for Internet in their teaching.[3]

In line with this finding, national policies in some countries have provided teachers with assistance to acquire a home computer. In Sweden every teacher who takes part in the national in-service training programme ITiS, receives a computer.[4] In the

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[1] Henry. J. Becker, *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use,* Teaching, Learning and Computing: 1998 National Survey Report #1, Center for Research on Information Technology and Organizations (February 1999), p17-18.

[2] Cyril Drury, *Implementing Change in Education: The Integration of Information Technology into Irish post-primary schools,* (Unpublished MSc Thesis, University of Leicester, 1995), Chapter 6.

[3]Henry. J. Becker. *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use,* Teaching, Learning and Computing: 1998 National Survey Report #1, Center for Research on Information Technology and Organizations (February 1999), p11.

[4] Submission of the Swedish Government to the OECD expert group on ICT and the Quality of Learning, 2000. Unpublished. Section 2.5.

Netherlands teachers who buy a computer get a reduction on their income tax.[1] In the UK a £20m Computers for Teachers discount scheme, the first phase of which took place between January - April 2000, provided eligible teachers who completed or registered for New Opportunities Fund (NOF) training with the opportunity to claim back half the cost of a personal computer system (up to a maximum refund of £500).[2]

4.2d The role of school principals

In the 1989 IEA study, the researchers asked schools to identify the most important people in initiating the implementation of computers in schools. At both elementary and secondary levels, the school authorities or principals were identified most frequently as the most important initiators.[3]

The influence of the principal on adoption was equally strong for late adopters. Hypothesising that early adopters might have experienced more influence from within, and late adopters more from external pressures such as national policy, the researchers examined the relationship between the number of years the school had been using computers and the main initiator, but found no significant correlation between these variables.[4]

Fullan also highlights the critical role of school leaders in implementation of school innovations. He argues that while principals do not necessarily need to have a high level of technical skill, they need to be "knowledgeable about innovation goals" in order to understand the needs of teachers during the implementation.[5] In some schools, teachers "felt more secure trying out new ideas" if there was active support

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[1] Submission of the Netherlands Government to the OECD expert group on ICT and the Quality of Learning, 2000. Unpublished. Section 2.5.

[2] Submission of the UK Government to the OECD expert group on ICT and the Quality of Learning, 2000. Unpublished. Section 2.5.

[3] I.A.M. Janssen Reinen and Tjeerd Plomp, "The Decision Phase: Starting to Use Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p36.

[4] Ibid., p36.

[5] Michael Fullan, *Successful School improvement* (Buckingham: Open University Press, 1992), p49.

from the principal.[1] Similarly Pelgrum found that principals with a positive attitude towards computers tend to stimulate the use of computers in their schools.[2]

Scrimshaw suggests that a school's ability to use ICT successfully depends on both the stability of the technology and the management and capability of the school. He argues that

> *Very well managed and experienced schools and colleges can make something of underdeveloped or unreliable technology, even without much project support. Fairly poorly placed schools can promote learning with good technologies and timely and appropriate support through the project infrastructure, but similar schools may well fail to do so under less promising conditions.*[3]

There is also considerable evidence for the importance of the principal in influencing the pedagogy in the school. At least 65 studies between 1975 and 1988 provided evidence of the principal's role in instructional leadership.[4]

Despite the importance of the principals' vision in guiding the innovation, Fullan noted that principals are often "less enthusiastic and prepared than many regular classroom teachers".[5] In Ireland in1995 Drury reported that few post-primary principals had significant formal IT training, and that many made little use of IT.[6]

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[1] Ibid., p50.

[2] W.J.Pelgrum 'Attitudes of school principals and teachers towards computers: does it matter what they think?', *Studies in Educational Evaluation*, Vol. 19 No. 2 (1993), pp101-127.

[3] Peter Scrimshaw, *Preparing for the Information Age. Synoptic Report of the Education Departments' Superhighways Initiative,* (Department for Education and Employment, 1997), Paragraph 216.

[4] Kenneth Leithwood, "The Principal's Role in Teacher development" in Fullan, Michael and Hargreaves, Andy, eds. *Teacher Development and Educational Change,* (New York: Falmer Press 1992), p86.

[5] Michael Fullan, *Successful School improvement* (Buckingham: Open University Press, 1992), p50.

[6] Cyril Drury, *Implementing Change in Education: The Integration of Information Technology into Irish post-primary schools,* (Unpublished MSc Thesis, University of Leicester, 1995), Chapter 6.

4.2e ICT Co-ordinators

Within the school structure adoption of ICT may be facilitated by an ICT co-ordinator acting as a change agent and as a support to other teachers. In the UK in 1998 almost all schools (94% of primary schools and 96% of secondary schools) had an ICT co-ordinator.[1] However lack of time for the ICT co-ordinator to devote to the task is a potential barrier. As Drury puts it "it is obvious that the agent of change must have sufficient time if an innovation is to succeed".[2]

In addition the co-ordinator may not be well equipped for the role. Co-ordinators selected on the basis of their interest in computers may not have the skills or vision to act as a change agent. As the technology develops the skills demanded from the co-ordinator will also change. Scrimshaw suggests that:

> *Establishing, managing and exploiting an evolving network of external relationships with business people, with senior staff in local schools and colleges, and with schools across the world will be very different from managing face-to-face relationships within a familiar institution.*[3]

4.2f Teacher beliefs

Another key element in the process of adoption of ICT is likely to be the beliefs of the principals and teachers in the schools. In the 1989 IEA study school principals were asked to indicate their reasons for starting to use computers by selecting items from a list of options. The most frequently identified reason at both elementary and secondary level was "giving students experience for the future".[4] This widespread belief that the reasons for adoption of computers was learning about computers, as

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[1] Department for Education and Employment, *Survey of Information and Communications Technology in Schools 1998*, Statistical Bulletin Number 11/98, November 1998. Paragraph 45.

[2] Cyril Drury, *Implementing Change in Education: The Integration of Information Technology into Irish post-primary schools,* (Unpublished MSc Thesis, University of Leicester, 1995), Chapter 7.

[3] Peter Scrimshaw, *Preparing for the Information Age. Synoptic Report of the Education Departments' Superhighways Initiative,* (Department for Education and Employment, 1997), Paragraph 163.

[4] I.A.M. Janssen Reinen and Tjeerd Plomp, "The Decision Phase: Starting to Use Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems*, (Oxford: Pergamon Press, 1993), p22.

opposed to using computers to support learning, may have done much to shape the way computers were brought into schools.

Teacher beliefs may also determine access to technology. Love and McVeigh reported that some teachers felt that the Internet was inappropriate for use with children below third grade, on the basis that their reading skills would not be sufficient.[1]

Given the relative privacy of the classroom, the actual use to which ICT is put may depend on teachers' pedagogical beliefs. Scrimshaw suggests that teachers for the most part incorporate ICT by adopting those elements that serve their existing teaching style, rather than entirely changing to match the opportunities the technology may offer. This view arises from a study of the impact of superhighways initiative in schools in England and Wales, which showed that teachers with Internet access tended not to alter their pedagogy dramatically. Instead they used the technology to do better what they had done before.[2] If the use of ICT involves a change in teaching practices, and therefore changes in teachers' beliefs, this must be acknowledged to be a time consuming and complex process.[3]

4.2g Parent expectations and beliefs

Parent expectations form another factor in the adoption of ICT in schools. Parents are often very enthusiastic about computers viewing them as educational for their children. In the US, children's education is a major reason for domestic computer purchases.[4] This enthusiasm from parents can drive computer acquisition in schools. Cuban notes that even before legislators required computer literacy to be taught at school, many parents had donated computers, and had urged school

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[1] Robin Love and Mary McVey, *Teachers' use of the Internet,* Teachers College Record ID 10538 (June 2000), p2.

[2] Peter Scrimshaw, *Preparing for the Information Age: Synoptic Report of the Education Departments' Superhighways Initiative*, (London: Department for Education and Employment), 1997.

[3] Dale S. Neiderhauser and Trish Stoddart, "Teachers' instructional perspectives and use of educational software," *Teaching and Teacher Education* Vol. 17 (2001), pp15-31.

[4] Jane M. Healy, *Failure to Connect*, (New York: Simon and Schuster,1998), p20.

boards to buy computers.[1] This pressure resulted in a growth of the number of computers in schools, although this was not always been related to the frequency of teacher or student use.[2]

Where schools compete for pupils, the use of ICT may become a criterion for parents' choice of school. In the Swedish project schools in Färila and Mönsterås, the parents reacted very enthusiastically to the introduction of laptops for pupils. The pupils use of laptops engaged parents more in students' homework and raised the profile of the school in the community. Parent enthusiasm was so strong that nearby private schools began to adopt this approach.[3]

Fullan suggests that if parents actively support an innovation "boards and administrators are more likely to make it a priority, apply pressure and commit resources, and teachers are more likely to give it a try".[4] In Ontario parents were highly supportive of the introduction of the technology, resulting in teachers perceiving a "pressure not to reject".[5]

Parent pressure may also have a positive impact on the attitudes of teachers. In Fullan's study, one teacher reported that her colleagues showed little interest in the work she was doing with computers until the parents began a fund raising drive for computers.[6]

Such a pattern of parent pressure may have resulted in a domino effect, where once a few schools began to introduce computers, most others followed within a short

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[1] Larry Cuban, *Teachers and Machines. The Classroom Use of Technology Since 1920* (New York: Teachers College Press, 1986), p76.

[2] Ibid., p77.

[3] Kjell Dennersten. *Examples of successful use of ICT in Swedish schools.* A paper prepared for the OECD educational software quality group. Paper H9.2000.

[4] Michael Fullan, *Successful School improvement* (Buckingham: Open University Press, 1992), p51.

[5] Ibid., p51.

[6] Ibid., p36.

time. Pelgrum and Anderson noted such a pattern with computers in the late 1980s.[1]

However parent pressure is a double-edged sword. Fullan noted that there was a perception that the parents and teachers did not always have the same reasons for supporting the use of computers.[2] The public discourse on the issue of technology is often superficial. Selwyn suggests that the view of ICT as a tool for promotion of progressive teaching is not reflected in public discourse about ICT in education. Media and parents' comments frequently characterise technology as both inherently valuable and independent of teachers. He argues that this popular portrayal of ICT in the media, undervaluing the teacher role, disempowering the teacher and stressing the technology is undermining to the educational potential of the technology.[3]

Healy expresses concern that, responding to parent pressure, many schools are rushing to include "computer training" in their programmes. Such a development is often not based on a realistic analysis of information technology and society, but a 'vocationalization' of education at the cost of developing real intellectual skills.[4] In Sweden, a similar focus by parents on computers as an operational skill, taught for vocational purposes, was reported. In the Farila project, where ICT was used to facilitate a problem based pedagogy, the parents were initially worried that their children were not learning anything by heart.[5] In a sense there is a 'halo effect'

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[1] W. J.Pelgrum, "Hardware and Software Provision in relation to the Integrated Use of Computers" in W.J.Pelgrum and Tj. Plomp, (eds). *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p43.

[2] Michael Fullan, *Successful School improvement* (Buckingham: Open University Press, 1992), p51.

[3] Neil Selwyn, "Promoting Mr Chips: The construction of the teacher /computer relationship in educational advertising," *Teaching and Teacher Education* Vol. 17 (2001), pp3-14.

[4] Jane M Healy, *Failure to Connect*, (New York: Simon and Schuster, 1998), p106.

[5] Kjell Dennersten, *Examples of successful use of ICT in Swedish schools.* A paper prepared for the OECD educational software quality group. Paper H9.2000.

around computers, where they are presumed, incorrectly, to be 'better than' other media, such as television.[1]

4.2h Curriculum and examinations

In Ireland the absence of IT as part of the national curriculum was one of the top three factors identified as barriers to IT use in post-primary schools by co-ordinators, teachers and principals in 1995.[2] Another barrier to technology usage may be the testing practices. The pressure to prepare children for tests may lead to pressure to "teach to the test" to the exclusion of other activities. The focus on tests may also influence how information is presented.[3]

Love and McVeigh suggest that while technology provides opportunities for co-operative learning, guided discovery and an integrated curriculum, these are not the methods in use in classrooms focused on tests. Instead these classrooms tend towards whole group instruction, and a teacher accustomed to the whole group approach "may not be able to envision a means of using a limited number of computers in his or her classroom for instruction".[4]

4.2i A collaborative climate within the school

It is clear that incorporating ICT in a school context is a complex issue. The complexity of change leads Fullan to suggest that no one person can understand the complexities of the process. Instead he proposes that 'every person is a change agent', and that real change comes through collaborative professional work within organisations, rather than from individual leaders.[5]

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[1] Jane M. Healy, *Failure to Connect*, (New York: Simon and Schuster, 1998), p71.

[2] Cyril Drury, *Implementing Change in Education: The Integration of Information Technology into Irish post-primary schools* (Unpublished MSc Thesis, University of Leicester, 1995), Chapter 6.

[3] Robin Love and Mary McVey, *Teachers' use of the Internet,* Teachers College Record ID 10538 (June 2000), p2.

[4] Ibid., p2.

[5] Michael Fullan, *Change Forces*, (London: Falmer Press, 1993), p39.

> *Today, the teacher who works for or allows the status quo is the traitor. Purposeful change is the new norm in teaching.*[1]

Fullan stresses the importance of a "school wide consensus" in implementing the change. In a follow-up study on the Ontario project he found that the variations in use could not be explained by teacher training, background or other variables, but that

> *the main factors contributing to uniformly high use among teachers in a school were school wide consensus on the importance of net use for students, and the amount of teacher-teacher collaboration in helping each other learn, in solving facilities and scheduling problems, and in co-ordinating lab use to ensure maximum utilization at all times.*[2]

Shayo *et al.* also confirm that teachers who do not integrate ICT into their work are not influenced solely by individual factors of software characteristics. Rather, they suggest, the teachers are influenced by these and their interaction with the broader school environment.[3] However Fullan notes that what appears to be consensus may in fact be the uncritical acceptance or suppression of dissent, with teachers going along with group decisions in what he describes as 'groupthink'.[4]

What is required is a genuinely collaborative environment where teachers work together. Such a climate tends to generate a more questioning approach and more risk taking.[5] Fullan bases this conclusion on a study of UK schools. These UK schools did not first develop strategic plans, but rather began with action and reflection by teachers.[6] Leithwood similarly suggests that successful teacher development is most likely in school cultures in which teachers consciously reflect

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[1] Ibid., p14.

[2] Michael Fullan, *Successful School improvement* (Buckingham: Open University Press, 1992), p36.

[3] Conrad Shayo, Lorne Olfman and Ruth Guthrie, *Integration of IT into school curricula: perceptions of kindergarden to highschool teachers,* Proceedings of the ACM SIGCPR Conference (2000).

[4] Michael Fullan, *Change Forces* (London: Falmer Press, 1993), p82.

[5] Ibid., p63.

[6] Ibid., p64.

on their own practice and share their ideas. However he suggests that such norms of collaboration do not happen spontaneously, but reflect the norms generated by the principal.[1]

Rosenholtz classified schools as 'stuck' or 'moving' schools, based on their ability to make changes. She examined a sample of 78 elementary schools, and noted that the thirteen 'moving' schools were places where teachers learned from each other and from outside sources.[2]

Thus in the context of change the role of the leader may not be the traditional one of direction setting and motivating staff. Instead the role of leader in an organisation is centred on building a learning organisation, where the people in the organisation continually expand their own capabilities.[3] As Fullan concludes:

> *The ability to collaborate - on both a small and large scale - is becoming one of the core requisites of post modern society.*[4]

Riel and Becker[1] argue that teacher to teacher discourse is linked with adoption of ICT. They classify teachers on a continuum of professional engagement. At one end of the spectrum are "Private practice" teachers, who engage in little dialogue or few activities beyond the classroom. At the other end of the scale are "Teacher leaders", who place a high value on engagement outside the classroom, and sharing their knowledge with colleagues. In a survey of 4,000 US teachers, the "Teacher leaders" consistently proved to be better-educated, continuous learners, computer users and promote constructivist methods. They argue that teachers who had many professional contacts with other teachers at their school were three and half times

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[1] Kenneth Leithwood, "The Principal's Role in Teacher development" in Fullan, Michael and Hargreaves, Andy, eds. *Teacher Development and Educational Change* (New York: Falmer Press 1992), p96.

[2] S. Rosenholtz, "Teachers Workplace: The Social Organisation of Schools", Longman 1989, cited in Michael Fullan, *Change Forces* (London: Falmer Press, 1993), p85.

[3] Michael Fullan, *Change Forces* (London: Falmer Press, 1993), pp70-71.

[4] Ibid., p17.

as likely to employ a strong "knowledge construction" approach than teachers with few contacts.[2]

Although this finding does not prove a causal relationship, it is likely that teacher to teacher contact is an important element in the diffusion of a methodology. Teachers are likely to value the views of other teachers, and see their experiences as valid. The importance of peers is highlighted in a US study where teachers cited independent learning most frequently as preparing them to use technology (93%), followed by professional development activities (88%) and their colleagues (87%).[3]

Teacher to teacher collaboration cannot be assumed to develop without encouragement. The IEA Second Information Technology in Education Study (SITES) reported that only a small proportion of teachers in schools making high use of ICT reported increases in collaboration between teachers.[4] Developing strategies that encourage teacher to teacher interaction is a strategy likely to increase the rate of dissemination of ideas.

4.2j Technical support

Technical support for computers in schools may also have an influence on adoption. In the UK, the Office for Standards in Education (OFSTED) noted that teachers who had experience of faulty equipment were often sceptical about the potential of ICT to raise standards.[5] By contrast, "where technical help is readily

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[1] Margaret Riel and Hank Becker, *The Beliefs, Practices, and Computer Use of Teacher leaders*, Paper Presented at the American Educational Research Association (April 2000).

[2] CRITO, Center for Research on IT and Organizations, *Teacher Role Orientation: Classroom Focus versus Collaborative Professional Practice,* Research Snapshot #3, 1999. Published on the Web at : www.crito.uci.edu/tlc/findings/snapshot3/

[3] National Center for Educational Statistics, *Teachers' Tools for the 21st Century: A report on teachers' use of technology (*2000).

[4] Willem Pelgrum and Ronald Anderson, *ICT and the Emerging Paradigm for Life Long Learning: A Worldwide Educational Assessment of Infrastructure, Goals and practices,* (Amsterdam: International Association for the Evaluation of Educational Achievement, 1999), p224.

[5] OFSTED, *ICT in Schools. The Impact of Government Initiatives* (Interim Report, April 2001), p13.

available, teachers are able to concentrate on pupils' learning without feeling anxious about faulty equipment".[1]

4.2k Location of computers

The question of the ideal location for computers in schools has long been debated. In the 1989 IEA study Pelgrum postulated that the concentration of computers in computer rooms was more likely to preclude short sequences of instruction involving computers than if the computers were available in the classroom. The survey data suggested that classroom computers provided difficulties of classroom organisation for teachers. In fact 39% of the teachers using computers in the classroom reported that the difficulty of lesson organisation increased, compared with 33% of teachers using computers in a computer room.[2] Despite the difficulty however, the 1989 data indicated that the presence of computers in classrooms tended to co-vary with the integrated use of computers.[3] More recently Becker found that the greatest level of student Internet use was in classrooms with LAN based Internet connections where at least four computers were present.[4] However he suggests that this could be partly due to the teaching of the Internet being seen as the domain of the specialised "computer teacher", and thus being done in specialised computer rooms.[5]

4.2l ICT planning

Adapting to the potential of ICT in schools will require adjustment in the fabric of schools, in timetabling, classroom layout, subject boundaries and teacher duties.

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[1] Ibid., p18.

[2] W. J.Pelgrum. "Hardware and Software Provision in relation to the Integrated Use of Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p59.

[3] Ibid., p61.

[4] Henry. J. Becker, *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use,* Teaching, Learning and Computing: 1998 National Survey Report #1, Center for Research on Information Technology and Organizations (February 1999), p12.

[5] Ibid., p13.

These changes require a clear vision of the direction and a holistic view of ICT in the school plan. While the importance of ICT planning is recognised, funding patterns themselves frequently act as a barrier to planning. Funding for ICT is often provided through individual grants, or through short-term commitments that make it difficult for schools to plan for ICT development in the medium term. Fears about sustainability of funding are a barrier to development and planning in schools.[1]

4.2m Differences between primary and second level schools

Cuban suggests that the elementary schools have been more easily able to adopt technology. In 1940-41 educational radio in Ohio was used regularly by 8% of elementary schools but only 5% of secondary schools.[2] Similarly use of educational television although slight overall, was greater in elementary schools than in secondary schools.[3] Cuban argues that these differences between schools are a result of their different structures and "grammar". He points to differences in time allocation and student-teacher contact as factors in this difference. In addition he argues that the external demands for performance placed on secondary schools (by examinations) restrict their flexibility in varying the methodology and allocating time to different tasks.[4]

Cuban believes that the adoption of technology is more likely in elementary schools than in high schools. He proposes a series of differences between the two levels that contribute to this difference. In elementary schools, content is, he suggests, secondary to skills and often taught as a vehicle to develop skills. By contrast in high schools the focus is on the content. Secondly, in high schools the time is

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[1] NCREL (North Central Educational Laboratory), *Critical Issue: Providing Professional Development for Effective Technology Use*, 2000 published on the Web at www.ncrel.org/

[2] Norman Woelfel and Keith Tyler, *Radio and the School*, (World Book Co. 1945), p60-61, quoted in Larry Cuban, *Teachers and Machines. The Classroom Use of Technology Since 1920 (New York: Teachers College Press, 1986),* p23.

[3] Larry Cuban, *Teachers and Machines. The Classroom Use of Technology Since 1920* (New York: Teachers College Press, 1986), p49.

[4] Ibid., p64.

scheduled in small segments, while in elementary school the teachers typically spends much of the day with the same class. Thus over a 9 month year, an elementary teachers is with a group for 1,000 hours, while a high school teacher rarely meets the same people for more than 200 hours. This scheduling pattern gives the elementary schools the potential to make organisational changes. Thirdly, he suggests that the pressures of examination and assessment systems, and job market qualifications are greater at high school level, thus limiting the flexibility of the schools.[1]

In general student-computer ratio tends to be more favourable in secondary schools.[2] Despite this there is evidence of greater proportions of primary school teachers making use of ICT. In 1998 the Department of Education and Employment in the UK reported that 81% of teaching staff in primary schools were making use of ICT "on a regular basis" in their teaching, compared with 36% of teaching staff in secondary schools.[3]

The take-up of training in the UK was also slightly higher in primary schools. By 1998 41% of primary school teachers had undertaken some training, compared with 37% in secondary schools.[4] By 2000 the number of teachers who had undertaken training had risen but the proportion of secondary school teachers training still lagged behind that of primary teachers.[5]

The 1989 IEA study distinguished between use of computers to support learning in curricular subjects and use of computers to teach about computers. Despite

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[1] Larry Cuban, "Computers Meet Classroom: Classroom Wins" Teachers' College Record, Vol. 95 No. 2, TCR ID 82 (1993), p12.

[2] W. J.Pelgrum. "Hardware and Software Provision in relation to the Integrated Use of Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems*, (Oxford: Pergamon Press, 1993), p51.

[3] Department for Education and Employment, *Survey of Information and Communications Technology in Schools 1998*, (Statistical Bulletin Number 11/98, November 1998), Paragraphs 40-41.

[4] Ibid., Paragraph 43.

[5] Department for Education and Employment, *Survey of Information and Communications Technology in Schools, England 2000* (Statistical Bulletin Issue No 07/00, October 2000), p10.

considerable variation between countries in the balance between these two, there was consistently greater use of ICT in support of learning at primary level. The researchers suggested that this might reflect differences in underlying philosophies about the goals of computer use.[1]

Whatever the reason for the difference, the pattern persists. In 1999 in the UK primary schools were much more likely to use ICT across the curriculum, while secondary schools were more likely to treat ICT as a separate subject, as shown in the table below.

TABLE 4. 2: HOW ICT WAS TAUGHT IN UK SCHOOLS 1999[2]

	Percentage of primary schools			Percentage of secondary schools		
Year group	Across the curriculum	As a separate subject	Both	Across the curriculum	As a separate subject	Both
Reception/1/2	41	2	57			
3/4/5/6	30	3	67	22	28	50
7/8/9	56	6	39	25	29	45
10/11				35	23	42
12/13				40	21	39

The difference between the educational levels may also be reflected in the type of use of ICT. Evidence from the now dated 1989 survey found that elementary schools tended to use ICT in Mathematics and mother tongue, while in secondary schools used ICT to teach "informatics".[3] This difference was also reflected in the type of software used. Word-processing was the most frequently use type of software in secondary schools, with programming in second place. The picture was

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[1] W. J.Pelgrum. "Hardware and Software Provision in relation to the Integrated Use of Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p48.

[2] Department for Education and Employment (DFEE), November 1999, Statistics of education: Survey of information and communications technology in schools (1999).

[3] Dan Davis, "Implementation and Educational Uses of Computers", in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p77.

different in elementary schools with drill and practice software the most frequently used and skill games second.[1]

More recent surveys have also reported differences between primary and second level schools. The 2001 Eurobarometer survey identified the main barriers to Internet use in primary schools as lack of Internet access at the school or lack of access to computers and lack of Internet access in the classroom. For second level schools the situation was different with the most frequent barrier being perceived lack of relevance of the Internet to teaching.[2]

There may also be differences in outlook between primary and second level schools. Janssen Reinen and Plomp recorded that primary schools tended to use ICT for what they term "class oriented" reasons, or reasons focused on classroom use. By contrast they suggest second level schools tended to use rationales that were more "school oriented", or focused on the school as an organisation. Such reasons might include attracting more students or competing with other schools.[3]

4.3 Strategies to encourage use of ICT in schools

In the case of ICT the much higher levels of ICT in society and the growth of domestic ICT use may mean that the technology will be increasingly familiar to both teachers and learners. This may act as a driver for the use of ICT in schools. Indeed Fullan has argued that successful innovation must have a foot in both the 'microcosm' of the classroom and the 'macrocosm' of the learning society and the learning world.[4] Many educational systems have not relied entirely on external

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[1] W. J.Pelgrum, "Hardware and Software Provision in relation to the Integrated Use of Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p64.

[2] European Commission, *European youth in a Digital Age: eEurope 2002 Benchmarking,* Draft Working document of the Commission services Based on the Eurobarometer surveys of February 2001, p23.

[3] I.A.M. Janssen Reinen and Tjeerd Plomp, "The Decision Phase: Starting to Use Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p40.

[4] Michael Fullan, *Change Forces* (London: Falmer Press 1993), p145.

pressures, and have made attempts to stimulate the use of ICT in schools. This section explores some of the policy measures used to encourage the adoption of ICT in a range of countries.

Some of the national ICT strategies have relied heavily on provision of equipment. However Fullan argues that mere availability and access to technology is not enough to drive unenthusiastic teachers to use the technology.[1]

The IEA researchers support this view, concluding that:

> *Looking back on the 1980s, we see that most countries followed quite 'simplistic' introduction strategies, based on the assumption that the provision of hardware and software might result almost automatically in fundamental changes in instructional practices. For real changes, more sophisticated strategies need to be developed, taking into account that ultimately it is the teacher who determines changes in classroom practice.*[2]

The current campaigns to encourage adoption of ICT in schools have drawn on a wide range of innovation strategies, such as training, a focus on leaders and the use of change agents.

4.3a Training

The professional development of teachers has long been recognised as an important part in the diffusion of ICT into schools. Researchers involved in the 1989 IEA study concluded that school based in-service training for teachers needed to be intensified.[3] Fullan's case study of the information technology strategy in Ontario, although also dating from the late 1980s, reveals a similar need for training.[4] Many of the teachers in Fullan's case study found the short training courses inadequate. One grade 8 teacher reported being "uncomfortable, worried, and nervous" about using the technology after a 16 hour course. Another found the 16 hour training

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[1] Michael Fullan, *Successful School improvement* (Buckingham: Open University Press, 1992), p36.

[2] W. J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p239.

[3] Ibid., p138.

[4] Michael Fullan, *Successful School Improvement* (Buckingham: Open University Press, 1992), Chapter 2.

course very confusing and frustrating, and found the experience very unrewarding, and afterwards "avoided the computer like the plague".[1]

More recently the OECD has identified professional development for teachers as one of the key issues in the implementation of ICT in education, suggesting that:

> *There is no doubt that the role of teachers is central in making progress in the use of ICT in schools..... The neglect of teacher ICT training, which tends to lag behind physical investment, is often considered a major obstacle.*[2]

The age profile of teachers in most countries ensures that a majority went through their initial training at a time when there were few computers in schools. As the IEA study argues:

> *The present generation of teachers did not grow up with computers as a normal and integral part of society; and certainly not of school life and classroom practices. ... Teachers are ultimately the ones charged with the implementation of computers in educational practice and therefore 'education of the educators' or teacher training is an important aspect of the introduction of computers in schools.*[3]

In response to this pattern in-service teacher training programmes have frequently accompanied national initiatives in ICT in education. In the UK, updating the ICT skills of serving teachers was recognised as a crucial part of the drive to integrate ICT into schools. In the introduction to the National Grid for Learning, Mr Tony Blair identified teacher training in ICT as one of two main targets of government strategy.[4] The government allocated £230 million for training of practising teachers and school librarians in ICT as part of the New Opportunities Fund (NOF) initiative, beginning in April 1999. The aim of this initiative was to train serving

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[1] Ibid., p34.

[2] OECD, *Education Policy Analysis 1999* (Paris: OECD, 1999), p58.

[3] I.A.M. Janssen Reinen and Tjeerd Plomp, "Educating the Educators" in W. J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p125.

[4] *Connecting the Learning Society* UK government consultation paper (1998).

teachers to the level of ICT capability expected of newly qualified teachers by 2003.[1]

Similarly in Northern Ireland the DENI strategy document concluded that "raising the level of teacher competence was probably the single most important factor in providing the impetus for ICT development in schools".[2] However the document noted with concern that the proportion of teachers with ICT skills seemed to have reached a plateau in England and Wales, and that teachers who received training might quickly lose their skills if lack of suitable facilities prevented a practical application of them.[3]

In-service training initiatives of this type have often proved very popular, with high take-up rates, and excess demand. In the US, over a 3 year period 77% of teachers participated in professional development activities in the use of computers.[4] It is also believed to be successful. In the UK the NOF training was judged to have given teachers increased confidence to use ICT, and in secondary schools had led to an overall increase in the frequency of use of ICT in subject teaching.[5]

Pre-service

Many countries have also taken some steps to include ICT in the initial training of teachers. As a result most beginning teachers are now exposed to some ICT training as part of their professional qualification. The impact of this can already be seen in newly qualified teachers. In the US recently qualified teachers were much

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[1] Teacher Training Agency, *The use of ICT in subject teaching – expected outcomes of the New Opportunities Fund ICT training initiative for teachers in England, Wales and Northern Ireland,* Published on the Web at: http://www.teach-tta.gov.uk/library/tta00_05.pdf

[2] Department of Education Northern Ireland, A Strategy for Education Technology in Northern Ireland (DENI, 1997), p17.

[3] Ibid.

[4] NCES (National Center for Educational Statistics) *Teachers' Tools for the 21st Century: A report on teachers' use of technology,* (2000).

[5] OFSTED. *ICT in Schools. The Impact of Government Initiatives* (Interim Report, April 2001), p20.

more likely than their more experienced colleagues to report that college had prepared them to use technology and the Internet.[1]

Pedagogical components of teacher development

It is clear that teachers need both technical skills and educational perspectives on the use of ICT in the classroom. In the UK the Superhighways initiative reported problems arising when is was assumed that if technical training were provided, the appropriate educational application would immediately be apparent.[2] The report concluded that:

> *The central importance of both initial and continuing training needs to be recognised and budgeted for from the outset. Teachers need to know not only how to operate a system in the technical sense, but also what educational possibilities it has: these two aspects need to be developed together.*[3]

In the US, despite very large take-up of ICT courses for teachers, by 1999 only one third of teachers reported feeling prepared to use the Internet in classroom teaching.[4] While part of this lack of preparedness is related to technical skills, it is clear that many more teachers use the technology in lesson preparation than use it in the classroom.[5] Similarly in the UK, OFSTED concluded that there remain significant weaknesses in teaching using ICT, with only a minority of teachers

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[1] National Center for Educational Statistics, *Teachers' Tools for the 21st Century: A report on teachers' use of technology, (2000).*

[2] Peter Scrimshaw, *Preparing for the Information Age. Synoptic Report of the Education Departments' Superhighways Initiative,* Department for education and Employment, 1997. Paragraph 133.

[3] Ibid., Paragraph 157.

[4] National Center for Educational Statistics, *Teachers' Tools for the 21st Century: A report on teachers' use of technology, (2000).*

[5] Ibid.

demonstrating an ability to manage the technology so that effective subject learning took place.[1]

The gap between teachers' ability to use ICT in lesson preparation and their ability to use ICT appropriately in the classroom highlights the importance of teacher development in the pedagogical use of ICT.

This pattern has led the OECD to the view that not enough is being done to develop teacher skills in the educational use of ICT. While most teacher education institutions now offer a basic course in use of ICT, the OECD suggests that "a stand-alone course about IT is not the same as ensuring that courses in teaching methods integrate technology as a way of building understanding...".[2]

In Ireland too the IT training provided for teachers before IT 2000 was criticised for lacking educational context. Drury asserts that the training was not focused on change in teaching and learning, but typically concentrated on basic skills without reference to classroom use.[3] The training also frequently occurred without an opportunity for follow-on courses or other forms of development.

The impact of training on classroom use

Where teacher development has included the pedagogy as well as the technology, there is evidence of an impact on classroom practice. Early research such as the 1989 IEA study reported that "a majority of topics which are taught in the subject matter class, were also included in the training teachers received. A conclusion from this finding is that the content of training is apparently an important reference for what is actually taught in the lessons".[4]

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[1] OFSTED, *ICT in Schools. The Impact of Government Initiatives* (Interim Report, April 2001), p13.

[2] OECD, *E-Learning, The Partnership Challenge* (Paris: OECD, 2001), p54.

[3] Cyril Drury, *Implementing Change in Education: The Integration of Information Technology into Irish post-primary schools* (Unpublished MSc Thesis, University of Leicester, 1995), Chapter 2.

[4] I.A.M. Janssen Reinen and Tjeerd Plomp, "Educating the Educators" in W. J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p133.

However only a small proportion of the topics covered in training were also taught in classrooms, suggesting that the relationship is not a simple one. Given that instructional computer use did not belong in the 'standard repertoire' of most teachers, the study examined the relationship between training in the instructional/pedagogical aspects of computer use and the use of computers for instructional purposes. The study concluded that 'being trained in pedagogical/instructional aspects of computer use can be considered an indicator of the amount of computer use in existing subjects', and recommended that 'pedagogical and instructional aspects of computer use need to be included more in teacher training activities'.[1]

In the more recent US TLC survey, teachers who attended formal staff development activities in which "how to use the Internet" was a topic were more likely to believe the Internet to be an essential classroom resource, and more likely to use the Internet than other teachers.[2] However attendance at such courses is voluntary and may attract those who are already Internet enthusiasts. For teachers with the same level of access at home and in their classrooms, those who attended courses were "somewhat more likely" to use the Internet in their teaching and professional work.[3]

The need for in-service courses to include a pedagogical dimension is further underlined by the very high take up of ICT courses among teachers. In some countries more teachers attend ICT courses than any other kind of course. For example, in the US, during the 1997-98 schools year more teachers attended professional development courses related to computer use than courses concerned with other instructional approaches.[4] In view of this enthusiasm for ICT courses,

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[1] Ibid., pp134-5.

[2] Henry. J. Becker, *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use,* Teaching, Learning and Computing: 1998 National Survey Report #1, Center for Research on Information Technology and Organizations (February 1999), p19.

[3] Ibid., p20.

[4] CRITO, The Center for Research on IT and Organizations, Research Snapshot 6, *Professional Development* (1999).

these courses provide a unique opportunity to expose large sections of the teaching force to alternative pedagogy.

ICT and teacher professionalism

The view of ICT integration as dependent on the pedagogical vision of the teacher makes greater demands on the professionalism of the teacher, and teachers become designers and developers of learning experiences.[1] As the President's Committee of Advisors in the US describe it:

> *The more ambitious and promising pedagogic applications of computers discussed in Section 4.3 call for considerably more skill from the teacher, who must select appropriate software, effectively integrate technology into the curriculum and devise ways of assessing student work based on potentially complex individual and group projects.*[2]

However teacher development in this context is not an easy task, as defining competencies for personal usage of ICT is relatively straightforward but establishing competencies for IT usage in the classroom is more problematic.[3]

It is unrealistic to think of the professional development of teachers as a one-time intervention. Given the speed of change of the technology, and the development of innovative methodology, teacher development must be viewed as an ongoing and integral part of teachers' professional lives.[4] Indeed Senge takes the view that all professional activity involves ongoing personal development. He phrases his position thus:

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[1] Yong Zhao and Paul Conway, "What's In, What's Out – An Analysis of State Educational Technology Plans", *Teachers College Record* (January 2001).

[2] President's Committee of Advisors on Science and Technology, *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States* (March 1997), Section 5.1.

[3] Cyril Drury, *Implementing Change in Education: The Integration of Information Technology into Irish post-primary schools* (Unpublished MSc Thesis, University of Leicester, 1995), Chapter 2.

[4] NCREL (North Central Educational Laboratory), *Critical Issue: Providing Professional Development for Effective Technology Use* (2000). Published on the Web at www.ncrel.org/

> *People with a high level of personal mastery live in a continual learning mode...personal mastery is not something you possess. It is a process. It is a lifelong discipline. People with a high level of personal mastery are acutely aware of their ignorance, their incompetence, their growth areas. And they are deeply self-confident. Paradoxical? Only for those who do not see that 'the journey is the reward'.*[1]

The process of teacher development may be seen, not as providing new skills or improving the conditions in which they work, but as changing the way that teachers view their work. This is deeper than a shift in the vocabulary used to describe teaching and involves a broader and richer understanding of the work. Jackson suggests that this may be analogous to art appreciation, where immersion in a work of art may result in an altered sensibility to the work.[2]

Commitment to teacher education

Such deep and continuous approaches to teacher education are expensive and few education systems have allocated sufficient resource to the task. Despite the almost universal emphasis on ICT training, the budgets allocated to it are sometimes relatively small. In the UK Selwyn argues that the expenditure of £230 million on teacher training amounts to a little under £500 per teacher.[3] This figure is much smaller proportion of the technology cost than would be expected in a commercial environment. For example, of $4.2 billion spent on technology in schools in the US in 1996, only 6% was spent on training. This figure had risen to 17% by 1999. However the training provided is "usually too little, too basic and too generic". 96% of teachers reported that the most common training received was concerned with basic computer skills.[4] Michael Fullan suggests that under-funding of teacher education may reflect a deeper distrust in the process. As he suggests:

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[1] Peter Senge, *The Fifth Discipline* (New York: Doubleday, 1990), p142.

[2] Philip Jackson, "Helping Teachers Develop", in Hargreaves, Andy and Fullan Michael eds. *Understanding Teacher Development,* (New York: Teachers College Press, 1992), p66.

[3] Neil Selwyn, "The National Grid for Learning initiative: connecting the learning society?" *School Leadership and Management,* Vol. 20, No. 4 (2000), pp407-414.

[4] OECD, *E-Learning, The Partnership Challenge,* (Paris: OECD, 2001), pp26-27.

> *Despite the rhetoric about teacher education in today's society, there does not seem to be a real belief or confidence that investing in teacher education will yield results.*[1]

4.3b Pilot projects

Rogers points out that innovation need not always follow a centralised model. In many cases innovations may not be generated at a centre, but arise at the operational level in the system. Such systems are often characterised by wide sharing of control, with innovation by users who are non-expert, and diffusion is done on a peer-to-peer basis.[2]

Example of this kind of approach can be found in the widespread use of pilot projects, which has been part of the ICT strategy in many countries. In Fullan's example of Ontario, the "Lighthouse Implementation project" funded some locally designed pilot projects, with a view to dissemination of their work for replication in other schools. The strategy aimed to "allow new models to evolve.... observe them .... do formative evaluation.... and then generalize across large numbers of teachers".[3]

A similar strategy was suggested in Ireland by Cyril Drury, who proposed that ICT implementation did not lend itself to the model of a "grand plan" imposed from the top. Instead a series of pilot projects with integral dissemination strategies could develop appropriate pedagogy and practice.[4]

Strategies based on pilot projects place more of the responsibility for the development in the hands of teachers. In this way they avoid the conventional "top down" view of many approaches to teacher development.

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[1] Michael Fullan, *Change Forces*, (London: Falmer Press 1993), p104.

[2] Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), pp333-335.

[3] Michael Fullan, *Successful School improvement* (Buckingham: Open University Press, 1992), p47.

[4] Cyril Drury, *Implementing Change in Education: The Integration of Information Technology into Irish post-primary schools* (Unpublished MSc Thesis, University of Leicester, 1995), Recommendations.

Many models of teacher development and educational change are based on "top down" strategies, in which teachers are the object of change. For some, these models are not part of the solution, but part of the problem, as they may place little value on teachers' own experience and capacity of self-development, and as a result may fail to engage teachers and secure their commitment.[1]

Centrally conceived and planned changes may meet resistance from experienced teachers. Some changes demand that teachers change their practice in ways which they believe to be inappropriate or impossible and the fact that they are required to implement these changes limits their professional freedom and contributes to the 'proletarianization' of teachers.[2] Even if teachers do not feel the changes are inappropriate, they are working in environments which are increasingly complex and demanding, and the imposition of changes is often associated with a deficit model which implies inadequacies on the part of the teachers.[3] Given the private context of classrooms, teachers are able to resist even changes required by law if they so wish.[4]

> *Imposed change carries official authority which challenges professional experience, judgement and expertise. .... The imposition of change can lead to low morale, dissatisfaction and reduced commitment.*[5]

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[1] Andy Hargreaves and Michael Fullan, *Understanding Teacher Development* (New York: Teachers College Press, 1992), p3.

[2] Patricia Sikes, "Imposed Change and the Experienced Teacher" in Fullan, Michael and Hargreaves, Andy, eds. *Teacher Development and Educational Change,* (London: Falmer Press, 1992), p37.

[3] Ibid.

[4] Ibid., p49.

[5] Ibid.,

Drury echoed this view, stating that teachers "must feel themselves to be 'active initiators' of these new developments rather than 'passive implementors'."[1]

In the light of his research on teacher life cycles, Huberman also concluded that real teacher development is more likely in decentralised and semi-formal networks, than in top-down strategies. Such networks would involve decentralisation of the resources and budgets including release time, materials and consultants nearer to the practitioners. He suggested that the key to success for such networks is "in the necessity of each member actually to experiment in the classroom with the skills or strategies that emerge from discussions and observations".[2]

A further difficulty with the conventional model is that strategic planning in advance of change can restrict the change process. Fullan suggests that 'premature visions and planning can blind', suggesting that the building of a realistic and shared vision must arise from action, rather than precede it.[3]

Drawbacks of the decentralised model

However the decentralised, "bottom up" model of development has drawbacks. The disadvantages of such a mechanism include the lack of quality control, the possibility of bad innovations spreading, and the lack of technical expertise, and suggests that such a mechanism is most appropriate when the innovation does not involve a high level of technical expertise and the users operate in relatively homogenous conditions.[1]

In the context of schools Fullan argues that a strategy based on pilot projects is dependent on an openness to change in the other schools and a high level of use of research knowledge. He concludes that "from what we know about knowledge

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[1] Cyril Drury, *Implementing Change in Education: The Integration of Information Technology into Irish post-primary schools* (Unpublished MSc Thesis, University of Leicester, 1995), Recommendations.

[2] Michael Huberman, "Teacher Development and Instructional Mastery", in Hargreaves, Andy and Fullan Michael, eds. *Understanding Teacher Development.* (New York: Teachers College Press, 1992), p138.

[3] Michael Fullan, *Change Forces*, (London: Falmer Press, 1993), p28.

utilization in schools, and about the developmental nature of change in practice among teachers, both presumptions are on shaky ground".[2]

The real value of pilot projects is determined by the extent to which they impact on the broader education system. Ensuring dissemination of project ideas is more difficult that it might appear. Teachers have traditionally worked in relative isolation, often with little tradition of collaboration or idea sharing. For example survey of US teachers in 1998 showed that only 16% had conducted a regular e-mail conversation with a teacher in another school. This was described by the researchers as "a fairly low participation rate for a category of adult professionals".[3]

There is also a risk of 'Balkanisation', where innovation may occur in isolated pockets within a school or district, but in isolation from the bigger scene.[4]

Hybrid models

One of the possible diffusion models proposed by Rogers is a hybrid of centralised and decentralised. He points to the example of the National Diffusion Network in the US, which funded "developer/demonstrator" schools to pilot new practices, and then actively diffused these within the system.[5]

To Fullan, both top-down and bottom-up strategies are essential for real change. Top-down strategies alone, he argues, depend on the illusion of control at the top, while in reality the policy makers have little control of the complexity of the situation. On the other hand he suggests that decentralised, bottom-up, solutions

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[1] *Diffusion of Innovations*, Third Edition, (New York: The Free Press, 1983), p338.

[2] Michael Fullan, *Successful School Improvement* (Buckingham: Open University Press, 1992), p48.

[3] CRITO Snapshot 2, *Regular teacher E-mail Contact with Teachers at Other Schools by Internet Access and Age* (1999).

[4] Michael Fullan, *Change Forces* (London: Falmer Press, 1993), p83.

[5] *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), p342.

often get bogged down in governance issues, and even when successful it is difficult to sustain the success without external support.[1]

4.3c ICT for school principals

School principals play an important role in the adoption of ICT. Adopting technology thoroughly will require a whole-school approach and a shared vision of the potential and implications. It is thus vitally important that the leaders of schools share in the pedagogical vision of ICT. Extensive use of the technology in administration will not ensure the development of an educational perspective on ICT. Some countries have tried to ensure that school principals experience for themselves the benefits of ICT in learning. In Norway school principals undergo training courses which make extensive use of ICT.[2] It is hoped that this exposure to learning through ICT will provide principals with personal experience of the learning potential of ICT.

In the UK school principals are provided with a laptop, and are connected to an on-line support network where they can share experiences with other principals. A National College for School Leadership (NCSL) will establish an interactive network of all heads and other schools leaders in the country, with strong links to the best school leaders internationally. This will allow school principals to learn from the experience of others on-line without spending time away from their own schools.[3]

4.3d Support for ICT co-ordinators

In recognition of the important role of ICT co-ordinators, some national strategies encourage the designation of a teacher to act as the central point for ICT issues in

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[1] Michael Fullan, *Change Forces* (London: Falmer Press, 1993), p37.

[2] Submission of the Norwegian Government to the OECD expert group on ICT and the Quality of Learning, 2000. Unpublished. Section 2.7.

[3] Submission of the UK Government to the OECD expert group on ICT and the Quality of Learning, 2000. Unpublished. Section 2.7.

the school, and support colleagues on technical and pedagogical issues. In Canada[1] and Norway[2] ICT co-ordinators are released from part of their teaching duties to fulfil this role.

4.3e ICT advisors - Change agents

In Ireland the IT 2000 strategy included the provision of ICT advisors. These advisors may be seen as acting as change agents for the innovation. The role of change agent is a well-established part of many organised innovations. These agents act as a link between the agency responsible for the change and the individuals in the "client system".[3]

The success of a change agent is related to the extent of the agent's contact with the clients. This role as an intermediary may result in role conflict for the change agents, who may empathise with the clients' difficulties, and at the same time have some bureaucratic responsibilities to the agency.[4] Rogers argues that the capacity to influence change is largely determined by the existence of an empathic relationship with the client, and so change agent success is related to the adoption of a client orientation rather than a change agency orientation.[5]

While change agent contact is highly related to the adoption of the innovation, change agents may tend, like other individuals to communicate more with the people they perceive as like minded. Change agents, who are often professional people, in many cases make more contact with clients of higher socio-economic status.[6] Some innovations have attempted to counter this trend through the use of para-professional change agents. Although such para-professionals may have

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[1] Submission of the Canadian Government to the OECD expert group on ICT and the Quality of Learning, 2000. Unpublished. Section 2.5.

[2] Submission of the Norwegian Government to the OECD expert group on ICT and the Quality of Learning, 2000. Unpublished. Section 2.5.

[3] *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), p314.

[4] Ibid., pp317-8.

[5] Ibid., p319.

[6] Ibid., p322.

lower "competence credibility" than professionals, they may have higher "safety credibility", that is they may be seen as trustworthy and empathetic by the community.[1] This pattern leads Rogers to formulate the general principle that "change agent success is positively related to credibility in the client's eyes".[2] However one of the difficulties with paraprofessional aides is that they may begin to model the behaviours and attitudes of the professionals, thus reducing their credibility with the community.[3]

> *One of the change agent's unique contributions to the diffusion process is technical competence, which allows him or her to provide this expertise to clients in making innovation decisions. But if the change agent takes a long range approach to change, he or she should seek to raise the clients technical competence and ability to evaluate potential innovations themselves.*[4]

4.3f Technical Support

Technical support for teachers has often not been adequate. In 1994 a US study reported that: "Support for teachers' use of technology is not very deep. Only 10% of teachers work at schools where there is a person who provides substantial support for computer use and where teachers can receive help in how to use computers in specific subjects."[5]

Some countries have attempted to address the problem of technical support in different ways. In Belgium[6] both telephone help-lines and Web help are provided. In Canada some jurisdictions are developing other solutions such as training students as technical support staff or bringing in outside resources such as local

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[1] Ibid., p328.

[2] Ibid., p329.

[3] Ibid., p331.

[4] Ibid., p332.

[5] Henry Jay Becker, *Analysis and Trends of School Use of New Information Technologies,* Prepared for the U.S. Congress Office of Technology Assessment (March 1994).

[6] Submission of the Belgian(French) Government to the OECD expert group on ICT and the Quality of Learning, 2000. Unpublished.

volunteers on call from business or higher education.[1] In other countries direct technician support is provided. In Luxembourg the Centre de Technologie de l'Education provides a pool of technicians who divide their time between schools.[2]

In the UK the focus has been to develop 'managed services' based on public private partnerships.[3] Schools are encouraged to purchase a managed service, including the hardware, technical support and technical training. The NGfL (National Grid for Learning) Certified Managed Services offer a way of purchasing ICT infrastructure and services. They provide an integrated package of equipment, facilities and services, with clear points of contact for support and advice. NGfL Managed Services provide educational institutions with a local area network of computers, the cabling infrastructure, access to the Internet, technical support and training.[4] However to date many schools have not opted to take up the managed services offered, often being put off by the high costs involved.[5]

4.3g National IT diffusion policies

In 1995 Drury argued that a "lack of a national policy" was a major barrier to IT implementation in Ireland.[6] In the late 1990s many countries launched or renewed policy initiatives related to ICT in schools. In the UK, for example, the National Grid for Learning (NGfL) set targets for ICT in the education system, including:

- By 2002 all schools should be connected.
- By 1999 all newly qualified teachers should become ICT literate.

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[1] Submission of the Canadian Government to the OECD expert group on ICT and the Quality of Learning, 2000. Unpublished. Section 1.6.

[2] Submission of the Luxembourg Government to the OECD expert group on ICT and the Quality of Learning, 2000. Unpublished. Section 1.6.

[3] OECD, *E-Learning, The Partnership Challenge* (Paris: OECD, 2001), p60.

[4] NGfL documentation, published on the Web at http://managedservices.ngfl.gov.uk/explorer.html

[5] OFSTED, *ICT in Schools. The Impact of Government Initiatives*, (Interim Report, April 2001), p19.

[6] Cyril Drury, *Implementing Change in Education: The Integration of Information Technology into Irish post-primary schools* (Unpublished MSc Thesis, University of Leicester, 1995), Chapter 7.

- By 2002 all serving teachers should be confident and competent to use ICT within the curriculum.
- By 2002 most school leavers should be ICT literate, based on set standards.
- By 2002 the UK should become a centre of excellence for software development.
- By 2002 administrative communication with schools should largely cease to be paper based.[1]

In Australia the focus has been slightly different. Central funds were delegated to school districts and individual schools. This has led to much higher degrees of local decision-making and control over the implementation. As a result the Australian picture is far from homogenous.[2]

In New Zealand all head teachers and teachers were required to undergo ICT training before they could apply for ICT funding for their schools. As a result 90% of teachers now have some ICT training, and on the whole it is believed that teachers have engaged with ICT more than in other countries.[3]

4.4 Equality and innovation

As identified earlier, one of the key motivations for the use of ICT in education is the attempt to avoid a "digital divide". As a result one of the key questions in the move towards technology in schools is whether these technologies are equalising availability of information, or simply reinforcing existing inequalities in access.[4]

Unfortunately this conventional pattern of innovation provides the benefits of innovation earliest to those least in need of it, as those with least economic strength

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[1] OECD, *E-Learning, The Partnership Challenge*, (Paris: OECD, 2001), p58.

[2] Ibid., p63.

[3] Ibid., p64.

[4] Jane M Healy, *Failure to Connect* (New York: Simon and Schuster, 1998), p97.

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[1] OECD, *E-Learning, The Partnership Challenge*, (Paris: OECD, 2001), p58.

[2] Ibid., p63.

[3] Ibid., p64.

[4] Jane M Healy, *Failure to Connect* (New York: Simon and Schuster, 1998), p97.

are likely to be the last to innovate.[1] This pattern may be enhanced by the tendency of change agents to focus their energy on those most likely to respond resulting in a further widening of the gaps between the innovators and the laggards.[2]

Although early adopters of an innovation pay a high cost in terms of the risk of the innovation, they also tend to gain "windfall profits" if the innovation is beneficial.[3] Those who adopt early also gain the benefits early, and this effect tends to widen the gap between the adopters and non-adopters. Rogers expresses this thus:

> *Windfall profits are a relative type of gain that one individual in a social system receives and others do not. Windfall profits are a reward for innovativeness and a penalty for laggards. We know that innovators are initially wealthier than laggards. Usually new ideas make the rich richer and the poor poorer, widening the socioeconomic gap between earlier and later adopters of a new idea.*[4]

In the context of schools it is less obvious how an economic benefit could derive from the adoption of ICT. However there are mechanisms by which innovative schools could gain tangible benefits. In areas where parents can select schools, those schools perceived to be innovative may attract more students, or have the option of selecting the most enthusiastic students or those with the most financially supportive parents. Dennersten provides an example of Swedish schools investing in ICT as a result of a need to compete with an ICT intensive local school.[5] Innovative schools may also find it easier to attract other funding,[6] perhaps through participation in projects.

There have been some exceptions to the pattern of innovation widening gaps. Where these exceptions have occurred, they have often been linked to the social

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[1] *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), p264.

[2] Ibid., p265.

[3] Ibid., p381.

[4] Ibid., p382.

[5] Kjell Dennersten, *Examples of successful use of ICT in Swedish schools,* A paper prepared for the OECD educational software quality group. Paper H9.2000.

[6] Michael Fullan, *Change Forces* (London: Falmer Press 1993), p85.

context of the innovation. Rogers points out that while the introduction of irrigation systems into Pakistan displaced smaller farmers as the rich farmers grew richer, the same innovation in Bangladesh was managed by small farmers on a co-operative basis and the benefits were distributed more evenly, although the innovation was adopted more slowly.[1] Thus Rogers argues that in principle gap narrowing strategies can succeed, but that these may come at the cost of slowing the innovation as change agents and the change process may have to focus on the less easy clients.[2]

4.5 The outcomes - the impact of policy

The earlier sections of this chapter have considered the adoption of ICT in schools and the policies used to encourage adoption. A number of studies have attempted to measure the impact of these policies, and some have tried to measure the relative importance of the factors associated with successful adoption. This section examines what these studies reveal about the ingredients of a successful policy.

Firstly, it must be acknowledged that the diffusion of ICT into schools has met with mixed results. In the UK by 2001 only about a third of primary schools and two thirds of secondary schools had created their own Web pages.[3] Although the strategy resulted in increases in teachers' confidence with ICT, and their ability to teach ICT as a subject, there was less progress in teachers' use of ICT within curricular subjects. OFSTED concluded that this pattern stemmed typically from "weak links between the computer tasks and the lesson objectives", citing a case where a science package had replaced a real experiment with a simulation that placed very few demands on pupils.[4]

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[1] *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), p401.

[2] Ibid., p408.

[3] OFSTED, *ICT in Schools. The Impact of Government Initiatives* (Interim Report, April 2001), p17.

[4] Ibid., p12.

Love and McVey point out that in the US, although 89% of schools had Internet access and 51% of classrooms were wired, the proportion of teachers using the Internet as part of their work was much lower. Less than half the teachers with Internet in their classrooms had their students use the Internet as a research tool at least three times in the year, and even fewer involved students in collaborative projects of Web publishing.[1]

Innovation campaigns do not always succeed, and Rogers has pointed out that one major risk of failure arises when the change agents are more interested in the innovation than in the clients' needs.[2] In the case of schools, slow uptake of innovations has sometimes resulted in a perception of teachers or principals as hostile to technology.[3] However as Fullan asserts:

> *It is probably closer to the truth to say that the main problem in public education is not resistance to change, but the presence of too many innovations mandated or adopted uncritically and superficially on an ad hoc fragmented basis.*[4]

Analysis of the factors determining success or failure of these innovations seems an attractive direction, but Hargreaves and Fullan warn of the impossibility of the task:

> *Indeterminacy in educational research is unavoidable. Because of this, the purpose of such research should be to generate critical conversations with the wisdom and expertise of current practice, rather than to authorise the imposition and implementation of new practices from elsewhere.*[5]

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[1] Robin Love and Mary McVey, *Teachers' use of the Internet,* Teachers College Record ID 10538 (June 2000), p1.

[2] *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), p319.

[3] Larry Cuban, *Teachers and Machines. The Classroom Use of Technology Since 1920* (New York: Teachers College Press, 1986), p51.

[4] Michael Fullan, *Change Forces* (London: Falmer Press 1993), p23.

[5] Andy Hargreaves and Michael Fullan, *Understanding Teacher Development* (New York: Teachers College Press, 1992), p4.

Senge suggests a model of 'dynamic complexity', based on the principle that the interactions involved in an innovation are so complex and fluid that no individual could 'figure out all these interactions'.[1] In response to this complexity, he proposes examining interrelationships rather than a single cause.[2]

4.5a General factors in educational innovation

Fullan has identified a series of factors which he believes are linked with at least "partial success" in educational innovations. These include:

- Getting clear on the focus of change.
- Making the change organisational and systemic.
- Managing the ongoing change process.
- Deploying state resources to spur the change.[3]

Fullan considers the case of a US teacher training initiative which, despite training 11,000 teachers, had little transformational effect. He suggests that some of the reasons for the failure were that:

- The programmes were based on vague conceptions rather than a clear idea of what should be done and how. They provided an ideology, but not the required knowledge and skill.
- They focussed on individuals rather than taking into account institutions.
- The interventions were non-systemic, that is they did not adequately consider the inter-institutional relationships.[4]

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[1] Peter Senge, *The Fifth Discipline* (New York, Doubleday, 1990), p81.

[2] Ibid., p73.

[3] Michael Fullan, *Change Forces* (London: Falmer Press 1993), pp59-61.

[4] Abbreviated from Michael Fullan, *Change Forces* (London: Falmer Press 1993), pp109-110.

4.5b Factors associated with implementation of ICT

A number of studies have attempted to model the relative influence of the various factors on the progress of ICT in schools. Tuijnman and Brummelhuis, using data from the 1989 COMPED study, examined the factors associated with successful implementation of ICT in six countries.[1] The highest ranking factors across all countries were internal innovation assistance and teacher competence and readiness. However there was much variation between the six countries in terms of the relative importance of these factors. This variation may have been a result of the different stages in the implementation of computer use in different countries. In the US, which had the longest experience in computer use, the variation between the factors used in this analysis was smaller than in other countries, and the most significant factor was school size. In Japan, which had the least experience of computer implementation, there were strong associations between computer use and a series of other factors, including school policy, perceived importance, and internal staff development.[2]

The study also identified four areas of schools organisation which might prove to be obstacles to implementation of ICT, namely:

- A lack of encouragement and support from school management.
- A negative school climate and mutual support by teachers.
- Absence of a computer co-ordinator.
- Lack of a long term supply and maintenance of hardware.[3]

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[1] Albert Tuijnman and Alfons ten Brummelhuis, "Predicting Computer Use in Six Systems: Structural Models of Implementation Indicators", in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), pp193-195.

[2] Ibid., pp212-214.

[3] I.A.M. Janssen Reinen and Tjeerd Plomp, "The Decision Phase: Starting to Use Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p5.

In the US a programme working with 14 schools in disadvantaged areas to boost ICT integration concluded that leadership in the school was the key ingredient for success. The SEIR-TEC programme identified key traits of principals linked with success in ICT, namely:

- Having a vision of what is possible with ICT.
- Leading by example, perhaps by participating in professional development opportunities.
- Supporting the efforts of teachers who try to use technology.
- Maintaining a stable interest in the reform, by avoiding the temptation to focus constantly on new reforms.[1]

The significance of adoption by individual teachers is underlined by the examples of successful school ICT projects that have reported motivated purposeful learners, yet have ceased when a teacher moves on.[2] In a multivariate analysis of factors related to teacher use of the Internet, Becker found that eight variables had important independent relationships to usage:

- Level of classroom connectivity.
- Teacher's computer experience.
- Constructivist pedagogy
- Participation in staff development on Internet use.
- Involvement in professional leadership activities.
- Having informal contacts with other teachers at their school.
- The teacher age (younger more likely to use and believe in its value)

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[1] Elizabeth Byrom, *Factors Influencing the effective Use of Technology for Teaching and Learning: Lessons from the SEIR-TEC Intensive Site Schools,* Extracts from the SEIR TEC three year report 1998, p1.

[2] Jane M Healy, *Failure to Connect* (New York: Simon and Schuster, 1998), p70.

- Not being a Mathematics teacher.[1]

Of these eight the three most important were level of classroom connectivity, teacher computer expertise, and teacher's pedagogical beliefs and practices.[2] Despite the numbers of computers in schools, it is clear that frequent educational use of them has occurred in only a minority of classrooms. Yet the TLC survey in the US reported that a **majority** of teachers had their students make active and regular use of ICT in the classroom where three conditions coincided. These conditions are: computers in the classroom, adequate teacher skill and a constructivist teacher orientation.[3]

The issue of easy access to computers is also central to integration. In the US in 1999 secondary teachers who use ICT were three times as likely to use ICT on a regular basis if they had computers in the classroom, and a ratio of at least one computer to four students.[4] Similarly teachers with classroom Internet access were four times as likely to have conducted regular e-mail exchanges with other teachers.[5] Such findings are not confined to the US. In Finland one study concluded that:

> *An important reason for the low intensity of ICT usage appears to be that computers were usually located in a separate computer laboratory instead of other classrooms where learning and instruction actually happens. Consequently, students and teachers, in many cases, had access to ICT during special ICT courses. Commonly an ICT expert teacher may have taken up 80-90% of computer laboratory time or*

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[1] Henry. J. Becker, *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use,* Teaching, Learning and Computing: 1998 National Survey Report #1, Center for Research on Information Technology and Organizations (February 1999), p27.

[2] Ibid., p29.

[3] Henry Jay Becker, *Findings for the Teaching, Learning and Computing Survey: Is Larry Cuban Right?* School Technology Leadership Conference of the Council of Chief State Schools Officers, Washington D.C. (2000), p29.

[4], Henry Jay Becker, Jason Ravitz, and Yan Tien Wong, *Teacher and Teacher directed Student Use of Computers and Software,*Teaching, Learning and Computing: 1998 National Survey, Center for Research on Information Technology and Organizations (1999).

[5] CRITO, Center for Research on IT and Organizations, *Regular teacher E-mail Contact with Teachers at Other Schools by Internet Access and Age, Research Snapshot #2,*(1999).

> *otherwise controlled access to the computers. In order to facilitate intensive and pedagogically meaningful use of ICT, it is necessary to bring computers into the classrooms...*[1]

In 1999 the majority of US teachers (80%) felt that lack of time to schedule access to computers was a barrier to use of computers with students.[2] Furthermore, integrated constructivist activities may be better suited to longer class periods and so fit less well in school timetables. Secondary teachers who work in schools involving longer blocks of time were more likely to use ICT during class, even if they met those classes less frequently.[3]

These varied findings suggest that a range of factors may play an important part in encouraging ICT use. At the level of the individual teacher, these include teacher ICT skill, teacher beliefs about ICT and approach to teaching. At school level, key factors may include the support of the principal, the provision of easy access to ICT, an ICT co-ordinator and a positive school climate.

4.5c Unintended consequences

Rogers points out that little of the research on innovation has focused on the consequences of innovation. In this sense the research has tended to have a pro-innovation bias, being more likely to ask what variables are related to innovativeness than to ask what the effects of the innovation are.[4] It is difficult to anticipate all of the consequences of a change, and there may be unintended consequences well outside the scope of the initial vision of the innovation. A dramatic example of unintended consequences can be found in the case of the

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[1] K. Hakkarainen,, L, Ilomaki, L. Lipponen, H, Muukkonen. M. Rahikainen, T. Tuominen, M. Lakkala, and E. Lehtinen. "Students Skills and practices of using ICT: results of a national assessment in Finland", *Computers and Education*, Vol.34 (2000), p116.

[2] National Center for Educational Statistics, *Teachers' Tools for the 21st Century: A report on teachers' use of technology, (2000).*

[3] Henry Jay Becker, *Findings for the Teaching, Learning and Computing Survey: Is Larry Cuban Right?* School Technology Leadership Conference of the Council of Chief State Schools Officers, Washington D.C. (2000), p3.

[4] *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), p375.

introduction of steel axe heads to a stone age aborigine tribe. The change caused changes in the social structure, lowered respect for elders, and a breakdown of trading relations, and an eventual rise in forced prostitution.[1] Rogers concludes that there are usually unintended consequences of an innovation, and that it "is usually difficult or impossible to manage the effects of an innovation so as to separate the desirable from the undesirable consequences".[2]

In the case of ICT in schools one of the potential unintended consequences is the loss of whatever is displaced by the adoption of ICT. The money spent on ICT is large by school standards and recurring, as computers require frequent renewal. As a result, Stoll suggests that computers can do damage by what they displace. In the US there are examples of schools that have cut both supply and staff budgets in order to finance computer purchases, and school districts that have financed computers through issuing 30 year bonds.[3] In many cases the computers have displaced creative activities such as art and music, and in some cases even taken over art or music rooms, or displaced practical work in science.[4]

A second possible unintended consequence is that teachers may become disheartened if educational reforms fail to meet expectations. Huberman found that many teachers engaged in a period of renewal at some point in their careers, sometimes as part of a major national initiative. For some the renewal led to a period Huberman describes as 'positive focussing' where the teacher focused on his/her own teaching in a positive way. For others the result was 'negative focussing' where the teacher retreated into his/her own work, avoiding additional commitments and innovations. Thirdly, for some teachers renewal was followed by a period of bitterness or disenchantment, where the teachers judge the innovation

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[1] Ibid., p389.

[2] Ibid., p383.

[3] Clifford Stoll, *High Tech Heretic* (New York: Doubleday 1999), pp23-24.

[4] Ibid., p28.

negatively. These teachers were often male and many felt resentment of failed policies, mindless paperwork and ill advised approaches.[1]

The type of approach to renewal was a powerful predictor of the follow-on to the renewal. The general pattern reported was that those teachers who were engaged in exploration and experimentation within their own classrooms, and 'tinkering' with ideas and methods, were more likely to be positively focussed after the renewal period. Those teachers heavily involved in school-wide or district wide projects were more likely to be negatively focussed or disenchanted. Other factors associated with long-term teacher satisfaction included having role shifts every few years (typically changes in the grade, subject or stream taught) and having experience of significant successes.[2]

4.6 ICT and pedagogy

The adoption of ICT in schools is often viewed as a process of pedagogical change rather than the introduction of a new area of study. As David Puttnam describes it:

> *..It's become accepted that technology is, in itself, a bridge to learning rather than any kind of destination; and that a critical factor to the successful introduction of new learning tools is the intervention and involvement of a brilliant teacher.*[3]

The significant push factors driving ICT into schools and the relative enthusiasm with which schools are embracing the technology and associated training have lead to discussion of the potential of ICT as a "Trojan Horse".[4] In this view ICT is seen

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[1] Michael Huberman, "Teacher Development and Instructional Mastery", in Hargreaves, Andy and Fullan Michael, eds. *Understanding Teacher Development.* (New York: Teachers College Press, 1992), p130.

[2] Ibid., p131.

[3] David Puttnam. *TES Keynote Speech for the BECTA Awards*, BETT conference, January 11 (2001).

[4] Seymour Papert, *Why School Reform Is Impossible*, The Journal of the Learning Sciences Vol 6, No 4 (1997), pp417-427. Also at www.papert.com/articles/school_reform.html

as the mechanism that allows change in to the normally resistant educational system.

4.6a Catalytic effect

Many education systems anticipate that the adoption of ICT will have a catalytic effect, encouraging the adoption of open approaches, and leading to an increased emphasis on learner centred pedagogy. As this occurs the role of the teacher is altered to include more support and encouragement of learning and less direct exposition. Support for this view is found in some studies as early as the COMPED study, which reported that schools with a longer history of use of computers had higher levels of integrated use of computers.[1]

Some empirical studies have established a link between use of ICT and pedagogy. In the 1989 IEA survey, teachers using computers reported a range of benefits including an increase in students helping each other.[2] The IEA SITES project, a large scale international study, showed a relationship between high levels of ICT in a schools and these teaching styles, described in the study as "emergent practices".[3] In the US, Becker concluded that the teachers using ICT in an open way in the classroom were more likely to have constructivist views of teaching.[4]

> *We have also found that the teachers who have students use non-skills-oriented computer software in academic classes have fairly distinctive teaching philosophies, being disproportionately supportive of constructivist pedagogies such as developing student responsibility for selecting and carrying out learning tasks, emphasizing group work*

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[1] W. J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p231.

[2] Dan Davis, "Implementation and Educational Uses of Computers", in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p117.

[3] Willem Pelgrum and Ronald Anderson. *ICT and the Emerging Paradigm for Life Long Learning: A Worldwide Educational Assessment of Infrastructure, Goals and practices* (Amsterdam: International Association for the Evaluation of Educational Achievement, 1999).

[4] Henry Becker, *Findings for the Teaching, Learning and Computing Survey: Is Larry Cuban Right?* School Technology Leadership Conference of the Council of Chief State Schools Officers, Washington D.C. (2000), p28.

> *involving discourse, and the use of projects, products and performances for outside audiences.*[1]

These suggest that high levels of ICT use are associated with a shift to styles of teaching which are more focused on individual learners, problem based learning, project work, and helping learners to construct their own understanding. These approaches can be considered to be indicative of a broadly "constructivist" approach to teaching.

4.6b ICT and "emerging practices"

The IEA Second Information Technology in Education Study, known as SITES, was a comparative study of ICT in 26 countries. The data for SITES Module 1 were collected in 1998, and published in November 1999.[2]

One part of the study investigated the linkages between pedagogical practices and ICT. School principals were asked to indicate the presence of a list of pedagogical practices in their schools on a three-point scale. Some items on the list were seen as clear manifestations of "emerging practices", while others were interpreted as indicators of "traditionally important practices". The responses were used to construct indices of the level of adoption of the "emerging" and "traditionally important" pedagogical practices in schools.[3]

Emerging pedagogical practices were considered to be indicated by teaching and learning of particular types, described in the table below.

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[1] Ibid., p28.

[2] W.J. Pelgrum and R.E. Anderson, eds. *ICT and the Emerging paradigm for Life Long Learning: a Worldwide Educational Assessment of Infrastructure, Goals and practices* (Amsterdam: International Association for the Evaluation of Educational Achievement, 1999).

[3] W.J. Pelgrum, "Curriculum and pedagogy" in *ICT and the Emerging paradigm for Life Long Learning: a Worldwide Educational Assessment of Infrastructure, Goals and practices*, ed. by W.J. Pelgrum and R.E. Anderson (Amsterdam: International Association for the Evaluation of Educational Achievement, 1999), p92.

TABLE 4. 3: TERMS USED TO IDENTIFY EMERGENT PRACTICES IN SITES[1]

Statements about pedagogical practices deemed to be indicative of emerging pedagogical practices.
• Students developing abilities to undertake independent learning.
• Providing weaker students with added instruction.
• Organising teaching and learning so that differences in entrance level, learning pace, and learning route are taken into account.
• Students learning to search for information, process data, and present information.
• Students largely responsible for controlling their own learning progress.
• Students learning and/or working during lessons at their own pace.
• Students involved in co-operative and/or project based learning.
• Combining parts of schools subjects with one another (multidisciplinary approach)
Statements about pedagogical practices deemed to be indicative of traditionally important pedagogical practices.
• The emphasis in learning is on the development of skills.
• Students working on the same learning materials at the same pace and/or sequence.
• Teachers keeping track of all student activities and progress.

Using the descriptors above, the IEA team constructed measures of the type of pedagogical practice in schools. This allowed the researchers to explore the relationship between length of time using ICT in the schools and the adoption of the "emerging" pedagogical practices. If it is believed that ICT has an effect in facilitating or encouraging the adoption of the alternative pedagogical practices, then might be hypothesised that there would be a higher incidence of these practices in schools with a long history of ICT usage.

Although there was a wide variation both within and between countries, overall the data did not support this hypothesis. Schools which had been using ICT for a long period reported higher levels of emerging pedagogical practice, but also higher levels of traditionally important pedagogical practice. The two indices tended to co-vary in a similar way with the number of years of ICT usage. This pattern occurred at all three levels.[2]

However, schools with low computer-pupil ratios (i.e. High levels of equipment), show much higher levels of the emerging pedagogical practices.[3] These data lead to

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[1] Ibid, pp 91-92.

[2] Ibid., pp95 and 96.

[3] Ibid., p116.

the tentative suggestion that the level of ICT equipment in the school may have some relationship to the pedagogical practices.

4.6c Teacher constructivist beliefs and ICT use

In the US, Becker examined the relationship between teachers' pedagogical beliefs and their use of the Internet. Having develop an index of constructivist beliefs, he found that teachers with higher score on constructivist thinking were more likely to value the Internet as an educational tool, to use the Internet themselves, to have their students use the Internet and to lead their students to publish material on the Internet.

TABLE 4. 4: TEACHERS BELIEFS AND INTERNET USE, TLC STUDY, US 1998[1]

Figures shown are scores on constructed scales. (Values between 0 and 1)	Teacher's perception of the value of the Internet	Teacher Internet Use	Student Research using the Internet	Student Projects and Publications on the Internet
Most traditional (22%)	.34	.12	.11	.02
More traditional than constructivist (31%)	.43	.12	.16	.04
More constructivist than traditional (29%)	.54	.25	.25	.07
Most constructivist (19%)	.65	.30	.31	.09

However Becker suggests that simply having teachers use computers may not change their practices to be more constructivist. Rather, he suggests, the technology "is having an emancipating effect on those teachers who believe in project-based teaching and other constructivist-compatible practices".[2]

4.6d Limitations to the evidence

It must be acknowledged that the evidence for the impact of ICT adoption on pedagogy is limited and there is a good deal of counter-evidence. In some cases ICT may be used without achieving the kinds of meaningful learning environment

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[1] Henry J. Becker, *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use,* Teaching, Learning and Computing: 1998 National Survey Report #1, Center for Research on Information Technology and Organizations (February 1999), p23.

[2] Ibid., p32.

anticipated. The recent OFSTED report on the progress of ICT in UK schools noted that in Key stage 2 (late primary school), the range of ICT experiences had broadened, and use of word processing was widespread, but that the use of the Internet was still limited. Many pupils were unable to recognise useful material or synthesise what they found and needed teachers to filter the information. However the report recorded that "too often there is little purpose to the search beyond the exploration itself, and pupils simply print out the blocks of text, pictures, tables and graphs as ends in themselves".[1]

4.7 Conclusion

This chapter has been concerned with ICT as an innovation. In the context of the substantial investment in ICT in education in many countries and the sometimes uneven and disappointing results, the question of how adoption of ICT in schools could be supported is of interest. Conventional innovation theory has suggested that adoption of innovation tends to follow a regular pattern, and that the "early adopters" are identified by characteristics such as higher disposable income, higher level of education and greater levels of communication with others. In the conventional model the innovation "takes off" after a certain point, and then is rapidly adopted by the majority. However writers focused specifically on adoption in schools have suggested that innovation in schools is a more complex process, because of the nature of schools as organisations.

Janssen Reinen and Plomp suggest a three level model of the factors affecting the implementation of ICT in schools. At the macro level the implementation is influenced by government policy, curriculum, software publishers, teacher training and support agencies. At the micro level the key influences are the student, and in particular student objectives, home support and attitudes to school. Between these two the meso level includes the influences of teachers, school principals and school

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[1] OFSTED, *ICT in Schools. The Impact of Government Initiatives* (Interim Report, April 2001), p8.

departments.[1] The focus of this review has been mainly on the meso level, which for clarity has been further divided into the *teacher level* and *school level.*

At the level of the individual teacher, a series of factors have been shown to influence use of ICT in the classroom. These include teacher ICT skill and confidence, ease of access to technology in school, and access to ICT at home. There is also evidence that teacher adoption of ICT may be influenced by teacher beliefs about ICT and about teaching, and in particular that teachers with a constructivist approach to teaching may be more likely to use ICT in their classrooms.

At school level the factors which have been suggested to impact on adoption include the interest and support of the school principal, the presence and approach of the ICT co-ordinator and the location of the equipment. There are also suggestions that the successful adoption may depend on a positive school climate, and the ability of the staff to plan as a unit.

Other factors, external to the school, also appear to be significant. The attitudes and expectations of parents may be important influences on school policy. The curriculum and examination system in which the school operates, may also have a significant influence, and may make adoption more difficult, particularly at post-primary level.

Many government strategies have attempted to support the adoption of ICT in schools through a series of measures. Strategies employed have often included programmes of teacher training, pilot projects, and the use of active change agents such as ICT advisors. However all of these strategies carry the risk of generating unequal adoption. Courses may be attended by only the most interested, pilot projects reach only a number of schools, and advisors may tend to work with the people most amenable to change.

Given the level of interest in ICT by policy makers, it is not surprising that some studies have attempted to isolate specific factors with the most impact on the

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[1] I.A.M. Janssen Reinen and Tjeerd Plomp, "The Decision Phase: Starting to Use Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p8.

adoption of ICT. However these have not produced a single clear result. Instead the adoption of ICT appears to be influenced by a complex of inter-related factors, and the main factors may be different in different countries.

A key question both for policy makers and educators is whether the use of ICT has an impact on pedagogy. While there is evidence that use of ICT is associated with constructivist pedagogy, some have argued that the presence of ICT may act as a catalyst encouraging the development of constructivist approaches. However other studies have suggested that ICT does not encourage these approaches, but allows an existing constructivist orientation to emerge.

This uncertainty remains in current debate about the role of ICT. Technophiles view the technology as the change agent, and so see the solution in increasing the numbers of computers and developing software and infrastructure. Cuban offers an alternative development model, with slower change as schools "take time to learn how to use computers to guide student learning". However such change is inexorable, as education must inevitably adapt to the nature of work and society. In this "Cautious Optimist's" view, change is driven slowly by a gradually increasing number of teachers who use computers.[1]

Fullan's dictum that 'you cannot mandate what matters', suggests that what really matters are complex changes of skill, attitudes and commitment. While having a policy is important, he contends that policy alone cannot produce these kinds of changes, and that the more the policy attempts to define the changes, the more narrow the goals become.[2]

> *It is no denial of the potential worth of particular innovations to observe that unless deeper change in thinking and skills occur there will be limited impact.*[3]

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[1] Larry Cuban, "Computers Meet Classroom: Classroom Wins" Teachers' College Record, Vol. 95 No. 2, TCR ID 82 (1993), pp8-9.

[2] Michael Fullan, *Change Forces* (London: Falmer Press, 1993), p22.

[3] Ibid., p23.

Similarly Rogers points out that many organisational changes fail because they start too big, moving too quickly over the "routinizing" of activities.[1] All three of these perspectives point to the change in schools to be a gradual, organic process focused on the teacher and the culture of the individual school, rather than an simple matter of equipment and training. However such an organic diffusion process may have equality implications, at least in the short term, and may widen the gaps between early adopters and late adopters.

[1] *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), pp364-6.

CHAPTER 5

METHODOLOGY

This study is an examination of the patterns of adoption and use of ICT in Irish schools in the period 1998 to 2000. The design of the research was influenced by the lack of prior large-scale empirical work in this area in Ireland. Once the need to undertake a large-scale study had been identified, a postal survey suggested itself for reasons of both practicality and objectivity. One of the risks of such a method is that it can provide a "cross sectional" picture, of little use in identifying causal factors.[1] Two strategies were adopted to avoid this difficulty. The first was the use of a longitudinal research model,[2] with surveys before and after the major policy initiative. The second was a qualitative component, centred on a series of case studies, which were used both to refine and to interpret the quantitative work.

The research thus included three major components. Two written surveys of all the schools in the population under study were conducted, one in 1998 and the other in 2000. The third component was a series of case studies of schools conducted by personal visits to schools in 1999. The two quantitative studies were used to provide a picture of the state of ICT in Irish schools in 1998 and 2000 and to conduct an analysis of the changes that occurred during the period. The case studies, although small in number and making no claim to be representative, informed the design of the second survey and provided insights not accessible through the quantitative surveys.

As this study is primarily based on quantitative surveys, it may be considered to be descriptive research, in that it did not set out to make a change, but to record events.[3] The primary analytical method was comparison,[1] usually comparison of the situation of different types of schools.

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[1] Louis Cohen and Lawrence Manion, *Research Methods in Education,* Fourth Edition (London and New York: Routledge, 1994), p69.

[2] Ibid., p69.

[3] Ibid., p67.

Bell warns that quantitative studies based on broad objectives risk resulting in large quantities of data and little idea of what to do with it.[2] Although this study was not designed to demonstrate any specific theory, studies in other countries suggested a series of working hypotheses which were used to structure the research. These hypotheses can be organised into two main themes. The first of these is derived from the social rationale for the use of ICT in schools.[3] If, as assumed in this argument, ICT is an important skill for full participation in society then it is important that all citizens should be prepared with such skills while in school. Yet there is evidence from other countries that schools may do little to address the social pattern in ICT skills, and in some cases may even act to enhance it.[4] This study sought to examine whether such social patterns in ICT within school existed in Ireland and how they had changed in response to policy initiatives. The working hypotheses derived from this argument were:

- That ICT tended to be more developed in boys' schools than in girls' schools.
- That ICT tended to be less developed in the schools attended by the socially disadvantaged learners.
- That ICT tended to be less developed in rural schools than in urban and suburban schools.
- That smaller schools tended to be disadvantaged in terms of ICT equipment compared with larger schools.

The second series of hypotheses was derived from the pedagogical rationale. If, as suggested by the pedagogical rationale,[5] ICT offers the potential to make a qualitative improvement in teaching and learning, then the extent to which ICT is

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[1] Bruce W. Tuckman. *Conducting Educational Research*, Fourth Edition (Forth Worth, Texas: Harcourt Brace College Publishers, 1994), p11.

[2] Judith Bell. *Doing Your Research Project,* Second Edition (Buckingham, UK: Open University Press, 1993), p19.

[3] See section 1.1a

[4] See sections 2.2 and 3.4

[5] See section 1.1b

used in support of teaching and learning is important. The study sought to examine the use of ICT in support of curricular subjects, and the factors associated with successful adoption of ICT in this role. Hypotheses related to this argument included:

- That curricular use of ICT was heavily influenced by teachers' ICT skill.[1]
- That curricular use of ICT was influenced by teachers' home computer access.[2]
- That curricular use of ICT was influenced by teachers' pedagogical thinking about ICT.[3]
- That curricular use of ICT was influenced by whole school interest in ICT, as indicated by joint planning.[4]
- That curricular use of ICT was influenced by the school principal.[5]

These two areas of enquiry were related, as evidence from other countries suggested the presence of social patterns in the pedagogical use of ICT.[6] This led to the formulation of a further working hypothesis that:

- Schools attended by socially disadvantaged students make less curricular use of ICT than other schools and engage in fewer of the constructivist activities, such as those involving Web publication.

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[1] See section 4.3

[2] See section 4.2c

[3] See section 4.2f

[4] See section 4.2L

[5] See section 4.2d

[6] See section 3.4

5.1 1998 survey

The 1998 data were gathered in the Schools IT 2000 School Survey, which was conducted by Telecom Eireann, in conjunction with the NCTE and the Department of Education and Science. The 1998 survey was not conducted as part of this study, and was designed by Telecom Eireann and the other survey partners. Following the data input, the raw data files were provided to this study, in return for which an analysis of the data was provided to Telecom.[1]

All primary, post-primary and special schools in Ireland, with the exception of fee-paying Catholic schools,[2] were surveyed in Spring 1998 using a postal questionnaire. Follow-up phone calls were used to remind schools which did not reply. Schools had an additional incentive to reply, as the completed questionnaires were used to plan the distribution of equipment and services by Telecom Eireann. In all 3,995 schools replied, resulting in a response rate of 97.7%.

TABLE 5. 1: RESPONSE TO 1998 SURVEY

School type	Total[3]	Response	% response rate
Primary schools	3200	3156	98.6
Post-primary schools	775	723	93.3
Special schools	115	108	93.9
Schools of unknown type. (Did not reply fully)		8	
No of schools	**4090**	**3995**	**97.7**

[1] This report is reproduced as Appendix E.

[2] Catholic fee-paying schools were excluded from the *Schools IT2000* programme and did not receive the equipment grants. As this survey was part of the Schools IT2000 programme, it did not include the fee-paying Catholic schools. This policy excluded approximately 35 schools from the survey. The exclusion of fee-paying Catholic schools from the *IT2000* programme was consistent with Department of Education and Science practice in other programmes. This policy was explained by NCTE in informal communication as resulting from a desire not to fund fee-paying schools combined with a desire not to discriminate against non-Catholic schools, which are over-represented among the fee-paying schools.

[3] Total number of schools of each type taken from *Brief Description of the Irish Education System*, Department of Education 1996.

5.1a Questions

A single questionnaire was used for all schools, primary and post-primary. The questionnaire, included in appendix A, covered the following major areas:

TABLE 5. 2 THEMES IN THE 1998 SURVEY

Section	Main theme	Topics.
A	General Information	School type, size and location.
B	Computer Equipment	Number and type of computers, network, peripherals.[1]
C	Computer Use	Subject areas in which computers were used and frequency of use. Types of applications and "usefulness" of these applications.
D	Classes with access to computers	Classes with access and average hours per week of access.
E	Internet access	Type of internet access.
F	Readiness for ICT	ICT co-ordinator, participation in ICT pilot projects. Skill level of teachers, male and female.
G	Contact information.	

All questions were designed for rapid data input. There were no questions that allowed for opinion or comment, and all replies were either numbers or factual text items. There were a number of limitations to this survey. In section D, respondents were asked to indicate for each class whether computers were used, and the Number of hours per week of computer use with this class. While the first part of the question was unambiguous, the latter part was open to different interpretations. Some schools may have provided the total amount of computer time used by first year classes, while others may have given the amount of computer time given to each first year class. Obviously this ambiguity is of most significance in larger schools, where there are multiple classes of each type.

In section C the respondents were asked to indicate the use of computers in a series of subject areas. Unfortunately not all subjects were included in this list, Technology was omitted and English and Irish were not listed separately, but included under the general heading of Languages.

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[1] The table on peripherals in the 1998 survey included questions about "peripherals with CD ROMs, and MODEMs". While these were presumably an error, they may have made the responses to this table less reliable.

The 1998 survey did not record some of the general school characteristics of interest to this study. Gender of students was not recorded, nor was the location of the school or whether the school had disadvantaged status.

5.2 Case studies of ICT in schools

During the spring of 1999 a sample of 30 schools was selected and surveyed in more detail. While it is clear that a small sample of schools is unlikely to be genuinely representative[1], the case studies were intended to complement and contribute to interpretation of the quantitative data. As Cohen and Manion suggest, their role was "to probe deeply and to analyse intensively the multifarious phenomena".[2]

5.2a Selection of schools, post-primary

The schools involved in this part of the study were selected using a stratified cluster[3] sampling procedure. Given the small number of schools to be included, it was not possible to design a sample that could be regarded as representative of Irish schools. Instead the sampling was designed to ensure that the schools selected reflected that range of contexts and types of school.

Stratification was based on the 1998 survey data. This data revealed variation with school type in post-primary schools, and variation with school size in primary schools. In addition the survey had revealed some regional variations, although no clear geographical pattern. Hence for post-primary schools the stratification was based on type and location, while for primary schools it was based on size and location.

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[1] Robert E. Stake, *The Art of Case Study Research* (London: Sage, 1995), p5.

[2] Louis Cohen and Lawrence Manion, *Research Methods in Education,* Fourth Edition (London and New York: Routledge, 1994), p106.

[3] Ibid., p88.

TABLE 5. 3: KEY INDICATORS FOR POST-PRIMARY SCHOOLS, 1998 DATA

Type of school	Number of schools	Total number of pupils	Number of computers	Average computers per school	Pupil computer ratio
Secondary	388	195,876	9,829	25	20
Vocational	172	64,132	6,221	36	10
Comprehensive	15	8,267	598	40	14
Community college	51	25,131	2,021	40	12
Community school	58	40,641	2,582	45	16
Total	**684**	**334,047**	**21,251**	**31**	**16**

Fifteen post-primary schools were selected. Three sampling regions were identified, and within each five schools were selected, as follows:

- 1 single-sex boys' secondary school.
- 1 single-sex girls' secondary school.
- 1 mixed secondary school.
- 1 community school / community college / comprehensive school.
- 1 vocational school.

As a result of this pattern, 60% of the schools were secondary, but there were vocational and community/comprehensive schools selected in each region. The selection of boys', girls' and mixed schools in each region provided an opportunity to examine the gender patterns revealed in the 1998 data.

The regions were selected on the basis of existing regional patterns as indicated by average computer pupil ratios in the 1998 survey. Regions were based on the regional groupings used in the Department of Education and Science listing of Post-primary schools. These regions are normally counties, but in the cases of Dublin, Cork, Galway and Limerick, the city and county areas are separated.

The regions selected were Dublin City and two counties outside Dublin, roughly reflecting the national distribution of schools with approximately one third in the Dublin area. The counties outside Dublin selected were those with the highest and lowest average computer pupil ratio. In order to avoid distortions of the pattern caused by extreme cases, a 5% trimmed mean was used. This resulted in the selection of the following 3 areas:

TABLE 5. 4: SAMPLING AREAS FOR CASE STUDY SCHOOLS, 1999

Area	Average computer pupil ratio based on 5% trimmed mean (1998 survey).
Dublin City	23.1
Wexford	30.6
Galway county.	17.7

Within each category (eg. Vocational schools in Co Galway) the schools to be visited were selected at random from the Department of Education published list of schools, thus even schools which had not replied to the 1998 survey were included in the random sampling.

5.2b Selection of primary schools

The selection of primary schools was designed to parallel the sampling in the post-primary school survey. The same three regions were selected and a similar number of schools in each region were included. In each region, only those schools in the hinterlands of the post-primary schools surveyed were included. Primary schools were stratified by schools size. The stratification was matched to the size profile of primary schools in the national system. The size stratification was arranged as follows:

TABLE 5. 5: SIZE STRATIFICATION USED IN SELECTION OF CASE STUDY PRIMARY SCHOOLS, 1999

	Dublin	Galway and Wexford
Schools 1 and 2	Schools under 100 pupils	Schools under 100 pupils
School 3	School between 101 and 200 pupils	School between 101 and 200 pupils
School 4	School over 200 pupils.	School over 200 pupils.
School 5	Additional school over 200 pupils.	Additional school under 100 pupils.

The variation in sample between Dublin and the other two areas reflects the size profile of schools in these areas. Within each category schools were selected at random as with the post-primary schools.

5.2c School codes

Schools are not identified by name in this report, but logical codes are used throughout. Codes beginning with the letter S are post-primary schools, while those

with the letter P are primary schools. The second letter indicates the region, and the number indicates the school type, as follows:

TABLE 5. 6: SCHOOLS CODES USED FOR CASE STUDY SCHOOLS

Initial letter	Second letter	Final number, post-primary schools	Final number, primary schools
S Post-primary P Primary	D Dublin City G Galway County W Wexford	1 Single-sex boys' secondary school. 2 Single-sex girls' secondary school. 3 Mixed secondary school. 4 Community school / community college / comprehensive school. 5 Vocational school.	1 Schools under 100 pupils 2 Schools under 100 pupils 3 School between 101 and 200 pupils 4 School over 200 pupils 5 (D) Additional school over 200 pupils. (G or W) Additional school under 100 pupils.

Hence school SW4 is a community school in Wexford, and PD2 is a small primary school in Dublin.

Each of the schools selected was approached and asked to participate. All of the post-primary schools selected agreed to be interviewed. All but one of the primary schools selected agreed to be interviewed. The remaining school was unable to co-operate[1] and was replaced using the same random selection system.

The post-primary schools involved in this part of the study included one private fee paying school and 4 schools with disadvantaged status. They ranged in size from 130 students to 1,500 students, as follows:

TABLE 5. 7: SIZE DISTRIBUTION OF POST-PRIMARY CASE STUDY SCHOOLS

	No of schools in sample.
Under 200 students	3
200 - 499	4
500 - 1,000	7
Over 1,000	1

Five of the post-primary schools sampled were in Dublin city and suburbs. Another 5 were in towns (population over 3,000). The remaining 5 were in smaller centres of population, including some small towns and villages, and one in a rural location.

Schools were asked to give an indication of the social background of the students, and the proportion with home access to computers. Some were unable to estimate

[1] The school was being closed down and was about to cease operations at the end of June 1999.

the level of home computer access, but for the others there was a wide variation in estimates, ranging from "almost all" to "less than 20%". Urban schools with middle class catchment areas had the higher rates of home access. Vocational schools and schools in smaller centres of population had lower rates of home access.

The fifteen primary schools selected comprised 5 city schools, 2 in towns, 4 in villages, and 4 away from centres of population. Four of the primary schools were designated as disadvantaged. The schools included 10 mixed schools, 3 boys' schools, and 2 schools that were primarily girls' schools.

5.2d Nature of visits

Each of the selected schools was visited and the principal and /or IT co-ordinator were interviewed. Interviews were chosen because of the greater depth of examination that they allow.[1] However some potential bias in the interviews must be recognised. Bell notes that case study interviews can be biased through the selection of the topics,[2] or through the reaction of the interviewer during the interview.[3] There is also some risk of miscommunication, either accidentally, or through deliberate holding back on the part of the interviewee.[4]

The interviews were designed to elicit as many unstructured responses as possible.[1] However to ensure that the same areas were discussed in each interview, the interviews were organised around a series of issues for discussion. These were not specific questions, but "areas of enquiry", and were intended to allow schools to tell the story of ICT in their schools from their perspective as far as possible. These approximate to Stake's suggestion of a "short list of issue-oriented questions",

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[1] Ibid., p271.

[2] Judith Bell. *Doing Your Research Project,* Second Edition (Buckingham, UK: Open University Press, 1993), p9.

[3] Ibid., p95.

[4] Louis Cohen and Lawrence Manion, *Research Methods in Education,* Fourth Edition (London and New York: Routledge, 1994), p275.

which can be followed by additional probing questions.[2] The structure of these interviews was derived from the hypotheses in this research and from experience of a previous research project where a similar interview technique had been employed.[3]

In order to ensure that interviewees provided "informed consent",[4] each interview began with an explanation of the research project and the uses to which the information given would be put. Interviewees were assured that their comments would be noted, but that specific schools would not be identified in the report. The interviews were not tape recorded, but notes were taken on paper and elaborated in more detail as soon as possible after each visit.[5]

TABLE 5. 8: MAIN TOPICS USED IN CASE STUDY SCHOOL INTERVIEWS

	Section	Main topics.
1	Usage of ICT	**Time allocated to ICT and pattern of access.** Total amount of time used in computer room (scheduled, impromptu classes, "open use time", voluntary extra curricular activities.) Pattern of take-up of voluntary extra curricular activities, and open use time (gender, home computer, ability) **Type of Use of ICT.** Kind of software used, amount of integration. **Internet use.** Connectivity, usage, regulation and cost.
2	Equipment	Numbers and quality of computers. Schools network. Location of computers. School expenditure on ICT, the impact of the grant. Maintenance and renewal. Links with local bodies, industry, community groups, or parents. Software used and how it was selected.
3	Background of students	Estimates of socio-economic status of students and the proportion with home computer access.
4	Teacher ICT skill	Proportion of teachers using ICT, or having ICT skill. Training activities and participation in training.
5	Schools vision of ICT	School ICT plan, its status and main vision, and the process used to develop it. Schools vision of the benefits of ICT. Were any pedagogical benefits anticipated or noticed? Was there any social-equality intention? Were any differences in responses to ICT, with gender, academic performance or home access. The perceived key issues for future development and barriers to further use of ICT.

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[1] Bruce W. Tuckman. *Conducting Educational Research*, Fourth Edition (Forth Worth, Texas: Harcourt Brace College Publishers, 1994), p218.

[2] Robert E. Stake, *The Art of Case Study Research* (London: Sage, 1995), p65.

[3] Aidan Mulkeen. *Irish Tech Corps External Evaluation.* (Unpublished report, 1998).

[4] Louis Cohen and Lawrence Manion, *Research Methods in Education,* Fourth Edition (London and New York: Routledge, 1994), p349.

[5] Robert E. Stake, *The Art of Case Study Research* (London: Sage, 1995), p66.

5.2e Teacher survey

Following the case study visit, each school was asked to co-operate in administering a whole staff survey of ICT skills, usage and attitudes. This survey provided the opportunity to examine the pattern of teacher ICT skill and its variation with age and gender. It also provided information on usage of ICT and barriers to usage. This survey was an important component of the research in that it provided an opportunity to examine teacher's attitudes. In all other parts of the research, attitudes recorded were "school attitudes" reported by the principal or ICT co-ordinator. Earlier studies have noted differences between the attitudes of principals and teachers with regard to ICT. The 1989 IEA study for example, examined the school principals' and teachers' opinions of the problems that might occur in the implementation of computer use in schools. Both teachers and principals identified the technical infrastructure as the most significant problem. However the principals identified teacher skill as the second most significant problem, while the teachers identified lack of time for preparation as the second most significant problem.[1]

TABLE 5. 9: MAIN TOPICS IN TEACHER SURVEY

	Section	Main topics.
1	Home computer	Home computer access, age of computer and frequency of use. Home internet and e-mail.
2	Computer skill	Self-assessment based on ability to perform a series of specific tasks.
3	Computer courses	Participation in courses to do with ICT.
4	Using ICT in teaching.	Was ICT used in teaching, if so in which subjects, and what kind of activities (selection from list). If not, what were the barriers to use (selection from list)
5	Personal	Age and gender.

Of the 15 post-primary case study schools, ten responded to the teacher survey. One school declined to participate in this part of the study, and a further four agreed to participate but did not respond. The 10 schools that responded had 370 teachers, of whom 242 replied, a response rate of 65%.

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[1] Dan Davis, "Implementation and Educational Uses of Computers", in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems*, (Oxford: Pergamon Press, 1993), p111.

Fourteen of the fifteen primary schools responded to the survey. These 14 schools had 102 teachers of whom 90 replied, a response rate of 88%.

5.3 The 2000 survey

The second quantitative survey was timed to reach schools in the spring of 2000, at the same time of year as the earlier survey. In the two years between 1998 and 2000 schools had received equipment and support from Telecom Eireann, initial grants from NCTE in 1998 and subsequent grants from NCTE in 1999. The two-year interval also allowed time for teachers to participate in training and for school structures and practices to adapt to the presence of the equipment.

This second survey was supported financially by NCTE. The survey carried the logos of the Department of Education and Science and the NCTE and the covering letter was signed by the director of the NCTE. This branding of the survey was deliberate and was intended to make schools aware that the data would be available to NCTE and to encourage a high response rate.

5.3a Questionnaire design

The questionnaire used in 2000 was designed with a series of parameters in mind. It was intended for use in conjunction with the 1998 survey and therefore some of the questions were matched to those in the earlier survey. However it was also aimed at exploring a wider range of issues, informed by the literature reviews and the issues arising from the visits to the case study schools. As a result the survey aimed to record more of the general characteristics of the school, such as gender, location and disadvantaged status. It also probed the type of use of ICT in more detail than the earlier survey, and examined schools' own attitudes and thinking about ICT.

TABLE 5. 10: THEMES IN THE 2000 QUESTIONNAIRE.

Section	Theme	Main topics.
A	General Information	School type, size, location, gender of students, indicators of special categories such as disadvantage.
B	Technology	Number and type of computers, network, peripherals. Location of computers.
C	Internet	Internet connectivity and usage. Teacher and principal use of e-mail. School website.
D	Use of ICT	Classes with access and frequency of access. Subject areas in which computers were used and frequency of use. Factors determining pattern of use. Types of applications and proportion of ICT time devoted to these applications.
E	Teachers and training in ICT	Teacher participation in ICT courses. Teachers with home computers or Internet. Teachers using ICT in teaching. Estimate of teachers with some ICT skills.
F	Experience and structures.	Presence of an ICT co-ordinator and school plan. Participation in pilot projects. Technical security and maintenance.
G	School Priorities and needs for ICT	Satisfaction with current provision. Educational priorities. Priorities for training and support. Priorities for equipment. Priorities for infrastructure development.

Separate questionnaires were developed for primary and post-primary schools. These were very similar, but adapted to the classes and subject areas of primary and post-primary schools. The form for post-primary schools enquired about certification of ICT skills, but this was not included in the primary school survey for fear of encouraging the adoption of certification in primary schools. The primary school survey included a question (F3) about school targeting of software to avoid duplication, which was not considered relevant for post-primary schools.

Within the primary school survey, a second version of section D was included for use by Special schools. This section included the age categories and curricular areas in use in special schools.

The survey was designed to be as convenient to complete as possible. Most of the questions required either numerical answers or ticking of boxes. In other cases the questions required scaled responses. These provide data that can be used without

re-coding and can be treated as interval data.[1] Where scaled responses were required, definitions were provided for each of the possible answers.

TABLE 5. 11: EXAMPLE OF QUESTION D1, SHOWING THE FREQUENCY SCALE

Access to ICT	**N/A** Not applicable		**Never** No access in class time	**Occasional** Less than 1 period per month	**Regular** Less than 1 period per week	**Frequent** 1 period per week	**Very Frequent** 2 or more periods per week		**Out of hours** Access outside of timetabled classes
1st year	☐		☐	☐	☐	☐	☐		☐

5.3b Pilot study

The questionnaire was designed in early 2000. Following the initial design the draft questionnaire was presented to NCTE staff and its contents discussed. Specific NCTE interests resulted in the inclusion of additional questions, such as the use of ScoilNet, the prevalence of virus protection software, and the awareness of the Data Protection Act.

The survey was pilot tested on a small group to check that the questions and instructions were clear, were interpreted consistently and measured the intended items.[2] The pilot test was carried out on 6th March 2000 with a group of teachers interested in ICT, mainly ICT co-ordinators. This was an opportunity sample, using students on a postgraduate course in NUI Maynooth.[3] These teachers were asked to complete the form for their own school, and also to provide feedback on any part of the form that they found unclear. All of the pilot forms were completed correctly and the group reported no difficulty with the questionnaire design. This pilot exercise demonstrated that the survey could be completed in around 20 minutes by people who were familiar with ICT in their schools.

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[1] Bruce W. Tuckman. *Conducting Educational Research*, Fourth Edition (Forth Worth, Texas: Harcourt Brace College Publishers, 1994), p222.

[2] Ibid., p235.

[3] The course was the Higher Diploma in Arts, Applications of ICT in Education. This is a one-year part-time postgraduate programme for experienced teachers.

In design of the questionnaire, two alternative approaches to identifying school priorities were considered. The first was to ask schools to rate each item as a high or low priority using a 4-point scale. This approach allowed schools to consider each item individually, but raised the risk of schools simply marking all as high priority. A second alternative was asking schools to rank the possibilities. In the pilot survey the questions in section G used a mixture of these two approaches. Those questions using attitude scales were generally filled in appropriately, while the ranking alternative seemed to have presented more difficulty. Following this pilot, all questions in section G were adapted to use attitude scales.

In the questionnaires learners in primary schools were referred to as pupils, while those in post-primary schools were students, as per the NCTE standard. The same terminology was used throughout this study, but where both primary and post-primary learners were considered at the same time the word students was used as a generic term for both.

5.3c Administration – response and follow up

Both questionnaires were produced in both Irish and English versions. These were printed back to back, so that both languages were provided to each school. The survey was posted on Tuesday 9th May 2000. The primary version was posted to 3,311 schools and the post-primary was posted to 722 schools, based on a list provided by the Department of Education and Science to NCTE. As with the 1998 survey, fee-paying Catholic schools were excluded from this mailing.

On the day of posting, the on-line version of the survey form was not ready for use. In its place, a Web page advised that the survey should be returned to NCTE by post. The on-line version was made operational on Wednesday 17th May. However the initial version worked only with Microsoft Internet Explorer and not with the alternative Netscape browsers.

By the closing date, May 26th, a total of 1,755 questionnaires had been returned in paper form, and a further 70 had been returned electronically (45% of the total). From 1st June 2000, four students were employed to work as research assistants to the project. Between 1st and 26th June, these research assistants contacted all of the schools that had not replied to the survey. Initial contact was by telephone, and follow-up contact was made in writing where there was no response. By the end of

July the response had grown to 3,481 schools, or 86% of the total. These figures compare favourably with the typical response rates of 40% rising to 75% after three follow-up contacts suggested by Cohen and Manion.[1]

TABLE 5. 12: RESPONSE TO THE 2000 SURVEY BY AUGUST 2000

Primary	Post-primary	Total	Percentage of primary schools	Percentage of post-primary schools	Percentage of schools
2861	620	3481	86.4	85.9	86.3

5.3d Data entry and cleaning

Data entry began on June 5th, and was completed by the end of July. The responses received on paper were entered into a database via an online entry form similar to that used by schools that replied online. This arrangement ensured that online and paper replies were subject to the same restrictions. The research assistants working on the data entry were instructed to amend the written data in the following situations:

TABLE 5. 13: CODING DECISIONS MADE DURING DATA ENTRY PHASE

Question	Decisions
A7 Pupil gender	Some primary schools are "girls schools", but have boys in infants (or vice versa). In these cases they were coded as all boys or all girls. Note that this means some schools coded as single-sex might identify gender as a priority issue.
A9 Number of teachers.	Some schools reported fractions of teachers, often with a note in the margin indicating a shared resource teacher. In these cases the numbers were rounded down to the number of full time teachers. Note that this might mean more teachers participating in courses than the total number of teachers in the school.
B1 Equipment in school.	In this table of equipment present, some schools included the numbers of computers, but not the totals. In this case totals were calculated at the time of data entry.
B2 Classrooms with computers.	Some schools had computers on trolleys. Classrooms with occasional access via a trolley were NOT considered to have a computer for the purposes of B2.

[1] Louis Cohen and Lawrence Manion, *Research Methods in Education,* Fourth Edition (London and New York: Routledge, 1994), p99.

D3 Factors determining use of ICT	Some schools ticked multiple factors, although the question asked for one factor. In these cases the factor most indicative of a developed school strategy was chosen. Hence: Having a school strategy took priority over the others, and Teacher skill took priority over teacher interest.
D4 % of ICT time spent on each type of application.	Some schools included percentages that did not add to 100%. Where this was an apparent adding error the figures were reduced in proportion. Where the totals were not calculated, these were included.
D6 School certification of ICT skills	Some schools ticked multiple options. In these cases the highest option was selected, thus: External certification took precedence over internal, and internal certification took precedence over no certification.

Data cleaning and testing

Following data entry the data was subjected to a process of cleaning and verification. A number of schools had been entered twice, and some more frequently. Often this was a result of a school responding online and sending a copy on paper. When the database was complete a full list of duplicate entries was compiled. Each of the entries was examined, and the more complete record was retained and the other deleted.

Schools are identified by a unique number known as a roll number. This number consists of a numerical string with a single letter at the end. This letter is a check digit, determined by a calculation from the earlier numbers. In some cases schools entered numbers without a check digit. In these cases the digit was added, following a cross check of the school name.

Some schools provided roll numbers that did not appear on the list of schools. Each of these was checked individually. Some were errors in writing the number, and the correct school could be identified by the school name. In other cases schools had genuinely new numbers, as a result of amalgamations or the building of new schools. In these cases the new numbers were added to the database.

A small number of schools wrote to the project reporting errors that they made when entering the data on-line. These modifications were made in the database during the checking process.

The data was then inspected visually for inconsistencies or unlikely values. The database was checked one field at a time. In each case the data was sorted on the field to be checked, and then checked by scrolling through the records. This process identified mainly typing errors, typically cases where county names were misspelled or non-numerical data in numerical fields. This process also identified a small number of "unlikely values" such as a school with 5 pupils. These were checked against the written form and repaired as appropriate.

Following these visual inspections, a series of numerical tests were devised to highlight unlikely values for checking. One calculation divided the number of pupils by the number of teachers and examined the extreme values. A second examined the extreme values for pupil:computer ratio. These tests revealed few data entry errors, as most of the extreme values were explained by unusual circumstances in the school.

Once the data was cleaned and tested, a sample of schools was selected at random for checking. For each of these schools the survey form was compared with the database entry. This final check revealed no errors, and analysis of the data was begun.

During data entry comments written on the survey form were entered into a text file and indexed. These were later grouped into those on similar themes and summarised in a short report (Appendix K).

5.4 Analysis

The data was transferred from the database, in Microsoft Access, to an SPSS file. This file was used to perform the initial analysis and produce a statistical report, which was provided to NCTE in August 2000. Following this initial report, a more thorough analysis was begun. As this analysis involved comparisons between the 1998 and 2000 data, these were merged into a single database. This was done using the "relationship" function in MS Access to match schools with the same roll number in the 1998 and 2000 databases.

Much of the analysis was based on descriptive statistics, either counts of particular categories or averages. Where the term average is used it refers to the arithmetic

mean, unless otherwise stated. Where comparisons were done, the significance of difference was examined using two tests. Spearman's t-test was used where ratio data were involved. Nominal data were examined using cross-tabulation and the chi square test.

Throughout this study the .05 alpha level has been used. Where statistical tests revealed *p*-values less than or equal to .05, the relationships were deemed to be significant. Where *p*-values were greater than .05, the relationships were deemed to be not statistically significant, and recorded in tables as "NS".

In order to highlight those aspects of the data that are most relevant to this study, a number of tables present a sub-set of the full data. For example, frequency of access to ICT was recorded using a 5 point scale (Never, Occasional, Regular, Frequent, and Very Frequent), but was presented at times in a more condensed form, such as "percent with frequent or very frequent access". Where such condensed data were presented in tables, the chi square statistic was calculated using the full range of categories available. A worked example of such a calculation is provided in appendix O. It should be noted that this study involved the analysis of more than a million data items, and that in order to keep an already large thesis within bounds, some reduction in the quantity of data presented was deemed essential.

While much of the analysis was concerned with the factors associated with high use of ICT in subject areas, no attempt was made to use regression analysis to identify the most important factors. This was not the aim of the study and to include it would have involved two methodological difficulties. Firstly, some of the factors used for analysis were proxy measures, often involving crude approximations. For example, the ICT skill of the school principal was not measured directly but indicated by a proxy measure asking how frequently the principal used e-mail. While such measures were sufficient to demonstrate whether the school principal was associated with ICT adoption, they may not be valid measures of the extent of that association. Secondly, some of the factors used may have been either cause or effect of the use of ICT in the school. The e-mail usage of the school principal is again an example. While the question of a regression analysis may be of interest for a further study, these limitations may make these data unsuitable for the purpose.

One of the difficulties with longitudinal studies is the risk of sample attrition between the first and second samples.[1] In this case there was some attrition, as the response to the 2000 survey was lower than that to the 1998 survey. To avoid discrepancies, the merging was based on the 2000 data, which means that schools that replied in 1998 and did not reply in 2000 were excluded from the data. This method of merging, although it excluded a substantial number of schools from the 1998 survey, means that comparisons between 1998 and 2000 are based on a common set of schools. The merging of the databases allowed analysis of the patterns of gender and location in 1998, as this information was not collected in the 1998 survey, but was presumed not to have changed between 1998 and 2000.

In this report, the initial analysis of the 1998 survey is based on the full data set for 1998. All subsequent analysis of 1998 figures is based on the reduced 1998 data set in the combined database.

TABLE 5. 14: DATABASES AND THEIR USE IN THIS RESEARCH.

Database	Contents	Used in
1998 database	All schools that replied to the 1998 survey.	1998 Statistical report.
2000 database	All schools that replied to the 2000 survey	2000 Statistical report.
Combined 98-2000 database	All schools that replied to the 2000 survey, and the matching schools in the 1998 survey	Analysis of gender and social patterns and changes between 1998 and 2000.

In analysis of the data a number of ratios and indices were calculated. Ratios such as student:computer ratio were calculated using the IEA standard as follows:

> *The student:computer ratio is calculated by taking the total number of students in a school and dividing by the total number of computers that are available in the school.*[2]

Where ratios such as student:computer ratio were calculated, the figures were calculated for each individual school and an overall average was then calculated. Thus schools which had provided incomplete information were excluded from the

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[1] Ibid., p71.

[2] W. J.Pelgrum. "Hardware and Software Provision in relation to the Integrated Use of Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems*, (Oxford: Pergamon Press, 1993), p51.

overall average. This provided a more accurate figure than simply taking the totals for all schools and calculating the average from them.

While student computer ratio is widely used indicator, "it does not indicate how many students actually share computers, because schools may have a policy to restrict access only to certain groups of students",[1] and it does not indicate the type of computer use. To address these questions three new indicators were developed.

5.4a Access score

In order to facilitate comparison of access across schools in different categories an "access score" was constructed. This is a single composite figure giving a numerical score representing the number of classes with access to ICT and the frequency with which they have access. This score was calculated as follows. For primary schools each class from Junior Infants to 6th class was assigned a numerical code representing the frequency with which the class had access to ICT. Occasional access was assigned a score of 1, regular access a score of 2 and so on. The sum of these numerical codes formed the access score. Using this formula the minimum score of 0 indicates no access during class time for any class from junior infants to 6th class. The maximum possible score of 32 indicates that all classes have access to ICT for 2 or more periods per week.

TABLE 5. 15: CALCULATION OF ACCESS SCORE.

Response	Defined in the survey as.	Score
Never	No access in class time	0
Occasional	Less than 1 period per month	1
Regular	Less than 1 period per week	2
Frequent	1 period per week	3
Very frequent	2 or more periods per week	4

For post-primary schools the access score was calculated using the same codes, and using all classes from 1 year to 6th year, excluding transition year and the Leaving Certificate Applied (LCA) and Leaving Certificate Vocational Programme (LCVP).

This method of calculating the index is not intended to be directly representative of the total volume of ICT usage in the school. The index excludes out-of-hours access, which is examined separately, and use with special classes because these

[1] Ibid.

are not present in every school. The weighting of the index is towards a spread of access rather than intense use in a single class. So for example, occasional use in 4 classes has the same effect as very frequent use with one class. There is also some potential for inaccuracy in the index if some schools do not have all the classes measured. This index provides a crude amalgamation of ICT access into a single number for the purposes of guiding more detailed examination.

5.4b The Subject Use score

This is a score based on the subjects in which ICT was used and the frequency of use in each subject. Use of ICT in teaching computer skills or as "computer studies" was not included in this score. This is therefore an indicator of the level of use of ICT within curricular subjects. The subject use score was calculated as follows. Each subject in which ICT was used was assigned a score based on the reported frequency of use. Occasional access was coded as 1, frequent access as 2 and regular access as 3. The sum of these scores formed the subject use score. This score was calculated for primary and post-primary schools, and was treated as an indication of the extent of integration of ICT into subject areas in the school.

TABLE 5. 16: CALCULATION OF SUBJECT USE SCORE.

Response	Defined in the survey as	Score
Never	No access in class time	0
Occasional	A few time a year	1
Frequent	Approximately monthly	2
Regular	Weekly or more	3

5.4c Subject Count

A subject use score for 1998 could not be calculated, as frequency of use was not recorded accurately in the 1998 survey. To analyse the changes between 1998 and 2000 two matching indicators were developed. The subject count is the number of subjects from the list provided, in which ICT was used.

In the post-primary schools the subject count includes eight subjects, (Mathematics, Languages, Science, Art, History, Geography, Business and Religion). In primary schools count is based on six subjects, because two of the subjects on the list in 1998 (Business Studies and Religion) were not included in the 2000 survey.

There are a number of limitations to these measures. Firstly, the list of subjects at post-primary level excludes some of the subjects where very high use was reported such as technical graphics. English was not listed as a subject in the1998 survey, and some schools may have included use in English under languages. A further limitation is the lack of any indication of the volume of use. As a result any change in the frequency of use is unrecorded, and the measure is simply an indication of the range of subjects in which ICT was used. Despite these methodological difficulties, these data provide an opportunity to examine changes in subject use of ICT over time. A similar simplification of subject use data may be found in the 1989 IEA survey, where the researchers found that many schools reported no use of ICT in some subjects, and so simplified the data into the percentage of schools making some use of ICT in each subject.[1]

These data provide opportunities for increasing confidence in the findings through triangulation.[2] A number of cross-checks were possible. Firstly, the 1998 data were compared with the 2000 data. For example, the total number of computers reported in schools in 2000 was greater than that reported in 1998, but the difference was consistent with the expenditure on computers between these two years. A second set of cross-checks compared different variables within the 2000 data. When comparing the level of equipment in schools the primary indicator was student:computer ratio. This was supported by examination of the number of printers and other peripherals which are also indicative of expenditure on ICT infrastructure.

Triangulation was also possible within the case study visits.[3] Statements by interviewees were confirmed by other interviewees, or supported by evidence. For example, one common statement in post-primary schools was that there was no time for more use of ICT because the computer room was in constant use. This

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[1] Dan Davis, "Implementation and Educational Uses of Computers", in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems*, (Oxford: Pergamon Press, 1993), p74.

[2] Louis Cohen and Lawrence Manion, *Research Methods in Education,* Fourth Edition (London and New York: Routledge, 1994), p233.

[3] Ibid.

was probed by asking for the timetable for the room and enquiring about maintenance time. Interestingly this was one of the issues on which interviewees frequently revised their initial statements.

Although the pedagogical context in which ICT is used is clearly of interest in this research, the survey did not explicitly explore this issue. This omission was deliberate, in the belief that the terminology involved would be unfamiliar and therefore lead to unreliable responses. Instead this issue was examined through a series of proxy measures, such as the type of software used. Several earlier studies have demonstrated the association between software use and integration. For example the IEA survey found that in general high use of software suited to use in learning with computers was associated with a greater integration of computers. By contrast high use of general-purpose software such as word processing was generally associated with learning about computers.[1]

5.4d Limitations

Despite the high response rate, there are some limitations and potential errors in this data. It is possible that schools may have deliberately under or over-reported their position. Although there is no direct evidence of such deliberate distortion it is plausible that schools may have under-reported the amount of equipment present in the hope of attracting increased grants, or over-reported in the hope of being selected for pilot projects.

A second possible source of inaccuracy lies in the fact that the survey may have been completed by one individual within the school. Pelgrum noted that estimates from school principals of usage of computers within subjects are likely to be inflated both because of a tendency to include teachers who talk about computers rather than using them, and a tendency to include teaching about computers in subject time under the heading of integrated use.[2] In some of the survey questions this source of error was compounded by the requirement for secondary reporting.

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[1] W. J.Pelgrum. "Hardware and Software Provision in relation to the Integrated Use of Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems*, (Oxford: Pergamon Press, 1993), p67.

[2] Ibid., p47.

The person completing the survey was asked to estimate the ICT skills of the teachers, for example.

A third possible source of error lies in the possibility of volunteer bias in response to the survey.[1] Although the response rate was very high, it is possible that schools that were uninterested in ICT may be over-represented among those that did not reply. The research assistants involved in making the follow-up calls to schools reported a wide range of reactions, ranging from very co-operative to quite angry. While some of schools may have failed to reply as a result of error, misplaced forms or pressure of other work, it is possible that the schools that refused to reply may also have been less enthusiastic adopters of ICT.

The survey was also limited by the methods employed. The use of a large-scale questionnaire survey and the need to ensure that the questionnaire could be completed quickly and reliably encouraged the use of objective questions in the survey. While the replies demonstrated significant associations between factors, these surveys cannot prove causal relationships between factors.

A further limitation of the design was the use of only two survey dates. While this longitudinal model provides evidence of change, it does not distinguish between change that occurred as a result of the policy initiatives, and change that occurred as part of an on-going pattern. Tuckman suggests that this distinction could be detected by using a series of surveys at fixed time intervals.[2] However, given the rapidly changing nature of technology and its rapid diffusion into homes in this period it is unlikely that even a long series of surveys could allow the separation of the impact of the policy interventions from the changes occurring for other reasons.

The use of designated disadvantaged status as the sole indicator of social disadvantage is also a limitation. Schools are designated as disadvantaged by the Department of Education and Science and consequently receive additional funding. However it cannot be assumed that all the non-designated schools are equally well

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[1] Louis Cohen and Lawrence Manion, *Research Methods in Education,* Fourth Edition (London and New York: Routledge, 1994), p101.

[2] Bruce W. Tuckman. *Conducting Educational Research*, Fourth Edition (Forth Worth, Texas: Harcourt Brace College Publishers, 1994), p156.

resourced, and indeed it is quite possible that substantial difference between non-disadvantaged schools exist. Ideally a separate indicator of socio-economic status would have been used to examine the social pattern in more detail, but this was outside the scope of this research.

A further limitation of the research model is that it is primarily research at school level, and involves generalisations based on the behaviour of groups of schools. These generalisations may mask exceptional behaviour in some schools, and by some teachers within schools. It is noteworthy also that where attitudes were recorded, these were usually the attitudes of the principal and ICT co-ordinator, and these may differ from those of the teachers.

5.4e Significance of this study

Despite these limitations this study adds considerably to the state of knowledge on ICT in Irish schools. The 1998 and 2000 surveys are the only full-scale surveys conducted on the topic of ICT in Irish schools to date. Such full-scale surveys are rare even in other countries such as the US[1] and UK[2] where surveys were based on samples. The high response to both surveys provided a very valuable census of the state of ICT in Irish schools and offer confidence in the accuracy of the data.

The longitudinal research method and the timing of the two surveys, before and after a major policy initiative, provided a unique indicator of the changes during the period of IT 2000. This offers an insight into the development of ICT in Irish schools, but also a broader insight into the impact of policy on schools and the factors involved in educational change. As Rogers suggests, the tendency of innovation to widen the gap between adopters and non adopters means that measuring the impact of an innovation simply in terms of average gains is of limited value. One approach to this has been to look at the impact of the innovation on groups within the population. The basis of classification may vary with the innovation but the general pattern emerging from many studies is that the section

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[1] National Center for Educational Statistics. *Internet Access in Public Schools and Classrooms 1994-98*. NCES 99-017 (February 1999). Also available at http://nces.ed.gov/pubs99/1999017.html

[2] Department for Education and Employment. *Survey of Information and Communications Technology in Schools 1998*. Statistical Bulletin Number 11/98, (November 1998).

with an advantage at the start (the "ups") adopt earlier and widen the gap between them and those at a disadvantage at the start (the downs).[1]

Research is significant both in deepening understanding and in informing policy. While it would be naïve to assume that a single study such as this could have a direct impact on policy,[2] this research has immediate policy implications. As policy makers are concerned about the potential emergence of a digital divide, the role of ICT in schools in combating that divide is likely to become more important, and therefore the inequalities in school ICT are highly relevant. Furthermore, as future policy seeks to enhance the position of ICT in schools and encourage meaningful integration of ICT into curricular subjects, the analysis of factors associated with high levels of integration to date provides insights for development strategies.

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[1] Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), p398.

[2] OECD, *Evaluating Educational Programmes*. (Paris: OECD, 1976), p43.

CHAPTER 6

SUMMARY OF RESEARCH FINDINGS

As described in the previous chapter, the study involved three distinct research activities. First was an analysis of data from the survey of schools conducted in 1998. The second was a series of case studies of ICT in schools conducted in 1999, including surveys of the teachers in those schools. The third component was a national survey of schools conducted in 2000.

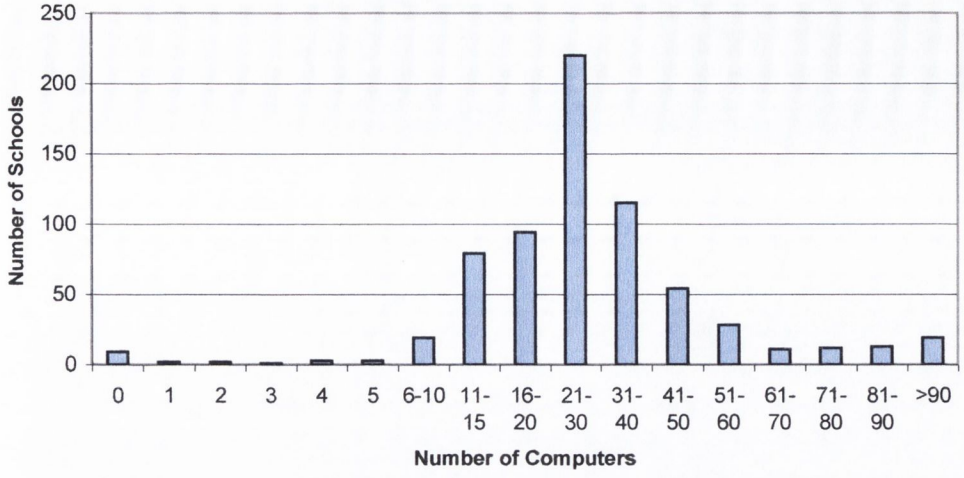
This chapter is intended to provide a brief outline of the main findings of these research activities, as a background to the more detailed analysis of specific themes in the following chapters. The research findings are outlined in chronological order in the following sections.

6.1 The 1998 School Survey[1]

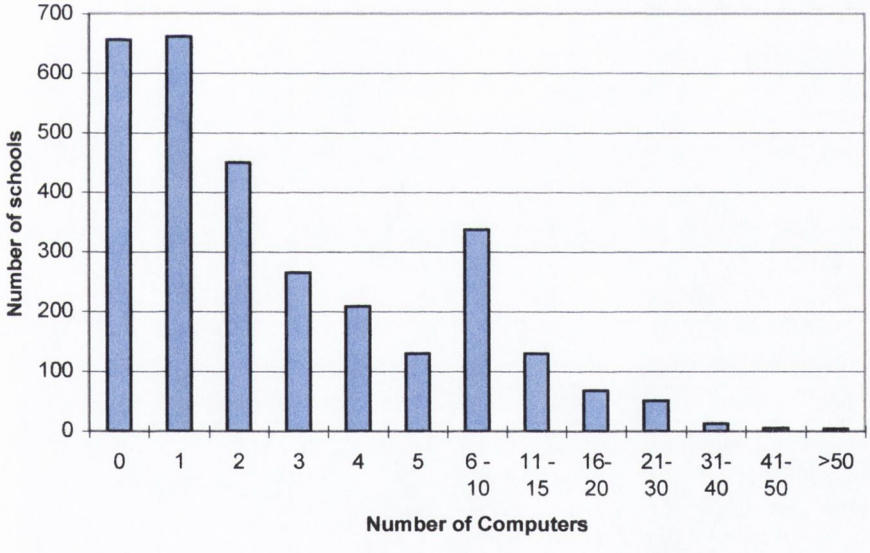
The survey revealed that most post-primary schools had a significant ICT infrastructure. The average number of computers per school was 31, giving a student:computer ratio of 16. The distribution of computers showed a normal distribution, with the majority of schools having between 11 and 50 computers (Graph 6.1).

The level of equipment in post-primary schools varied with the type of school. Vocational schools were the best equipped, with an average of 10 students per computer, while secondary schools were the least equipped, with an average of 20.

[1] A more detailed report is attached as Appendix E.



GRAPH 6.1. FREQUENCY DISTRIBUTION OF COMPUTERS IN POST-PRIMARY SCHOOLS 1998.



GRAPH 6.2 FREQUENCY DISTRIBUTION OF COMPUTERS IN PRIMARY SCHOOLS IN 1998

TABLE 6. 1: COMPUTER EQUIPMENT AND POST-PRIMARY SCHOOL TYPE, 1998

Type of school	Number of schools	Average computers per school	Student-computer ratio
Secondary	388	25	20
Vocational	172	36	10
Comprehensive	15	40	14
Community college	51	40	12
Community school	58	45	16
Total	**684**	**31**	**16**

The ICT infrastructure in primary schools was less developed. Primary schools had an average of 3.8 computers. For schools that had computers, the average pupil-computer ratio of 37. However 656 schools, 22% of the total, had no computers at all. These schools were mainly smaller schools, with an average of only 75 pupils, but nevertheless accounted for 11% of the total primary student population. The distribution pattern of computers in primary schools showed that the majority of schools had small numbers of computers, and only 25% of schools had more than 4 computers (Graph 6.2).

TABLE 6. 2: SUMMARY OF KEY INDICATORS, 1998

	Primary	Post-primary	Special
Number of schools	2,980	684	103
Number of Pupils	419,506	334,047	6,205
Number of computers	11,348	21,251	704
Average computers per school	3.8	31.0	6.8
Pupil-computer ratio	37	16	9

Some of the computers were relatively new. In all 46% of the computers reported were either Pentium PCs or Apple PowerMac computers, suggesting that they were less than 3 years old. Similarly 43% of the computers had CD ROM drives.

The majority (73%) of post-primary schools had Internet access and 22% had a school website. Internet access was much less common in primary schools. Only 14% of primary schools had Internet access and only 3% had a website. Most of the schools that had Internet access used a telephone line shared with other uses. Only 11% had a dedicated telephone line, and only 1.5% had ISDN access.

6.1a Use of ICT in schools

In primary schools the access to ICT increased with age. 28% of junior infant classes used computers. This figure rose progressively with each year and reached 63% by sixth class.

In post-primary schools the pattern of usage was quite different. The peak in usage was in the non-exam classes and use of ICT declined as exams approached. There was high usage in fifth year (70%), transition year (68%), and first year (66%) while only 39% of third year classes and 50% of sixth years had access to computers at school.

In post-primary schools the use of ICT was heavily concentrated on office applications. Word processing was the most frequently used application and was used in 98% of post-primary schools. Spreadsheets and databases were also heavily used (93% and 91% respectively).

In primary schools word processing was also the most frequently used application and was used in 66% of schools. However there was much smaller usage of spreadsheets and database and more use of other software, such as drawing packages.

The post-primary schools reported a strong focus on using computers to teach "computer studies". ICT was used in "computer studies" by 96% of the schools. ICT was also used in career guidance in a majority of schools (67%). Only a minority reported use of ICT in subject areas, with the greatest use in Business Studies (46%) and in Science (36%).

In the primary schools more of the focus was on the use of ICT in subject areas. Computers were most frequently used in Mathematics (56%), Geography (48%), Languages (47%) and History (38%). Only 36% used ICT to teach "computer studies".

6.1b ICT readiness

Although the majority of schools (60%) had a teacher designated as IT co-ordinator, only 14% of schools had a written IT plan. The majority of teachers had some knowledge of computers, but three patterns emerged:

1. Many more teachers had some knowledge of computers than had some knowledge of the Internet, particularly in primary schools.
2. The proportion of teachers with some knowledge of computers was higher in primary schools than in post-primary schools.
3. There was a slight gender pattern, with more male teachers having some knowledge, particularly about the Internet.

TABLE 6. 3: SUMMARY OF TEACHER ICT SKILL, 1998

% of teachers with Some Knowledge of:	Primary	Post-primary
Computers (M)	79.3	61.8
Computers (F)	74.5	55.1
Computers Total	75.5	58.1
Internet (M)	42.2	39.1
Internet (F)	26.9	29.9
Internet Total	30.5	33.9

6.2 1999 School Case studies[1]

During 1999 case study surveys of thirty schools were conducted. These were intended to provide an "early indicator" of the changes resulting from the first year of equipment grants and training, and to provide insights into the way in which ICT was being used in those schools. These thirty schools account for less than 1% of the total school population and so make no claim to provide representative statistics. The following sections outline briefly the changes recorded in these schools between 1998 and 1999 and some of the main issues reported in the schools.

6.2a Equipment in schools, primary

In the case study primary schools, the first year of IT 2000 saw a big increase in the numbers of computers, and in some cases the first computers in the school. The average number of computers per school rose from 3.3 to 8.2, and the average

[1] More detail reports are attached as Appendices F and G.

pupil-computer ratio dropped from 44 to 18. Four of the case study schools had had no computers at all in 1998, but these had at least two computers each by 1999.

There was also a very marked increase in Internet connectivity. Most of the schools had no Internet access in April '98. All had an Internet connection in May '99, although in a few cases they reported that it was not yet working properly.

For most of the primary schools, the IT 2000 grants were the only funds spent on computer equipment during the period. However 4 of the 15 schools spent more than the grant received from NCTE, and in two cases this involved very substantial fundraising from parents to develop ICT facilities.

- School PG1, a two-teacher school in a rural area, had no computers in April '98. When it received the grant and a free computer from Telecom Eireann,[1] money was raised from parents, an extra room was built onto the school, and 2 computers were put in it. A local woman was paid by the parents to work one morning per week, and all the children were taught IT in a rota.
- School PD5, a suburban Dublin school, had 6 old computers in April '98. With the advent of IT 2000 it decided that it was time to develop the IT facilities in the school. Parents raised £35,000 and a computer room was developed and equipped.

In some cases computers were provided from other sources. One of the schools had received a very substantial grant of 10 machines and some additional equipment from a corporate sponsor. A few of the schools had received smaller donations of second-hand machines, or won machines in competitions or through saving tokens.[2]

Most of the case study schools had chosen to concentrate their computers in computer rooms or other shared areas. This was true for all five of the Dublin schools and half of the schools outside Dublin.

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[1] Telecom Eireann provided each school with a computer, a telephone line or ISDN line and call credits as part of the Information Age Schools project, associated with Schools IT 2000.

[2] The TESCO supermarket chain ran a promotion during this period in which tokens collected by purchasing goods were exchangeable for computers for schools.

6.2b Equipment in schools, post-primary

The situation in the case study post-primary schools was very different. For most, the grant received from IT 2000 was a small proportion of their expenditure on computer equipment. At the time of the case studies, the IT 2000 grants had funded less than 10% of the computers in use in these schools. One school had spent £70,000 over the last year in a major re-development of its computer facilities. None of the schools received significant commercial support. A few had tried to raise money from local businesses, but in most cases they received token amounts or offers of scrap computers.

Overall the student-computer ratio in the case study schools fell from 26 to 19. There was a general pattern of narrowing of the difference between the best and least equipped schools. This may be partly explained by two factors. Some of the best equipped schools did not increase their overall level of equipment, but used their grants to replace or upgrade older machines, or to consolidate by networking. In the least equipped schools there was more emphasis on increasing the number of computers, and in some cases the period saw additional fundraising and a major investment. The schools below exemplify these patterns:

- School SG1 had a computer room of 25 machines in '98. They used the IT 2000 grant to buy a laptop and a scanner and to pay for some peripherals.
- School SW1 had only four computers in April '98. During the year the staff identified IT as a priority, and money was raised from the parents to develop a computer room. By 1999 the school had 16 Pentium PCs in a computer room, used for twenty periods per week by first year and transition year students.

The level of access to the Internet increased during the year. Over half of the schools had Internet access in April '98, in all cases via a telephone line to a single machine. By May '99 all had Internet access and five had Internet access via a network to multiple machines.

The post-primary schools had all chosen to locate their computers in computer rooms. All of the schools had a computer room and four of the fifteen had a second computer room. Very few of the schools had computers in other teaching rooms.

6.2c Use of ICT, primary schools

One of the most striking features of the primary case study schools was the variety of ways in which ICT was organised in the schools. For many schools ICT use was focused on teaching computer applications, mainly word processing. For six schools, the sole use of ICT was in teaching computer applications. By contrast one school was using only curricular software and had deliberately decided that teaching the operation of the computer was not an objective. Another seven schools mixed teaching computer applications with the use of ICT to support teaching, often assigning curricular software to the younger or weaker children. Finally in one school the use of computers had degenerated mainly into game playing.

There was a similar variety in the arrangements for access to computers. The majority of the schools had concentrated their computers in a computer room. The schools with computer rooms usually had time-tabled access. In most cases the children were time-tabled for access once or twice a week, for a period of 30 to 45 minutes. Some of these schools had time-tabled all of their classes for access, while others restricted ICT to the older children. Some brought whole classes to the computer room, while others withdrew pupils from class to go to the computer room. In a number of cases this meant that people who were not qualified teachers taught the computer activities. Two used workers on CE schemes as computer teachers and another two arranged for part time assistance in the computer room, funded by the parents.

In the remaining schools the computers were distributed around the classrooms, and used by the class teachers as they chose. Some had developed quite sophisticated systems to support this. For example, School PG4 had computers in most classrooms. Teachers were encouraged to integrate IT into their normal work, and the school had a range of software and applications. Software was classified into that suitable for junior and seniors, and some teachers were actively reviewing software and matching it with curricular aims. In other schools the use of ICT was more haphazard, and depended largely on the individual teacher. In School PD1 only one teacher was interested in ICT and only her classes got access to the computers. In a minority of schools the computers were mainly used outside of class time, in one case during break, and in another before the start of classes.

In almost all the schools the most used software was content-free applications, principally word processing of some sort. As one teacher said "the content-free is the stuff you keep coming back to...". In some schools the children were being taught to use the computer and in a few cases being taught to type. However the main use of word processing was in creative writing and project work, where children produced typed materials which were displayed on the walls.

A few schools made some use of curricular software. There was a very wide range of software in use. In some schools they simply used the software which was bundled with the machines, often reference works like Encarta. A few schools had identified specific topics which were enhanced by the addition of specific software (time, using clock software for example).

There was a very low level of use of the Internet. Two thirds of the schools reported either very low or no use of the Internet. Only five used the Internet with the children, and in most cases this was irregular. A few schools reported having "no idea" what to do with the Internet. A few schools made some use of the Internet, and encouraged children to use it to look up material:

- In school PW4 all children from second to sixth classes were shown how to use the Internet and the older classes used it for research. It was used about two hours per day.
- In school PG3 the Internet was used about one hour a day. The school organised the children to correspond with pen-friends in the US using e-mail. It was also used sporadically for research by senior classes.

6.2d Use of ICT, post-primary schools

There was much greater consensus on the use of ICT in post-primary schools. All of the post-primary case study schools had concentrated their computers into computer rooms although a few had some machines distributed in other areas. The main use of IT in all cases was for teaching computer applications. Some schools provided certification for this, using a variety of sources. Others were searching for suitable certification. The main applications were word processing, followed by other office applications. Where ICT was used in curricular subjects, it was mainly with word processing in the production of "projects". There was also a good deal

of use of IT in business and technical subjects. There was little use of ICT with curriculum software, the two examples being Mathematics software and language software.

Although almost all of the use of computers was for "computer classes", there were variations in the classes that had scheduled access. In schools running PLC courses, these dominated the computer time. An extreme example of this is provided by school SW5, which had two computer rooms with a total of thirty computers. However almost all of the time was used for PLC courses and there was no time-tabled access for the "uniformed school". Hence, for students who did not remain in the school for PLC courses, there was no access to ICT at all. Transition year and LCVP/LCA, where offered, also took up a good deal of computer time. Most of the schools time-tabled some of the other classes, but use was concentrated in the non-examination classes. For example, school SG2 had fifteen computers and all first and second year students were time-tabled for one period per week, while fifth year received four periods.

Most of the post-primary schools were using the Internet, typically for a few hours per week. The most frequent uses were research by students and teachers. Although most of the schools did not allow unsupervised access, a number had already experienced difficulties with unsuitable material.

6.2e Teacher ICT skill and participation in training

In the case study primary schools roughly two thirds of teachers were "IT literate" and one third had done NCTE courses. Six of the post-primary schools had organised NCTE supported training in the school. In theses cases a substantial proportion of the staff had attended and staff computer literacy had grown dramatically. In some of these schools there was evidence of some increase in "integration" activities. Schools relying on training outside the school had lower attendance rates, and reported a smaller impact.

6.2f Plan and vision

Most of the primary case study schools did not have a written ICT plan. Few had clear direction for future development. Where the schools had a clear direction, the most frequently expressed aims were expanding the amount of equipment and

expanding the access to all classes. A small number of primary schools said they had no wish to develop ICT further as they felt it had already reached an appropriate level.

Most of the schools saw ICT as a "life-skill" and did not anticipate learning gains in other curricular areas. Despite this the majority believed they were experiencing some learning gains, either through enhanced motivation or self-confidence. Many felt the use of computers particularly helped weak learners.

A number of the primary schools noted that much of the impetus for ICT in the school was a result of parent pressure. They reported that parents were very anxious for their children to use computers and in a few cases the parents were putting pressure on the school to increase computer access.

There was a similar pattern in the post-primary schools. Most did not have a written ICT plan or clear vision for the future of ICT in their schools. Where the schools had plans these were most frequently concerned with the provision of certification, the expansion of ICT skills to all students and the development of the technological infrastructure. Most of the schools saw ICT as a subject, and time-tabled and taught it as such. Most did not aim for learning gains in other curricular areas. Despite this almost half believed they were experiencing some learning gains, either through enhanced motivation and self-confidence or by helping weaker learners. The post-primary schools also reported that parent pressure was one of the driving forces. Some felt that they could not attract students unless they could offer "computers".

Barriers

Both primary and post-primary schools identified three main areas that were barriers to the development of ICT, although not in the same order of priority. These three barriers were lack of time in the curriculum, funding for equipment and staff skill.

In the primary schools curriculum time was the most frequently identified barrier. Many felt the curriculum was already crowded and they were not sure they could fit in ICT. Others were not sure what they should be doing with IT, and asked for guidelines and suggestions. The second issue was funding for equipment and

infrastructure. Primary schools also reported that lack of skill was a barrier. Many staff using the computers were not confident of their own ICT skills. Others wanted curriculum specific training, and were confident of their skills but not sure how to use IT appropriately in the classroom.

For the post-primary schools the main barrier reported was staff ICT skill. Shortage of staff who felt confident to use the technology was a limiting factor, and even in some cases a barrier to the teaching of computer applications. Curricular pressure was also an issue in post-primary schools. Some had difficulty finding time to schedule ICT, some had dropped Mathematics classes to fit in IT, another considered reducing the time for Religion. Funding for equipment, maintenance and renewal was also highlighted as an issue. Most of the schools noted that IT had distorted school spending and was causing more expenditure than any other subject area.

6.2g Conclusions

Overall the post-primary case studies showed that, for these schools, the first year of IT 2000 had shown a modest increase in the level of ICT equipment, although the difference between the best and least equipped narrowed and Internet access developed. However there was little change in the established pattern of use of ICT. Most schools treated ICT as if it were an additional subject, time-tabled for specific times and distinct from other subjects. There was little emphasis on the use of ICT in support of learning, and some schools were not even aware that this was a stated aim of IT 2000.

ICT in the case study primary schools was much less developed at the start of the period and some schools had had no computers at all. Between 1998 and 1999 there was a very substantial increase in the level of computer equipment and even the schools approaching ICT *ab initio* made significant progress. Although there was a marked increase in levels of teacher ICT skill, there was no consensus on the direction and place of ICT. Some schools specifically asked for guidance, or expressed concern at the lack of a direction. In the absence of a shared vision, schools developed their own, sometimes very different, configurations of ICT. In many cases these configured ICT as a skills area, separating it from learning in

other subjects. As with the post-primary schools, few were aware of the aims of IT 2000 or the broader potential of ICT.

It was interesting that for both primary and post-primary schools, parent pressure was described as a significant driver of development of ICT. While many schools reported parent pressure, in all reported cases this was pressure to learn computer applications, rather than a pressure to use ICT in support of other learning.

Equality of access to ICT

In both primary and post-primary schools there had been considerable variation in the level of equipment in 1998. During the year there was a general pattern of narrowing of the gaps. In post-primary schools this was a result of investment by the weakest schools while the strongest consolidated. In the primary schools the small schools with no computers in 1998 were all equipped to a reasonable level by 1999.

None of the primary schools had taken any specific actions to ensure equal participation by girls, or those without home computers. Within primary schools there was no differential treatment of boys and girls with regard to ICT. A few primary schools had noted that boys were more likely to be attracted by games, and girls more likely to take a lot of care in the layout and presentation of project work. Home access to computers varied widely among the sample primary schools. Although home access gave some children a head start, the schools did not see this as a major difficulty.

Although the vocational schools had much higher levels of equipment than the other post-primary schools, this was not reflected in a high level of access by students, as the usage was dominated in some cases by PLC courses. In the post-primary schools, mixed schools (even mixed secondary schools) were generally better equipped than single-sex schools. Within post-primary schools there was no obvious gender differentiation. Where ICT was time-tabled it was rarely optional, and there was little opportunity for boys or girls to select in or out or it. A few schools noted a male dominance of use of ICT outside school hours. None of the post-primary schools had any positive discrimination measures.

6.3 Survey of Teachers in Case Study Schools[1]

Within each of the case study schools, a survey of all teachers was conducted. This survey yielded data provided by individual teachers rather than reported about teachers at school level. However, as this survey was confined to teachers within the case study schools, the findings cannot be presumed to be representative of teachers as a whole.

When the individual teachers in the case study schools were surveyed, the majority of primary teachers (70%) reported that they had used ICT in their teaching at some point in the previous year. The most frequently reported uses were using curriculum software (68%), getting the students to do project work (30%), teaching computer applications (29%) and using standard applications in teaching curricular subjects (22%).

In the post-primary schools the usage was much lower, with only 29% of the teachers using ICT in their teaching in the previous year. The main uses were in getting the students to do project work (17%), using the Internet as a resource (15%) and using curriculum software (14%).

Lack of ICT skill was reported by both groups of teachers as the main barrier to use, and was reported much more frequently than any of the other options. Among primary teachers who did not use ICT, the most frequently reported barrier to use was lack of IT skill (59%). The second most frequently reported barrier was inability to see an appropriate use for IT (11%). For the post-primary teachers who did not use ICT, the most frequently identified barrier to use was lack of IT skill (62%). Lack of time was the second barrier (25%).

There was also evidence that ICT skill was associated with use in teaching. Teachers who had recently attended a training course in ICT, and teachers who had a computer at home were more likely to have used ICT in the previous year than other teachers.

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[1] More detail reports are attached as Appendices H and I.

6.3a Teacher ICT skill

The majority of teachers, both primary and post-primary, had some ICT skill. Sixty percent of primary teachers and 53% of post-primary teachers could easily produce a document on a word processor. However for many their computer skill did not extend far beyond word-processing, and only a minority (34% of both primary and post-primary) felt confident to browse the Web. Even fewer could use a spreadsheet or set up an Internet connection. As might be expected, teachers who had done a recent ICT course or had a home computer had higher skill levels than other teachers.

6.3b Access to computers at home

A majority of the teachers (61% of primary teachers and 57% of post-primary) had access to a computer at home. Most of these computers were less than 2 years old, and roughly half of them had Internet access. However only 63% of teachers with a home computer used it regularly and only approximately half described themselves as the "main user" of the home computer.

6.3c Age of teachers

Despite the stereotyped view of ICT skill being concentrated in younger teachers, there was little variation in computer skill with age. In primary schools, the oldest teachers showed a very slightly greater level of skill, while in post-primary schools the younger teachers showed a very slightly greater level of skill. The youngest teachers were also least likely to have a home computer.

Interestingly, the teachers who most frequently reported making use of ICT in their teaching were in the mid-career age groups, teachers in their 40s in primary schools and teachers in their 30s in post-primary schools.

6.3d Gender

The survey revealed only slight gender differences in teachers' ICT skill and usage. A slightly greater proportion of the male teachers had a home computer, although the difference was smaller in the case of computers less than two years old, suggesting that the female teachers were "catching up" in terms of home computer access.

In the primary schools the male teachers reported slightly more skill than female teachers, using a composite score on a self-report test. Male teachers had an average score of twenty, while female teachers averaged eighteen. However this difference in skill was not reflected in the use of ICT in the classroom. In primary schools the same proportion of male and female teachers made use of ICT in their teaching.

In post-primary schools the difference was much smaller, with skill scores of 17.7 and 17.2 for males and females respectively, but marginally fewer of the female teachers used ICT in their teaching.

6.4 The 2000 Survey[1]

The 2000 survey revealed that the number of computers in Irish schools had risen by 65% from 1998. The increases in equipment had a greater impact on pupil-computer ratio in primary schools both because they were smaller in size and because they had far fewer computers initially. The number of computers in primary schools grew by 129%, to an average of nine computers per school. In the same period the number of computers in post-primary schools grew 38% to an average of 43 computers per school.

TABLE 6. 4: COMPUTERS IN SCHOOLS, 2000

	Average number of computers per school		Average number of students per computer	
	1998	**2000**	**1998**	**2000**
Primary schools	3.8	8.6	35	18.1
Post-primary schools	31.0	42.7	16	13

In the same period the ICT infrastructure in schools became more sophisticated. More primary and post-primary schools developed internal school networks. Internet connectivity increased as virtually all schools got Internet access, and the

[1] A more detailed report is attached as Appendix J.

majority of post-primary schools had ISDN access and had Internet access shared between a number of machines.

As in 1998, most of the computers in post-primary schools were located in computer rooms. In primary schools the majority remained in classrooms, but a substantial proportion of primary schools had some kind of separate computer room, and these accounted for one third of all computers in primary schools.

TABLE 6. 5: SCHOOL NETWORKS AND LOCATION OF COMPUTERS, 2000

2000 data	% of schools with a network	% with ISDN Internet access	% of computers in computer rooms	% of computers in classrooms
Primary schools	18	15	33	48
Post-primary schools	77	69	72	7

During the period there was a growth in the proportion of computers that were based on the Windows operating system. In 1998 75% of computers in schools were Windows machines and the rest were Apple, Acorn and other types. By 2000 91% were Windows and the proportion of all other types had fallen. Almost 80% of the computers were relatively new machines (Pentium PC, PowerMac or Laptop).

6.4a Teachers and Training in ICT

One of the striking features of the period was the high participation by teachers in the training courses provided. From the schools that provided information, 75% of their teachers had done at least one course. The courses attended by most teachers were the NCTE Phase 1 and Phase 2.[1] Many of the post-primary schools had organised courses in the school. Fewer of the primary schools had done this, possibly because fewer of them had computer rooms.

These training courses were associated with a rise in ICT skill among teachers. By 2000 over 90% of primary teachers had some computer skill and 74% had some Internet skill. In post-primary schools 77% of teachers had some computer skill

[1] The aims of these course are outlined in appendix P.

and 64% had some Internet skill. In both cases these figures were significantly higher than those reported in 1998.

TABLE 6. 6: ICT COURSES AND TEACHER SKILL, 2000

2000 data (1998 figures in brackets)	% of teachers who attended some course	% of schools that had training in the school	% of teachers with some computer skill	% of teacher with some Internet skill
Primary schools	84	22	92 (76)	74 (30)
Post-primary schools	65	67	77 (58)	64 (34)

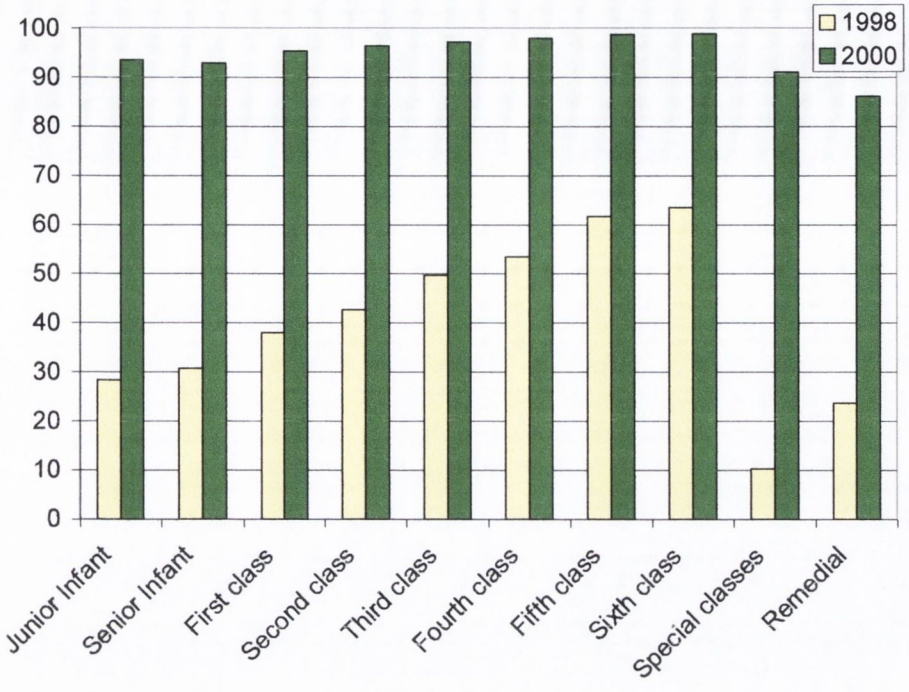
6.4b Use of ICT

During the period the amount of access to ICT provided to classes in schools increased. In 1998 only 38% of First Classes in primary schools had some access to computers, while by 2000 this figure had risen to 95%, with 60% having access on a weekly basis. This trend carried through all classes in primary schools (Graph 6.3).

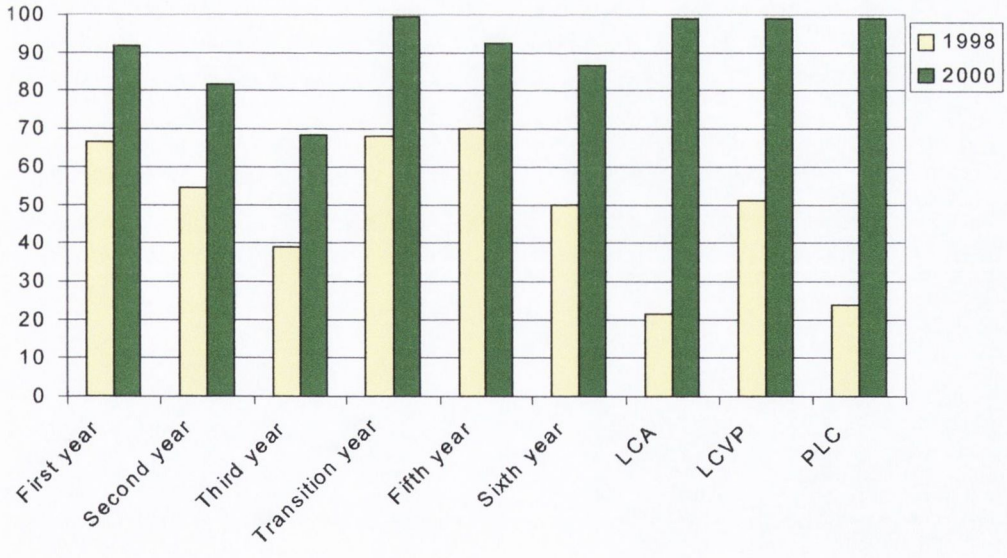
TABLE 6. 7: ACCESS TO ICT IN PRIMARY SCHOOLS

Primary schools	Some access 1998	Some access 2000	Weekly access 2000
Junior Infants	28.4	93.5	59.7
Senior Infants	30.7	92.8	60.2
First class	38.0	95.3	62.8
Second class	42.6	96.3	63.5
Third class	49.7	97.2	67.7
Fourth class	53.5	97.9	70.0
Fifth class	61.6	98.7	72.7
Sixth class	63.5	98.8	73.2
Special classes	10.3	91	75.4
Remedial	23.6	86.1	61.9

There were also increases in access to ICT in post-primary schools. In 1998 66% of First Year classes had access to ICT. This had risen to 92% by 2000. Access was not evenly distributed, with the highest rates of access in transition year and the lowest in examination years (Graph 6.4).



GRAPH 6.3. PERCENTAGE OF CLASSES IN PRIMARY SCHOOLS WITH SOME ACCESS TO ICT



GRAPH 6.4. PERCENTAGE OF CLASSES IN POST-PRIMARY SCHOOLS WITH SOME ACCESS TO ICT.

TABLE 6. 8: ACCESS TO ICT IN POST-PRIMARY SCHOOLS

Post-primary schools	Some access 1998	Some access 2000	Weekly access 2000
First year	66.4	91.8	70.0
Second year	54.5	81.7	57.0
Third year	39.1	68.3	40.9
Transition year	68.0	99.4	97.4
Fifth year	70.1	92.5	77.5
Sixth year	49.9	86.6	64.8
LCA	21.4	98.9	97.8
LCVP	51.2	99.0	94.1
PLC	23.9	98.9	98.4

In the junior classes in primary schools the most used applications of computers were CD ROM resources and "skill and practice" software. For all other classes word processing was the most widely used application of ICT. In most schools teachers and students used the Internet for research. However only a minority of schools used the Internet as a means of publishing student work.

TABLE 6. 9: USE OF THE INTERNET IN SCHOOLS

2000 data	% where teachers use the Internet for research	% where students use the Internet for research	% with a school website	% with student work published on a website
Primary schools	80.0	61.8	14.5	8.3
Post-primary schools	91.3	83.7	46.1	10.8

6.4c Use of ICT in curricular subjects

Although there was a good deal of use of ICT in schools, much of that use was focused on teaching computer skills. This was particularly true in post-primary schools where more than two thirds of schools had arranged some form of external certification of ICT skills. The use of ICT in curricular subjects was greater in primary than in post-primary schools and was greater in some subjects. In primary schools there was particularly high use of ICT in English, Languages and Mathematics.

TABLE 6. 10: USE OF ICT IN SUBJECT AREAS IN PRIMARY SCHOOLS

Curricular area	% of schools where ICT is used at least monthly.		% of schools where ICT is used at least monthly.
English	87	SESE	35
Language	81	Arts Education	29
Mathematics	75	Gaeilge	17
Geography	64	SPHE	11
History	56	Physical Education	3
Science	49		

In post-primary schools there was high use in extra curricular projects and in careers. The greatest subject use was in Technology and Business subjects.

TABLE 6. 11: USE OF ICT IN SUBJECT AREAS IN POST-PRIMARY SCHOOLS

Curricular area	% of schools where ICT is used at least monthly.		% of schools where ICT is used at least monthly.
Extra curricular projects	73	English	23
Careers guidance	71	Other languages	19
Technology	57	Geography	16
Learning support / remedial education	54	Mathematics	14
Business subjects	38	History	13
Sciences	29	Religion	10
Arts	24	Irish	4
Music	24		

6.4d School priorities and needs

Approximately half of the schools were happy with the amount of computer access they provided to their students (57% of primary schools and 41% of post-primary schools). A smaller number were happy with the amount of Internet access they provided (48% of primary schools and 34% of post-primary schools).

Schools were asked to identify their need for future development. Interestingly the top priority was not equipment. Instead the priority was more training for teachers. The second and third priorities were technical support and additional equipment.

TABLE 6. 12: TOP 5 PRIORITIES FOR ICT, 2000.

Primary Schools.	% rating this a high priority	Post-primary Schools.	% rating this a high priority
More training for teachers	91	More training for teachers	94
More technical support	87	Additional computer equipment	92
Additional computer equipment	85	More technical support	90
In-school ICT training	81	Replacement / renewal of older equipment	90
Funding software purchase / licences	80	Funding software purchase / licences	88

CHAPTER 7

SOCIAL PATTERNS IN ICT IN SCHOOLS

As reported in Chapter 2, there is some concern internationally about the potential of ICT to become a social dividing line, disadvantaging those without ICT skills and providing benefits for those comfortable with the technology. In response, some policymakers have suggested that schools should redress this imbalance by ensuring access to ICT for all.[1] However despite this intention, there is evidence from the US and the UK that schools may mirror the existing social pattern of ICT access, by providing more ICT to the groups with high home access.[2] This chapter is an examination of the patterns of ICT equipment and usage in Irish schools. It examines the state of ICT provision in schools serving different parts of the community, questioning whether schools are acting to reduce the digital divide.

The limited available research in Ireland, cited in Chapter 3.2 suggests that certain social groups have higher levels of ICT skill and have been quicker to make use of the Internet. Urban, middle-class families with high income and high levels of education seem likely to be the most *digitally advantaged*. By comparison other groups may be termed *digitally disadvantaged*, having less access to and experience of the technology.

This analysis is based on the assumption that if schools provide better ICT experiences to digitally advantaged students than to the digitally disadvantaged students, they are acting to enhance the digital divide. Conversely if schools were acting to reduce the digital divide it might be expected that the digitally disadvantaged students would receive better ICT experience in school.

Variation in the quality of ICT experience provided in schools might result from two different factors, the amount of equipment in the schools and the way the equipment was used. There is evidence in the existing research to suggest that both

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[1] See section 2.2.

[2] See section 2.2a

may occur. Inequalities in level of ICT equipment in schools have been reported on a number of dimensions, including school size, location (rural/urban), the ethnic group and socio-economic status of the students and the geographical region.[1]

The second possible area for inequality is the way in which the available technology is used within the schools. Schools working with the most disadvantaged groups may use ICT in less exciting ways, with more focus on the routine operational skills, and less engagement with the activities involving higher order thinking. The Internet in particular, may be used more frequently and in more sophisticated ways in schools serving the socially advantaged students. By contrast the teachers in schools serving the disadvantaged may be more likely to use "drill and practice" type applications, and to use ICT in the main subject areas.[2]

This chapter begins with an examination of the level of equipment in schools. Sections 7.1 and 7.2 examine the variations in equipment level for primary and post-primary schools respectively. The focus then shifts from equipment to the amount of access to ICT that students receive, and sections 7.3 and 7.4 examine this issue for primary and post-primary schools. These findings are drawn together in section 7.5, which identifies the main areas for concern about equipment and access. The analysis then turns to the question of how the technology was used. Section 7.6 looks at the variations in the use of ICT within curricular subjects, the type of software used, and the use of the Internet.

7.1 Patterns in ICT equipment in primary schools

7.1a ICT equipment and designated disadvantaged status, primary schools

Schools serving economically disadvantaged communities may have fewer opportunities to raise money, either directly from parents, or through parents' contacts in business. As a result such schools may have fewer computers and less developed ICT infrastructure, as reported in the US studies.[3] This section examines

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[1] See section 2.2a.

[2] See section 2.3.

[3] See section 2.2.

whether a similar pattern occurred in Irish primary schools, by comparing the designated disadvantaged schools with other primary schools. As noted earlier, this indicator has the advantages of being easy to determine and being based on objective criteria, but it is limited in that it takes no account of the wide variation in the context of schools that were not designated disadvantaged. The use of designated disadvantaged status as the separator gives rise to an alternative hypothesis. Designated disadvantaged schools received additional funding from the state and also received larger grants as part of the Schools IT 2000 programme.[1] As a result they may have had greater levels of ICT equipment than other schools.

Of the primary schools that responded to the 2000 survey 12.5% were designated disadvantaged. These disadvantaged schools were slightly larger than the other schools with an average of 198 pupils each, compared with 131 pupils in other schools.

TABLE 7. 1: DISADVANTAGED PRIMARY SCHOOLS.

Primary schools	Designated disadvantaged schools	Other schools
Number of Schools	344	2,406
Number of pupils	65,704	305,439
Average pupils per school	198	131

The disadvantaged schools were better equipped than other schools, both in numbers of computers and of pupil-computer ratio. In 2000, disadvantaged primary schools had an average of 14.4 computers each, compared with 7.8 in other schools. The disadvantaged schools had 16 pupils per computer, while other schools had 19 (t-test, p=.001). The disadvantaged schools were also better equipped with all of the peripheral devices recorded in the 2000 survey. More of the disadvantaged schools had printers, scanners, digital cameras, laptops and data projectors.[2]

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[1] An Roinn Oideachais agus Eolaíochta. *Schools IT 2000 Achievements to Date.* Published on the Department website at www.irlgov.ie/educ/it2000/it2000update.htm in 1998.

[2] Data tables in appendices L2 to L4.

This difference can not be attributed entirely to the IT 2000 grants, as the disadvantaged schools had been better equipped before the start of IT 2000. In 1998 fewer of the disadvantaged schools had no computers. Of those schools that had computers, the disadvantaged schools had an average of 5.3 computers each, compared with 2.5 in the other schools. As a result they had 50 pupils per computer, compared with 58 in other schools (t-test, p=.049).

TABLE 7. 2: NUMBERS OF COMPUTERS, PRIMARY SCHOOLS

Primary schools	Designated disadvantaged schools	Other schools
Number of computers 1998	1,821	6,059
% of schools with no computers	30.8	42.7
Average computers per school 1998	5.3	2.5
Pupils per computer 1998	50.2	58.0

Primary schools	Designated disadvantaged schools	Other schools
Number of computers 2000	4,939	18,761
Average computers per school 2000	14.4	7.8
Pupils per computer 2000	15.9	18.9

During the period 1998 to 2000 the gap between disadvantaged and other schools narrowed slightly, as the non-disadvantaged schools began to catch up. The suggestion that the non-disadvantaged schools were catching up was reinforced by the finding that more of their computers had CD ROM drives, suggesting that they were newer computers.[1]

Location of computers

The disadvantaged schools had more of their computers located in computer rooms and fewer in classrooms. In the disadvantaged schools, 44% of the computers were in computer rooms, while in the other schools 30% were in computer rooms. Conversely, in disadvantaged schools fewer of the classrooms had computers and had computers with Internet access than the other schools. In disadvantaged schools 52% of classrooms had a computer, compared with 64% in other schools (t-test,

[1] Data table in appendix L1.

p=.000). Similarly 12% of the classrooms in disadvantaged schools had Internet access compared with 24% of those in other schools (t-test, p=.000).[1]

Networking and Internet connectivity

Networks were more developed and more prevalent in disadvantaged schools. In the disadvantaged schools 24% of all computers were networked, compared with only 20% in other schools.[2]

The disadvantaged schools also had more developed Internet access. In 1998 more of the disadvantaged schools had Internet access. By 2000, when virtually all schools had Internet access, the disadvantaged schools had an average of 4.2 computers connected to the Internet, compared with 2.6 in other schools. The disadvantaged schools also had a more favourable ratio of pupils to Internet-connected computers. In disadvantaged schools there was an average of 85 pupils per Internet-connected computer, compared with 112 in other schools (t-test, p=.000).[3]

Disadvantaged primary schools, conclusion

There was little to suggest that disadvantaged primary schools were being left behind in terms of levels of computer equipment. On the contrary, in both 1998 and 2000 the disadvantaged schools had more computers on both a "per school" and a "per pupil" basis. In addition the disadvantaged schools had higher levels of all the peripherals recorded, including digital cameras and data projectors.

Despite the increased grants to disadvantaged schools, there was evidence that the gap between disadvantaged and other schools narrowed slightly during the period and the other schools appeared to catch up. However this trend may have been due to the larger size of the disadvantaged schools, as the IT 2000 grants were weighted towards smaller schools.

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[1] Data table in appendix L5.

[2] Data table in appendix L6.

[3] Data table in appendix L7.

The disadvantaged schools had more of their computers in computer rooms, and had more networks and larger networks. They also had more computers connected to the Internet, and more favourable ratios of pupils per Internet-connected computer. Both of these may also have been related to the larger average size of disadvantaged schools.

7.1b ICT equipment and geographical location, primary schools

A second dimension of the digital divide is location. There are indications both internationally and in Ireland that ICT skills are less frequently found in rural areas.[1] However a number of studies in the US and UK have reported the opposite pattern within schools, recording higher levels of ICT equipment in rural schools.[2] This section is concerned with the rural/urban pattern in the level of equipment in Irish primary schools.

The data for this analysis is drawn from a self-classification of schools in the 2000 survey. Schools were asked to classify their location as one of four types, namely "Rural", "Small Town",[3] "Suburban" or "Urban". The majority of primary schools responding to the survey were rural, with smaller numbers in the other three categories. The rural schools were smaller than the others with an average of 77 pupils, compared with 154 for small town schools and over 250 in each of the two urban categories.

TABLE 7. 3: LOCATION OF PRIMARY SCHOOLS.

Primary schools	Rural	Small town	Suburban	Urban
Number of Schools	1,648	412	246	409
Number of pupils	126,184	63,457	70,638	105,178
Average pupils per school	76.6	154.0	287.1	257.2

In 1998 more of the rural schools were without computers than schools in any other type of location. However, those rural schools with computers had more

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[1] See section 3.2b.

[2] See section 2.2d.

[3] Small Town was defined in the survey as under 10,000 in population.

favourable pupil-computer ratios than schools in other areas. Rural schools that had computers had an average of 51 pupils per computer, while urban schools had an average of 61 (t-test, p=.011).

By 2000 all schools had some computers, the pupil-computer ratio in all four locations had fallen, and the gaps between locations had narrowed substantially. The rural schools reached 16.6 pupils per computer, while the urban schools averaged 21.9 (t-test, p=.000). During the period the ratio in suburban schools fell more rapidly than that in other locations, and they overtook the urban schools (Graph 7.1).

TABLE 7. 4: NUMBERS OF COMPUTERS, PRIMARY SCHOOLS.

Primary schools	Rural	Small town	Suburban	Urban
Number of computers 1998	2,008	1,329	1,698	2,716
% of schools with no computers	49.5	34.7	25.8	25.1
Average computers per school in schools with computers, 1998	1.2	3.2	6.9	6.6
Pupils per computer 1998	50.8	60.5	64.1	60.9

Primary schools	Rural	Small town	Suburban	Urban
Number of computers 2000	8,452	3,909	4,334	6,585
Average computers per school 2000	5.1	9.5	17.6	16.1
Pupils per computer 2000	16.6	18.7	20.2	21.9

The majority of computers in all schools had CD ROM equipment, but as might be expected the proportion was slightly higher in the rural schools, where more of the computers were recently acquired.[1] There were no unusual patterns in the distribution of peripherals. The urban and suburban schools had greater numbers of computers, and more of them had laser printers, other printers, scanners, digital cameras, data projectors and laptops than the small town and rural schools.[2]

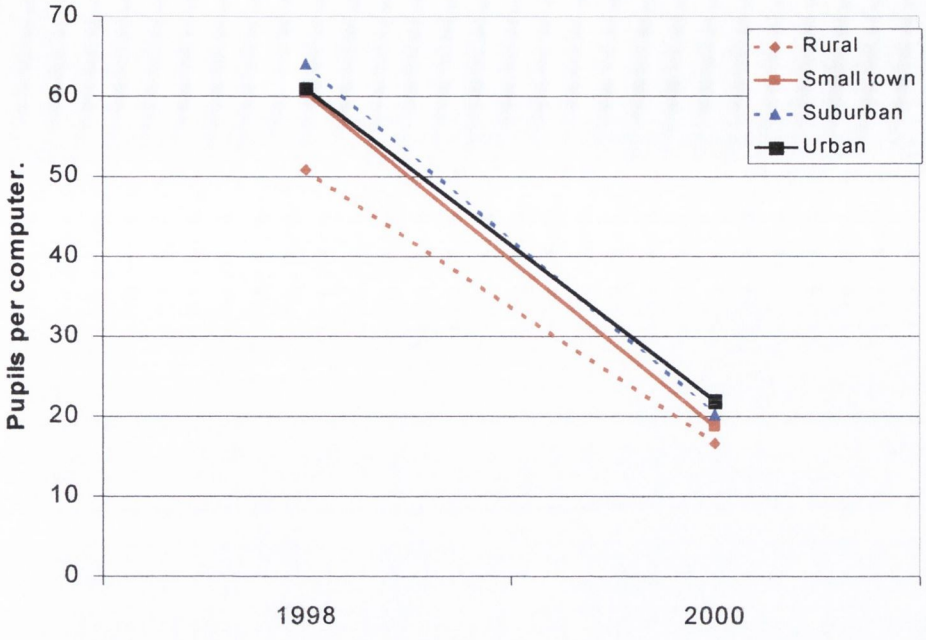
Location of computers

In the urban and suburban schools, more of the computers were in computer rooms and fewer in classrooms. In suburban schools, 48% of the computers were in

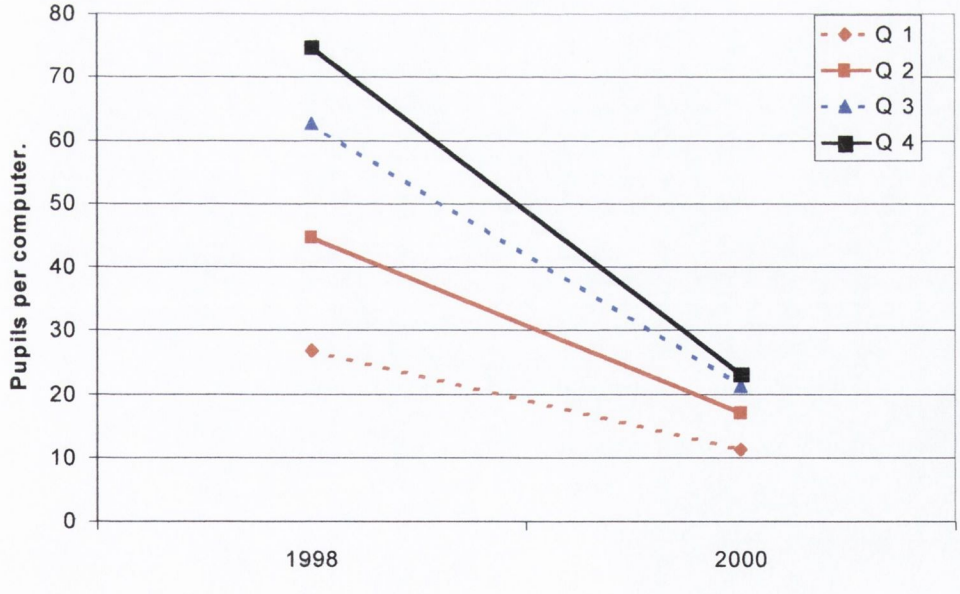
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[1] Data table in appendix L8.

[2] Data tables in appendices L9 to L11.



GRAPH 7.1. PRIMARY SCHOOLS; LOCATION OF SCHOOLS AND PUPIL COMPUTER RATIO



GRAPH 7.2. PRIMARY SCHOOLS; PUPILS PER COMPUTER BY SCHOOL SIZE (QUARTILES)

computer rooms and 32% in classrooms. By contrast the rural schools had 16% in computer rooms and 68% in classrooms. This resulted in computers in 77% of classrooms in rural schools and 51% of classrooms in urban schools (t-test, p=.000). Rural schools also had Internet access in 36% of their classrooms, compared with 12% of urban school classrooms (t-test, p=.000).[1]

Networking and Internet connectivity

As might be expected, a smaller proportion of the rural primary schools had a network. Only 5% of rural schools had a network, compared with 22% of small town schools and 35% of suburban schools. In the rural schools with a network, the networks were smaller than the others with an average of only five computers connected. In total only 11% of the computers in rural schools were networked, compared with 23% in small town schools, 29% in suburban and 28% in urban schools.[2]

In 1998 the rural schools had lagged behind urban schools in terms of Internet access. Only 10% of rural schools had Internet access, compared with 21% of suburban schools. By 2000 almost all schools had Internet access, but the rural schools had fewer computers connected to the Internet, and spent fewer hours online per month. However because of their smaller size the rural schools had a greater proportion of their computers connected to the Internet and more favourable ratios of pupils per Internet computer. In the rural schools in 2000 there were an average of 59 pupils per computer with Internet access, while the urban schools had an average of 151 (t-test, p=.000).[3]

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[1] Data table in appendix L12.

[2] Data table in appendix L13.

[3] Data table in appendix L14.

Regional pattern

As some US studies have reported regional variations in ICT equipment in schools,[1] the schools were examined on a county by county basis to identify patterns. The number of pupils per computer ranged from 13 in County Mayo to 22.5 in County Louth. Although there was a variation in the level of ICT equipment by county, there was no clear pattern to this variation.[2]

Location of primary schools, conclusion

In 1998 more of the rural schools were without computers, but those that had computers were better equipped than average in terms of pupil-computer ratio. By 2000 this pattern was well established, and rural schools had the best pupil-computer ratios, followed by small town, suburban and urban schools. The same sequence was followed for pupils per Internet-connected computer.

However the urban and suburban schools were larger, and had greater numbers of computers in absolute terms. They had more of their computers concentrated in computer rooms, and more of them had a network. Many of these differences could easily be explained in terms of school size. It is easy to imagine, for example, that larger schools are more likely to set up a network, while smaller schools are more likely to disperse computers in classrooms. This issue will be examined further after an analysis of the pattern of equipment by school size.

7.1c ICT equipment and school size, primary schools

This section examines the variation in level of ICT equipment in primary schools with the size of the school. This has been identified as an important variable in the US, where the 1998 TLC study reported that smaller schools were better equipped and had more developed networks and Internet connectivity. The US study also notes that much of the difference between rural and urban schools may be

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[1] See section 2.2f.

[2] Data table in appendix L15.

explained by the difference in their size.[1] Size of school is a matter of particular concern in the Irish context, where there are a very large number of small schools, and where ICT grants under IT 2000 were weighted towards smaller schools.[2]

The Irish primary schools responding to the survey had an average of 444 pupils each, with a standard deviation of 224. The analysis of the variation in ICT equipment with school size is based on a division of the schools into four size categories, using the quartiles as the break points between groups. The four size categories were:

TABLE 7. 5: QUARTILES OF SIZE OF PRIMARY SCHOOL

Primary schools	Q 1	Q 2	Q 3	Q 4
Number of pupils	1- 51	52-92	93-186	187 and over
Number of Schools	659	661	676	662
Number of pupils	21,495	47,034	88,158	214,456
Average pupils per school	32.6	71.2	130.4	324.0

In 1998 more of the smaller schools were without any computers (chi square, p=.000). Over 57% of the smallest schools had no computers, compared with only 21% of the largest schools. However for those schools with some computers, the smallest schools had the most favourable pupil-computer ratios.

This pattern was repeated in the second survey. By 2000, all schools had at least one computer, and the smaller schools had consistently more favourable pupil-computer ratios than the larger schools. The largest schools were the worst equipped with 23 pupils per computer while the smallest schools had an average of 11 (t-test, p=.000).

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[1] R. E. Anderson and A. Ronnkvist, *The Presence of Computers in American Schools,* Teaching, Learning and Computing: 1998 National Survey Report #2. Center for Research on Information Technology and Organizations (June 1999), pp15-16.

[2] An Roinn Oideachais agus Eolaíochta. *Schools IT 2000 Achievements to Date.* Published on the Department website at www.irlgov.ie/educ/it2000/it2000update.htm in 1998.

TABLE 7. 6: NUMBERS OF COMPUTERS BY SIZE OF SCHOOL, PRIMARY SCHOOLS

Primary schools	Q 1 1- 51	Q 2 52-92	Q 3 93-186	Q 4 187 +
Number of computers 1998	436	834	1,609	4,703
% of schools with no computers	57.3	49.0	39.3	20.8
Average computers per school 1998	0.7	1.3	2.4	7.1
Pupils per computer 1998	26.7	44.5	62.5	74.6
Number of computers 2000	2,203	3,372	5,370	11,787
Average computers per school 2000	3.3	5.1	7.9	17.8
Pupils per computer 2000	11.2	16.9	21.2	23.0

The smallest schools also had the greatest proportion of their computers equipped with CD ROM drives, reflecting their lower numbers of older machines.[1] The presence of peripherals in the schools was associated with the size of the schools. Larger schools had more scanners, digital cameras, laptops and data projectors than smaller schools.[2]

Location of computers

As might be expected, more of the computers in the larger schools were located in a computer room, while the smaller schools had more of their computers in classrooms. In the schools in the largest category (Q4) 44% of the computers were in computer rooms, while only 35% were in classrooms. In the schools of the smallest category only 8% were in computer rooms and 80% were in classrooms.

As the smaller schools had fewer classrooms and more of their computers in classrooms, more of the classrooms in small schools had a computer. In the Q1 schools 86% of classrooms had a computer, while in Q4 schools there was a computer in only 51% of classrooms (t-test, p=.000). The small schools had more Internet-connected classrooms too, with an average of 54%, compared with 11% in the large schools (t-test, p=.000).[3]

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[1] Data table in appendix L16.

[2] Data tables in appendices L17 to L19.

[3] Data table in appendix L20.

Networking and Internet connectivity

Networks were in place mainly in the larger schools. Almost one third of schools in the fourth quartile had a network, compared to only 15% of those in the third quartile and 13% and 10% of the second and first quartile. More of the computers in large schools were networked. In the largest schools 29% of the total number of computers were networked, while in the smallest schools only 9% were. Although more of the larger schools had a network, where small schools had a network they had a more favourable ratio of students to networked computers than large schools. In the smallest schools there was an average of 13 pupils per networked computer in the schools with a network, compared with 32 in the largest schools (t-test, p=.000).[1]

In 1998 more of the larger schools had Internet access. Of the smallest schools only 5% had Internet access compared with 23% of the largest schools. By 2000 almost all schools had Internet access, but the largest schools had more computers connected to the Internet. The smallest schools had an average of 1.4 computers with Internet access, while the largest had nearly 6. However this difference was not enough to compensate for the difference in pupil numbers, and the smallest schools had the most favourable ratio of pupils per Internet computer. In the smallest schools (Q1) there were 27 pupils per Internet computer, while in the largest schools the figure was over 176 (t-test, p=.000). This pattern may be partly a result of the large number of schools, 64% of the total, with Internet access on only one computer, which resulted in better ratios in the schools with smaller pupil numbers.[2]

Size of schools, conclusion

The relationship between school size and ICT equipment might be hypothesised to work in either of two directions. It might be assumed that larger schools would have greater resources at their disposal and would be more easily able to invest in

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[1] Data table in appendix L21.

[2] Data tables in appendices L22 and L23.

ICT. Alternatively, following the pattern in the US reported earlier,[1] it might be supposed that smaller schools would be better equipped, perhaps because of a closer relationship with parents, thereby facilitating fundraising.

This study provides some support for both hypotheses. In the period up to 1998, which might be termed the *laissez-faire* period, schools investment in ICT was largely at their own discretion. In 1998 more of the small schools had no computers at all, and more had no Internet connection. These findings offer some support to the hypothesis that larger schools were among the first to invest in ICT.

However at the same time, in the 1998 survey, when schools without computers were excluded, the smallest primary schools were the best equipped group. This seems to support the suggestion that some characteristic of small schools gives them an advantage in developing an ICT infrastructure.

Between 1998 and 2000, the ICT equipment grants given to schools were weighted towards smaller schools[2] and in addition each school received one free computer from Telecom Eireann. These inputs provided disproportionate assistance to the small schools. By 2000 the pupil-computer ratios for most school sizes had converged substantially, but the smallest schools remained noticeably better equipped than other school sizes (Graph 7.2).

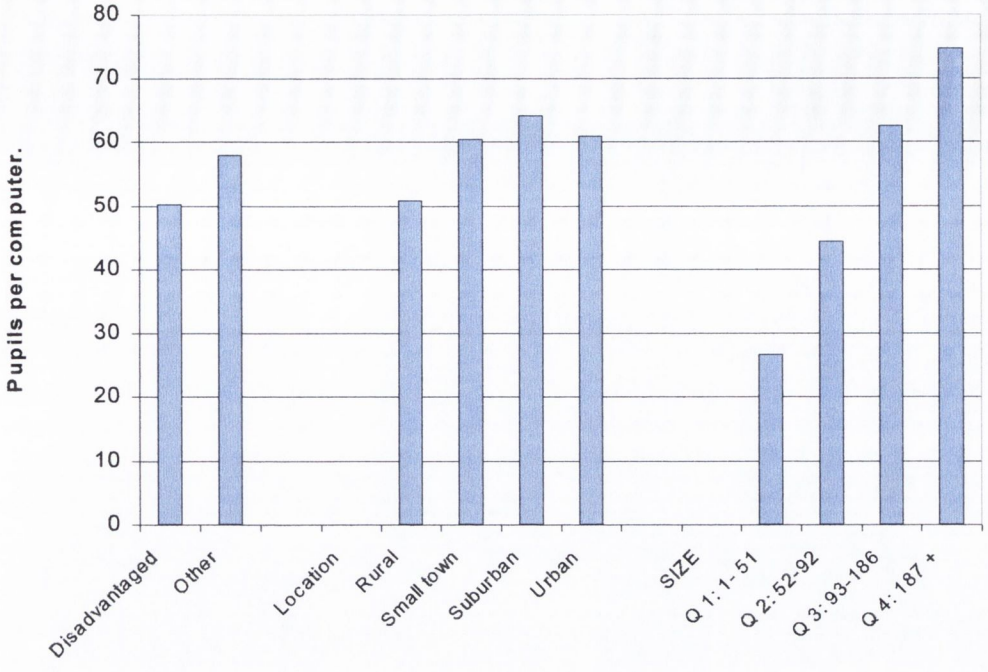
7.1d Interrelation ships between size, disadvantage and location

The three previous sections have examined three dimensions of the pattern of ICT equipment in schools, namely disadvantaged status, geographical location and size. In all three dimensions there were inequalities in level of equipment in 1998, and these gaps had narrowed by 2000. These inequalities are summarised in the table below, showing the variation in the pupil-computer ratio for each of the three

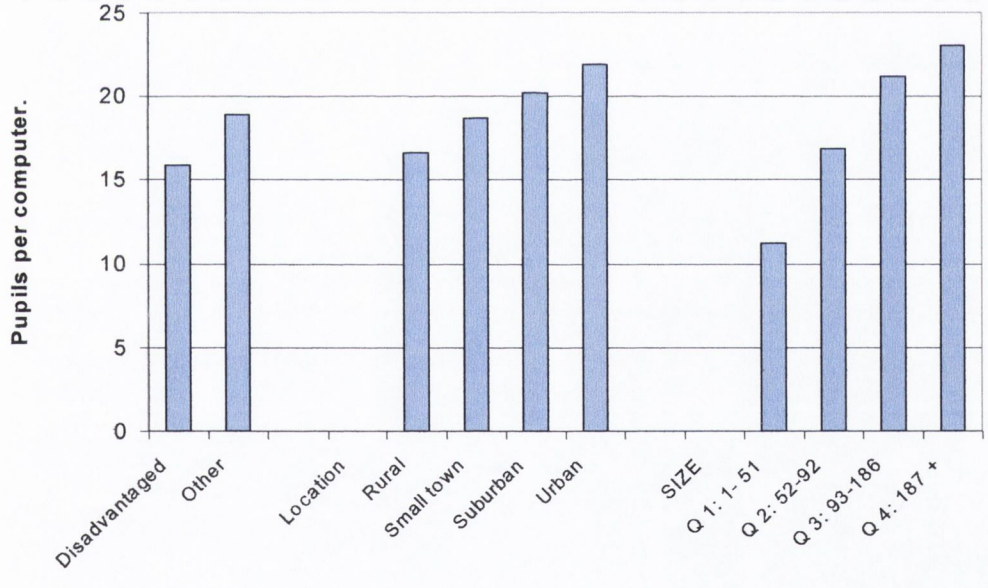
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[1] R. E. Anderson and A Ronnkvist, *The Presence of Computers in American Schools,* Teaching, Learning and Computing: 1998 National Survey Report #2. Center for Research on Information Technology and Organizations (June 1999), pp15-16.

[2] Grants distributed in 1998 were calculated as £2000 plus £5 per pupil. This means that a school with 100 pupils received £2500, while a school with 500 pupils received £4500.



GRAPH 7.3. PRIMARY SCHOOLS; PUPILS PER COMPUTER 1998.



GRAPH 7.4. PRIMARY SCHOOLS; PUPILS PER COMPUTER 2000.

dimensions (represented graphically in Graphs 7.3 and 7.4) This section explores the relationships between the dimensions, asking whether the pattern in one dimension can be explained by variation in another. This analysis is done in three parts. The first explores the relationship between school size and location, the second examines school size and disadvantaged status and the third examines location and disadvantaged status.

TABLE 7. 7: PATTERNS IN PUPIL COMPUTER RATIO, PRIMARY SCHOOLS 1998 AND 2000

	Pupils per computer 1998	Pupils per computer 2000
Disadvantaged	50.2	15.9
Other	58.0	18.9
Location		
Rural	50.8	16.6
Small town	60.5	18.7
Suburban	64.1	20.2
Urban	60.9	21.9
SIZE		
Q 1: 1- 51	26.7	11.2
Q 2: 52-92	44.5	16.9
Q 3: 93-186	62.5	21.2
Q 4: 187 +	74.6	23.0

Size and Location

Reports in the US have suggested that although rural schools have higher levels of equipment, these differences may be a result of their smaller size, rather than their location.[1]

In Ireland too, the size of schools was associated with their location. The majority of the rural schools were in the smaller quartiles of size, with 36% in the smallest group and 34% in the second quartile. The schools located in small towns were larger, with 38% in the third quartile (93-186 pupils) and 32% in the largest

[1] President's Committee of Advisors on Science and Technology, *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States,* (March 1997), Section 7.3.

category. The majority of the urban and suburban schools were in the largest category, with 66% of suburban and 78% of urban schools in this quartile.

TABLE 7. 8: RELATIONSHIP BETWEEN LOCATION AND SCHOOL SIZE, 2000

Size categories based on quartiles.	Q 1 1- 51	Q 2 52-92	Q 3 93-186	Q 4 187 +
% of rural schools	36%	34%	25%	5%
% of small town schools	14%	16%	38%	32%
% of suburban schools	2%	3%	17%	78%
% of urban schools	4%	10%	20%	66%

This association raises the question of whether the higher level of ICT equipment in small rural schools was a function of their smallness or their rural setting. The table below shows pupil-computer ratio cross tabulated by size and location. Disadvantaged schools were excluded from this table to avoid confounding effects.

This data suggests that the greater part of the variation may be attributed to school size. For each location, small schools were better equipped than large schools. For example small rural schools had an average of 11 pupils per computer, while the large rural schools had 24 pupils per computer and mid-size rural schools fell between the two. This pattern was consistent for each location category.

There was also some weak evidence that rural schools were less well equipped than urban schools of the same size. In the smallest schools, rural schools had less favourable pupil-computer ratios than their urban and suburban counterparts. However this pattern was not consistent for the other sizes of school.

The previous table reveals a strong association between pupil-computer ratio and school size. However when schools of similar size were compared, there was little consistent variation with location. This suggests that much of the variation in pupil-computer ratio with location can be explained by the size of the schools.

TABLE 7. 9: PRIMARY SCHOOLS (EXCLUDING DISADVANTAGED SCHOOLS), PUPILS PER COMPUTER 2000 BY SIZE AND LOCATION.

Pupils per computer 2000.	Q 1 1- 51	Q 2 52-92	Q 3 93-186	Q 4 187 +
Rural	11.3	17.2	22.7	23.9
Small Town	10.7	16.6	19.9	21.9
Suburban	8.7	15.4	26.4	22.2
Urban	10.8	18.4	19.0	29.1

School Size and Disadvantaged Status

The designated disadvantaged primary schools were also concentrated in the largest size categories. Nearly three-quarters of disadvantaged schools were in the larger two quartiles, with 49% in the largest quartile and a further 24% in the third quartile (93-186 pupils).

TABLE 7. 10: DISADVANTAGED STATUS AND SCHOOL SIZE, PRIMARY SCHOOLS

Primary schools, 2000	Q 1 1- 51	Q 2 52-92	Q 3 93-186	Q 4 187 +
% of disadvantaged schools	11%	15%	24%	49%
% of other schools	27%	26%	26%	21%

In all size categories, designated disadvantaged schools were better equipped than other schools, although the gap was smaller in the smallest schools. In the largest schools the disadvantaged schools had 18 pupils per computer while the other schools had 25.

TABLE 7. 11: SIZE, DISADVANTAGED STATUS AND LEVEL OF EQUIPMENT, PRIMARY SCHOOLS

Primary schools, 2000	Q 1 1- 51	Q 2 52-92	Q 3 93-186	Q 4 187 +
Disadvantaged	10.7	14.0	16.2	17.6
Other	11.2	17.1	21.9	24.7

School Location and Disadvantage

Disadvantaged primary schools were also concentrated in urban and suburban areas, with fewer in small towns and rural areas. Sixty-three percent of disadvantaged schools were located in urban or suburban areas, compared with only 18% of other schools. By contrast only 35% of disadvantaged schools were in rural areas or small towns, compared with 81% of other schools.

TABLE 7. 12: LOCATION AND DISADVANTAGED STATUS

Primary schools, 2000	Rural	Small town	Suburban	Urban
% of disadvantaged schools	25%	10%	17%	46%
% of other schools	65%	16%	8%	10%

In most locations disadvantaged schools had higher levels of equipment than other schools. In urban areas the disadvantaged schools had an average of 17 pupils per

computer, while other schools had 25. One exception to this pattern was in small towns where the disadvantaged schools were slightly less well equipped with 19.3 pupils per computer, compared with 18.6 for other schools.

TABLE 7. 13: LOCATION, DISADVANTAGED STATUS AND LEVEL OF EQUIPMENT

Primary schools 2000	Rural	Small town	Suburban	Urban
Disadvantaged	14.1	19.3	14.4	16.8
Other	16.8	18.6	22.1	25.3

Inter-relationships, conclusion

This analysis suggests three conclusions for primary schools. Firstly, in 2000 the greatest variation in level of equipment was associated with school size, and small schools were better equipped than large schools. Secondly, disadvantaged schools were better equipped than other schools, and this pattern was consistent for disadvantaged schools of all sizes and in most locations. Thirdly, rural schools were better equipped than urban and suburban schools, but most of this difference was explained by their smaller average size.

7.2 Patterns in ICT equipment in post-primary schools

The previous section has examined ICT equipment in primary schools along the dimensions of disadvantaged status, school location and school size. This section and the following sections replicate this analysis for post-primary schools, beginning with a comparison of ICT equipment in disadvantaged and other post-primary schools.

7.2a ICT equipment and designated disadvantaged status, post-primary schools

Of the 620 post-primary schools that responded to the survey, 175 were designated disadvantaged schools. These schools were slightly smaller than other schools, having an average of 405 students, compared with 434 in other schools.

TABLE 7. 14: DISADVANTAGED POST-PRIMARY SCHOOLS

Post-primary schools	Designated disadvantaged schools	Other schools
Number of Schools	175	445
Number of students	70,983	193,168
Average students per school	405.6	434.1

As with the primary schools, disadvantaged post-primary schools were better equipped than average. In 1998 disadvantaged schools had an average of 20 students per computer compared with 25 students per computer in other schools. By 2000 the disadvantaged schools had retained their lead, with 11 students per computer, while the other schools had 14 (t-test, p=.000). Disadvantaged schools were also better equipped with most of the peripherals recorded, although the other schools had slightly more of their computers equipped with CD ROM drives, suggesting newer machines.[1]

TABLE 7. 15: NUMBERS OF COMPUTERS, DISADVANTAGED POST-PRIMARY SCHOOLS

Post-primary schools	Designated disadvantaged schools	Other schools
Number of computers 1998	4,840	9,544
Average computers per school 1998	27.7	21.4
Students per computer 1998	20.7	25.4
Number of computers 2000	8,506	17,971
Average computers per school 2000	48.6	40.4
Students per computer 2000	11.0	13.8

The disadvantaged post-primary schools had slightly fewer of their computers in computer rooms and slightly more in classrooms, although the differences were very small. In disadvantaged schools, 71% of the computers were in computer rooms and 8% in classrooms, while in other schools the figures were 73% and 6% respectively. Accordingly, computers were available in 14% of classrooms in disadvantaged schools and 12% of classrooms in other schools.[2]

More of the disadvantaged schools had a network, and on average their networks were larger than the non-disadvantaged schools'. Networks were present in 79% of disadvantaged schools and 76% of other schools. Networks in disadvantaged schools had an average of 34 computers, while in other schools the average size was 29 computers. As a result the disadvantaged schools had an average of 24

[1] Data tables in appendices L24 to L27.

[2] Data table in appendix L28.

students per networked computer, while other schools had an average of 34 students per networked computer (t-test, p=.044).[1]

There was little difference in the proportion of schools with Internet access in 1998. By 2000 almost all schools had Internet access, but the disadvantaged schools reported more computers connected to the Internet. Consequently disadvantaged schools had 82 students per Internet-connected computer, compared with 85 in other schools.[2] The disadvantaged schools also reported spending more time on-line, with 50 hours each month compared with 40 in other schools.

These data indicate that the disadvantaged post-primary schools were better equipped for ICT than other schools. Although smaller in size they had more computers both in 1998 and 2000. Consequently they had more favourable student-computer ratios. They also had more sophisticated technical structures, with more networking and more Internet connectivity.

7.2b ICT equipment and location in post-primary schools

The level of equipment in post-primary schools also varied with geographical location. Of the post-primary schools responding to the survey, 226 were located in small towns, 182 were in urban areas, 91 were in suburbs and 113 were in rural areas. The rural schools were smaller than the others, with an average of 308 students. The suburban schools were the largest with 516 students.

TABLE 7. 16: LOCATION OF POST-PRIMARY SCHOOLS.

Post-primary schools	Rural	Small town	Suburban	Urban
Number of Schools	113	226	91	182
Number of students	34,853	94,719	46,957	83,922
Average students per school	308.4	419.1	516.0	461.1

At the start of the research period in 1998, rural schools and small town schools were the best equipped with 23 students per computer. Urban schools were slightly

[1] Data table in appendix L29.

[2] Data table in appendix L30.

behind with an average of 24 students per computer, and the suburban schools were in the worst position with an average of student-computer ratio of 30.

Between 1998 and 2000 the level of computer equipment in all locations increased. Rural schools increased their equipment slightly faster than small town schools, and suburban schools increased more quickly than urban schools (Graph 7.5). By 2000 the rural schools were best equipped with 11.5 students per computer, significantly better than the ratio of 13.9 in urban schools (t-test, p=.009).

TABLE 7. 17: NUMBERS OF COMPUTERS AND LOCATION OF POST-PRIMARY SCHOOLS.

Post-primary schools	Rural	Small town	Suburban	Urban
Number of computers 1998	2,010	4,740	2,257	5,225
Average computers per school 1998	17.8	21.0	24.8	28.7
Students per computer 1998	22.8	22.7	30.1	23.9
Number of computers 2000	3,377	8,479	4,832	9,546
Average computers per school 2000	29.9	37.5	53.1	52.5
Students per computer 2000	11.5	12.4	14.2	13.9

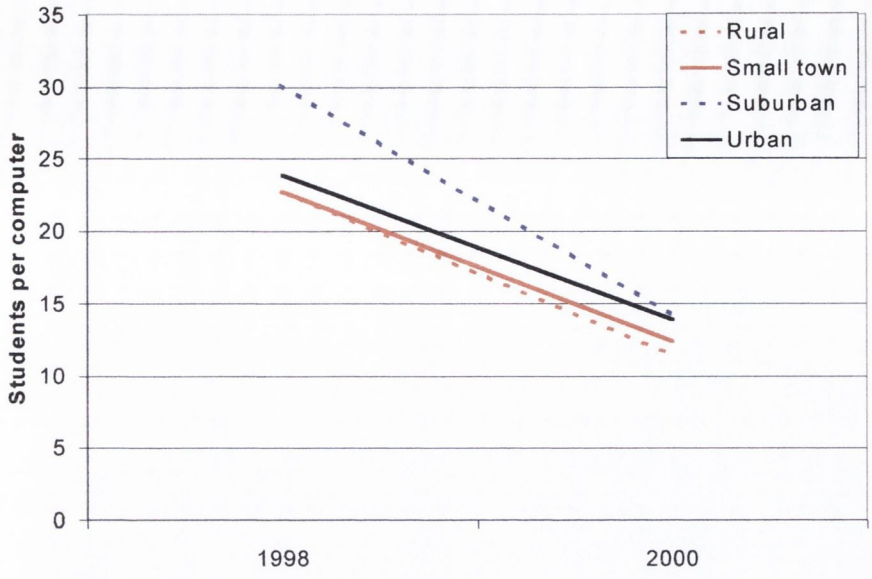
Although the rural schools were better equipped in terms of student-computer ratio, more of the urban and suburban schools had most of the peripherals recorded. For example, both data projectors and laptops were found in more of the suburban schools than schools in other locations. Data projectors were present in 54% of suburban schools but only 30% of rural schools. Laptops were in 44% of suburban schools and 27% of rural schools.[1]

In the urban and suburban schools more of the computers were located in computers rooms and fewer in classrooms. In urban schools 76% of computers were in computer rooms, compared with 70% in suburban schools, 69% in small town schools and rural schools. Conversely only 4.6% of the computers in urban schools were in classrooms, while 8% of those in rural schools and 8.6% of those in small town schools were in classrooms. Consequently more of the classrooms in rural schools had computers and had Internet access, but the differences were not statistically significant.[2]

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[1] Data tables in appendices L31 to L34.

[2] Data table in appendix L35.



GRAPH 7.5. POST PRIMARY SCHOOLS; LOCATION OF SCHOOLS AND STUDENT:COMPUTER RATIO

More of the urban schools had networks than schools in rural areas. Networks were in place in 83% of urban schools and 81% of suburban schools, but only 70% of rural schools and 73% of small town schools. The networks in urban and suburban schools were larger, as might be expected in view of their greater student numbers. Suburban schools with a network had an average of 40 computers networked, compared with 21 in rural schools. As a result the suburban schools had the most favourable ratio of students to networked computers. However, it was the urban schools that were in the least favourable position with nearly 40 students per networked computer.

TABLE 7. 18: NETWORKED COMPUTERS, POST-PRIMARY SCHOOLS, 2000.

Post-primary schools 2000 data	Rural	Small town	Suburban	Urban
Number of schools with a network	79	165	74	151
% of schools with a network	69.9	73.0	81.3	83.0
Average number of computers networked in those schools	21.6	26.5	40.3	34.3
Total number of networked computers	1,706	4,375	2,984	5,172
% of computers networked	50.5	51.6	61.8	54.2
Students per networked computer	26.4	29.2	24.4	39.8

Internet access was also better developed in the suburban schools. In 1998 more of the suburban schools had Internet access than schools in other locations. By 2000 the suburban schools had more computers connected to the Internet, a more favourable ratio of students to Internet computers, and spent more time on-line than schools in other locations. By contrast rural schools had the lowest proportion connected to the Internet in 1998, and had the least favourable ratio of pupils to Internet computers in 2000. Rural schools had 90 students per Internet-connected computer, while the urban schools had an average of 71.[1]

Overall, these findings suggest a complex pattern of variation with location. Rural schools were the best equipped in terms of students per computer, but fewer of them had the more expensive peripherals, or a school network. The rural schools also had fewer Internet-connected computers and spent less time on-line. As with

[1] Data table in appendix L36.

the primary schools, there was no clear regional pattern, although student-computer ratio ranged from 9.7 in County Leitrim to 15.7 in County Cavan.[1]

The suburban schools were the largest in terms of student numbers. In 1998, they were the least equipped in terms of students per computer. However, they showed the fastest growth in the period 1998 to 2000, and by 2000 had narrowed the gap markedly. More of the suburban schools had the peripherals, more were networked, and more of their computers had Internet access.

7.2c ICT equipment and type of post-primary school

ICT equipment in post-primary schools also varied with the type of school. Over half (331) of the responding schools were secondary schools, and these had an average of 475 students each. There were also 163 vocational schools with an average of 269 students. There were smaller numbers of community schools, community colleges and comprehensive schools.

TABLE 7. 19: SCHOOL TYPES, POST-PRIMARY SCHOOLS

Post-primary schools	C. College	C. School	Comp.	Secondary	Vocational
Number of Schools	49	60	15	331	163
Number of students	20,521	34,352	7,749	157,051	43,864
Average students per school	418.8	572.5	516.6	474.5	269.1

At the start of the research period in 1998, vocational schools were the best-equipped type of school, while secondary schools were in the worst position. Vocational schools had an average of 13.6 students per computer, compared with 29 in secondary schools (t-test, p=.000). By 2000 the numbers of computers had increased but the pattern remained similar, with secondary schools having the lowest level of equipment and vocational schools the highest. In 2000 the secondary schools had an average of 16 students per computer, while the vocational schools had eight students per computer (t-test, p=.000).

However during the period the community schools had the greatest increase in equipment, moving from an average of 30 computers each to 61 computers each.

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[1] Data table in appendix L37.

Consequently by 2000 the community schools had similar student-computer ratios to the community colleges and comprehensive schools. As a result by 2000 the secondary schools were substantially behind all other school types in terms of student-computer ratio (Graph 7.6).

TABLE 7. 20: NUMBERS OF COMPUTERS, POST-PRIMARY SCHOOLS

Post-primary schools	C. College	C. School	Comp.	Secondary	Vocational
Number of computers 1998	1,168	1,775	469	6,196	4,751
Average computers per school 1998	23.8	29.6	31.3	18.7	29.1
Students per computer 1998	18.5	28.9	18.1	29.3	13.6
Number of computers 2000	2,321	3,663	683	10,912	8,725
Average computers per school 2000	47.4	61.1	45.5	33.0	53.5
Students per computer 2000	10.7	11.3	11.7	15.9	8.1

Comprehensive schools had the slowest growth during the period relative to other schools. Fewer of their computers equipped with CD ROM drives, and they had fewer laptops and data projectors than other school types. This pattern suggests that the comprehensive schools, while relatively well equipped in 1998, were investing less in ICT than other schools in the period.[1]

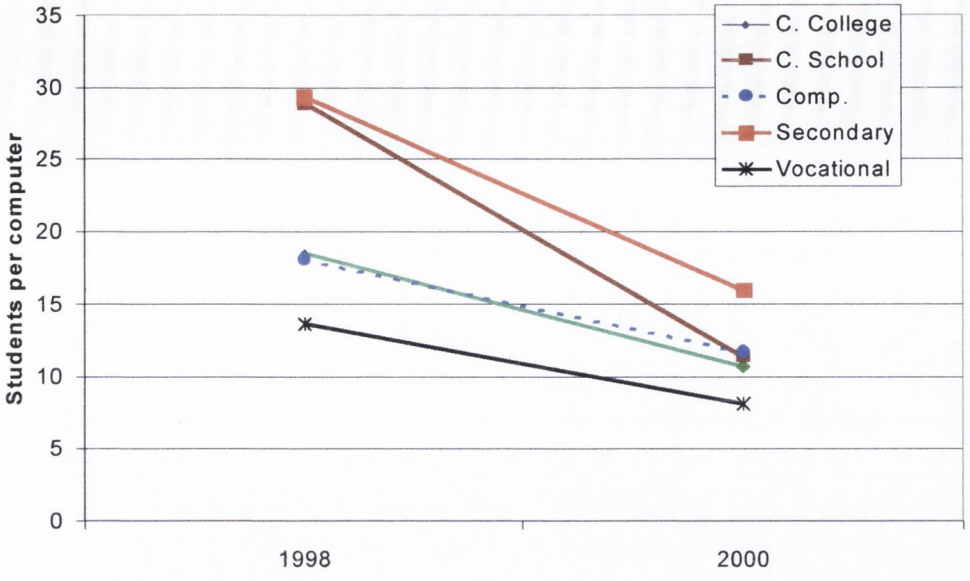
Vocational schools had more of their computers in computer rooms than any of the other school types. The vocational schools reported that 80% of their computers were in computer rooms, compared with 70% in secondary schools and 65% in community schools. Comprehensive schools had the lowest percentage in computer rooms at 59%. Conversely the comprehensive schools had more of their computers in classrooms, while secondary schools had the smallest proportion in classrooms.

Vocational schools had significantly more classrooms with computer and with Internet connections than secondary schools. In vocational schools 19% of classrooms had a computer, compared with 9% in secondary schools (t-test, p=.000). Similarly in vocational schools 8% of classrooms had Internet access, compared with 4% of secondary schools (t-test, p=.010).[2]

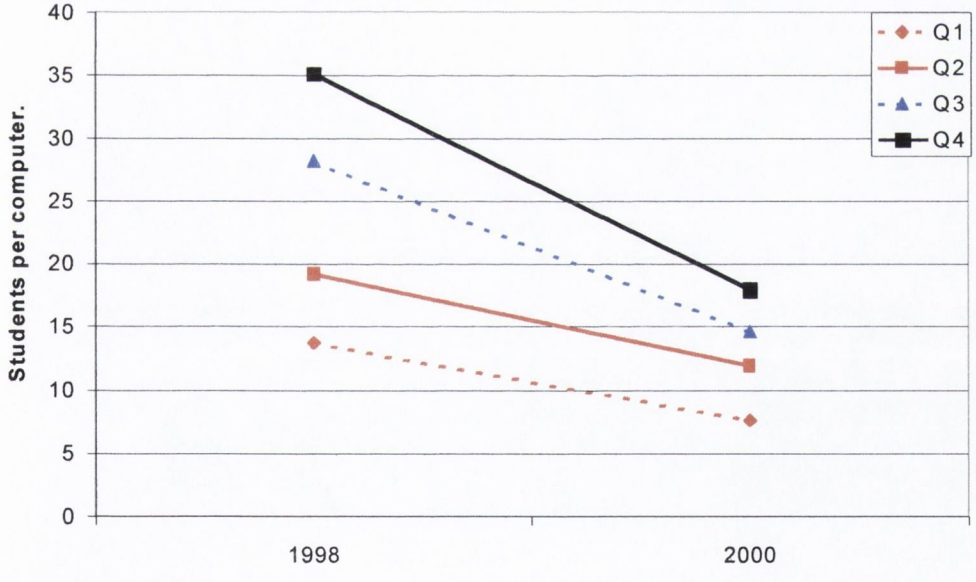
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[1] Data tables in appendices L38 to L41.

[2] Data table in appendix L42.



GRAPH 7.6. POST PRIMARY SCHOOLS; SCHOOLS TYPE AND STUDENTS PER COMPUTER.



GRAPH 7.7. POST PRIMARY SCHOOLS; STUDENTS PER COMPUTER AND SCHOOL SIZE

School networking was most developed in vocational schools, where there were ten students per networked computer. Networking was least developed in the secondary schools, with 27 students per networked computer.[1] Internet access followed the same pattern, with 65 students per Internet-connected computer in vocational schools, and 99 in secondary schools (t-test, p=.003).[2]

The general pattern was that the vocational schools were the best equipped in terms of students per computer, students per networked computer and students per Internet computer. Secondary schools were consistently the least equipped on all three of these indicators. The remaining three school types were clustered in mid positions.

7.2d ICT equipment and school size, post-primary

The post-primary schools responding to the survey had an average of 444 pupils. To examine whether the level of ICT equipment was related to school size, the schools were divided into four groups, using quartiles as the break points between groups. The four size categories were:

TABLE 7. 21: SIZE CATEGORIES OF POST-PRIMARY SCHOOLS

Post-primary schools	Q1	Q2	Q3	Q4
Number of students	1-266	267-424	425-602	603+
Number of Schools	147	150	150	148
Average students per school	172.7	346.8	509.8	745.1

Smaller schools were better equipped in terms of student-computer ratio than larger schools. This relationship appeared consistently for all four quartiles, both in 1998 and 2000. In 1998, the schools in Q1 had 14 students per computer, while those in Q4 had 35 (t-test, p=.000). Between 1998 and 2000 the gap between the schools of different sizes narrowed slightly (Graph 7.7). By 2000 the schools in Q1 had an average of eight students per computer, while those in Q4 had 18 (t-test, p=.000).

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[1] Data table in appendix L43.

[2] Data table in appendix L44.

TABLE 7. 22: NUMBERS OF COMPUTERS, POST-PRIMARY SCHOOLS.

Post-primary schools	Q1 1-266	Q2 267-424	Q3 425-602	Q4 603+
Number of computers 1998	2,802	2,977	3,885	3,830
Average computers per school 1998	19.1	19.8	25.9	25.9
Students per computer 1998	13.7	19.2	28.2	35.1
Number of computers 2000	4,970	5,273	6,491	7,446
Average computers per school 2000	33.8	35.2	43.3	50.3
Students per computer 2000	7.6	11.9	14.6	18.0

More of the larger schools had other peripherals such as a digital camera, a data projector or a laptop. The difference was most marked for data projectors, which were reported in 60% of the largest schools (Q4), but only 26% of the smallest schools (Q1).[1]

The larger post-primary schools had fewer of their computers located in computer rooms and more located in classrooms. In the smallest schools 77% of the computers were in computer rooms, while in the largest schools only 66% were. In the smallest schools 17% of classrooms had a computer, compared with 10% of the largest schools. Significantly more of the classrooms in smaller schools had Internet access, with 8% of classrooms having access in the smallest schools compared with 4% in the largest schools (t-test, p=.017).[2]

More of the large schools (Q4) had a network. Only 63% of the small schools (Q1) had a network, but the proportion increased with school size and 90% of the largest category (Q4) had a network. Where there were networks those in the larger schools included more computers, and in total more of the computers in the large schools were networked. Despite this the small schools had a more favourable ratio of students to networked computers. Where there was a network, in the smallest schools the ratio was 15 students per networked computer, and this rose to 47 in the largest schools (t-test, p=.000).[3]

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[1] Data tables in appendices L45 to L48.

[2] Data table in appendix L49.

[3] Data table in appendix L50.

More of the large schools had Internet access in 1998, with 78% of the schools in the fourth quartile reporting access, compared to 59% of those in the first quartile. By 2000 the large schools had more computers connected to the Internet, and a greater proportion of their total number of computers connected. However the smaller schools had a more favourable ratio of students to Internet computers, with 62 students per Internet computer in the smallest schools and 103 in the largest (t-test, p=.007).[1]

These findings reveal a very consistent pattern with school size. Smaller post-primary schools were significantly better equipped than larger ones both in 1998 and in 2000. More of the large schools had the expensive peripherals such as data projectors, and more of them had networks. However, where there were networks, the smaller schools had more favourable ratios of students to networked computers. Similarly, larger schools had more Internet-connected computers, but the smaller schools had significantly better ratios of students to Internet-connected computers.

7.2e Interrelation ships between size, type, disadvantage and location

The preceding data has demonstrated unequal distributions of computers among post-primary schools along four dimensions, namely size, location, type and disadvantaged status. The differences in student-computer ratio can be summarised as follows:

- Smaller schools were better equipped than larger schools.
- Rural schools were better equipped than urban schools.
- Vocational schools were better equipped than secondary schools.
- Disadvantaged schools were better equipped than other schools.

The interrelationships between these dimensions present the possibility of interference. For example vocational schools, being smaller than average may contribute to the pattern of higher equipment levels in smaller schools, or conversely, the vocational schools may be better equipped simply because they are

[1] Data table in appendix L51.

smaller. This section is concerned with examination of the inter-relationships between these dimensions.

TABLE 7. 23: PATTERNS IN STUDENT:COMPUTER RATIO, POST-PRIMARY SCHOOLS

	Pupils per computer 1998	Pupils per computer 2000
Disadvantaged	20.7	11.0
Other	25.4	13.8
Location		
Rural	22.8	11.5
Small town	22.7	12.4
Suburban	30.1	14.2
Urban	23.9	13.9
Size		
Q 1:	13.7	7.6
Q 2:	19.2	11.9
Q 3:	28.2	14.6
Q 4:	35.1	18.0
Type		
C. College	18.5	10.7
C. School	28.9	11.3
Comp	18.1	11.7
Secondary	29.3	15.9
Vocational	13.6	8.1

School location and size

This subsection is concerned with the relationship between schools size and location, given that rural schools were over-represented in the smaller sizes, and suburban and urban schools over-represented in the larger sizes.[1] The table below shows the inter-relationship of school size and location, using student-computer ratio as the key indicator. To avoid possible interference by type or disadvantaged status, only secondary schools and non-disadvantaged schools are included in this table. This analysis shows that within each location the general pattern with size was the same, smaller schools were better equipped than larger schools.

[1] Data table in appendix L52.

However within the smallest size category, urban schools were better equipped than rural schools. This is true for the smallest and largest sizes, but not for the two intermediate sizes. This suggests that, as with the primary schools, most of the advantage of rural schools is associated with their size rather than their rural character.

TABLE 7. 24: RELATIONSHIP BETWEEN SCHOOLS SIZE AND LOCATION. STUDENT:COMPUTER RATIO IN SECONDARY SCHOOLS ONLY, EXCLUDING DISADVANTAGED SCHOOLS, 2000

School Size	Rural	Small town	Suburban	Urban
Q1	9.8	11.4	8.1	8.9
Q2	13.6	11.6	12.4	14.5
Q3	15.5	14.8	16.7	16.1
Q4	21.7	17.1	15.4	18.8

The table below is also based on the single indicator of students per computer. It shows a tabulation of student-computer ratio by size, type and location. Disadvantaged schools are again excluded from this table to avoid interference. In some cases the number of schools is so small that analysis of patterns may be unreliable. This is particularly true in the case of the community schools and colleges and comprehensive schools.

As noted above, the strongest pattern is that associated with school size. In almost all locations and school types, where numbers permit analysis, smaller schools had better levels of equipment than larger schools. For example, small rural vocational schools had an average of 5.5 students per computer, while the larger schools had an average of 18.7.

Within the size categories, the pattern of variation with school type described earlier remained. Vocational schools of all sizes were better equipped than secondary schools of the same size and location. For example small secondary schools in small towns had an average of 11.4 students per computer, while the vocational schools of the same location and size had an average of 5.3. The extent of the gap varied with size and location but there was no category where the secondary schools were better equipped than the vocational. In general, the gap between secondary and vocational schools was greater in urban areas than in rural areas and this was true in all four of the size quartiles.

Among vocational schools, urban schools were better equipped than rural schools, and this was true in all four size categories. This pattern was not so consistent in the secondary schools. Among large and small secondary schools the urban schools were better equipped than the rural, but this was reversed for the schools in the second and third quartiles, where the rural schools were slightly better equipped.

TABLE 7. 25: POST-PRIMARY SCHOOLS, EXCLUDING DISADVANTAGED SCHOOLS: NUMBER OF SCHOOLS AND STUDENTS PER COMPUTER (S PER C), BY TYPE, LOCATION AND SIZE

Location	Size	C. College		C. School		Comp.		Secondary		Vocational	
	Q	N	S per c	N	S per c	N	S per c	N	S per c	N	S per c.
Rural	1	4	5.5	1	0.9			15	9.8	17	5.5
	2	1	13.5	1	6.8			12	13.6	6	9.7
	3	1	13.2		-	1	10.2	7	15.5	5	13.6
	4	1	33.7	2	11.0	1	16.9	2	21.7	1	18.7
Small town	1	3	5.1					17	11.4	25	5.3
	2	4	11.7	1	7.3	2	9.3	32	11.6	10	11.5
	3	5	10.3	7	11.2	1	11.3	25	14.8	6	12.1
	4	3	13.7	10	14.7	1	10.8	24	17.1	2	9.0
Suburban	1	1	15.0					3	8.1	2	3.3
	2	1	13.8	1	4.8			6	12.4		
	3	1	16.5	3	7.7			11	16.7	3	11.5
	4	3	10.5	5	13.2	2	18.1	21	15.4		
Urban	1	1	10.6					6	8.9	9	2.0
	2	1	5.5	1	7.2			15	14.5	3	7.0
	3	1	12.7			1	9.8	21	16.1	1	3.0
	4	3	13.2					33	18.8	2	12.0

A similar analysis was conducted for the disadvantaged schools, as disadvantaged schools were underrepresented in the largest size of schools, and more of them were located in urban areas.[1] In almost all cases the level of equipment in disadvantaged schools was higher than in the comparable other schools. However, within the disadvantaged schools, some of the same patterns emerged. Within almost all categories smaller schools were better equipped than larger schools. Disadvantaged vocational schools in urban areas were better equipped than disadvantaged rural schools in all four of the size categories. [2]

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[1] Data tables in appendices L53 and L54.

[2] Data table in appendix L55.

A number of general inferences may be drawn from these findings. Firstly, there was variation in level of equipment with school size, which cannot be explained by the variation in the other variables. Secondly, there was a consistent pattern of variation with school type, which appeared within each size and location. Thirdly, disadvantaged schools were better equipped than other schools, and this could not be attributed to variation in size, location or type. Finally, while rural schools were better equipped than average, most of that variation could be explained by their smaller size, and when comparing schools of the same size, rural schools were in some cases less well equipped.

7.3 Access to ICT, primary schools

The focus of this section is on examining the level of access to ICT provided in schools. Meeting the objective of providing ICT skills for all learners is not met simply by having ICT in schools. Clearly it is also necessary that learners have access to ICT. Given that school computers may not be in use all of the time, it is not safe to assume that the level of access is directly related to the level of equipment. Access was measured through the questions in the 2000 survey asking schools to indicate the classes with access and the frequency of access. This measure involved an estimation on the part of responding schools, and so must be acknowledged to be less objective than measures of equipment. These school estimates of access were amalgamated into a composite access score,[1] based on the number of classes with access and the frequency of access in each class, but excluding access outside of school hours.

Analysis of the access scores for primary schools revealed that for school size and location, the pattern of access generally reflected that of equipment. The table below shows the average access scores for primary schools, excluding disadvantaged schools. Small schools had higher access scores than large schools. The smallest schools (Q1) had an average score of 21, while the largest (Q4) had an average score of 17 (t-test, p=.000). Rural primary schools had higher access

[1] Section 5.5a

scores than urban schools. On average rural schools had an access score of 19.6, while urban schools had an average of 16.6 (t-test, p=.000). This was true for schools in all four size categories, suggesting that it was not simply an effect of the smaller size of rural schools.

TABLE 7. 26: AVERAGE ACCESS SCORE FOR PRIMARY SCHOOLS (EXCLUDING DISADVANTAGED SCHOOLS) BY LOCATION AND SIZE[1]

	Rural	Small town	Suburban	Urban	**All locations**
Q1	21.0	19.9	17.0	16.1	**20.7**
Q2	19.6	16.9	14.6	18.5	**19.2**
Q3	17.7	16.1	17.4	15.5	**17.1**
Q4	18.5	16.8	17.9	16.7	**17.3**
All sizes	**19.6**	**17.0**	**17.7**	**16.6**	**18.7**

TABLE 7. 27: AVERAGE ACCESS SCORE FOR DISADVANTAGED PRIMARY SCHOOLS BY LOCATION AND SIZE[2]

	Rural	Small town	Suburban	Urban	**All locations**
Q1	20.7	32.0		24.0	21.1
Q2	21.2	15.8		12.7	17.5
Q3	20.5	17.6	14.9	16.4	17.3
Q4	11.7	18.8	17.6	17.1	17.3
All sizes	20.5	18.4	16.9	16.4	17.8

In disadvantaged schools, the pattern of ICT access did not reflect the level of equipment. Despite having higher levels of equipment (as measured in pupils per computer), disadvantaged schools had slightly lower access scores than other schools. Disadvantaged primary schools had an average access score of 17.8 compared with 18.7 for other schools. This gap was not statistically significant and appeared only in some size and location categories.

A class by class comparison of access in disadvantaged and other primary schools reveals that slightly more of the disadvantaged schools provided frequent or very frequent access to ICT. This was true for all classes from junior infants to 6th class, although the margins were very small in some cases. However more of the other schools had some access to ICT. Again this was true for all classes, and the margins were slightly larger (Graph 7.8).

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[1] Full data table including numbers of schools in appendix L56.

[2] Full data table including numbers of schools in appendix L57.

Access to ICT outside of school hours might be considered one of the obvious measures to compensate for absence of computers in the home.[1] However provision of out-of-hours access was less frequent in disadvantaged primary schools. For example 12% of sixth class groups in disadvantaged school had access outside school hours, compared with 14% of those in other schools. This gap was wider for younger classes. In disadvantaged schools out-of-hours access was provided for 2.9% of First classes, compared with 6.1% in other schools.

TABLE 7. 28: PRIMARY SCHOOLS: ACCESS TO ICT IN DISADVANTAGED AND OTHER SCHOOLS.

Primary schools 2000	% of schools where this class has frequent or very frequent access to ICT		% of schools where this class has some access to ICT		% of schools where this class has Outside hours access to ICT	
Class	Other schools	Disadv. schools	Other schools	Disadv. schools	Other schools	Disadv. schools
Junior Infants	43.3	44.8	69.0	61.9	5.4	2.3
Senior Infants	45.9	49.4	72.3	66.6	5.8	2.0
1st class	51.5	52.0	79.3	70.9	6.1	2.9
2nd class	54.4	57.0	83.9	77.3	6.8	4.4
3rd class	59.2	62.2	86.5	79.7	9.0	5.5
4th class	59.2	62.2	86.5	79.7	10.3	6.7
5th class	61.7	63.7	87.4	80.8	13.0	9.6
6th class	64.6	65.4	88.8	81.4	14.0	11.9

For primary schools, the analysis of equipment patterns in the previous sections had indicated that small schools, rural schools, and disadvantaged schools were better equipped in terms of pupils per computer. This section suggests that in primary schools these differences in equipment were reflected in greater access to ICT in small schools and in rural schools. There was even some indication that the greater access to ICT in rural schools was more than could be explained by the difference in school size.

However, the greater level of equipment in disadvantaged schools was not reflected in greater access to ICT. At all ages, more of the classes in other schools had some access to ICT. In addition access to ICT outside of school hours was provided less

[1] Section 3.4.

frequently in the disadvantaged schools, despite the obvious role of such access in addressing unequal home access.

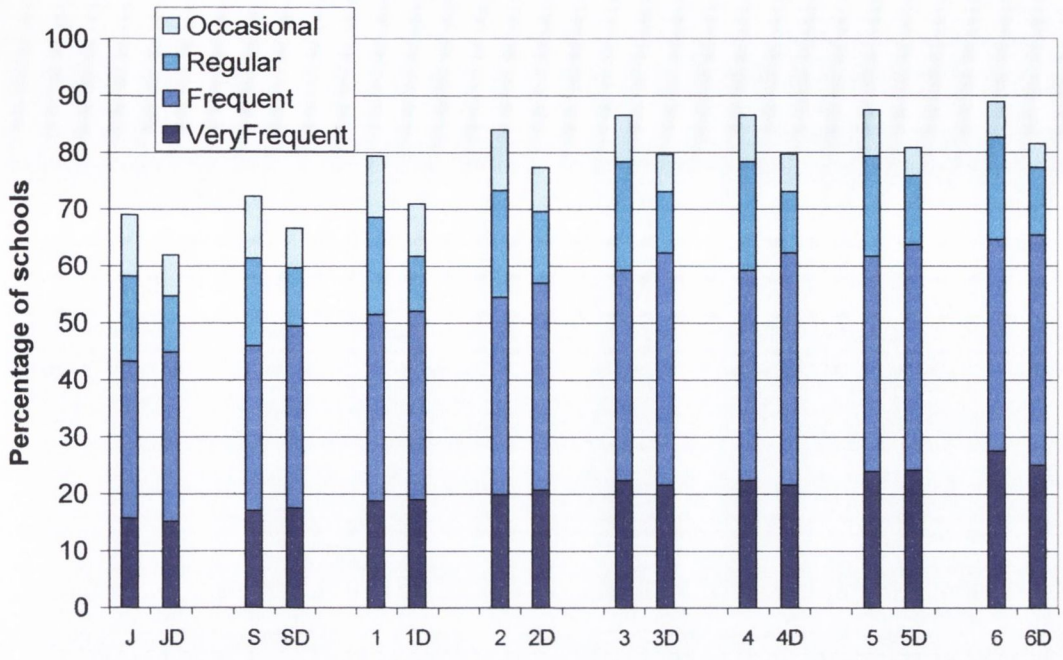
7.4 Access to ICT, post-primary schools

A similar analysis of access to ICT was conducted for post-primary schools. In calculating the access score for post-primary schools the classes included were 1st to 3rd year and 5th to 6th year. Transition year was excluded because it is not offered in all schools. Thus for post-primary schools the maximum possible score was 20.

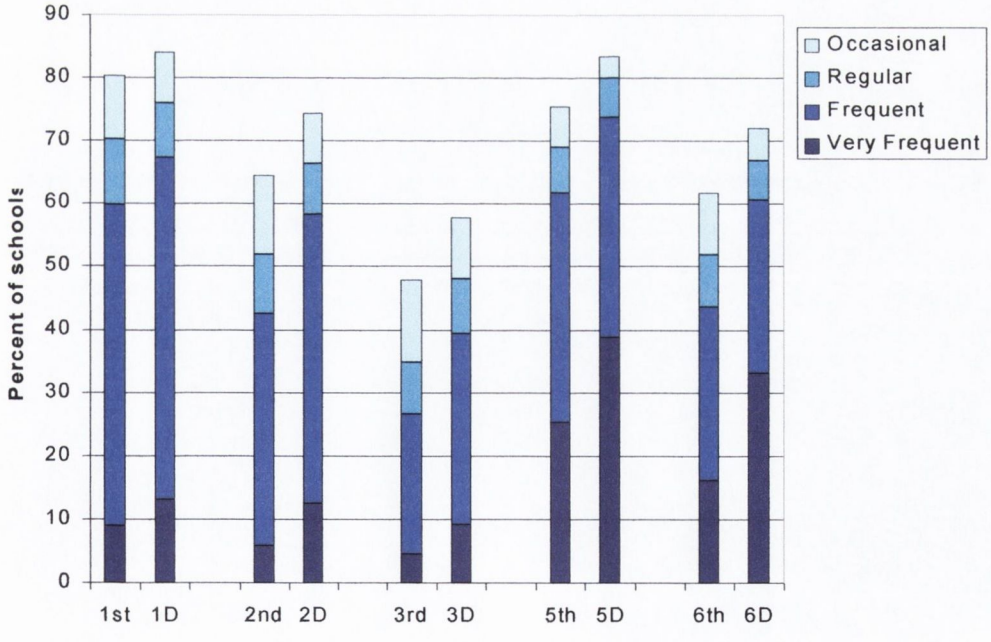
In general the smaller schools offered their students higher levels of access to ICT. The smallest schools (Q1) had an average access score of 10, while the largest had a score of 8 (t-test, p=.000). However this pattern varied with location. In the rural and small town areas the smaller schools (Q1 and 2) had higher access than the larger schools (Q3 and 4). In urban areas this pattern was reversed, and the larger schools had higher access.

Rural schools had higher access scores than urban schools, with an average of 9.8, while urban schools scored 8.4, but this difference was not statistically significant. This pattern was not consistent across all school sizes. Small rural schools had higher access scores than urban schools, but for larger schools the position was reversed.

These data, recorded in the table below, suggest a weak pattern of interaction between schools size and location, with greater access in large urban schools and small rural schools. By contrast the lowest access scores were in the large rural schools and in small suburban schools. In both cases the numbers of schools were small, but the scores were less than 5, a level that could be achieved by occasional (less than 1 period per month) access for each of the years of post-primary schooling.



GRAPH 7.8. FREQUENCY OF ACCESS TO ICT BY DISADVANTAGED STATUS, PRIMARY SCHOOLS, 2000



GRAPH 7.9. POST PRIMARY SCHOOLS 2000. FREQUENCY OF ACCESS TO ICT BY CLASS AND DISADVANTAGED STATUS

TABLE 7. 29: AVERAGE ACCESS SCORE FOR POST-PRIMARY SCHOOLS, EXCLUDING DISADVANTAGED SCHOOLS, 2000[1]

School size.	Rural	Small town	Suburban	Urban	**All locations**
Q1	10.8	11.2	4.5	7.3	**10.1**
Q2	11.9	11.1	9.6	7.8	**10.4**
Q3	7.0	9.5	10.1	9.7	**9.1**
Q4	4.9	8.3	7.7	8.5	**8.0**
All sizes	**9.8**	**10.1**	**8.3**	**8.4**	**9.3**

7.4a Access to ICT in disadvantaged post-primary schools

Unlike the primary schools, the disadvantaged schools reported a higher overall level of access than other schools. The average access score for the disadvantaged schools was 11, compared with 9 in other schools (t-test, p=.000). As with the other schools, the smaller disadvantaged schools had higher access scores than large schools, and rural and small town schools had higher access than urban and suburban schools.

TABLE 7. 30: AVERAGE ACCESS SCORE FOR DISADVANTAGED POST-PRIMARY SCHOOLS, 2000[2]

School size.	Rural	Small town	Suburban	Urban	**All locations**
Q1	11.5	11.8	12.0	11.2	**11.5**
Q2	11.5	11.1	12.7	12.7	**12.0**
Q3	14.8	13.2	8.9	9.3	**10.9**
Q4	7.7	12.6	12.1	9.2	**10.2**
All sizes	**11.6**	**12.0**	**11.2**	**10.7**	**11.3**

A class by class analysis of the access in disadvantaged primary schools confirmed that the disadvantaged schools offered higher access to ICT. This was true both for "frequent access" and for "any access". In some cases the gap was quite substantial. In disadvantaged schools 60% of 6th year classes had frequent access to ICT, while this was only the case in 44% of other schools (Graph 7.9).

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[1] Full data table including numbers of schools in appendix L58.

[2] Full data table including numbers of schools in appendix L59.

Only a minority of schools offered access to ICT outside of school hours. The differences between disadvantaged and other schools in this regard were small and not statistically significant. Slightly more of the disadvantaged schools provided out of hours access for senior cycle students, while slightly more of the other schools offered access to junior cycle students.

TABLE 7. 31: POST-PRIMARY SCHOOLS: ACCESS TO ICT IN DISADVANTAGED AND OTHER SCHOOLS

Post-primary schools 2000	% of schools where this class has **frequent or very frequent** access to ICT		% of schools where this class has **some access** to ICT		Chi square, *p*-value[1]	% of schools where this class has Outside hours access to ICT	
Class	Other schools	Disadv. schools	Other schools	Disadv. schools		Other schools	Disadv. schools
1st year	59.8	67.4	80.2	84.0	NS	25	25
2nd year	42.5	58.3	64.5	74.3	.000	27	23
3rd year	26.7	39.4	47.9	57.7	.002	27	25
5th year	61.8	73.7	75.5	83.4	.001	26	28
6th year	43.6	60.6	61.8	72.0	.000	35	36

7.4b Post-primary school type and access to ICT

Level of access also varied with type of school. A high proportion of community schools and colleges provided frequent access to ICT. In community schools 70% of first year classes had frequent or very frequent access to ICT. Comprehensive schools had lower levels of access than the community schools and colleges, with only 47% providing frequent access to their first year classes.

Although the vocational schools had the highest level of equipment (5 students per computer), and secondary schools had the lowest (14.4 students per computer), these figures were not reflected in the access they provided to students. The vocational schools provided less access to first and second year students than the secondary schools. In 65% of secondary schools first year classes had frequent access to ICT, while this was the case in only 54% of vocational schools.

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[1] Throughout this study the chi square statistic was normally calculated using the full range of categories possible, as explained in Appendix O. Thus the chi square p-values shown in this table are calculated using all of the recorded categories of access to ICT within school hours (Never, Occasional, Regular, Frequent, Very Frequent).

For all school types the percentage of classes offered frequent access to ICT declined through the junior cycle, with third year classes having less access than second year, and second year less than first year. However this decline was less steep in vocational schools. In first year 65% of secondary schools classes had frequent access to ICT, but by second year this had fallen to 48% and by third year to 34%. In vocational schools 54% of first year classes had frequent access, compared with 44% of second year classes, and 35% of third year classes (Graph 7.10).

Frequent access to ICT was provided in more of the secondary schools than vocational schools, for all classes except third year and sixth year (the two examination classes). These differences were not statistically significant except in sixth year, where 58% of classes in vocational schools had frequent access compared with only 44% of classes in secondary schools (t-test, p=.006).

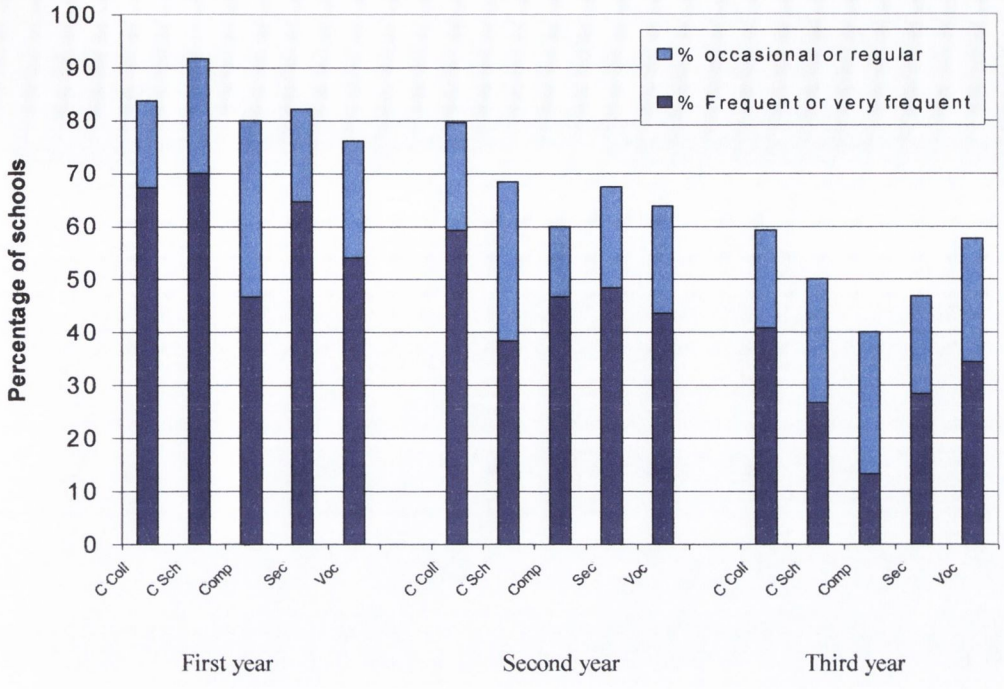
TABLE 7. 32: FREQUENT ACCESS TO ICT, BY CLASS AND SCHOOL TYPE, POST-PRIMARY SCHOOLS 2000[1]

% with very frequent or frequent access	Community College	Community School	Comprehensive School	Secondary school	Vocational school
First year	67.3	70.0	46.7	64.7	54.0
Second year	59.2	38.3	46.7	48.3	43.6
Third year	40.8	26.7	13.3	28.4	34.4
Fifth year	61.2	70.0	40.0	66.8	63.8
Sixth year	53.1	53.3	20.0	43.5	57.7

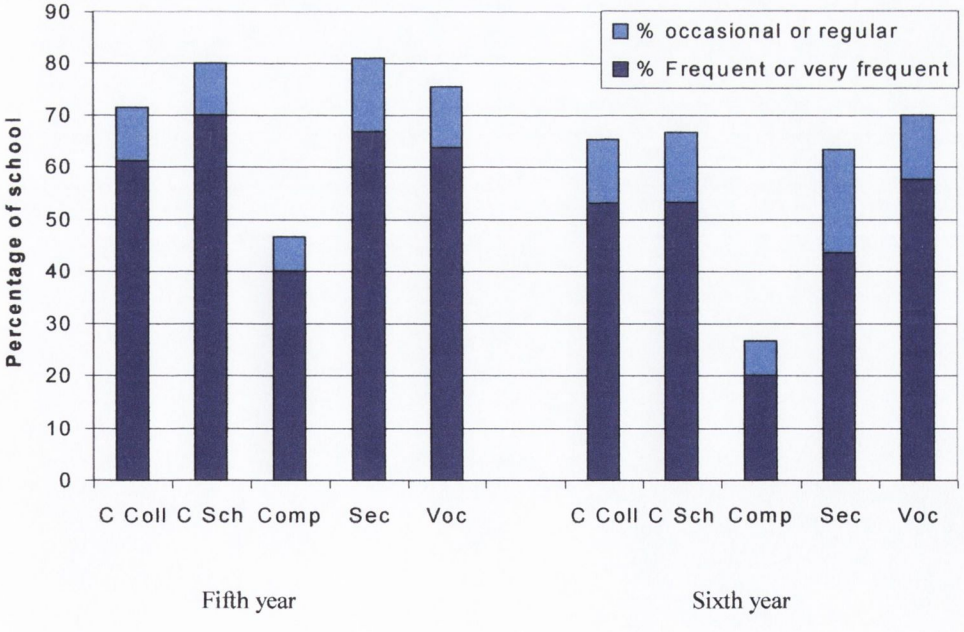
In the senior cycle a similar pattern emerged. Secondary schools provided higher levels of access in fifth year than vocational schools, despite having less equipment. Although schools of all types offered less frequent access in 6th year, the decline was more steep in the secondary schools than in vocational schools (Graph 7.11).

For all classes, significantly fewer of the vocational schools provided access to ICT outside of school hours.

[1] Full data table in appendix L60.



GRAPH 7.10. POST PRIMARY SCHOOLS 2000. FREQUENCY OF ACCESS TO ICT BY CLASS AND SCHOOL TYPE.



GRAPH 7.11. POST PRIMARY SCHOOLS 2000. FREQUENCY OF ACCESS TO ICT BY CLASS AND SCHOOL TYPE.

TABLE 7. 33: PERCENTAGE OF SCHOOLS PROVIDING ICT ACCESS OUTSIDE SCHOOL HOURS

	Secondary	Vocational	Chi square, secondary and vocational schools, *p*-value[1]
1st Year	27.2	18.4	.032
2nd Year	28.4	18.4	.016
3rd Year	29.6	18.6	.008
Transition Year	32.9	9.8	.000
5th Year	37.5	26.4	.014
6th Year	38.7	26.4	.007

7.4c Other programmes and access to ICT

The qualitative study offers some suggestion that engagement by schools in other programmes, particularly Post Leaving Certificate (PLC) courses, may impact on the level of access provided in the school. However, the suggested direction of the impact is unclear, with contradictory examples from different schools. In one school all of the computer room time was taken up with PLC courses, and the "uniformed school" had virtually no access to ICT[2]. In another school the principal argued that PLC courses provided the funding to equip the school to a high standard, increasing the level of ICT access for the "mainstream" classes.[3]

The survey asked schools to indicate how frequently ICT access was provided to each of four programmes outside of the conventional junior and senior cycles. These were:

- Transition Year (TY)
- Leaving Certificate Applied (LCA)
- Leaving Certificate Vocational Programme (LCVP)
- Post Leaving Certificate Courses (PLC)

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[1] Throughout this study the chi square statistic was normally calculated using the full range of categories possible, as explained in Appendix O. In this case, only secondary and vocational schools were included in the calculation.

[2] Vocational school, Wexford.

[3] Community school, Dublin.

For the purposes of analysis, schools which recorded that some ICT time was given to these groups were separated from those where there was no time recorded, or no reply. This analysis indicated that schools that gave some of their computer time to PLC courses had more computers than other schools, and more favourable student-computer ratios. However their access scores were no different.

TABLE 7. 34: ACCESS SCORES IN SCHOOLS WHERE SOME ICT TIME WAS GIVEN TO PLC COURSES

PLC courses	Number of schools	Average Number of computers	Student: computer ratio	Average access score
Some access: i.e. Very Frequent, Frequent, Regular or Occasional	186	60.7	8.6	9.6
No recorded access: i.e. Never, Not Applicable or no reply.	434	35.0	14.8	9.6

TABLE 7. 35: ACCESS SCORES IN SCHOOLS WHERE SOME ICT TIME WAS GIVEN TO TRANSITION YEAR

TY courses	Number of schools	Average Number of computers	Student: computer ratio	Average access score
Some access: i.e. Very Frequent, Frequent, Regular or Occasional	403	41.4	14.1	9.5
No recorded access: i.e. Never, Not Applicable or no reply.	217	45.1	10.9	9.0

Of the 620 responding schools 403 reported some ICT time given to transition year. These schools had a slightly smaller numbers of computers than other schools, and had less favourable student-computer ratios. Despite this, they had slightly higher access scores. Schools which gave some ICT times to LCVP or LCA classes also had slightly more equipment, but had slightly lower access scores than other schools.[1]

Thus there was no evidence that PLC courses were associated with a reduction in ICT access for other classes. On the contrary, schools with PLC courses had higher access scores. However, there were slightly smaller access scores in schools where ICT time was given to LCA and LCVP classes.

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[1] Data tables in appendices L61 and L62.

7.4d Conclusions

The data presented in section 8.3 indicate that at post-primary level, small schools, rural schools and disadvantaged schools were better equipped than other schools. In all three cases, this advantage in equipment was reflected in greater access to ICT for school students. Small schools had greater access scores than large schools, and rural schools had greater access scores than urban schools. These patterns were not consistent for all sizes and locations, and the general pattern was that small schools provided better access in rural areas, but not necessarily in urban and suburban areas.

Disadvantaged schools also provided greater access to ICT within school hours, for all classes. However the non-disadvantaged schools provided greater access outside of school hours, except at senior cycle level.

One major inconsistency between the equipment pattern and the access pattern was with school type. Although vocational schools had the highest level of equipment, they did not provide more access to ICT. In fact secondary schools, which had the least favourable levels of equipment, provided greater access to ICT in all but the examination classes (3rd and 6th year).

For all school types, access to ICT declined as examinations approached. This removal of ICT from examination classes suggests that ICT is not seen in schools as supporting examination-relevant learning. It is interesting that the decline is most marked in the secondary schools, and least marked in the vocational schools. This may reflect a greater emphasis on examination performance in the secondary schools than in the vocational schools.

7.5 Equipment and access, causes for concern

This chapter began by raising the concern that the patterns of ICT skill in society, known as the digital divide, might be exacerbated by matching patterns of ICT within schools. This concern may be expressed in the form of two general questions, thus:

1) Were students in rural areas receiving less access to ICT, thus reinforcing the rural-urban digital divide?

2) Were students from lower socio-economic backgrounds receiving less access to ICT, thus reinforcing the social digital divide?

The data presented above suggests that there was little cause for concern in terms of geographical location. At both primary and post-primary levels rural schools were better equipped than urban and suburban schools. This advantage in equipment was also reflected in access, as rural schools provided more access to ICT than urban schools.

For both primary and post-primary schools the variation in ICT equipment with location was associated with variation in school size. As might be expected, more of the rural schools were small, and the urban schools large. The variation with size was much greater than the variation with location, and the pattern at both primary and post-primary levels was that smaller schools were better equipped. The data suggest that the higher levels of equipment in rural schools were mainly a result of their smaller size. The differences in access were also mainly associated with school size, although rural primary schools provided slightly greater access to ICT than urban schools of the same size.

There was therefore little to suggest that the pattern of ICT in rural schools was reinforcing the rural-urban pattern of ICT skill. On the contrary students in rural schools had both better-equipped schools and had more access to ICT within school.

7.5a ICT and Social disadvantage

The question of the relationship between in-school ICT and the socio-economic background of the students was examined through comparison of the designated disadvantaged schools and other schools. For post-primary schools a secondary analysis was done by comparing the different types of school. In particular this focused on the comparison of vocational schools, which have traditionally been associated with students from lower socio-economic backgrounds, with the secondary schools.

Disadvantaged schools had more ICT equipment than other schools, at both primary and post-primary levels, presumably as the result of the additional funding they received. However this was not reflected in the access provided to students. In disadvantaged primary schools the pupils received less access to ICT than pupils in other schools. At post-primary level this was reversed, and the students in disadvantaged schools received greater access, particularly in the examination years.

Students in disadvantaged schools and in vocational schools also received less out-of-hours access to ICT than students in other schools, despite the obvious role of such access in counteracting lack of home access. This was true for all classes in primary schools, and for post-primary schools up to junior cycle, but reversed for senior cycle.

At post-primary level the vocational schools were substantially better equipped than other schools, particularly the secondary schools. However this was not reflected in greater access to ICT. In fact they provided less access to ICT in all except the examination classes.

Taken overall this pattern indicates that students from low socio-economic backgrounds received less access to ICT at primary level, and their access increased at post-primary level. By contrast students in other schools received more ICT access at primary level, and their access reduced more steeply in post-primary examination years. Thus for the socially disadvantaged, access to ICT came later, and more of it was in examination classes.

This pattern of greater use of ICT in examination years in schools dealing with low socio-economic status students may be explained in one of two ways. Either these schools were using ICT in ways that contribute to examination performance, or they were less focused on examination performance than other schools, and used ICT as an alternative to examination-oriented teaching. In either case, this suggests that the type of use of ICT may have been different in these schools.

7.6 Type of Use of ICT

This section is concerned with the suggestion that ICT might be used in different ways in schools serving students from lower socio-economic status backgrounds. As reported in chapter 2, a number of existing studies have suggested such patterns in other countries. In the US Becker reported that teachers working in "low income" schools used computers more frequently in three of the four main academic subjects, (ie English, Social Studies and Math)[1]. He suggests that the explanation for this pattern may lie in the variation in the aims of computer use by teachers in different types of schools, with teachers working with the disadvantaged learners more likely to use computers for remediation and mastery exercises, while the teachers in more privileged schools were more likely to use computers to achieve higher order objectives[2].

Similarly schools with higher SES students are reported to be more likely to engage in programming, while schools with lower SES students focus on "drill and practice" activities.[3] There is also the possibility that the Internet may be used for higher order activities including more sophisticated searches and Web publication.[4]

The following sections explore whether such patterns occur in Irish schools, using data from the 2000 survey. This analysis is divided into three main themes. Firstly, the data on use of ICT within each subject area is used to examine whether disadvantaged schools focus more on the use of ICT in "core subjects". Secondly, the proportion of time spent on types of ICT activity is used to examine whether disadvantaged schools place more emphasis on skill and practice software. The third area examined is the use of the Internet, and the use of websites to publish student work.

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[1] Becker, Henry. J. *Who's Wired and Who's Not.* Report from the 1998 TLC survey published on the Web at http://www.crito.uci.edu/tlc/html/findings.html p5.

[2] Ibid., p6.

[3] President's Committee of Advisors on Science and Technology, *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States,* (March 1997), Section 7.2.

[4] See section 2.3.

7.6a Type of use of ICT in disadvantaged primary schools

Subjects in which ICT was used, primary schools

The Irish primary schools revealed a pattern of use within subjects somewhat similar to that reported in the US, with significantly more of the disadvantaged schools reporting regular or frequent use of ICT in Learning Support, Mathematics, Language and English. The greatest difference was in Learning support, where ICT was used regularly or frequently in 63% of disadvantaged schools and 45% of other schools.

Significantly more of the other schools (those not designated disadvantaged) reported regular use of ICT in History, Geography and Arts. More of the non-disadvantaged schools also used ICT in science and extra curricular activities, although these differences were not statistically significant.

TABLE 7. 36: PRIMARY SCHOOLS USE OF ICT IN SUBJECT AREAS, 2000

Primary schools, 2000.	% of schools using ICT frequently or regularly in this subject in **non-disadvantaged** schools	% of schools using ICT frequently or regularly in this subject in **disadvantaged** schools	Chi square, *p*-value
Mathematics	69.3	80.8	.000
Language	67.6	80.2	.000
Irish	11.2	10.5	
English	79.3	84.3	.001
SESE	19.6	21.5	
History	47.9	43.0	.004
Geography	56.3	52.0	.019
Science	38.7	35.2	
Arts Education	18.8	22.4	.019
Physical education	1.2	1.2	
SPHE	6.0	7.6	
Learning Support	44.8	63.4	.000
Extra Curricular	39.2	38.1	

Type of software used, Primary schools

This pattern of more use of ICT in "core subjects" in disadvantaged primary schools is consistent with the suggestion that disadvantaged schools may use ICT more for reinforcement than other schools. Further evidence to suggest this type of difference is in the reported proportion of ICT time spent on different activities. At junior level in primary schools, the disadvantaged schools reported more use of "skill games" than other schools. Skill games on average accounted for 34.1% of

the use of ICT with junior classes in disadvantaged schools, while they amounted to only 29.6% of ICT use in other schools (t-test, p=.018). The disadvantaged schools also gave significantly less of their time to use of the Internet. Internet use accounted for an average of 8% of ICT time in disadvantaged schools and 12% of time in other schools (t-test, p= .003). Disadvantaged schools also made slightly more use of word-processing with junior classes.

For junior classes in the non-disadvantaged schools significantly more of the time was spent on the Internet (t-test, p=.003). They also reported that slightly more of their use included use of Database and Spreadsheets, Powerpoint and multimedia, Programming, and Simulations.

TABLE 7. 37: TYPE OF USE OF ICT IN JUNIOR CLASSES IN PRIMARY SCHOOLS, 2000. (FIGURES ARE AVERAGE OF % OF ICT TIME SPENT ON EACH ACTIVITY)

Junior primary Average % use of ICT	Word processing	CD ROM	WWW	Skill Games	Simulations
Non-disadvantaged	26.9	53.3	12.2	29.6	16.5
Disadvantaged	27.4	53.2	8.3	34.1	14.1
T-test, *p*-value	NS	NS	.003	.018	NS

Junior primary Average % use of ICT	Graphics	Database Spreadsheet	Powerpoint Multimedia	Programming
Non-disadvantaged	15.9	10.1	13.5	18.9
Disadvantaged	15.6	6.4	11.9	1.0

There were similar difference for senior primary classes. In disadvantaged schools the senior classes spent slightly more of their ICT time on skill games. In the non-disadvantaged schools significantly more ICT time was spent on the Internet and Powerpoint and multimedia. Internet use accounted for 11% of time in disadvantaged schools and 13% of time in other schools (t-test, p=.006). Powerpoint and multimedia accounted for 10% of time in disadvantaged schools and 12% of time in other schools (t-test, p=.026).

TABLE 7. 38: TYPE OF USE OF ICT IN SENIOR CLASSES IN PRIMARY SCHOOLS, 2000. (FIGURES ARE AVERAGE OF % OF ICT TIME SPENT ON EACH ACTIVITY)

Senior primary Average % use of ICT	Word processing	CD ROM	WWW	Skill Games	Simulations
Non-disadvantaged	34.3	35.6	13.0	18.0	12.5
Disadvantaged	33.5	34.4	11.2	18.6	11.5
T-test, *p*-value	NS	NS	.006	NS	NS

Senior primary Average % use of ICT	Graphics	Database Spreadsheet	Powerpoint Multimedia	Programming
Non-disadvantaged	11.3	9.4	12.4	11.5
Disadvantaged	11.1	9.0	10.1	8.5
T-test, *p*-value	NS	NS	.026	NS

Use of the Internet

The data presented above indicate that in disadvantaged schools, a smaller proportion of the ICT time was spent on the Internet. Despite the higher levels of Internet connectivity in disadvantaged schools,[1] there were other indicators that lend support to the suggestion that the disadvantaged schools were making less use of the Internet. Fewer of the disadvantaged schools provided e-mail accounts for their pupils, and fewer allowed their pupils to use the Internet for research. Pupils used the Internet for research in 56% of disadvantaged schools and 63% of other schools (t-test, p=.014).

However, more of the disadvantaged schools reported having a website. Websites were reported in 22% of disadvantaged schools and 13% of other schools (t-test, p=.000). Websites carrying some pupil work were reported in 13% of disadvantaged schools and 8% of other schools (t-test, p=.000). This apparent inconsistency may in part be a result of greater involvement in pilot projects by the disadvantaged schools. In total 16% of the disadvantaged schools were involved in the Schools Integration Projects (SIP) or other externally funded pilot projects, compared with 8% of other schools.[2]

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[1] See section 8.2a

[2] Data table in appendix L63.

7.6b Type of use of ICT in disadvantaged post-primary schools

Use of ICT in curricular subjects, post-primary

The disadvantaged post-primary schools' use of ICT in school subjects was slightly different from that of other schools. The greatest difference was in English, where ICT was used regularly or frequently in 22% of disadvantaged schools, compared with 14% of other schools (t-test, p=.038). More of the disadvantaged schools also reported regular or frequent use of ICT in Languages, Geography and Irish. By contrast more of the other (non-disadvantaged) schools used ICT regularly in careers work, and in Arts and Music. Although there was little difference in the proportion of schools using ICT regularly in Mathematics, fewer of the disadvantaged schools used ICT frequently in Mathematics.[1]

These patterns offer some, but not very consistent, support to the hypothesis that the disadvantaged schools were concentrating their use of ICT on "core subjects". If this hypothesis were correct it might be expected that there would be greater use of ICT in English and Mathematics in disadvantaged schools, and while this was true for English, it was not the case for Mathematics.

One additional unexpected pattern was that the disadvantaged schools made less use of ICT for learning support and remedial work than other schools. This finding too seems contrary to the hypothesis.

Type of use of ICT, post-primary

There were also some differences in the type of software used in disadvantaged and other schools. At junior cycle level the proportion of time given to word-processing was significantly higher in disadvantaged schools, while the other schools gave more time to almost all of the other types of activities and especially to programming. On average word-processing accounted for 54% of ICT time in disadvantaged schools and 49% of time in other schools (t-test, p=.027). By

[1] Data table in appendix L64.

contrast, programming accounted for only 0.6% of time in disadvantaged schools, and 4% of time in other schools. (t-test, p=.016).[1]

At transition year there were no statistically significant differences in the proportion of time spent on different applications by disadvantaged and other schools. However the disadvantaged schools spent slightly more of their ICT time on word-processing, CD ROM, skill games and graphics. The other schools gave more time to all of the other activities, including programming, the Internet and simulations.[2]

At senior cycle level the disadvantaged schools also gave a greater proportion of their ICT time to word-processing, skill games and graphics. Word processing accounted for 46% of the time in disadvantaged schools and 41% of that in other schools (t-test, p=.028). The other schools again gave a greater proportion of the time to all of the other activities, including the Internet, programming, simulations and careers.[3]

Thus at all three stages of post-primary education where data were collected (junior cycle, transition year and senior cycle), the disadvantaged schools gave a greater proportion of their ICT time to word processing. The difference was statistically significant for both junior and senior cycles. By contrast the other schools gave more of their time to programming, the Internet and database and spreadsheets. For some of the other applications, the pattern was more variable. For example, at junior cycle level the disadvantaged schools gave more of their time to careers, while at senior cycle the other schools gave more time to careers. Conversely in disadvantaged schools less of the time was given to graphics at junior cycle but more of the time in transition year and senior cycle.

This analysis provides only weak support for the hypothesis that the use of ICT in disadvantaged post-primary schools concentrated more on skill and practice software than on other applications. Skill software accounted for slightly more of the ICT time in transition year and senior cycle, but the differences were not

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[1] Data table in appendix L65.

[2] Data table in appendix L66.

[3] Data table in appendix L67.

statistically significant. The data suggest that the disadvantaged schools devoted more of their ICT time to word-processing, and spent less time on a broad spectrum of other applications. However, it is not safe to infer from this that the use of ICT was focused on applications involving lower order skills, as word processing may be used in a range of different ways.

Use of the Internet

The data above indicates that the disadvantaged schools devoted slightly less of their ICT time to use of the Internet, in junior and senior cycles and in transition year. Although the disadvantaged schools had more Internet-connected computers per student, and more had internal school networks, fewer of them provided e-mail accounts for students. Similarly, student use of the Internet for research was reported in only 81% of disadvantaged schools but 85% of other schools.

Slightly fewer of the disadvantaged schools had a school website, and the website was maintained by students in only 11% of disadvantaged schools and 17% of other schools. Fewer of the disadvantaged schools had student work published on their websites. This occurred in 9.7% of disadvantaged schools and 11.2% of other schools.

These findings reveal that while disadvantaged schools had more Internet connectivity, and greater participation in pilot projects, they made less use of the Internet on all of the available indicators.

7.6c Post-primary school type and type of use of ICT

Use of ICT in school subjects and School type, post-primary.

As reported previously, vocational schools and secondary schools had very different patterns of access to ICT. This section examines this difference further, comparing the type of use of ICT in different school types. Given that vocational schools have traditionally been associated with students from lower socio-economic status backgrounds, the vocational schools might be expected to follow the pattern of the disadvantaged schools in their use of ICT.

Vocational schools made significantly less use of ICT in subject areas. Vocational schools had an average subject score of 6.5, compared with 8.4 for secondary

schools (t-test, p=.000). Where there was subject use of ICT, it was concentrated in different subjects. Significantly more of the vocational schools made use of ICT in technology. ICT was used in technology in 40% of vocational schools and 32% of secondary schools (chi square, p=.015). Slightly more of the vocational schools also made use of ICT in business, but the difference was not statistically significant.

Significantly more of the secondary schools made use of ICT in Mathematics, Geography, History, Religion, Careers Guidance, Art and Music. More of the secondary schools also reported extra-curricular use, with 60% reporting regular use of ICT for extra curricular projects, compared with 55% of vocational schools.[1]

Type of use of ICT and school type, post-primary

At junior cycle level vocational schools spent significantly less of their ICT time on the Internet and on programming. Internet activities accounted for an average of 15% of time in secondary schools and 12% in vocational schools (t-test, p=.048). Programming amounted to 0.9% of ICT time in vocational schools but 5% of time in secondary schools (t-test, p=.048).[2]

In transition year the vocational schools spent significantly less of their time on programming, but there were no other significant differences.[3]

In senior cycle vocational schools spent significantly more time on word-processing and graphics, while secondary schools spent more time on careers software and programming. Word-processing occupied an average of 46% of the ICT time in vocational schools and 41% of that in secondary schools (t-test, p=.011).[4]

Although the differences were not always statistically significant, at all three stages in the post-primary system at which data was collected, the secondary schools allocated more of their ICT time to programming, the Internet and careers

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[1] Data table in appendix L68.

[2] Data table in appendix L69.

[3] Data table in appendix L70.

[4] Data table in appendix L71.

guidance. By contrast, the vocational schools devoted more of their ICT time to word processing at junior and senior cycles, while the two were almost the same at transition year. Vocational schools also gave more of their time to CD ROM and graphics at both junior and senior cycle levels.

As with the comparison of disadvantaged and other schools earlier, these findings provide some weak support for the hypothesis that the schools serving the students from low socio-economic backgrounds focused on a narrower range of ICT applications, making more use of word processing and less use of the Internet.

This suggestion is supported by the figures for use of the Internet. The vocational schools had far higher levels of Internet connectivity, and more of them reported student use of the Internet for research. However more of the secondary schools reported providing e-mail accounts to students, having a website, and involving students in Web publication. In addition significantly more of the secondary schools had their websites maintained by students (chi square, p=.024).[1]

7.6d Type of use, conclusions.

The suggestion that schools serving students from less privileged backgrounds may focus their use of ICT in subjects on a smaller number of "core subjects" was partly supported by the data. At primary level significantly more of the disadvantaged schools made use of ICT in English, Mathematics, Languages and Learning Support, and significantly less in History, Geography and Arts. At post-primary level significantly more of the disadvantaged schools made use of ICT in English, but fewer used ICT in Careers, Art and Music.

A parallel pattern appeared in the vocational schools. The vocational schools made less use of ICT in subject areas, and their use was concentrated on different subjects. Significantly more of them used ICT in technology, while significantly fewer of them used ICT in a range of subjects including Mathematics, Geography, History, Religion, Careers, Art and Music.

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[1] Data table in appendix L72.

Although these findings do not provide a clear list of subjects on which use in concentrated, they indicate that in the schools serving the less privileged students subject use of ICT was focused in a different way from other schools. In disadvantaged primary schools this concentration was on what could be described as "core subjects". At post-primary level the focus was more specifically on English and in vocational schools the concentration was on technology.

A second initial hypothesis was that the schools serving the less privileged might focus on different types of application of ICT, in particular concentrating on drill and practice activities at the expense of applications involving higher order thinking. There was some evidence of a greater emphasis on skill software in disadvantaged schools. Disadvantaged schools made significantly more use of skill software at junior primary level, and slightly more use at senior primary level and at transition year and senior post-primary level.

These findings also suggest that the use of ICT in the disadvantaged and vocational schools involved more word processing, and less of the more challenging applications. Disadvantaged and vocational schools consistently made less use of the Internet and programming. They also made less use of database/spreadsheet, Powerpoint and multimedia, and simulations at most levels. At all of the post-primary levels, the disadvantaged and vocational schools made more use of word processing.

TABLE 7. 39: SUMMARY OF VARIATION IN TYPES OF ICT APPLICATION USED, AS INDICATED BY THE PERCENTAGE OF ICT TIME GIVEN TO EACH

* indicates statistically significant difference	Disadvantaged primary	Disadvantaged post-primary	Vocational (compared with secondary)
Junior	**More:** Skill games*, Word processing **Less:** Internet*, Programming, Simulations, Powerpoint, Database	**More:** Word processing*, careers **Less:** Programming*, Internet, Database, graphics	**More:** Word processing, CD ROM, Simulations, Graphics, Powerpoint. **Less:** Internet, Database, Powerpoint, Programming*, Careers
Transition year		**More:** Word processing, Skill games, graphics **Less:** Simulations*, Programming, Internet, Database	**More:** Graphics **Less:** Internet, Simulations, Database, Programming*, Careers
Senior	**More:** Skill games (slightly) **Less:** Internet*, Powerpoint*, Programming, Simulations, Database	**More:** Word processing*, Skill games, Simulations, graphics **Less:** Internet, Database, Powerpoint, Programming, Careers	**More:** Word processing*, CD ROM, Skill games, Graphics* **Less:** Internet, Simulations, Database, Programming*, Careers*

Despite the importance of Internet experience in the social rationale for ICT as described in Chapter 1, one of the most consistent patterns in this analysis was the smaller proportion of ICT time devoted to the Internet in disadvantaged and vocational schools. This was matched by evidence from other indicators in Internet use. Although the disadvantaged and vocational schools had better Internet connectivity, they seemed to make less use of it. Fewer of the disadvantaged schools provided e-mail accounts for students, and allowed students to use the Internet for research. Disadvantaged post-primary schools and vocational schools were less likely to have a website than other schools, and fewer of them had student work published on their websites.

7.7 Social patterns, conclusion

With the increasing focus on the concept of an "information society", there is concern that those without ICT skills, and particularly information handling and research skills may be socially excluded, giving rise to a "digital divide".[1] While schools are frequently seen as agents to counter such a trend, there is evidence from the US and UK that schools vary in their level of ICT equipment and usage, and that these variations may mirror rather than counter the social patterns of ICT skill.[2]

This chapter has examined whether such a digital divide existed within Irish schools, exploring the dimensions of the schools' geographical location and size and the socio-economic status of the students.

Geographical patterns

The data indicated that rural schools were better equipped than urban or suburban schools by 2000. This was reflected in greater access to ICT in these schools, at both primary and post-primary levels. Much of the variation with location was explained by the variation in school size. Smaller schools were better equipped than larger schools and provided greater access to ICT. These findings are consistent with the pattern reported in the US and UK, where rural schools have been found to have better levels of equipment per student than urban schools.[3] The finding that smaller schools were generally better equipped than larger schools was also consistent with the US data, as is the suggestion that much of the differences may have been a result of the smaller size of the rural schools.[4]

Social disadvantage

The pattern was not so consistent for the schools serving the students of lower socio-economic status. Both disadvantaged schools and vocational schools were

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[1] Stephen McNair,. "The Emerging Policy Agenda" in *Learning to Bridge the Digital Divide*, (Paris: OECD, 2000), p10.

[2] See section 2.2.

[3] See section 2.2d.

[4] See section 2.2e.

better equipped than other schools, but this was not always reflected in greater access to ICT. At primary level the disadvantaged schools provided less access to ICT, while at post-primary level the disadvantaged and vocational schools provided more access mainly in examination classes. Disadvantaged schools also provided less access to ICT outside of school hours than other schools, despite the importance of this as a compensatory measure for those without home access. These findings suggest that there remains cause for concern about the social digital divide, as students who are least likely to have home access to a computer receive less access in school, especially in the early part of their schooling.

These findings echo the pattern reported in the US where studies have reported that schools with more poor students may be at a disadvantage in terms of ICT access. However the patterns are different in one important respect. In the US, the studies have suggested that schools serving poorer students are at a disadvantage because they have less equipment,[1] while in Ireland the data suggests that the disadvantaged schools provide less access to some classes despite having more equipment.

The pattern reported in the US may be easily explained in terms of variations in funding, especially where schools are funded from local taxes, which vary with the wealth of the district. Even where this obvious funding difference does not occur, there are other mechanisms some schools may be more easily able to raise funds through parents than others.[2] In addition schools near to large industries may be able to attract more equipment in donations from those industries, a factor which could be quite significant given the Eurobarometer finding that one in five computers in European primary schools came from non-government donations[1].

However in the Irish case the pattern is less easily explained. The failure to provide greater access to ICT despite having higher levels of equipment suggests that the provision of ICT was being determined by decisions taken within the school, rather

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[1] See section 2.2a and 2.2c.

[2] Department for Education and Employment. *Survey of Information technology in Schools 1996.* Statistical Bulletin no 3 (March 1997), p11.

than by the amount of equipment available. Thus access to ICT may be seen as a construct of school thinking, which appears to vary with the SES of the students.

Further evidence of the different construction of ICT in the schools serving the least privileged students was provided by the analysis of the type of use of ICT. In general the disadvantaged and vocational schools used ICT in a narrower range of subjects. The disadvantaged schools concentrated on what might be considered core subjects, while the vocational schools concentrated on technology. By contrast other schools tended to make greater use of ICT in Arts, Music and humanities.

The disadvantaged and vocational schools also focused their use of ICT on a different range of applications. They tended to make more use of word processing and skill games, but less use of the Internet, and a range of other applications including database/spreadsheet, Powerpoint/multimedia and simulations. It cannot be assumed that word processing necessarily involves only lower order skills or that use of Powerpoint necessarily involves some more creative task. Nevertheless these findings suggest a greater concentration on a narrower range of applications in the disadvantaged and vocational schools.

The disadvantaged and vocational schools also tended to make less use of the Internet. Despite greater connectivity, they spent less of their ICT time on the Internet at all levels, and tended to make less use of it for student research. At post-primary level they also made less use of the Internet as a means of publishing student work.

These variations in the type of use of ICT also seem consistent with findings from the US, where studies have suggested that the use of ICT with disadvantaged students places more emphasis on drill and practice programmes, and use of ICT in "core subjects", compared with better-off students.[2] However the key difference is that in the US studies this pattern was found in a context where there were fewer

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[1] European Commission. *European youth in a Digital Age: eEurope 2002 Benchmarking.* Draft Working document of the Commission services Based on the Eurobarometer surveys of February 2001, p11.

[2] See section 2.3.

computers in the disadvantaged schools.[1] This variation could therefore be explained in terms of the suggestion that the "higher-order" applications of ICT in education are associated with high levels of computer equipment.[2] However in the Irish case the disadvantaged schools had higher levels of equipment, again suggesting that the type of use of ICT was a product of factors within the school.

Taken as a whole these findings suggest two major conclusions. The first is concerned with whether the inequalities in access to ICT in Irish schools are likely to reinforce the existing inequalities in ICT skill in society.[3] These findings suggest that there is little cause for concern in the geographical pattern, with rural schools exceeding the level of access of urban and suburban schools. However the data provide reasonable cause for concern that students from less privileged backgrounds may receive less access to ICT at school, and that it may come later in their schooling. In addition their use of ICT may be more focused on basic ICT skills such as word processing, and on skill software, with less time devoted to the more varied and creative uses of ICT.

The second conclusion is that these patterns were not a result of the pattern of equipment or funding, but resulted from choices made within the schools. As a result of there variations in the way ICT is constructed in schools, the ICT experience of a student in a disadvantaged or vocational school may be quite different from those of a student in another school, in ways which give further advantages to the already privileged.

This is not intended to suggest that the disadvantaged or vocational schools deliberately set out to design a less interesting or challenging pattern of use of ICT. When asked to indicate their educational priorities for ICT, disadvantaged primary schools assigned significantly higher priority to greater integration of ICT, ensuring equality, and providing ICT access and skills for parents. At post-primary level the disadvantaged and vocational schools also assigned significantly higher priority

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[1] See section 2.2a.

[2] See section 4.6.

[3] Information Society Commission, *Information Society Ireland. Third Report of Ireland's Information Society Commission.* (Ireland: Information Society Commission, December 2000), p68.

than other schools to ensuring equality for girls, and supporting parents, although interestingly not to ensuring equality for those without home access.[1] However these intentions were not reflected in the use of ICT with students. If, as suggested here, the shape of ICT usage in schools is not determined by funding or by deliberate school priorities, this raises the question of what factors help to shape schools' use of ICT. These factors will be examined in chapter 9.

[1] Data tables in appendices L73 toL75.

CHAPTER 8

ICT AND GENDER, A COMPARISON OF SINGLE SEX BOYS' AND GIRLS' SCHOOLS

The research cited in Chapter 3 revealed gender patterns in ICT skill and usage, both internationally and in Ireland. There is some evidence that this gender difference is also found in young people, with girls having less computer skill and interest than boys.[1] The gender pattern in young people may be associated with differences in access, as some studies have found that girls with high access to computers have attitudes similar to those of boys.[2]

The existence of this difference is a major challenge for schools. Early data from the IEA suggest that girls are less likely to have home access to a computer and that girls form the majority of those who only have computer access at school.[3] However to ensure equality of outcome the role of schools must go beyond being the regulators of access, as the OECD has declared:

> *Several things are needed if girls are to be given better scope for using and learning about ICT. One is that teachers must be better aware of the difference in girls' and boys' use of ICT and work actively to give both sexes equal opportunities. The learning environment must be arranged in such a way as to appeal to girls, giving them equal access to equipment and ample opportunities to pursue their own interests independent of boys.*[4]

Despite the important potential role of schools in addressing this issue, schools may be further enhancing rather than reducing the gender divide. The gender gap in attitudes appears to grow during the period of schooling, and some studies have

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[1] See sections 3.2 and 3.3.

[2] See section 3.3d.

[3] Ingeborg Janssen Reinen and Tjeerd Plomp, "Gender and Computers: Another Area of Inequity in Education?". in *Schools, Teachers, Students and Computers: a Cross National Perspective* ed. by W.J. Pelgrum, I.A.M. Reinen Janssen and Tj. Plomp (Amsterdam: IEA, December 1993), p108.

[4] Sten Lungdahl, "ICT, Equity and the Challenge of Lifelong Learning: The Swedish Approach", in *Learning to Bridge the Digital Divide* (Paris: OECD, 2000), pp110-111.

found schools allowing boys to get more access to computers than girls.[1] In addition, there is some evidence that boys may have a broader range of ICT experiences at school, and few schools have specific policies to address gender issues.[2] Thus there are a number of mechanisms by which schools may inadvertently enhance the gender divide.

This chapter examines the gender divide in Irish schools. The analysis is focused on differences at school level, where the existence of large numbers of single-sex schools provides an opportunity to compare the extent and use of ICT in boys' and girls' schools. It must also be recognised that there may also be intra-school gender differences in mixed schools, but these surveys provide little data at this level.

The analysis begins with a comparison of the level of ICT equipment in boys' and girls' schools. The second section then examines student access to ICT. The analysis then examines how ICT was used in boys' and girls' schools. This begins with an examination of the type of software used (section 8.3). The following section focuses specifically on the use of the Internet, in view of the suggestions that it may have specific appeal to girls. Then section 8.5 considers the subjects in which ICT was used.

The later parts of the chapter look at how boys' and girls' schools have responded to the challenge of ICT. They begin with an analysis of teacher ICT skill and participation in training (section 8.6). This is followed by a consideration of the school structures and priorities for ICT. Finally, section 8.8 considers whether the gender pattern varies with SES.

Of a total of 2,742 primary schools that responded to the survey and indicated the gender of their pupils, 84% were mixed. Valid responses were received from 263 boys' schools and 171 girls' schools. The mixed schools were on average smaller in size than the single sex schools with an average of 124 pupils compared with 211 in the single sex schools. This size difference is partly explained by the large numbers of small rural primary schools, most of which are mixed. Of the 1,603 schools reporting their location as rural, 97.5% were mixed. Among the single sex

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[1] See section 3.4.

[2] See sections 3.4a and 3.4h.

schools, the girls' schools were slightly larger with an average of 267 pupils compared with 196 for boys' schools.

TABLE 8. 1: PRIMARY SCHOOLS, 2000 DATA

Primary schools 2000	Single sex boys	Single sex girls	Mixed
Number of Schools	263	171	2,308
Average pupils per school	196	267	124

The majority of post-primary schools responding to the survey were mixed, although there were higher proportions of single sex schools than was the case in the primary sector. Of the total, 61% were mixed, with 18% single sex boys' and 22% single sex girls'. The single sex girls' schools were larger than boys' schools, with an average of 541 pupils, compared with 474 for boys' schools.

TABLE 8. 2: POST-PRIMARY SCHOOLS, 2000 DATA

Post-primary schools 2000 data	Single sex boys'	Single sex girls'	Mixed
Number of Schools	106	128	361
Average pupils per school	473.8	541.2	400.7

8.1 Gender differences in ICT equipment and infrastructure

One of the possible gender inequalities is in the level of ICT equipment in boys' and girls' schools. The finding in the ITIP study that girls' schools had fewer computers than average raises the possibility that girls schools were slower to invest in ICT than other school types.[1] This section examines this general hypothesis that girls' schools were at a disadvantage in terms of ICT equipment, when compared with boys' schools.

If such a pattern existed, it is unlikely to be a result of the pattern of government funding of schools. There were similar numbers of boys' and girls' single sex schools and they were of similar size. However a gender pattern could result from different attitudes to girls' use of ICT at local level, either in the school or in the community. Two different possible mechanisms could be advanced to explain such a pattern. It is possible that girls' schools spent a smaller proportion of their

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[1]Cyril Drury, ITIP study, 1995, cited in An Roinn Oideachais. *Submission by the Department of Education to the Information Society Steering Committee* (September 1996), p4.

resources on ICT, perhaps as a result of different priorities or different attitudes to ICT. Alternatively it may be that the girls' schools had less money available to spend, due to smaller parent contributions, especially in the period before the IT 2000 grants. If a gender pattern emerged as a result of such attitudinal differences, the gender gap might be expected to be greater in the period before the start of IT 2000, where much of the expenditure on ICT was at the discretion of the individual school.

8.1a Student-computer ratio

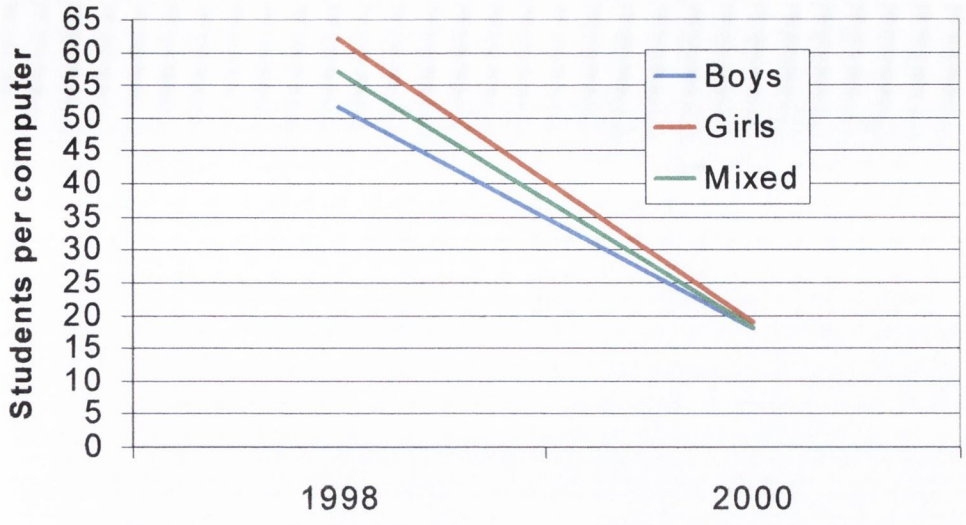
Analysis of the pupil-computer ratio in primary schools reveals a gender gap, although the differences were small and not statistically significant. In 1998 single-sex boys' schools were better equipped than girls' schools. Mixed primary schools, although smaller in size, fell between the two. Between 1998 and 2000 the situation in all primary schools improved and the gap narrowed dramatically (Graph 8.1). Despite this narrowing of the gap, in 2000 boys' schools were over-represented among the best-equipped schools. Nineteen percent of boys' schools had less than ten pupils per computer, compared with only eleven percent of girls' schools (Graph 8.2).

TABLE 8. 3: PUPIL-COMPUTER RATIO IN PRIMARY SCHOOLS

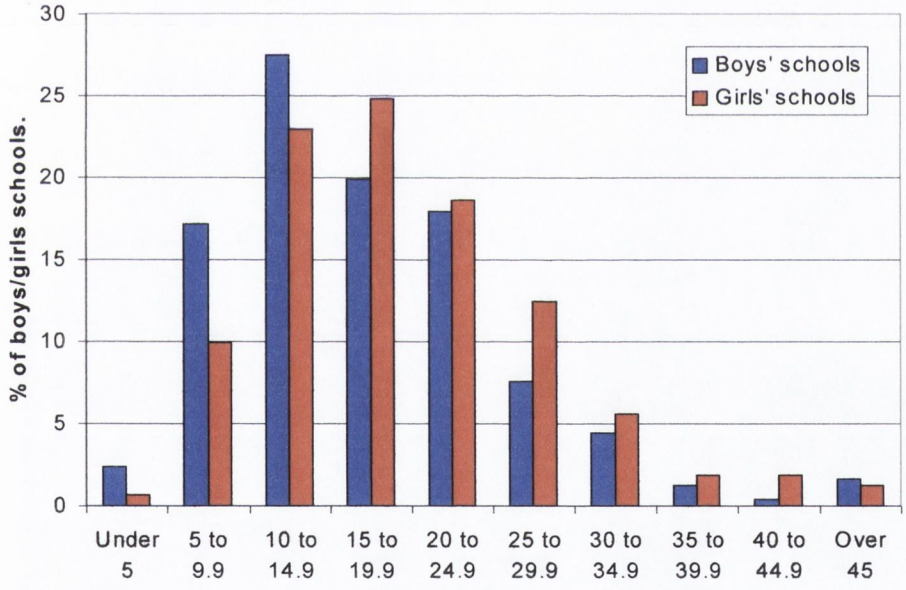
Primary schools	Single Sex Boys	Single Sex Girls	Mixed
Pupils per computer 1998	51.6	62.1	57.0
Pupils per computer 2000	18.0	18.8	18.1

The pattern in post-primary schools was quite different. In 1998, the mixed post-primary schools were the best equipped in terms of students per computer, with an average of 20 students per computer. Much of this was explained by the over-representation of the better-equipped vocational, community and comprehensive schools in the mixed schools. However when these schools were excluded, even the mixed secondary schools were better equipped than the single sex schools. There was very little difference in the level of equipment of boys' and girls' single sex schools, and the girls had a slight advantage, with 29.5 students per computer, compared with 30.7 in boys' schools.

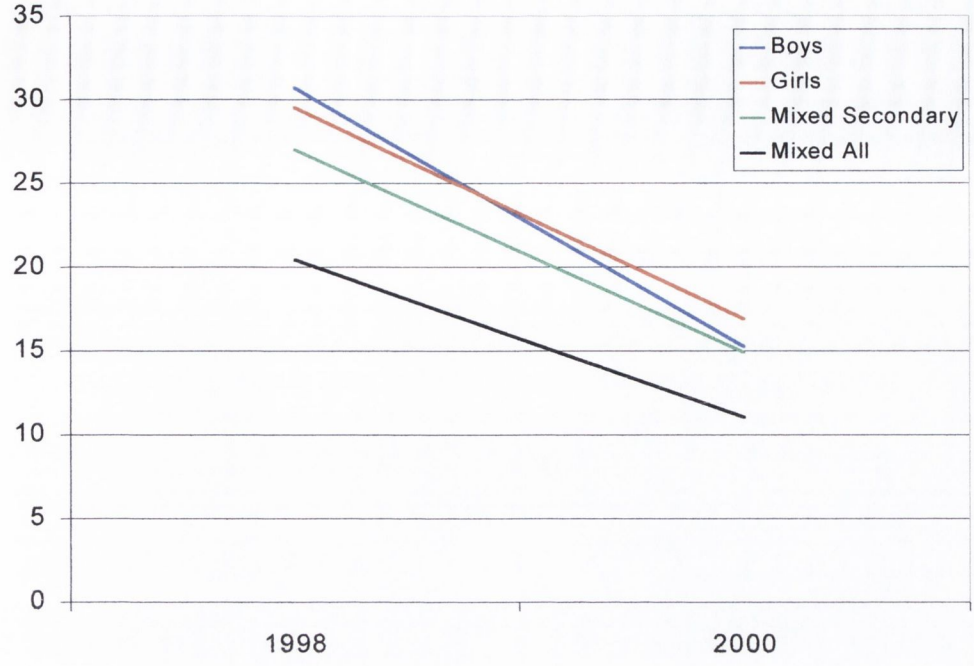
Between 1998 and 2000 the numbers of computers increased in all types of post-primary schools. The mixed schools remained better equipped in terms of students



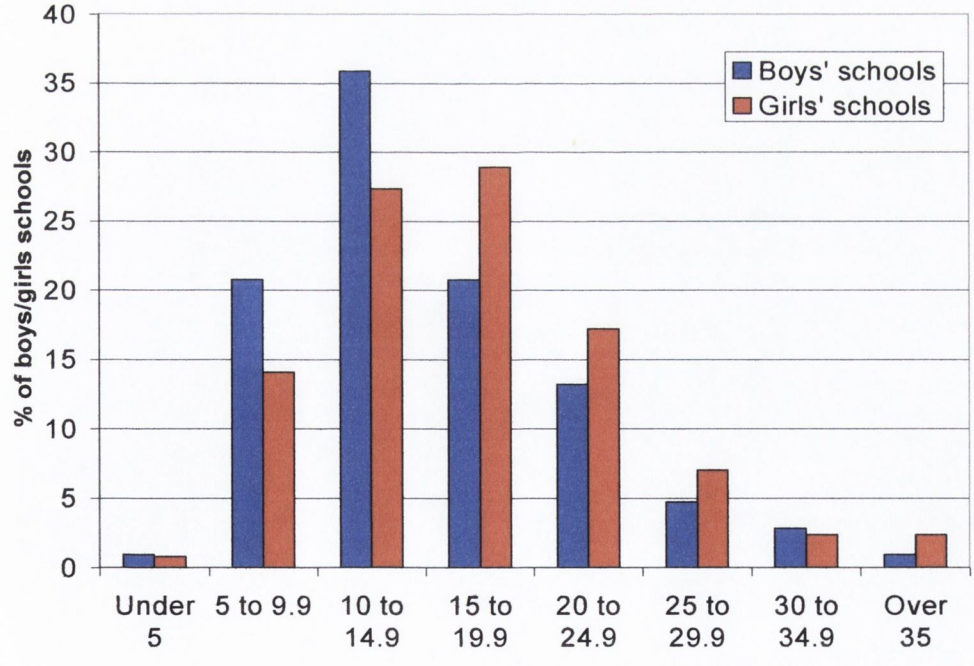
GRAPH 8.1 PRIMARY SCHOOLS, CHANGES IN PUPILS PER COMPUTER 1998-2000



GRAPH 8.2 PRIMARY SCHOOLS. FREQUENCY DISTRIBUTION OF PUPIL COMPUTER RATIO, 2000



GRAPH 8.3. POST-PRIMARY SCHOOLS, CHANGES IN STUDENTS PER COMPUTER 1998-2000



GRAPH 8.4. POST-PRIMARY SCHOOLS. FREQUENCY DISTRIBUTION OF STUDENT COMPUTER RATIO, 2000.

per computer than other schools. However during this period the boys' schools overtook the girls' schools (Graph 8.3). By 2000 there were 15.2 students per computer in boys' schools compared with 16.9 in girls' schools.

TABLE 8. 4: STUDENT-COMPUTER RATIO IN POST-PRIMARY SCHOOLS

Post-primary schools	Single Sex Boys	Single Sex Girls	Mixed Secondary	Mixed, all types
Students per computer 1998	30.7	29.5	27.0	20.4
Students per computer 2000	15.2	16.9	14.9	11.0

Although the differences in averages were small, boys' schools were consistently over-represented among those with the best levels of equipment, while girls' schools were consistently among those with the lowest (Graph 8.4).

8.1b School networks

A second dimension to the ICT infrastructure is the sophistication of the school network. While this is a limited indicator, dependent on school decisions about the location of computers and the kind of use to which they are to be put, the presence and scale of school networks provide some insight into the technical infrastructure in schools.

At both primary and post-primary levels, networks were more developed in boys' schools than in girls' schools. At primary level, few schools had a network in 1998. However by 2000 more of the boys' schools had a network and where networks existed there were more computers connected to them, despite the slightly smaller size of boys' primary schools. Boys' primary schools reported significantly more classroom computers connected to a network than the girls' schools (t-test, p=.015).

TABLE 8. 5: NETWORKS IN PRIMARY SCHOOLS

Primary schools, 2000 data.	Single Sex Boys	Single sex Girls	Mixed
% of schools with a network	29.7	26.3	16.0
Number of computers per network	13.5	13.4	9.1
Students per networked computer in schools with a network	25.5	30.9	25.8

At post-primary level the boys' schools also had more developed networks. In 1998 slightly more of the boys' schools had a network and their networks were slightly larger, with an average of 16 computers networked, compared with 14 in girls' schools. The gender gap remained in 2000. Slightly more of the boys'

schools had a network, and boys' schools with networks had significantly more computers networked, with average network sizes of 28 in boys' schools and 23 in girls' schools (t-test, p=.027). This left the boys' schools with a more favourable ratio of students per networked computer than the girls' schools.

TABLE 8. 6: NETWORKS IN POST-PRIMARY SCHOOLS

Post-primary schools	Single Sex Boys	Single sex Girls	Mixed.
% of schools with a network 1998	51	49	50
% of schools with a network 2000	78	77	81
N of computers per network 1998	16	14	22
N of computers per network 2000	28	23	34
Students per networked computer in schools with a network, 2000	29.6	46.4	26.4

8.1c Internet access

The level of Internet connectivity in schools is also an important dimension to the analysis of gender patterns in ICT infrastructure. Access to the Internet is clearly important in providing the skills for participation in an information society. Internet access may be particularly important in girls' schools, in view of the suggestion that it may provide an application of technology of more interest to girls and hence may act to bridge the gender gap in ICT usage.[1]

While this might suggest that Internet connectivity would be greatest in girls' schools, in fact the opposite was the case. In 1998 the proportion of primary schools connected to the Internet was greater in boys' schools than in girls' schools. By 2000 Internet connectivity was almost universal, but more of the boys' schools had the Internet available on multiple machines, giving the boys' schools an average of 115 pupils per Internet-connected computer, compared with 168 for girls' schools.

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[1] Gill Valentine, Sarah Holloway and Nick Bingham, "Children's social networks, Virtual Communities and On-line Spaces". Report of the Cyberkids research project, published on-line (1999) at www.shef.ac.uk/~g/staff/valentine_gill/about.htm, cited in Chapter 2.

TABLE 8. 7: INTERNET CONNECTIVITY IN PRIMARY SCHOOLS.

Primary schools	Single Sex Boys	Single sex Girls	Mixed
% of schools with Internet access 1998	15.8	12.4	13.7
Average number of computers with Internet access 2000	4.6	4.0	2.5
Pupils per Internet-connected computer in schools with Internet access, 2000. T-test, boys' and girls' schools, p=.000.	114.9	168.0	79.3

Internet connectivity was similarly better developed in boys' schools at post-primary level. In 1998 a greater proportion of the boys' schools had Internet access. By 2000 boys' schools had significantly more computers connected with an average of 21 computers with Internet access compared with 16 in girls' schools (t-test, p=.029). As a result in boys' schools there was an average of 87 students per Internet-connected computer, compared with 114 in girls' schools.

TABLE 8. 8: INTERNET CONNECTIVITY IN POST-PRIMARY SCHOOLS.

Post-primary schools	Single Sex Boys	Single sex Girls	Mixed
% of schools with Internet access 1998	74.8	66.2	77.8
Average number of computers with Internet access 2000.	20.5	15.8	21.6
Students per Internet computer in schools with Internet access, 2000	87.2	114.3	72.9

8.1d Peripherals

There were also some variations in the peripheral equipment available in the schools. At primary level more of the boys' schools had scanners and digital cameras, while more of the girls' schools had data projectors and laptops. At post-primary level, more of the boys' schools had all of these devices.

TABLE 8. 9: PERIPHERALS IN PRIMARY SCHOOLS

Primary schools 2000	Single Sex Boys	Single sex Girls	Mixed
% of schools with a scanner	79.1	74.3	65.3
% of schools with a digital camera	27.0	19.9	19.0
% of schools with a laptop	10.6	14.0	9.5
% of schools with a data projector	3.8	5.3	2.0

TABLE 8. 10: PERIPHERALS IN POST-PRIMARY SCHOOLS

Post-primary schools 2000	Single Sex Boys	Single sex Girls	Mixed
% of schools with a scanner	84.3	94.6	94.3
% of schools with a digital camera	51.9	42.6	55.4
% of schools with a laptop	32.4	26.4	35.8
% of schools with a data projector	39.8	36.4	44.9

The major exception to the pattern was the numbers of printers, where girls' schools had greater numbers. There are a number of possible explanations for this. Greater numbers of printers may be a reflection of lower levels of networking, as networked schools may prefer to have a smaller number of shared printers. Networked printers are more likely to be laser printers, which may explain part of the pattern in post-primary schools, where the boys' schools reported higher numbers of laser printers, but lower numbers of other printers. A second possible explanation for the pattern is that girls' schools may place greater emphasis on activities such as word processing, and hence on printers.

8.1e Conclusions - gender and ICT infrastructure

Overall, these data offer some evidence to support the hypothesis that boys' schools were better equipped than girls' schools. At primary level the boys' schools were better equipped in 1998, but the gap had almost been eliminated by 2000. At post-primary level both boys' and girls' single sex schools lagged behind mixed schools in 1998. However between 1998 and 2000 the boys schools improved their position at a faster rate than other school types, almost reaching the level of the mixed secondary schools. Although these differences were small and not statistically significant, they raise the possibility that boys' and girls' schools may have been adopting ICT at slightly different rates.

Although the differences in numbers of computers were relatively small, there were more substantial, and in some cases statistically significant differences in the level of technical sophistication of the ICT infrastructure in the schools. Boys' schools had more of most of the peripherals, and had more developed networks and Internet connectivity.

8.2 Gender differences in access to ICT

Self-evidently the amount of equipment is not a definitive indicator of usage. The investigation of gender patterns therefore requires some examination of how the computers were used. The first part of this examination is concerned with the amount of use of ICT by each class. Existing research, cited in Chapter 3, provides some suggestions as to patterns which may emerge. Girls may make lower use of ICT in school, and may make less use of access after school hours.[1] The pattern of these findings might suggest the hypothesis that girls' schools make less use of ICT both within and outside of school hours.

There are also suggestions that the usage gap between boys' and girls may increase with age.[2] These findings give rise to a tentative hypothesis that a gender gap in use of ICT would be greater at second level, or at least in the early years of second level schooling.

The extent and frequency of use of ICT were assessed through table D1 of the questionnaire, which asked schools to identify the classes that made use of ICT and the frequency with which each pupil would use it. From these replies an overall *access score* was calculated, indicative of both the number of classes using ICT and the frequency of their use. As described in chapter 5.4a, this is a single composite figure giving a numerical score representing the number of classes with access to ICT and the frequency with which they have access.

8.2a Pattern of Access within Primary schools

Contrary to the initial hypothesis, the access scores suggest that girls' schools provided significantly greater access to ICT than boys' schools at primary level. Girls' schools had an average score of 17.5, compared with 15.3 for boys' schools.

TABLE 8. 11: ACCESS SCORE, PRIMARY SCHOOLS

Boys' schools; Mean Access score	15.3
Girls' schools; Mean Access score	17.5
T-test, *p*-value	.003

[1] See section 3.4.

[2] See section 3.4c.

This finding was supported by analysis of the classes that made regular, defined as at least monthly, use of ICT. For all ages from Junior Infants to 6th class, a greater proportion of the classes in girls' schools made regular use of ICT than in the boys' schools (Graph 8.5). In 1st class for example, there was regular access to ICT in 81% of boys' schools and 83% of girls' schools. In 6th class there was regular access in 88% of boys' schools and 90% of girls' schools. These differences were relatively small and only statistically significant for the youngest three classes, Junior Infants, Senior Infants and 1st class (chi square, p=.000 in all three cases).

Although the general pattern was that there was slightly greater access to ICT in girls' schools, there were three exceptions to this pattern:[1]

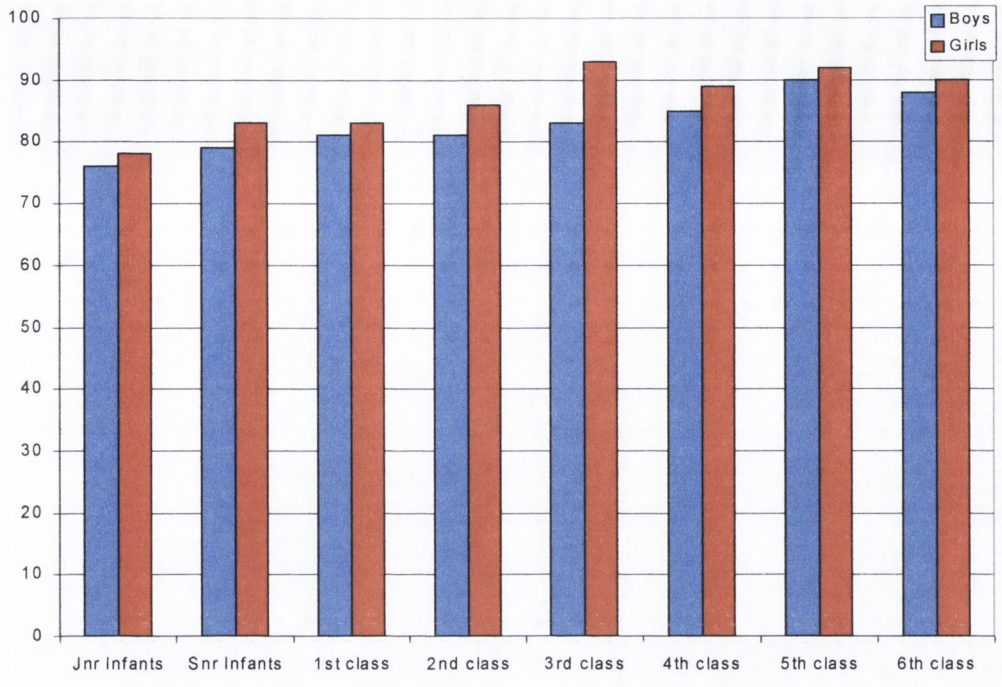
- Very frequent access to ICT,
- Access for learning support or remedial classes, and
- Access outside school hours.

Access to ICT on a "very frequent" basis was reported by a greater proportion of boys' schools than girls' schools. This was true for all classes from Junior Infants to 6th class. In third class for example, 19% of boys' schools had very frequent access to ICT, compared with only 15% of girls' schools. However more of the boys' schools also reported no use of ICT at all with each class. This unusual pattern suggests that more of the boys' schools had taken extreme positions on ICT, having either no use of very frequent use.

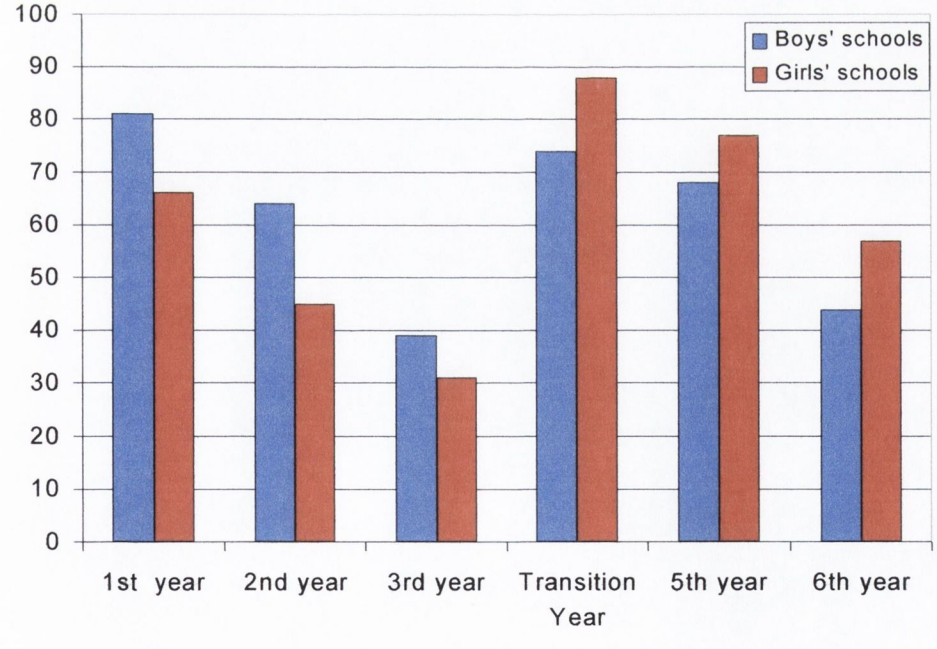
The second exception to the general pattern was in the area of learning support or remedial classes, which were more frequently given access to ICT in boys' schools. In boys' schools 85% of learning support/remedial classes had access to ICT, compared with 81% of those in girls' schools.

The third exception was in access outside school hours, which was higher in the boys' schools. Junior infants classes had access to ICT outside school hours in 4% of both boys' and girls' schools. This gap grew slightly wider for older classes, and by 6th class there was access outside hours in 19% of boys' schools and 13% of

[1] Data in appendices M1 and M2.



GRAPH 8.5. ACCESS TO ICT IN PRIMARY SCHOOLS, 2000. % OF SCHOOLS REPORTING ACCESS TO ICT FOR EACH CLASS.



GRAPH 8.6. ACCESS TO ICT IN POST-PRIMARY SCHOOLS, 2000. % OF SCHOOLS REPORTING ACCESS TO ICT FOR EACH CLASS

girls' schools. The opposite was the case for learning support/remedial classes, where the girls' schools provided more out-of-hours access.

These data suggest that girls' primary schools were providing greater access to ICT for all regular classes, while boys' schools were providing more access for remedial classes and after hours activities. This pattern is consistent with the suggestion that boys, and therefore boys' schools, may view ICT partially as a hobby, and therefore use it more for after-school activities and to attract weak learners.

8.2b Pattern of Access within Post-primary schools

At post-primary level pattern of access to ICT was quite different. The boys' schools had higher access scores, with an average score of 9.7, compared with an average of 8.7 in girls' schools. However this difference was not statistically significant.

A year-by-year analysis reveals a reversal of the pattern between junior and senior cycles. At junior cycle more of the boys' schools provided regular access to ICT. For example in 1st year there was regular (or greater) access in 81% of boys' schools and 66% of girls' schools. In second year there was access in 64% of boys' schools and 45% of girls' schools.

In transition year and at senior cycle this pattern was reversed, with greater access in girls' schools. For example in 6th year, there was access to ICT in 57% of girls' schools and 44% of boys' schools (Graph 8.6).

TABLE 8. 12: ACCESS TO ICT IN POST-PRIMARY SCHOOLS

Year	Boys % regular or more	Girls % regular or more	Chi square, single sex schools only, *p*-value[1]
1st year	81	66	.007
2nd year	64	45	.028
3rd year	39	31	NS
Transition Year	74	88	NS
5th year	68	77	NS
6th year	44	57	NS

There was a matching pattern with regard to "very frequent" access to ICT. Slightly more of the boys' schools provided very frequent access in second and third year, while more of the girls' schools provided very frequent access in senior classes.[2]

The pattern of access outside of school hours also changed with age. In first year, slightly more of the girls' schools had out-of-hours access. However for the older classes there was slightly more out of hours access in boy's schools. The one exception to this was transition year, where there was more access in girls' schools.[3]

These data revealed a small difference in access to ICT between boys' and girls' schools. Although boys' schools had slightly greater access scores, the difference was small and not statistically significant. However there was a difference in emphasis, with boys' schools providing greater access to junior classes, while girls' schools provided greater access to senior classes.

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[1] Throughout this study the chi square statistic was normally calculated using the full range of categories possible, as explained in Appendix O. Thus the chi square p-values shown in this table are calculated using all of the recorded categories of access to ICT within school hours (Never, Occasional, Regular, Frequent, Very Frequent). However only single sex schools were included in the calculation.

[2] Data in appendix M3.

[3] Data in appendix M4.

8.2c Overall pattern of access

These data provide little evidence to support the hypothesis that girls in single sex schools were at a disadvantage in terms of access to ICT, when compared with single sex boys' schools. At primary level the girls' schools provided greater access. At post-primary level the boys' schools provided slightly greater access, but only at junior cycle.

The changes in access with age were partly consistent with the patterns suggested by other studies. As suggested in the COMPED study,[1] boys did not have an advantage in access in primary schools, but they did in the early part of post-primary school. Following the pattern observed by Becker and Sterling,[2] girls in-school use of ICT increased during post-primary school, overtaking boys by senior cycle.

There was some support for the hypothesis that boys' schools provide greater access to ICT outside of school hours. In all regular primary school classes, and senior classes in post-primary schools, there was greater out-of-hours access in boys' schools. Girls' schools provided more out of hours access for transition year, first year, and remedial classes in primary schools.

8.3 Types of applications of ICT used in boys' and girls' schools

A number of studies have reported gender differences in the types of use of ICT made by boys and girls.[3] Girls were reported to be less interested in ICT, to use a smaller range of applications and to concentrate more of their use on word processing. Other studies have reported similar patterns within schools, with girls making greater use of word processing. There has also been some suggestions that

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[1] Ingeborg Janssen Reinen and Tjeerd Plomp, "Gender and Computers: Another Area of Inequity in Education?". in *Schools, Teachers, Students and Computers: a Cross National Perspective* ed. by W.J. Pelgrum, I.A.M. Reinen Janssen and Tj. Plomp (Amsterdam: IEA, December 1993).

[2] H.J. Becker and C.W. Sterling, "Equity in School Computer Use: National Data and Neglected Considerations", *Journal of Educational Computing Research,* Vol. 3 No. 3 (1987), p302.

[3] See section 3.4a

the gender gap was greater for older classes.[1] However, these studies have mostly focused on differences in use within mixed schools. If these patterns were replicated in Irish single sex schools, it might be expected that:

- Boys' schools would use a broader range of ICT applications than girls' schools.
- Boys' schools would show a greater focus on technical uses of ICT.
- Girls' schools would show a greater emphasis on word processing.
- The greatest gender gap in use of word processing would appear in older classes.

The examination of the patterns of type of use of ICT in this study is based primarily on question D4 of the survey, which provided a list of types of software and asked schools to indicate the proportion of student use of software in each type. The list of types of software was as follows:

TABLE 8. 13: TYPES OF SOFTWARE INCLUDED IN QUESTION D4 ON THE 2000 SURVEY

Primary Schools	Post-primary schools
Writing packages such as word processors	Writing packages such as word processors
CD ROM resources	CD ROM resources
World Wide Web / Internet	World Wide Web / Internet
Skill/practice games	Skill/practice games
Simulations / exploratory environments	Simulations / exploratory environments
Graphics (drawing)	Graphics (drawing)
Spreadsheets / database	Spreadsheets / database
Presentation and Multimedia	Presentation and multimedia
Programming (e.g., C++, HTML)	Programming (e.g., C++, HTML)
	Careers software (e.g., Qualifax)

The question, recognising that this information was unlikely to be readily available in schools, asked schools to estimate the usage. Given the level of generalisation and estimation involved, these data must be treated with some caution. Despite this limitation, these data provide a basis for comparison of usage between boys' and girls' schools. This comparison was based on three statistics extracted from the data:

[1] See section 3.4c.

- The percentage of schools that reported some use under each heading.
- The average of "percentage of ICT time" in the schools that reported some use.
- An overall usage index, calculated from the product of these two.[1] This usage index is an approximate calculation of the percentage of ICT time nationally devoted to each application.

8.3a Applications used more in girls' schools than in boys' schools

The data provided some support for the hypothesis that more of the ICT usage in girls' schools was devoted to word processing. In the schools that made use of word processing, it occupied a greater proportion of ICT time in girls' schools for all ages except junior primary classes. The overall usage index was also greater for girls' schools for all except junior primary classes.

There was also some support for the suggestion that the gender gap increased with age. Girls' schools made slightly less use of word processing than boys' schools at junior primary level and slightly more at senior primary level. The gap increased in post-primary schools and in junior post-primary level and transition year the differences were more substantial and statistically significant. However in senior cycle in post-primary schools the gap was slightly smaller and not statistically significant.

TABLE 8. 14: FREQUENCY OF USE OF WORD PROCESSING, 2000

Word processing	% of boys' schools	% of girls' schools	% of time in boys' schools	% of time in girls' schools	T-test, *p*-value	Boys' schools usage index	Girls' schools usage index	Difference Girls' index minus Boys'.
Junior primary	48	50	30	26	NS	14.4	13.0	-1.4
Senior Primary	71	76	35	37	NS	24.9	28.1	3.3
Junior post-primary	81	72	47	56	.012	38.1	40.3	2.3
Transition year	69	80	35	42	.008	24.2	33.6	9.5
Senior post-primary	74	82	39	43	NS	28.9	35.3	6.4

[1] The calculation was Usage Index = % of schools using x % of ICT time / 100. Thus for example if 50% of schools used a particular application, and on average it accounted for 30% of their ICT use, this would result in a usage index of 15 (=50x30/100).

Word processing was not the only application that made up a greater proportion of ICT time in girls' schools than in boys' schools. The girls' schools also spent more of their ICT time on CD-ROM resources, skill games and careers software.

Girls' schools spent more of their ICT time on CD-ROM resources at all levels except junior post-primary. The difference was greatest at junior primary level, where CD-ROM use accounted for 55% of ICT time in the schools using them, but only 45% of time in the boys' schools. Girls' schools also reported greater use of skill games at all levels except senior primary classes, and of careers software at all post-primary levels, although the differences were not statistically significant.[1]

[1] Data tables in appendices M5 and M11.

TABLE 8. 15: FREQUENCY OF USE OF CD ROM RESOURCES, 2000

CD ROM	% of boys' schools	% of girls' schools	% of time in boys' schools	% of time in girls' schools	T-test, *p*-value	Boys' schools usage index	Girls' schools usage index	Difference Girls' index minus Boys'.
Junior primary	60	67	45	55	.002	27.0	36.9	9.9
Senior Primary	75	75	34	35	NS	25.5	26.3	.75
Junior post-primary	61	47	12	13	NS	7.3	6.1	-1.2
Transition year	43	59	9	11	NS	3.9	6.5	2.6
Senior post-primary	44	57	10	10	NS	4.4	5.7	1.3

8.3b Applications used more in boys' schools than in girls' schools

A series of the applications of ICT were used more extensively in boys' schools. These included the Internet, Powerpoint and multimedia, database and spreadsheets, graphics and simulations. The difference was particularly consistent in the case of the Internet, where boys' schools reported greater use at all ages. The difference was greatest at junior cycle post-primary, where use of the Internet accounted for 15% of ICT use in boys' schools and 12% of use in girls' schools.

TABLE 8. 16: FREQUENCY OF USE OF THE INTERNET, 2000

Internet use	% of boys' schools	% of girls' schools	% of time in boys' schools	% of time in girls' schools	T-test, *p*-value	Boys' schools usage index	Girls' schools usage index	Difference Girls' index minus Boys'.
Junior primary	14	9	11	7	NS	1.5	0.6	-0.9
Senior Primary	57	44	12	11	NS	6.8	4.8	-2.0
Junior post-primary	65	51	15	12	NS	9.8	6.1	-3.6
Transition year	61	64	19	15	NS	11.6	9.6	-2.0
Senior post-primary	63	66	16	14	NS	10.1	9.2	-0.8

The boys' schools also reported higher use of database and spreadsheet at all levels except transition year. These differences were greatest at post-primary level. Database and/or spreadsheets were used in 60% of boys' post-primary schools with junior cycle students, accounting for 19% of their ICT use. This was significantly greater than the usage in girls' schools where it was used by 44% of schools and

accounted for 14% of ICT usage (t-test, p=.029). There was a smaller difference in senior cycle, where database and/or spreadsheet were used in 57% of boys' schools and 59% of girls' schools accounting for 22% and 17% of ICT usage (t-test, p=.038).[1]

Boys' schools made more use of graphics at all levels, especially in senior cycle post-primary, where graphics software was used in 39% of boys' schools and represented 10% of their use of ICT, but used in 41% of girls' schools and accounted for 6% of their use of ICT (t-test, p=.007).[2] The boys' schools made more use of Powerpoint and multimedia software at all but senior cycle post-primary level, and made more use of simulations at all levels. However in both cases the differences were not statistically significant.[3]

There was very little use of ICT for programming. The very small numbers of primary schools reporting use for programming may make comparisons unreliable, especially as there is a risk of some schools having misinterpreted the term. At post-primary level, girls' schools report slightly more use of programming at junior cycle level, and boys' schools report more at transition year and senior cycle.[4]

8.3c Gender pattern of type of use

Overall, the data provided little evidence to support the suggestion that the use of ICT in girls' schools was focused on a narrower range of applications than that in boys' schools. The girls' schools generally reported greater usage in four of the ten categories provided, word processing, CD ROM, skill games and careers software. Boys' schools reported greater use of the Internet, Spreadsheet/database, graphics, simulations and multimedia (Summaries in graphs 8.7 to 8.9).

Although many of the differences recorded in this analysis were small and not statistically significant, they offer some suggestion that girls' schools were making less use of the applications of ICT which might be considered "high tech",

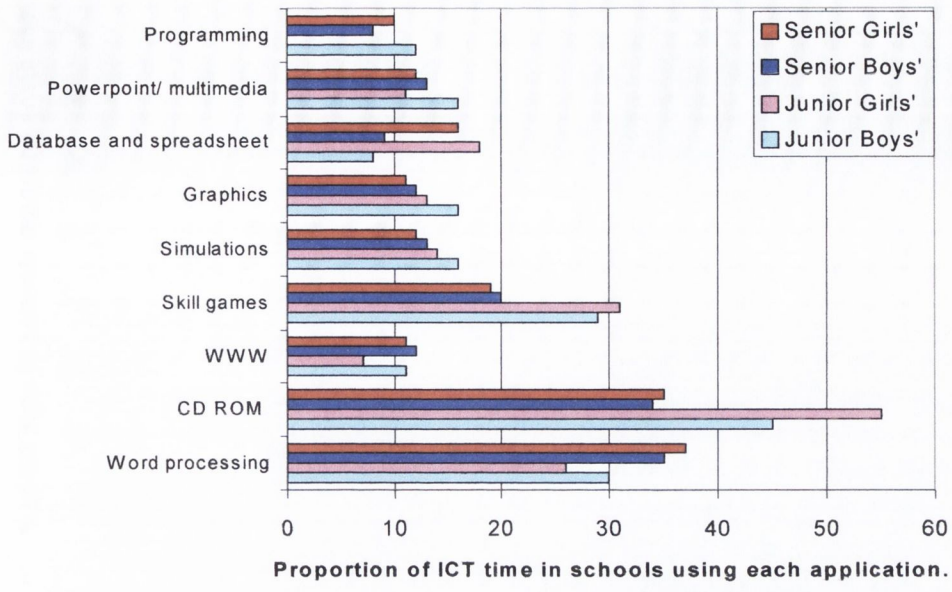
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[1] Data table in appendix M8.

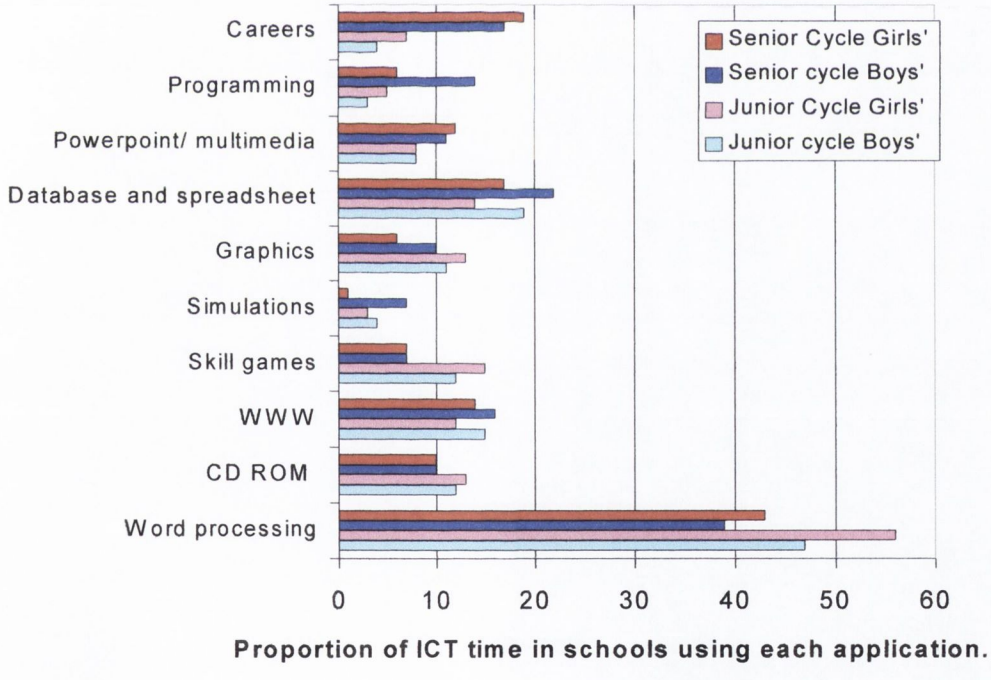
[2] Data table in appendix M7.

[3] Data tables in appendices M6 and M9.

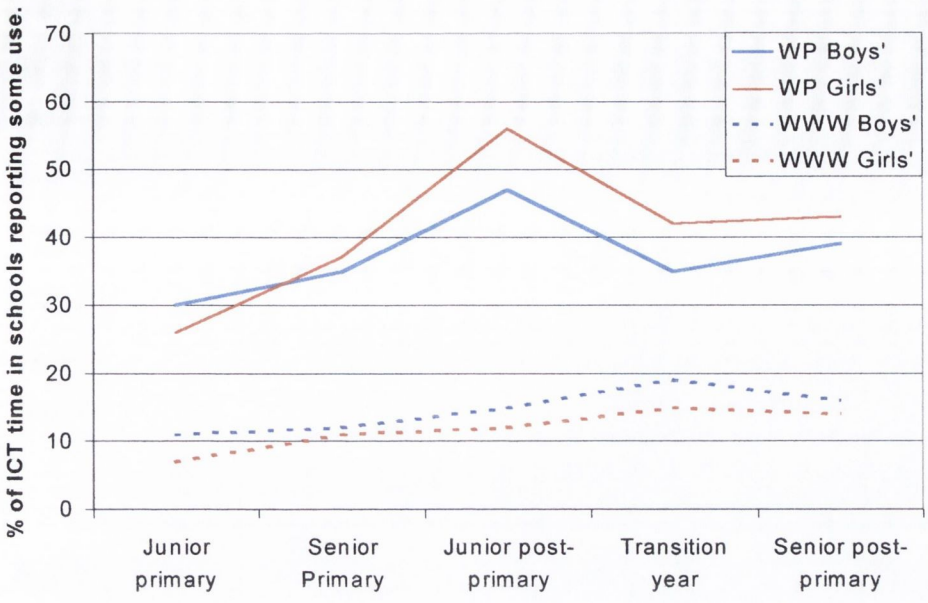
[4] Data table in appendix M10.



GRAPH 8.7. TYPE OF USE OF ICT IN PRIMARY SCHOOLS



GRAPH 8.8. TYPE OF USE OF ICT IN POST-PRIMARY SCHOOLS



GRAPH 8.9. COMPARISON OF PROPORTION OF ICT TIME SPENT ON WORD PROCESSING (WP) AND THE INTERNET (WWW)

including the Internet, spreadsheet/database and graphics. The areas where the girls' schools reported greater use than boys' schools included areas where the learner requires less technical skill such as CD ROM resources, skill games and careers databases.

The data did support the hypothesis that the use of ICT in girls' schools was more focussed on word processing than that in boys' schools. The gender gap in the use of word processing was greater in post-primary schools, although it was smaller in senior cycle than in junior cycle.

8.4 Use of the Internet in schools

The data in the previous section indicate that the use of Internet accounted for a greater proportion of ICT time in boys' schools than in girls' schools. This section examines the other available indicators of the nature and extent of use of the Internet, both for the purposes of triangulation and to examine variations in the manner in which the Internet was used.

The question of a gender pattern in Internet use is of particular interest for a number of reasons. The idea of an information society is heavily reliant on the Internet and hence learning to handle on-line resources appropriately is an important part of the social rationale for ICT in schools.[1] Existing data indicates a strong male bias in Internet skills thus underlining the importance of Internet access in schools. While this might suggest that at present the Internet is more attractive to males, leading to the hypothesis of greater use of the Internet in boys' schools, other researchers have suggested that the Internet is an application of ICT which is more attractive to girls than boys and may act as a mechanism for drawing girls in to technology.[2]

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[1] This argument is described in more detail in chapter 1.

[2] See section 3.3c.

8.4a Extent of Internet use

The data seem to support the suggestion in the previous section that Internet use was greater in boys' schools than in girls'. When schools were asked to estimate the amount of time spent online each month, the boys' schools reported more online time. In primary schools the average time spent online in boys' schools at 12.2 hours, compared with 9 hours in girls' schools. At post-primary level these figures were 39 and 28 hours for boys and girls respectively.

TABLE 8. 17: MEAN ONLINE HOURS PER MONTH, 2000

2000 data	Boys' schools	Girls' schools	Mixed schools	T-test, boys' and girls' schools, *p*-value
Primary	12.2	9.0	8.2	NS
Post-primary	38.8	28.3	48.7	NS

This is consistent with the pattern of equipment where boys' schools had more computers connected to the Internet than girls' schools, both in absolute terms and in proportion to their student numbers.[1] At both primary and post-primary levels, more of the boys' schools had ISDN lines, and more of them had the Internet routed to multiple computers. In addition at post-primary level more of the boys' schools provided e-mail accounts for their students than girls' schools.

TABLE 8. 18: INTERNET INFRASTRUCTURE

2000	Single Sex Boys	Single sex Girls	Mixed
% of primary schools with ISDN access	25.1	23.4	13.2
% of schools with Internet access routed to multiple machines	16.7	16.4	7.0
% of post-primary schools with ISDN access	75.9	66.7	67.6
% of post-primary schools with Internet access routed to multiple machines	65.7	59.7	62.1
% of post-primary schools where students are provided with e-mail accounts	20	16	19

8.4b Use of Internet for research

Internet infrastructure and online time are not adequate indicators of student use of the Internet, as time online might result from teacher use or other non-student

[1] See section 8.1

activities. The survey asked schools to indicate whether or not there was some student use of the Internet for research. A later question asked schools how many of their students used the Internet for research. The responses to these questions indicate that in most schools there was some use of the Internet for research and that this was more extensive in boys' schools at primary level.

At primary level some pupil research was reported in 61% of boys' schools and 49% of girls' schools (chi square, p=.012). Greater proportions of the pupils in boys' schools were recorded as using the Internet for research. At post-primary level the difference was smaller and not significant.

TABLE 8. 19: STUDENT USE OF THE INTERNET FOR RESEARCH

	Single Sex Boys	Single sex Girls	Mixed
% of primary school pupils reported to use the Internet "frequently" or "occasionally"	20	13	18
% of post-primary students reported to use the Internet "frequently" or "occasionally"	31	30	37

Relative to the numbers of schools using the Internet for research, slightly more of the girls' schools reported use of the ScoilNet website. While this pattern was weak and not statistically significant, it may be that a greater proportion of the Internet use in girls' schools was viewing known sites, rather than using searches to locate unknown sites.[1]

8.4c Websites

Use of the Internet for research is only one of the possible uses of the Internet in schools. A second possibility is the use of the Internet for publication of student work. Such work may provide authentic and motivating tasks for students and may involve the use of ICT in facilitating constructivist approaches to learning. However activity of this type is not necessarily indicated by the presence of a school website, as school websites may be teacher created, or the work of a few skilled enthusiasts.

The survey distinguished different types of school Web presence by asking:

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[1] See appendix M12.

a) whether or not there was a school website,

b) whether or not it was maintained by pupils/students, and

c) if it carried curricular work produced by pupils/students.

In primary schools the number involved in Web publication was low, but there were marked gender differences. Twenty-seven percent of boys' schools had a website, compared with only 12% of girls' schools. The website was maintained by pupils in 8% of the boys' schools but in only 2% of the girls' schools. More of boys' schools also had curricular or project work published on their websites, although the gender gap was smaller than in the case of maintenance. Fourteen percent of the boys' schools had curricular material on their website, compared with 5% of girls' schools.

TABLE 8. 20: PRIMARY SCHOOLS: GENDER PATTERN IN WEB PUBLICATION

Primary schools	% of boys' schools	% of girls' school	% of mixed schools	Chi square, single sex schools only, *p*-value
The school has a website	27	12	13	.000
The website is maintained by pupils	8	2	4	.002
The website carries pupils project or curricular work.	14	5	8	.008

At post-primary level more of the boy's schools had a website and more had the website maintained by students. Fifty five percent of the boys' schools had a website, compared with 43% of girls' schools. In 25% of the boys' schools the websites were student maintained, but this occurred in only 11% of girls' schools. Despite the greater numbers of websites in boys' schools, the same proportions of boys' and girls' schools (12%) had student produced curricular or project work on their website.

TABLE 8. 21: POST-PRIMARY SCHOOLS: GENDER PATTERN IN WEB PUBLICATION

Post-primary schools	% of boys' schools	% of girls' school	% of mixed schools	Chi square, single sex schools only, *p*-value
The school has a website	55	43	45	NS
The website is maintained by Students	25	11	14	.004
The website carries Students project or curricular work.	12	12	10	NS

8.4d Conclusion

The preceding analyses have identified a series of differences in the use of the Internet between boys' and girls' schools. These differences may be summarised as follows:

- Boys' schools had better Internet connectivity, as more of them had ISDN access and more had Internet access on multiple computers.
- Boys' schools spent more time online each month, and Internet use accounted for a greater proportion of their total ICT time than in girls' schools.
- More of the students in boys' schools used the Internet for research.
- More of the boys' schools had a website and had students involved in website maintenance.

These data provide little to support the earlier suggestion that the Internet acts as the acceptable face of technology for girls. Rather, the available indicators point to a greater and more consistent gender gap in Internet access and usage than was found in the use of ICT generally. Although girls' schools provided greater access to ICT than boys' schools at primary level, the boys' schools had more Internet access. Similarly at post-primary level, where the pattern of ICT access was variable, boys' schools provided more Internet access for all ages.

There was also some evidence to suggest that the boys' and girls' schools may use the Internet in different ways. Some indicators suggest greater emphasis on the technical aspects of the Internet in boys' schools, and a greater focus on the

curricular usage in girls' schools. Boys' schools reported greater student involvement in website maintenance, and more of them had a Web presence. For girls' post-primary schools more of the Web presence involved the publication of student work. Similarly in the case of Internet research, more of the students in boys' schools were involved in Web research, but there were indications of relatively greater use of the ScoilNet website in girls' schools.

8.5 Use of ICT in subject areas

Some of the uses of ICT in schools are focussed on *learning about* the technology, while other uses are aimed at *learning with* technology. This distinction is of particular importance in the context of the pedagogical rationale,[1] which is concerned with the use of ICT to enhance teaching and learning of other curricular areas. In this study the distinction was made through the questions that asked schools to identify the subjects in which ICT was used and the frequency of use. This was an imperfect measure, as there was no indication of the quality or context of the use of ICT within the subject area. Nevertheless it provided an indication of ICT usage integrated in some way into curricular subjects.

The extent of integrated use of ICT was measured using the Subject Use Score, an aggregate of the number of subjects in which ICT was used in each school, weighted by the frequency of use.[2] The Subject Use Score indicated that at both primary and post-primary levels girls' schools made more use of ICT in subject areas than boys' schools. At primary level girls' schools had an average score of 12.2, while boys' schools had an average of 11.8. At post-primary level the difference was greater, with the girls' schools having an average score of 8.7 and the boys' an average of 7.3.

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[1] See section 1.1b.

[2] The calculation of the Subject Use Score is described in section 5.4b.

TABLE 8. 22: AGGREGATE ICT SUBJECT USE SCORE

Aggregate score based on the frequency of use in each subject	Boys' schools Mean score	Girls' schools Mean score	T-test, *p*-value
Primary schools	11.8	12.2	NS
Post-primary schools	7.3	8.7	NS

These data suggest a greater focus on the use of ICT within subject areas in girls' schools. It is however not safe to conclude that girls' schools place a greater emphasis on *learning with technology* than boys schools. At post-primary level the girls' schools also reported greater use of external certification of ICT skills. Some external certification was in use in 63% of girls' schools and 43% of boys' schools.

8.5a Subjects in which ICT was used

Existing research has reported an association between ICT and particular subject areas, typically Mathematics and Sciences. It has also been suggested that this association may be a factor in discouraging girls' use of ICT.[1] If this is indeed a factor, then it might be expected that ICT would be associated with different subjects in boys' and girls' schools. The data partly supports such a suggestion, with a series of small gender differences in the subjects in which ICT was used (Graph 8.10).

At primary level slightly more of the girls' schools reported use of ICT in SESE, Mathematics, English, Arts Education and Languages. However more of the boys' schools used ICT in History, Geography, Physical Education and Learning Support. In all cases the differences were small, except in SESE where ICT was used in 45% of girls' schools and 38% of boys' schools (chi square, p=.033).[2]

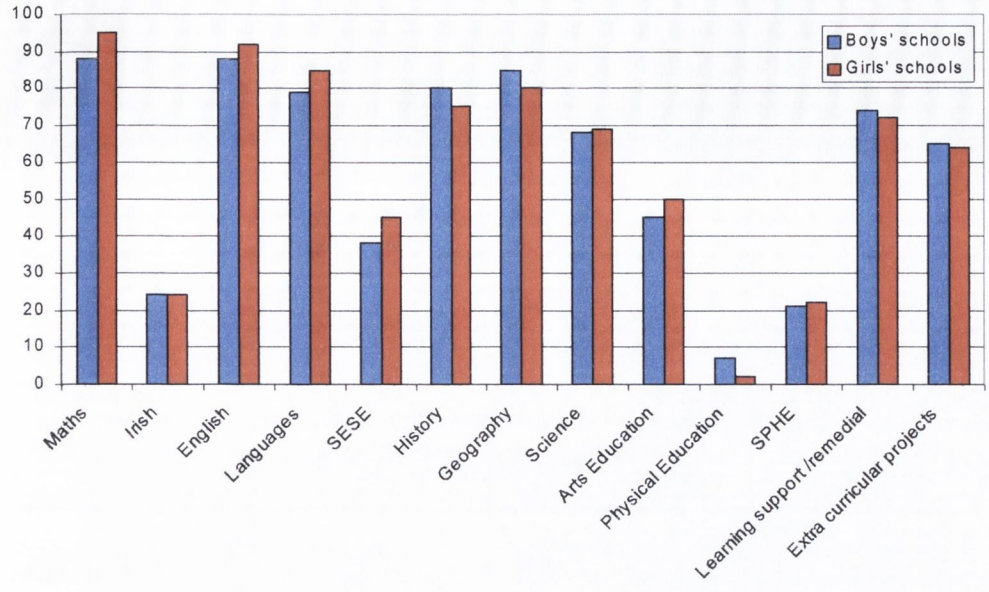
At post-primary level more of the boys' schools used ICT in Technology and Science, while more of the girls' schools used ICT in Art and Music[3]. Forty-nine

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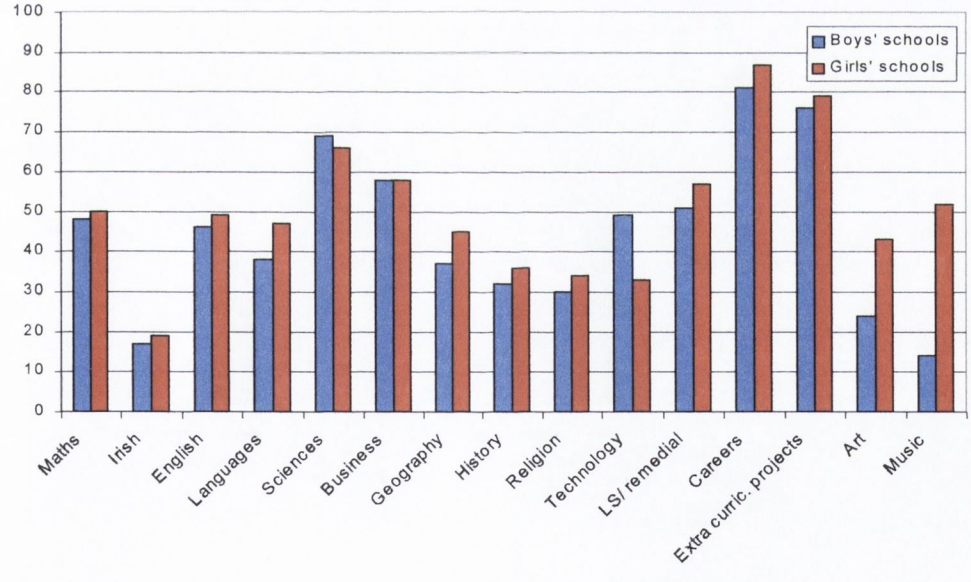
[1] See section 3.4e.

[2] Data in appendix M13.

[3] Data in appendix M14.



GRAPH 8.10. USE ICT IN CURRICULAR SUBJECTS, PRIMARY SCHOOLS, 2000. % OF SCHOOLS REPORTING ACCESS TO ICT IN EACH SUBJECT



GRAPH 8.11. USE ICT IN CURRICULAR SUBJECTS, POST-PRIMARY SCHOOLS, 2000. % OF SCHOOLS REPORTING ACCESS TO ICT IN EACH SUBJECT

percent of boys' schools used ICT in Technology compared with 33% of girls' schools (chi square, p=.023). ICT was used in Art in 43% of girls' schools and 24% of boys' schools (chi square, p=.024) and ICT was used in Music in 52% of girls' schools and 14% of boys' schools (chi square, p=.000). However it must be noted that in these subjects there may also have been variation in the subject availability in the girls' and boys' schools.

With the exception of these three subjects, the differences in ICT usage in subject areas were small and not statistically significant. While the boys' schools reported more use of ICT in Science and Technology, both reported equal use in Business, and girls' schools reported greater use in all other subject areas (Graph 8.11).

Overall these data suggest that at primary level the use of ICT in girls' schools was concentrated slightly more on the core subjects, such as English and Mathematics, while boys' schools made slightly greater use of ICT in areas such as humanities and learning support. At post-primary level the use of ICT in boys' schools was concentrated more on Science and Technology, while the girls' schools made greater use of ICT in a broader range of subjects.

8.6 Teacher ICT skill and course participation

This section is concerned with the teachers in the boys' and girls' schools. If ICT is of greater interest to males, as suggested by some of the research cited in Chapter 3,[1] then it might be expected that there would be a greater culture of interest in ICT in boys' schools, and that more of the teachers would have ICT skills or take up the training offered. This section examines three aspects of teachers and ICT. The first part considers teachers' participation in training provided under IT 2000, while the second and third parts examine the pattern of teacher ICT skill in 1998 and in 2000.

8.6a Participation in ICT courses

The survey asked schools to indicate the total number of teachers who had attended at least one ICT course. In both primary and post-primary schools participation in

[1] See section 3.2.

ICT training courses was significantly higher in the girls' schools than in the boys' schools. At primary level 79% of teachers in boys' schools and 86% of teachers in girls' schools reported attending at least one course. On average 7.8 teachers from each boys' primary school attended some training, compared with 10.8 teachers from each girls' post-primary school (t-test, p=.000).

The same pattern arose at the post-primary level. In the boys' schools a total of 58% of teachers had attended some courses, compared with 63% of teachers in girls' schools. On average 17.5 teachers in each boys' school attended a course, compared with 22.5 teachers in each girls' school (t-test, p=.001).

Types of courses attended

There were also some differences between boys' and girls' schools in the types of courses attended by the teachers.[1] Three main patterns emerged. Firstly, the courses concerned with basic skills were attended by a greater proportion of teachers from girls' schools than from boys' schools. Secondly, the very technical courses were attended by a greater percentage of teachers from boys' schools than from girls' schools. Finally, more of the girls' schools provided support for their teachers to attend courses.

Two of the courses provided by NCTE were aimed at providing basic ICT skills for teachers. These two courses, known as Phase 1 and Phase 2, were attended by significantly more teachers from girls' schools than from boys' schools. At primary level an average of 8.6 teachers from each girls' school attended the NCTE Phase 1 course, compared with 6.1 from each boys' school (t-test, p= .000). These figures represent 66% of teachers in girls' schools and 57% of teachers in boys' schools. Similarly the NCTE Phase 2 course was attended by an average of 5.4 teachers from each girls' primary school and 3.8 from each boys' school (t-test, p= .000). The same pattern emerged at post-primary level where on average 18.8 teachers from each girls' post-primary school attended the Phase 1 course, but only 14.9 from each boys' school (t-test, p=.012).

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[1] Data tables in appendices M15 and M16.

The second pattern was that teachers from girls' schools were under-represented at some of the most technical courses. At both primary and post-primary levels, more of the teachers from boys' schools attended the course on First Line Maintenance. At primary level more of the teachers from boys' schools also attended the courses on creating a school website and multimedia authoring. At post-primary level more of the teachers from boys' schools attended the Internet and e-mail course.

At both levels the girls' schools reported providing more support for staff to attend the courses. At primary level 25% of girls' schools and 16% of boys' schools provided financial support for attendance at courses (chi square, p=.035). More of the girls' schools reported that they encouraged attendance and organised in-school training, but the differences were not statistically significant. At post-primary level slightly more of the girls' schools encouraged participation in training, but the differences were small and not statistically significant.

8.6b Teacher ICT skill in 1998

The greater take-up of ICT training, particularly basic skills training, by teachers in girls' schools is open to a variety of interpretations. This could be seen as reflecting greater interest in ICT in girls' schools. Alternatively it could result from greater ICT skill in boys' schools before the start of IT 2000. This section examines the pattern of teacher ICT skill as reported in the 1998 survey. This analysis examines two main questions. The first is whether there was a higher proportion of teachers with ICT skill in boys' schools in 1998. The second is whether there was a gender pattern in teacher skill, with male teachers having more ICT skill than female teachers.

In the 1998 survey schools were asked to classify their teachers into three categories, those with no skill, those with some skill, and those comfortable with the technology. For the purposes of comparison, the following figures are based on the 1998 data, but including only those schools that also completed the 2000 survey.

Teacher ICT skills

In 1998 slightly more of the teachers in girls' primary schools had some computer skill. Approximately 78% of teachers in girls' primary schools and 77% of

teachers in boys' schools were reported to have had some computer skills. However more of the teachers in boys' schools had Internet skills. Twenty-nine percent of the teachers in boys' schools had some Internet skill, compared with 22% of teachers in girls' schools.

TABLE 8. 23: PROPORTION OF TEACHERS WITH ICT SKILLS IN 1998, PRIMARY SCHOOLS

Primary schools 1998 data	Computer skill		Internet Skill	
	Boys' school	Girls' School	Boys' school	Girls' School
N of teachers	2,071	1,882	1,503	1,258
% with some skill or comfortable	76.9	77.5	29.3	21.9

In post-primary schools the opposite pattern emerged, and a greater proportion of the teachers in girls' schools had both computer skills and Internet skills.

TABLE 8. 24: PROPORTION OF TEACHERS WITH ICT SKILLS IN 1998, POST-PRIMARY SCHOOLS

Post-primary schools 1998 data	Computer skill		Internet Skill	
	Boys' school	Girls' School	Boys' school	Girls' School
N of teachers	2,758	3,847	2,224	3,026
% with some skill or comfortable	50.5	57.7	23.3	33.2

Gender pattern of teacher skill

As noted earlier[1] slightly more male teachers were reported to have ICT skills in 1998, especially Internet skills. The single sex schools followed the same pattern, with slightly higher proportions of male teachers having computer and Internet skill in both primary and post-primary schools.

TABLE 8. 25: TEACHER SKILL AND TEACHER GENDER, 1998 (SINGLE SEX SCHOOLS ONLY)

% with some skill or comfortable	Primary School (Single Sex)		Post-primary school (Single sex)	
	Computer skill	Internet Skill	Computer skill	Internet Skill
Male teachers	79.7	35.5	56.5	30.3
Female teachers	76.3	22.5	53.6	28.2

[1] See section 6.1b.

The gender gap in ICT skill was greater in girls' schools than in boys' schools. This was particularly true of Internet skill. As the tables below reveal, male teachers in girls' schools were much more likely to have Internet skills than their female colleagues, but the gap was much smaller in boys' schools.

TABLE 8. 26: PROPORTION OF TEACHERS WITH ICT SKILLS IN 1998, PRIMARY SCHOOLS

% with some skill or comfortable	Computer skill		Internet Skill	
	Boys' school	Girls' School	Boys' school	Girls' School
Male teachers	79.8	77.2	35.4	41.7
Female teachers	74.2	77.5	23.8	21.7

TABLE 8. 27: PROPORTION OF TEACHERS WITH ICT SKILLS IN 1998, POST-PRIMARY SCHOOLS

% with some skill or comfortable	Computer skill		Internet Skill	
	Boys' school	Girls' School	Boys' school	Girls' School
Male teachers	52.9	71.2	25.2	50.9
Female teachers	44.1	55.7	18.3	30.6

This finding must be treated with caution, as the number of male teachers reported in single sex girls' schools was small.[1] However it does raise the possibility that ICT may have been a more 'gendered space' in girls' schools than in boys' schools. This may be an issue of particular interest because of the influence of female role models in encouraging girls' engagement with ICT.[2]

8.6c Teacher ICT skill in 2000

This section is concerned with teacher ICT skill in 2000, following two years of training. By 2000 the proportion of teachers with ICT skills had risen markedly with the proportion of teachers with Internet skill showing the greatest rise. There remained a difference between boys' and girls' schools. At primary level a greater proportion of the teachers had Internet skills in boys' schools. At post-primary level more of the teachers in boys' schools had both computer skills and Internet skills.

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[1] See appendices M17 to M20.

[2] See section 3.4d.

TABLE 8. 28: PROPORTION OF TEACHERS WITH ICT SKILLS IN 2000, PRIMARY SCHOOLS

Primary schools	Computer skill		Internet Skill	
	Boys' school	Girls' School	Boys' school	Girls' School
N of teachers	2,408	1,970	2,385	1,980
% with some skill	89.6	93.3	70.3	67.9

TABLE 8. 29: PROPORTION OF TEACHERS WITH ICT SKILLS IN 2000, POST-PRIMARY SCHOOLS.

Post-primary schools	Computer skill		Internet Skill	
	Boys' school	Girls' School	Boys' school	Girls' School
N of teachers	3,076	3,080	3,977	3,962
% with some skill	74.1	61.8	79.3	66.4

Gender pattern of teacher skill

The gender pattern of computer skill had reversed from the 1998 pattern. While in 1998 more male teachers had some computer skill, by 2000 slightly more of the female teachers had some computer skill, in both primary and post-primary schools. This was not the case for the Internet, where more of the male teachers had some skill in 2000.

TABLE 8. 30: TEACHER SKILL AND TEACHER GENDER, 2000 (SINGLE SEX SCHOOLS ONLY)

% with some skill	Primary School (Single Sex)		Post-primary school (Single sex)	
	Computer skill	Internet Skill	Computer skill	Internet Skill
Male teachers	89.9	71.8	67.9	81.9
Female teachers	91.7	68.4	68.2	71.6

As in 1998, there were variations between boys' and girls' schools in the gender gap in teacher skill, particularly in the case of Internet skill. In boys' primary schools there was little difference between male and female teachers, with 71% of male teachers and 70% of female teachers having some Internet skill. However in girls' schools there was a substantial gender gap, with 88% of male teachers and 68% of female teachers having some Internet skill. In the post-primary schools there were similar proportions of male and female teachers with Internet skill in boys' schools, but 77% of male teachers in girls' schools had some Internet skill, compared with 65% of female teachers.

The pattern of computer skill was less clear. In both primary and post-primary schools similar proportions of male and female teachers in boys' schools had some computer skill. However in the girls' post-primary schools more of the male teachers had some computer skill.

TABLE 8. 31: PROPORTION OF TEACHERS WITH ICT SKILLS IN 2000, PRIMARY SCHOOLS

% with some skill	Computer skill		Internet Skill	
	Boys' school	Girls' School	Boys' school	Girls' School
Male teachers	90	94	71	88
Female teachers	89	93	70	68

TABLE 8. 32: PROPORTION OF TEACHERS WITH ICT SKILLS IN 2000, POST-PRIMARY SCHOOLS

% with some skill	Computer skill		Internet Skill	
	Boys' school	Girls' School	Boys' school	Girls' School
Male teachers	74	87	62	77
Female teachers	74	78	62	65

These data must be treated with caution, as with the 1998 data, because the percentages are based on the total number of teachers reported in answer to the question. In other parts of this study percentages are based on the number of teachers in the school, but this was not possible in this case, because the number of teachers of each gender was not known. It is possible that some schools may have reported teachers with skill, but not recorded those without skill, thus inflating the figures.

However the available data suggest a series of patterns. Firstly the proportion of teachers with some computer skill was higher in girls' schools at primary level and in boys' schools at post-primary level. This is consistent with the pattern of access to ICT reported earlier.[1] Secondly, at both primary and post-primary levels, the proportion of teachers with Internet skill was higher in boys' schools. This may reflect a stronger male bias in Internet use than in computer use generally, and if so is consistent with the patterns of Internet usage reported earlier.[2] Thirdly, the data

[1] See section 8.2.

[2] See section 8.4.

suggest that the skill gap between male and female teachers is greater in girls' schools.

8.6d Teacher Use of ICT

The 2000 survey provided further indications of a gender divide in Internet use. The survey asked schools to indicate whether the principal used e-mail, and to estimate the number of teachers using ICT, e-mail and the Internet. The responses showed little difference between boys' and girls' schools in the proportion of teachers using ICT in lesson preparation or in their teaching. However in the boys' schools more of the teachers used e-mail, and used the Internet for research. For example in boys' primary schools 10% of teachers used the Internet frequently, compared with 7% of those in girls' schools. At post-primary level 14% of teachers in boys' schools and 11% of those in girls' schools used the Internet frequently.

More of the school principals in boys' schools were frequent users of e-mail than those in girls' schools. For example at primary level 17% of principals of boys' schools used e-mail frequently, compared with 13% of girls' schools.

TABLE 8. 33: USE OF ICT BY TEACHERS AND PRINCIPAL, PRIMARY SCHOOLS

Primary schools 2000.	Boys' schools	Girls' schools
% of teachers using ICT in teaching	52	53
% of teachers using ICT in lesson preparation	27	26
% of principals using e-mail frequently	17	13
% of all teachers using e-mail frequently	10	5
% of all teachers using the Internet frequently	10	7

TABLE 8. 34: USE OF ICT BY TEACHERS AND PRINCIPAL, POST-PRIMARY SCHOOLS

Post-primary schools 2000.	Boys' schools	Girls' schools
% of teachers using ICT in teaching	16	17
% of teachers using ICT in lesson preparation	30	30
% of principals using e-mail frequently	19	17
% of all teachers using e-mail frequently	12	10
% of all teachers using the Internet frequently	14	11

8.6e Change in gender pattern of teacher skill between 1998 and 2000

The pattern of change in teacher skill in primary schools is summarised in graph 8.12.[1] This graph shows that between 1998 and 2000 the proportion of teachers with ICT skills in girls' primary schools grew more rapidly than that in boys' schools. The girls' schools increased their lead in computer skills, and narrowed the gap in Internet skills. This pattern is consistent with the greater numbers of teachers from girls' schools attending training reported earlier.[2]

However the pattern in post-primary schools was very different. Although girls' post-primary schools also reported higher participation in training than boys' schools, the proportion of teachers with ICT skills increased more rapidly in boys' schools (Graph 8.13).[3] Thus while more of the teachers in girls' schools had both computer and Internet skills in 1998, by 2000 the boys' schools had overtaken them.

8.6f Teacher ICT skills and training, conclusion

The data provided little support for the initial hypothesis that more of the teachers in boys' schools would have ICT skills. On the contrary, in both primary and post-primary schools more of the teachers in girls' schools had some ICT skill in 1998.

Girls' schools also surpassed boys' schools in terms of participation in courses. At both primary and post-primary levels more of the teachers in girls' schools attended some ICT courses between 1998 and 2000. The only exceptions were for some of the most technical courses, and for courses leading to a higher degree.

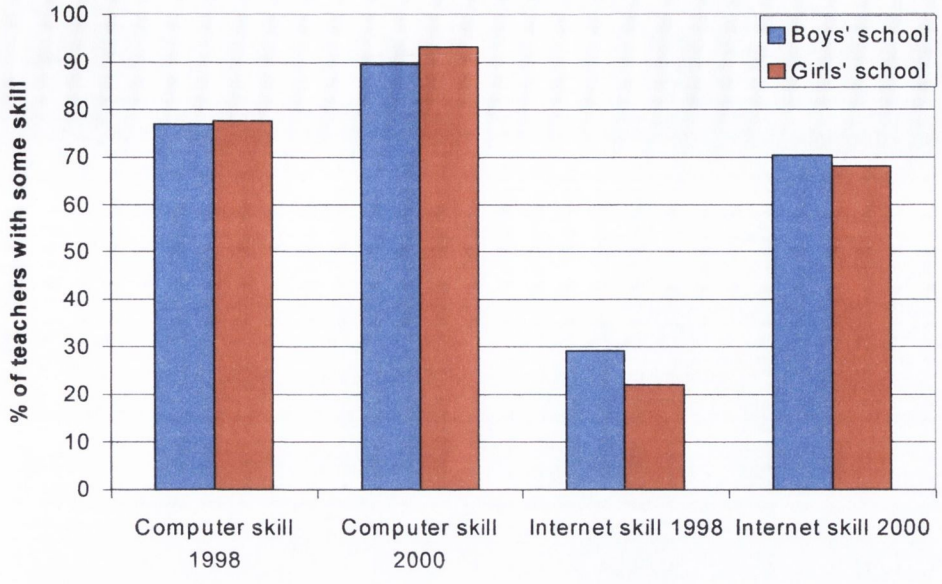
Despite the higher course participation by teachers in girls' schools, the proportion of teachers in boys' post-primary schools with ICT skills grew more rapidly than that in girls' schools and by 2000 more of the teachers in boys' schools had some ICT skills. This pattern is consistent with the pattern of equipment in boys' post-primary schools, which also increased more rapidly than other school types during the period.

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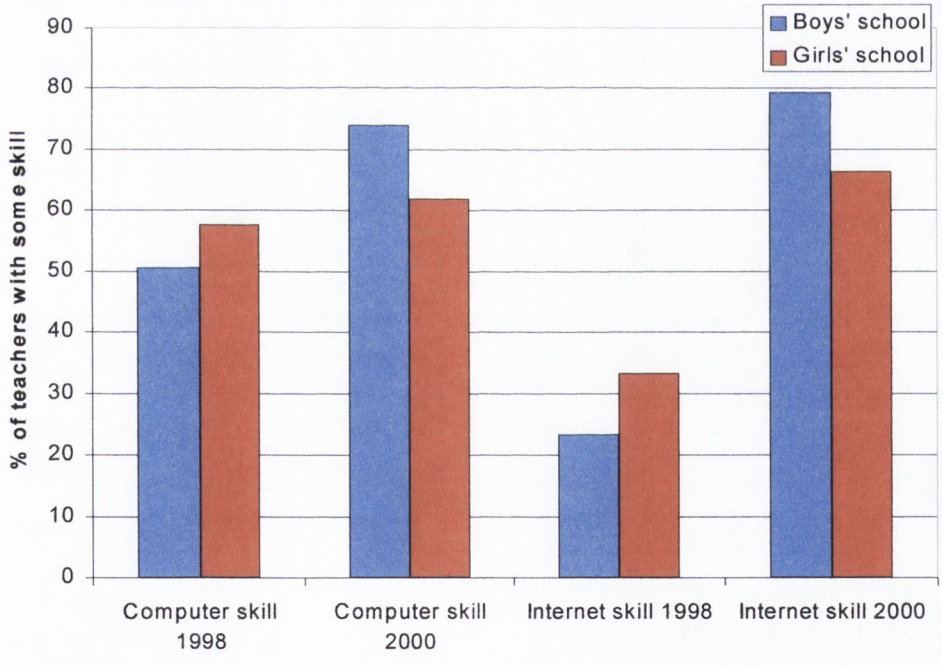
[1] Data table in appendix M21.

[2] Section 8.6.

[3] Data table in appendix M22.



GRAPH 8.12. PRIMARY SCHOOLS, TEACHER ICT SKILL



GRAPH 8.13. POST-PRIMARY SCHOOLS, TEACHER ICT SKILL

The data also provided further evidence of the greater emphasis on the Internet in boys' schools. At primary level, although more of the teachers in girls' schools had computer skill, more of the teachers in boys' schools had Internet skill. This pattern was less consistent in post-primary schools, but in 2000 the gap in Internet skill between boys' and girls' post-primary schools was greater than that in computer skill.

The suggestion that the Internet is more associated with males than other computer skills was further supported by the data on the use of ICT by teachers and principals. Internet use by teachers was more common in boys' schools, as were e-mail use by teachers and e-mail use by principals. By contrast there was little difference in the use of computers either in preparation or in the classroom between boys' and girls' schools.

The data did not reveal marked gender differences in teacher skill. The proportions of male and female teachers with computer and Internet skills were similar. However the gender gap was greatest in girls' schools and greatest for Internet skill. These patterns suggest that ICT may be more strongly associated with male teachers in girls' schools, and that in particular the Internet may have stronger male associations in girls' schools.

8.7 Schools' structures and priorities with regard to ICT

Given the research evidence cited in Chapter 3[1] indicating that boys perceive ICT to be of more relevance and interest, that they engage in a greater number of activities, and that they are more interested in the technical aspects of ICT, it is possible that a more technical ICT culture may emerge in boys' schools. This hypothesis was examined through the two groups of questions. One group of questions asked schools to identify their priorities for ICT, and a second asked schools to identify the organisational and procedural structures in place to support ICT.

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[1] Sections 3.2 and 3.3.

8.7a School Priorities for ICT

There were some differences in the educational priorities of the girls' and boys' schools.[1] At both primary and post-primary level involvement of small groups of students in high level ICT projects was a greater priority for boys' schools than girls' schools. In primary schools this was a priority for 48% of boys' schools and 41% of girls' schools. At post-primary level it was a priority for 71% of boys' schools and 65% of girls' schools.

By contrast, the girls' schools placed more emphasis on ICT integration. ICT integration was a priority in 92% of girls' primary schools and 85% of boys' primary schools. At post-primary level integration was a priority for 81% of girls' schools and 75% of boys' schools.

Girls' schools also placed more emphasis on ensuring that those without home access were not disadvantaged. This was a priority for 88% of boys' primary schools and 90% of girls' schools (chi square, p=.040), while at post-primary level it was a priority for 83% of boys' schools and 91% of girls' schools. At post-primary level girls' schools assigned higher priority to acquiring software and online resources. This was a priority for 83% of girls' schools and 69% of boys' schools (chi square, p=.011).

TABLE 8. 35: EDUCATIONAL PRIORITIES FOR USE OF ICT 2000

Schools assigning "High Priority" or "Very High Priority" to this aim:	% of boys' primary schools	% of girls' primary schools	% of boys' post-primary schools	% of girls' post-primary schools
To get some students involved in high level projects.	47.9	40.9	71.3	65.2
To integrate ICT into curricular subjects	85.1	91.8	75.0	81.4
To ensure that students with no computer at home are not disadvantaged.	87.5	90.1	83.3	90.7

There were also some differences in the development priorities set by girls' and boys' schools. At primary level the boys' schools gave slightly higher priority to the development of connectivity, including getting Internet access on more computers and developing the school network. At post-primary level these were

[1] Data tables in appendices M23 to M32

both priorities for more of the girls' schools (chi square, p=.003 and p=.002 respectively).

At both primary and post-primary levels, girls' schools give greater priority to getting more computers distributed around classrooms. Girls' schools also gave higher priority to getting independent advice on purchase of software, and on funding for software.

TABLE 8. 36: DEVELOPMENT PRIORITIES FOR USE OF ICT 2000

Schools assigning "High Priority" or "Very High Priority" to this aim:	% of boys' primary schools	% of girls' primary schools	% of boys' post-primary schools	% of girls' post-primary schools
More computers distributed around classrooms	78.7	81.4	73.2	78.3
Getting Internet access on more computers	62.0	61.9	71.3	77.6
Developing the school network	51.7	50.3	69.5	77.5
Independent advice on purchase of hardware	51.7	55.5	55.5	65.9
Funding for software purchase/licences.	82.8	90.6	87.9	90.0

8.7b Structures in support of ICT

These variations in educational and developmental priorities are consistent with the variations in organisational and procedural structures to support ICT.[1] The boys' schools had more developed technical procedures than girls' schools. More of them reported making regular backups, and having virus protection in place. However the girls' schools had better developed procedures in non-technical areas. More of them had taken account of the health and safety requirements, had a school plan, and recognised the work of the ICT co-ordinator with a position of responsibility. At primary level the ICT co-ordinator was a designated post of responsibility in 65% of girls' schools and 44% of boys' schools (chi square, p=.000).

[1] Data tables in appendices M33 to M41.

TABLE 8. 37: ICT PROCEDURES AND STRUCTURES, 2000

	% of boys' primary schools	% of girls' primary schools	% of boys' post-primary schools	% of girls' post-primary schools
Schools making regular backups	43	39	75	72
Schools having virus protection	66	62	87	85
Schools taking Health and Safety standards into account	51	57	39	44
Schools with an ICT plan	70	74	54	60
Schools where the ICT co-ordinator is a post of responsibility	44	65	46	49
Schools where the ICT co-ordinator is released from some teaching	6	11	13	16

While the differences were relatively small, and not all were statistically significant, they were replicated consistently in primary and post-primary schools.

8.7c Structures and priorities, conclusion

Overall these data suggest that boys' schools and girls' schools adopted slightly different values and structures in their approach to ICT. The girls' schools had generally better developed support structures, including recognition of the co-ordinator, school ICT plan, and in the primary schools more co-ordinated planning of software usage. The girls' schools also placed more emphasis on ensuring those without home access were not disadvantaged in ICT skills, on integration of ICT into subject teaching and the distribution of computers around classrooms.

By contrast the boys' schools had better developed technical structures, including virus protection and backup procedures. They placed more emphasis on developing their network and Internet infrastructure and on getting some students involved in high level ICT projects.

8.8 Gender and socio-economic status

The previous sections have examined the gender gap by comparison of the state of ICT in boys' and girls' schools. However Lynch has pointed out the danger that in treating women as a single undifferentiated group, disadvantages specific to working class women may be masked. [1] Studies such as that by Kirkman[2] have noted that girls' attitudes to computers varied with social class, with the working class girls' least likely to be interested in technology. This question was tested by comparison of the state of ICT in disadvantaged boys' and girls' schools. The majority of disadvantaged schools were mixed, resulting in small numbers of boys' and girls' schools, as shown in the tables below.

TABLE 8. 38: DISADVANTAGED PRIMARY SCHOOLS, 2000

Primary schools 2000	Single sex boys'	Single sex girls'	Mixed
Number of Schools	66	44	221
Average pupils per school	186	236	194

TABLE 8. 39: DISADVANTAGED POST-PRIMARY SCHOOLS, 2000

Post-primary schools 2000	Single sex boys'	Single sex girls'	Mixed
Number of Schools	24	33	114
Average pupils per school	464	541	368

The 1998 figures revealed that at both primary and post-primary levels, disadvantaged boys' schools were better equipped than girls' schools, but not significantly so. However the gap had narrowed by 2000, and in primary schools the girls' schools were marginally better equipped. The disadvantaged boys' schools had slightly better technical infrastructure. More of the boys' schools had a network and they had more computers connected to the Internet than the disadvantaged girls' schools[3].

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[1] Kathleen Lynch, *Equality in Education*, (Dublin: Gill and Macmillan, 1999), p147.

[2] C. Kirkman, "Computer experience and attitudes of 12-year-old students: implications for the UK National Curriculum". *Journal of Computer Assisted Learning*, Vol. 9 (1993), p58.

[3] Appendices M42 to M45.

TABLE 8. 40: PUPIL-COMPUTER RATIO IN DISADVANTAGED PRIMARY SCHOOLS

Primary schools	Single Sex Boys'	Single Sex Girls'	Mixed
Pupils per computer 1998	40.1	47.0	54.7
Pupils per computer 2000	15.9	15.3	16.1

TABLE 8. 41: STUDENT-COMPUTER RATIO IN DISADVANTAGED POST-PRIMARY SCHOOLS

Post-primary schools	Single Sex Boys'	Single Sex Girls'	Mixed
Students per computer 1998	21.2	27.8	18.4
Students per computer 2000	12.2	15.6	9.3

There were also small differences in usage of ICT. At primary level the girls' schools had higher access scores and slightly higher subject use scores. At post-primary level the pattern was reversed and the boys' schools had higher access and subject use scores.

TABLE 8. 42: ACCESS SCORE, DISADVANTAGED SCHOOLS

Access score	Boys' schools Mean score	Girls' schools Mean score	T-test, *p*-value
Disadvantaged Primary schools	15.7	17.4	NS
Disadvantaged Post-primary schools	12.0	9.9	NS

TABLE 8. 43: SUBJECT USE SCORE IN DISADVANTAGED SCHOOLS

Subject use score	Boys' schools Mean score	Girls' schools Mean score	T-test, *p*-value
Primary schools	13.0	13.7	NS
Post-primary schools	8.7	7.6	NS

The disadvantaged schools also reflected the gender pattern reported earlier with regard to the Internet. Disadvantaged boys' schools spent more time online than girls' schools, and more of them had websites. The gender gap was smaller with regard to Web publication of student work, and at post-primary level this occurred more frequently in girls' schools.[1]

This section provides little to suggest that the gender pattern in disadvantaged schools was significantly different from that of schools in general. As with the

[1] Appendices M46 to M47.

broader spectrum of schools, there was little difference in level of equipment although the boys' schools had more networking and Internet connectivity. The girls' schools provided slightly more access to ICT at primary level, but the boys' schools had higher access at post-primary level. While these findings reveal no marked variation in the gender pattern of ICT with socio-economic status, they must be treated with some caution, for two reasons. Firstly the very small number of single sex disadvantaged schools makes the figures less reliable than the figures for all schools. Secondly the use of designated disadvantaged status as the indicator of socio-economic status is of limited value, both because there may be wide variations in the schools which are not designated, and because the disadvantaged schools attracted additional funding as a result of their designation which may have distorted their behaviour.

8.9 Assessment of the gender divide

This study began to examine gender with the general hypothesis that a view of ICT as being of more relevance for boys might be reflected in schools' investment in, and use of, ICT. If this were the case, it might be expected that girls' schools would:

- Have less ICT equipment than boys' schools.
- Provide less access to ICT than boys' schools.
- Show evidence of less teacher interest in ICT.
- Have fewer support structures for ICT, such as written plans or ICT co-ordinators.

A second general hypothesis suggested that girls might use ICT in different ways, and that in schools this might be reflected in a focus on a narrower range of applications and particular emphasis on word processing.

The gender patterns revealed in the study were fairly small and many were not statistically significant, in line with the findings of other studies.[1] The patterns that emerged did not consistently support the hypotheses, but suggest a more complex pattern of gender difference. For primary schools the general hypothesis that girls' schools were less interested in ICT was not supported. There was little difference in numbers of computers, but the boys' schools tended to have more sophisticated technical infrastructures. Girls' primary schools provided more in-school access to ICT, although the boys' schools provided more access outside of school hours. More of the teachers in girls' schools had participated in the training and more of the teachers in girls' schools had computer skills.

For the post-primary schools the general hypothesis was partly supported. By 2000 the boys' post-primary schools had slightly more equipment than the girls' schools, and had more sophisticated technical infrastructures. Boys' post-primary schools also provided more access to ICT than girls' schools, but only at junior cycle level. Slightly more of the teachers in boys' post-primary schools were reported to have had computer skills in 2000, although fewer had attended courses.

The data also partly supported the hypothesis that the use of ICT in girls' schools was focused on different uses of ICT. In both primary and post-primary schools, girls' schools made more use of word processing. However the data did not suggest that the girls' schools concentrated on a narrower range of ICT applications, but rather than they concentrated on a different range of applications. The girls' schools made greater use of word processing, CD ROM resources and careers software, while boys' schools made greater use of the Internet, spreadsheet/database and multimedia.

It is clear that the difference in use of ICT was often not explained by differences in levels of equipment. Usage of ICT may therefore be seen, not as a function of funding, but as a product of the beliefs and thinking in the schools. Thus the configuration and usage of ICT in schools may be constructed by schools, rather than determined by equipment provision. The data provided in this study suggest

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[1] H.J. Becker and C.W. Sterling, "Equity in School Computer Use: National Data and Neglected Considerations", *Journal of Educational Computing Research,* Vol. 3 No 3 (1987), pp289-311

that ICT was constructed in subtly different ways in boys' and girls' schools. In this period boys' post-primary schools increased their level of equipment faster than girls' or mixed schools, although their grant income was similar to that of girls' schools. At the same time the proportion of teachers with ICT skills increased more than that in girls' schools, despite a smaller attendance at courses. These suggest that boys' post-primary schools perceived ICT as a greater priority for development during the period.

Although the differences were often small and elusive, a series of small differences prompt each of the following tentative propositions.

Learning with or learning about

The approach of the boys' schools could be seen as more focused on the technology per se, while that of the girls' schools was slightly more focused on the use of the technology in support of learning. Evidence supporting this general pattern can be found in a number of different parts of the data. While boys' and girls' schools had very similar levels of computer equipment in 2000, the boys' schools had more developed school networks and more sophisticated Internet access. The applications which received greater attention in boys' schools were those that might be perceived as "high tech", including the Internet, simulations, programming and graphics (at senior level). More of the boys' schools had engaged in Web publication, had involved students in Web authoring, and had involved students in maintenance of the equipment. Teachers from boys' schools were over-represented on the more "high tech" ICT courses, and more of the boys' schools reported that involving some students in high level ICT projects was a priority.

By contrast more of the girls' schools focused on broader use of ICT. They provided greater access to ICT at primary level, and there was a higher level of use of ICT within subject areas. More of the ICT time was devoted to CD ROM and other software likely to be used in support of teaching. In addition more of the teachers from girls' schools attended the basic ICT courses and more reported having basic ICT skills. There was also more evidence of integration of ICT into school structures in girls' schools. More of the girls' schools rewarded the co-ordinator with a post of responsibility or release time, and more had a school plan

for ICT. Although more of the boys' schools had websites, girls' schools were more likely to have student work on their websites.

A focus on ICT for all

The girls' schools may also have had a greater orientation towards the social rationale for ICT usage, and its aim of ensuring ICT access for all learners. Ensuring that some students were not disadvantaged was a policy priority for more of the girls' schools. This was matched by higher levels of access to ICT in primary schools and the senior cycle in post-primary schools. In addition, more of the girls' schools provided external certification of basic skills.

The combination of these two patterns suggest that girls' schools were using ICT both to support teaching and to ensure basic skills for all students, while the boys' schools were slightly more focussed on the technical aspects of ICT and on technology projects for small groups of students.

The Internet as male space

Despite the hopes that the Internet might act as the female friendly application of ICT[1], there was little to suggest that this was how it was perceived in the schools. Internet use was one of the areas in which boys' schools most consistently exceeded girls' schools. The boys' schools had better Internet connectivity, spent more time online and devoted more of their ICT time to the Internet. Although there was little difference in teacher computer skill, more of the teachers in boys' schools had some Internet skill, again suggesting that there was a greater interest in the Internet in boys' schools. Finally, more of the boys' schools had websites, and had students involved in Web maintenance.

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[1] Gill Valentine, Sarah Holloway and Nick Bingham, "Children's social networks, Virtual Communities and On-line Spaces". Report of the Cyberkids research project, published on-line (1999) at www.shef.ac.uk/~g/staff/valentine_gill/about.htm

The emergence of the gender pattern at post-primary level

As reported in other studies,[1] the pattern of greater use of the technology by boys' did not emerge in primary schools, but was apparent in post-primary schools. This was true both for the amount of equipment, and for the amount of access to ICT, although the pattern reversed at senior cycle.

[1] Section 3.4c.

CHAPTER 9

FACTORS ASSOCIATED WITH THE ADOPTION AND USE OF ICT IN SCHOOLS

The two previous chapters have indicated possible equality concerns arising from the way in which ICT was used in schools. In chapter 7, the schools attended by students from the least privileged social groups were found to be disadvantaged in their ICT use within school. In chapter 8, differences between boys' and girls' schools in their use of ICT were reported. In both cases the differences between schools were not attributable to differences in funding or equipment levels, but appeared to result from decisions taken within the schools. The use of ICT within schools was therefore described as a construct, or a product of factors within the school.

This chapter examines the construction of ICT within schools, using the data from the 1998 and 2000 surveys. It seeks to identify the factors within schools associated with high levels of ICT use and high integration of ICT into subject areas. In particular it focuses on the initiatives that might be used to encourage adoption of ICT in schools, with a view to identifying those likely to make an impact.

The adoption and use of ICT in schools may be influenced by factors at a series of different levels. Janssen Reinen and Plomp have distinguished macro level factors concerned with the education system and policy, and micro level factors involving individual learners. Between these two they propose a meso level, comprising those issues related to schools, teachers and school principals.[1] This section is concerned with the meso level factors related to adoption of ICT in schools. For the purposes of analysis, this level has been further divided into two sub levels, the *teacher level* and the *school level.*

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[1] I.A.M. Janssen Reinen and Tjeerd Plomp, "The Decision Phase: Starting to Use Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p8.

The analysis at teacher level is focused on the ICT readiness of teachers, and explores variables such as teacher ICT skills, participation in ICT training and home ICT access. At school level, the focus is on the variables outside the control of the individual teacher, but in the control of the school. These include the presence and role of the ICT co-ordinator, the role of the school principal and the school plan for ICT. It must be acknowledged that this separation is an imperfect one, as there is likely to be considerable cross influence between these two levels and because some issues, such as provision of in-school ICT training, clearly straddle both areas.

The next two sections of this chapter examine the association between the use of ICT and the factors at teacher and school level respectively. Following these, section 9.3 contains an analysis of the association between these factors and the growth in use of ICT between 1998 and 2000. The data is then used in section 9.4 to examine the extreme ends of the adoption curve, the schools that were in the lead in ICT in 1998, and the schools in which ICT was least developed in 2000. These various strands of analysis are then drawn together to outline the factors which appear to be associated with ICT adoption and use in schools.

9.1 Teacher level factors

Ultimately, teachers are the people charged with the implementation of ICT in educational practice. The importance of the individual teacher is underlined by the many examples of school ICT projects that have been successful, but have ended when an individual teacher has moved.[1] Recognition of the importance of the skills and beliefs of the individual teacher has made 'education of the educators' an important aspect of the introduction of computers in schools.[2] Teacher ICT skills were also an important part of the IT 2000 strategy, and the focus of one of its four

[1] Jane M Healy. *Failure to Connect*, (New York: Simon and Schuster, 1998), p70.

[2] See section 4.3a.

main policy directions, the Teaching Skills Initiative (TSI) which aimed to provide skill development to at least 20,000 teachers nationally.[1]

9.1a IT 2000 short courses

The Teaching Skills Initiative was mainly focused on the provision of a series of short ICT courses run throughout the country, delivered mainly by teachers working on a part-time basis. Participants were not paid to attend, but nevertheless large numbers of teachers took part in ICT related training courses between 1998 and 2000. In the primary schools responding to the 2000 survey nearly 83% of the teachers had done at least one course. The take-up of courses by post-primary teachers was slightly lower, with 65% of teachers having done some ICT courses. These figures are consistent with the high take-up of ICT training by teachers in other countries, and are perhaps indicative of the enthusiasm of teachers for ICT training.[2]

The courses most frequently attended were the NCTE Introductory courses known as Phase1 and Phase 2. These were courses of 16-20 contact hours, offered either in the evenings or as a one-week daytime course. These courses were aimed at providing "basic ICT skills", mainly focused on common applications including word-processing and the Internet.[3]

TABLE 9. 1: TAKE-UP OF ICT TRAINING, 1998-2000

Primary	Number	% of total
Number of primary teachers in responding schools	18,056	
Teachers who had done at least one computer course by 2000	14,973	82.9
Teachers who had done NCTE Phase 1 by 2000	11,677	64.7
Teachers who had done NCTE Phase 2 by 2000	6,583	36.5
Post-primary		
Number of post-primary teachers in the responding schools	18,132	
Teachers who had done at least one computer course by 2000	11,834	65.3
Teachers who had done NCTE Phase 1 by 2000	8,213	45.3
Teachers who had done NCTE Phase 2 by 2000	4,783	26.4

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[1] An Roinn Oideachais agus Eolaíochta, *Schools IT 2000, A Policy Framework for the New Millenium* (1997), p6.

[2] National Center for Educational Statistics, *Teachers' Tools for the 21st Century: A report on teachers' use of technology* (2000).

[3] See www.ncte.ie/skills.htm

In the same period the reported level of teacher ICT skills rose. Between 1998 and 2000 the proportion of primary teachers reported as having some computer skill rose from 66% to 90%. For post-primary teachers the increase was smaller, rising from 52% to 73%. The change in Internet skill was much greater, although starting from a lower base. In 1998, 18% of primary teachers and 24% of post-primary teachers had some Internet skill, while by 2000 these figures had risen to 71% and 61% respectively.

Thus between 1998 and 2000 the proportion of primary teachers with Internet skill overtook that of post-primary teachers. This pattern makes it unlikely that the rise in Internet skill can be attributed to factors external to the school system, such as the rise in Internet use in society. If this were the case there would be little reason to suppose that one group would overtake another group of similar income and level of education.

The combination of higher take-up of courses in primary schools with greater increases in teacher skill in these schools strongly suggests that the perceived need for ICT skills was greater among primary school teachers.

TABLE 9. 2: TEACHER TRAINING AND TEACHER ICT SKILLS 1998-2000

Primary	Number	% of total
Teachers with some computer skill in 1998	11,922	66.0
Teachers with some computer skill in 2000	16,210	89.8
Teachers with some Internet skill in 1998	3,288	18.2
Teachers with some Internet skill in 2000	12,869	71.3
Post-primary		
Teachers with some computer skill in 1998	9,429	52.0
Teachers with some computer skill in 2000	13,248	73.1
Teachers with some Internet skill in 1998	4,387	24.2
Teachers with some Internet skill in 2000	11,068	61.0

9.1b Usage of ICT

Technical skill in use of ICT is not necessarily enough to stimulate classroom use. It is clear that many teachers who are confident enough to use ICT in their lesson

preparation do not use it in their teaching.[1] As a result the impact of short skills-based courses for teachers has been called into question, both internationally[2] and in Ireland.[3] Nevertheless in some areas skills based courses have been reported to have increased teacher confidence in using ICT and resulted in increases in use within subject teaching.[4]

Analysis of the impact of teacher training and ICT skill on use of ICT in this study draws on three distinct indicators of usage. These usage indicators are:

1. **Teacher usage.** This is the percentage of teachers in the school who use ICT in their teaching, calculated from the total number of teachers in the school in 2000 and the number of teachers reported to use ICT in their teaching. While this indicates the proportion of the teaching staff who made use of the technology, it does not indicate how frequently, or in what ways, they used it.
2. **The Access score.**[5] This score is an indicator of the number of classes with access to ICT and the frequency with which they had access to ICT. It was calculated from the estimates of frequency of access to ICT provided to each class. It is therefore an estimate of the volume of ICT contact that a pupil would experience throughout his/her time at school.
3. **The Subject Use score.**[6] This is a score based on the subjects in which ICT was used and the frequency of use in each subject. Use of ICT in teaching computer skills or as "computer studies" is not included in this score. This is therefore an indicator of the level of use of ICT within other curricular subjects.

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[1] National Center for Educational Statistics, *Teachers' Tools for the 21st Century: A report on teachers' use of technology* (2000).

[2] OECD. *E-Learning, The Partnership Challenge* (Paris: OECD, 2001), p54.

[3] Cyril Drury, *Implementing Change in Education: The Integration of Information Technology into Irish post-primary schools* (Unpublished MSc Theses, University of Leicester, 1995), chapter 2.

[4] OFSTED, *ICT in Schools, The Impact of Government Initiatives* (Interim Report, April 2001), p20.

[5] For details on the calculation of the Access Score, see section 5.4a.

[6] For details on the calculation of the Subject Use Score, see section 5.4b.

Participation in ICT training and use of ICT in Primary schools

Participation in training in primary schools was analysed at two levels. Firstly, schools were grouped on the basis of the proportion of teachers who had attended any ICT training. Many of the schools reported that all teachers had done some training, making a normal quartile analysis impossible. Consequently the schools were divided into three groups, with the first two groups each comprising approximately one quarter of the schools, while the third group included the remaining half. Secondly, schools were grouped on the basis of the proportion of teachers who had done NCTE Phase2. This was done using quartiles and schools were divided into four groups of roughly equal size.

There was a significant relationship between teacher participation in courses and the proportion of teachers who made use of ICT in their teaching. For example, in the schools with the lowest participation in phase 2, on average only 53% of teachers made use of ICT in their teaching, while in the schools with the highest participation rate 84% of teachers used ICT. Participation in training was also associated with significantly higher access scores. Schools with the lowest participation in phase 2 had average access scores of 17, while those with the highest had scores of 21.

However participation in training was not associated with significantly higher subject scores. The schools with the lowest participation in phase 2 had an average subject score of 12.3, while the schools with the highest participation had an average subject score of 12.8. The difference between the top and bottom groups was not statistically significant for either participation in any course, or for participation in phase 2.

TABLE 9. 3: PARTICIPATION IN ICT TRAINING AND ICT USE, PRIMARY SCHOOLS

Schools grouped by rate of participation in any training course.	Group 1: 0-75% of teachers had ICT training	Group 2: 75.1-99.9% of teachers had ICT training	Group 3: 100% of teachers had ICT training.	T-test, groups 1 and 3, *p*-value
Average of % of teachers using ICT in their teaching	56.2	57.1	76.5	.000
Average ICT access score	17.1	17.3	19.5	.000
Average Subject use score	11.9	12.0	12.4	NS

TABLE 9. 4: PARTICIPATION IN NCTE PHASE 2 AND ICT USE, PRIMARY SCHOOLS

Schools grouped by rate of participation in NCTE phase 2. (Quartiles)	Group 1 0-33.3% of teachers did Phase 2	Group 2 33.4-50% of teachers did Phase 2	Group 3 50.1-87% of teachers did Phase 2	Group 4 87.1-100% of teachers did Phase 2	T-test, groups 1 and 4, *p*-value
Average of % of teachers using ICT in their teaching	53.4	69.2	69.5	83.6	.000
Average ICT access score	16.9	19.1	18.8	20.9	.000
Average Subject use score	12.3	12.4	12.4	12.8	NS

Post-primary

Participation in training in post-primary schools was also analysed in terms of both participation in any course and participation in NCTE phase 2. In both cases the schools were grouped based on the proportion of teachers reported to have attended courses.

As with the primary schools, participation in courses was significantly associated with teacher use of ICT, although the overall percentage of teachers using ICT was much lower. In the schools with the lowest participation in Phase 2 only 17% of teachers used ICT in their teaching, compared with 23% of those with the highest participation.

Participation in courses was associated with a slight variation in access scores. The schools with the lowest participation in Phase 2 had an average access score of 9, while those with the highest had an average access score of 10.8. In the case of participation in any course, the difference was not statistically significant.

As in the case of primary schools, course participation was not significantly associated with subject use scores.

TABLE 9. 5: PARTICIPATION IN ICT TRAINING AND ICT USE, POST-PRIMARY SCHOOLS

Groups of schools based on proportion of teachers with some ICT training. (Quartiles)	Group 1 0-45%	Group 2 46-68%	Group 3 69-86%	Group 4 87% +	T-test, groups 1 and 4, *p*-value
Average of % of teachers using ICT in their teaching	15.3	20.7	21.3	24.6	.000
Average ICT access score	9.0	10.2	9.9	10.0	NS
Average Subject use score	7.6	8.5	8.4	7.8	NS

TABLE 9. 6: PARTICIPATION IN NCTE PHASE 2 AND ICT USE, POST-PRIMARY SCHOOLS

Groups of schools based on proportion of teachers with NCTE phase 2. (Quartiles)	Group 1 0-11%	Group 2 12-31%	Group 3 32-55%	Group 4 56% +	T-test, groups 1 and 4, *p*-value
Average of % of teachers using ICT in their teaching	17.2	19.7	21.9	22.7	.007
Average ICT access score	9.1	9.9	9.4	10.8	.014
Average Subject use score	7.5	7.8	9.1	8.7	NS

9.1c Teacher skill and use of ICT

Primary

Teacher skill was also analysed in terms of two variables, the proportion of teachers with some ICT skill, and the proportion of teachers with some Internet skill. In the majority of primary schools all of the teachers were reported to have some ICT skill. As a result a quartile analysis was impracticable, and the schools were divided into 4 logical categories (not of equal size).

There was a significant positive relationship between teacher skill and teacher use of ICT. In the schools where less than half of the teachers had computer skill, only 41% used ICT in their teaching, while in the schools where all the teachers had

computer skill, 73% made use of ICT in teaching. Similarly in schools where a high proportion had Internet skills, more of the teachers used ICT in teaching. In both cases the differences between the highest and lowest categories were statistically significant.

There was also a significant positive relationship between the proportion of teachers with ICT and Internet skills and the access scores. Schools with high proportions of teachers with ICT skills had significantly higher access scores than those with low proportions of teachers skilled.

The relationship between teacher skill and subject use was slight. The average subject use score increased very slightly with the proportion of teachers with ICT skills, but the difference was not statistically significant. There was a positive relationship between the proportion of teachers with Internet skills and subject use, but this relationship, although statistically significant, was weaker than the relationship with teacher use and access scores.

TABLE 9. 7: TEACHERS WITH ICT SKILLS AND THE USE OF ICT, PRIMARY

Percentage of teachers in the schools with some ICT skill 2000.	0-50% n=43	51-75% n=156	76-99% n=200	100% n=1131	T-test, first and fourth groups, *p*-value
Average of % of teachers using ICT in their teaching	41.4	44.7	50.8	72.5	.000
Average ICT access score	13.8	15.9	16.5	19.1	.000
Average Subject use score	12.0	12.0	12.1	12.3	NS

TABLE 9. 8: TEACHERS WITH INTERNET SKILLS AND THE USE OF ICT, PRIMARY

Percentage of teachers in the schools with some internet skill 2000.	0-50% n=182	51-75% n=292	76-99% n=152	100% n=712	T-test, first and fourth groups, *p*-value
Average of % of teachers using ICT in their teaching	45.4	55.9	55.6	77.5	.000
Average ICT access score	16.3	17.6	16.8	19.7	.000
Average Subject use score	11.4	12.0	12.7	12.7	.005

Post-primary

In the post-primary schools the proportion of teachers with ICT skills was associated with the proportion of teachers using ICT in their teaching. For both computer skill and Internet skill, the schools in the highest quartile of teacher skill had significantly higher proportions of teachers using ICT in their teaching than those in the lowest quartile.

Teacher skill was also significantly associated with subject score. Schools in the lowest quartile of proportion of teachers with Internet skills had an average subject score of 7, while those in the highest quartile had an average score of 9. However for both ICT skills and Internet skills, the proportions of teachers skilled were not associated with significant variation in access scores.

TABLE 9. 9: PROPORTION OF TEACHERS WITH ICT SKILLS AND THE USE OF ICT, POST-PRIMARY SCHOOLS

Quartiles of percentage of teachers in the school with some ICT skill 2000.	Quartile 1 0-61%	Quartile 2 62-80%	Quartile 3 81-95%	Quartile 4 96% +	T-test, first and fourth groups, *p*-value
% teachers using ICT in their teaching	16.5	19.0	19.3	27.0	.000
Average ICT access score	9.3	10.1	9.6	9.7	NS
Average Subject use score	7.4	8.6	7.9	8.9	.016

TABLE 9. 10: PROPORTION OF TEACHERS WITH INTERNET SKILLS AND THE USE OF ICT, POST-PRIMARY SCHOOLS

Quartiles of percentage of teachers in the school with some internet skill 2000.	Quartile 1 0-47%	Quartile 2 48-63%	Quartile 3 64-86%	Quartile 4 86% +	T-test, first and fourth quartiles, *p*-value
% teachers using ICT in their teaching	14.7	20.2	20.7	25.9	.000
Average ICT access score	9.2	10.0	9.9	9.9	NS
Average Subject use score	6.9	7.8	8.9	9.2	.000

9.1d Training and skill patterns

The provision of basic ICT skills training for teachers has absorbed a good deal of the budget of national ICT initiatives, both in Ireland and in the UK. The preceding sections have examined the association between basic ICT skills in teachers and the use of ICT in schools, using four indicators:

- The proportion of teachers with basic computer skills, as estimated in the survey.
- The proportion of teachers with basic Internet skills, as estimated in the survey.
- The proportion of teachers participating in some training.
- The proportion of teachers participating in the NCTE phase 2 course.

Despite the concern expressed by Drury[1] that short technical courses might have little impact, and Fullan's observation that they might even have negative impact by making teachers frustrated and confused,[1] these data provide indications of a positive association between course participation and teachers' use of ICT in teaching. All four of these indicators were associated with use of ICT by a significantly greater proportion of teachers. These findings suggest that teacher skill is associated with usage of ICT, and that such skill is enhanced by course participation.

In primary schools all four indicators were also significantly associated with access scores. Hence, where more of the teachers in a school had participated in courses or had some ICT skills, the amount of access to ICT provided to pupils was greater. This was not the case for post-primary schools, where three of the four indicators were not significantly associated with access scores. This difference may be a result of the structure in most post-primary schools, where ICT is taught by a small number of specialist teachers, and consequently an increase in skill among other teachers may have little impact on access to ICT for students.

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[1] Cyril Drury, *Implementing Change in Education: The Integration of Information Technology into Irish post-primary schools* (Unpublished MSc Theses, University of Leicester, 1995), chapter 2.

Neither access scores nor teacher use necessarily reflect the use of ICT in support of subject learning. Access scores are a measure of the volume of time a student is likely to be with a computer, but this time may be concerned with learning about the computer. Similarly teacher use of ICT in teaching may include teaching about the computer.

The level of integration of ICT in support of teaching of other subjects was indicated by the subject use score. Participation in training was not significantly associated with higher subject use scores at either primary or post-primary level. However there was an association between teacher skill and use of ICT in subjects. In post-primary schools both computer skill and Internet skill were significantly related with higher subject use scores. In the primary schools, Internet skill, but not general computer skill, was associated with higher subject use.

These findings suggest that teacher ICT skill was associated with subject use of ICT, but that participation in the basic skills courses was not. These appear consistent with the concern expressed by the OECD that short stand-alone courses may not be effective in ensuring integration of ICT as a way of building understanding.[2] Similarly in the UK, OFSTED has concluded that despite teacher training, only a minority of teachers were able to manage technology effectively to support subject learning.[3]

This suggests that either the skills generated in the short ICT courses are not sufficient to develop the association with subject usage, or that not enough time had elapsed following the courses for appropriate uses to take root. The former possibility is consistent with the conclusion of the UK Superhighways initiative, which reported that when technical training was provided, the appropriate educational application was not immediately apparent.[4]

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[1] Michael Fullan, *Successful School improvement* (Buckingham: Open University Press, 1992), p34.

[2] OECD. *E-Learning, The Partnership Challenge* (Paris: OECD, 2001), p54.

[3] OFSTED, *ICT in Schools, The Impact of Government Initiatives* (Interim Report, April 2001), p13.

[4] Peter Scrimshaw, *Preparing for the Information Age. Synoptic Report of the Education Departments' Superhighways Initiative* (Department for Education and Employment, 1997), paragraph 133.

9.1e Postgraduate courses in ICT in education

The suggestion that the basic skill-based courses were not associated with higher subject use scores raises the question of whether higher-level, or more specialised courses were associated with increased use of ICT in curricular subjects.

During the period 1998 to 2000 a number of universities offered postgraduate qualifications at higher diploma or masters degree level in the application of ICT in education. Only 304 of the primary schools reported that one or more of their teachers had such a postgraduate qualification in ICT in education. Those schools had significantly higher subject use scores than other schools, but there was no significant difference in the percentage of teachers using ICT or the average access score.

TABLE 9. 11: TEACHERS WITH A POSTGRADUATE QUALIFICATION IN ICT IN EDUCATION AND ICT USE

Number of teachers with a postgraduate qualification in ICT in education.	No teacher N=2,451	One or more teachers N=304	T-test, *p*-value
% teachers using ICT in their teaching	69.2	66.7	NS
Average ICT access score	18.4	19.3	NS
Average Subject use score	11.95	13.4	.000

In 256 of the 620 post-primary schools, one or more teachers had a postgraduate qualification in the use of ICT in education. These schools reported also significantly higher subject use scores than other schools, but there was no significant difference in access and teacher use.

TABLE 9. 12: TEACHERS WITH POSTGRADUATE QUALIFICATION IN ICT IN EDUCATION AND ICT USE, POST-PRIMARY SCHOOLS.

Number of teachers with a postgraduate qualification in ICT in education.	No teacher N=364	One or more teachers N=256	T-test, *p*-value
% teachers using ICT in their teaching	19.4	21.9	NS
Average ICT access score	9.4	10.0	NS
Average Subject use score	7.6	8.7	.011

9.1f Specific "integration" courses

Some of the NCTE courses were not confined to basic skills, but were specifically focused on the integration of ICT in the classroom. One course aimed at primary teachers was specifically targeted at the integration of ICT into the primary curriculum. Schools where one or more teachers had attended this course showed significantly higher scores for subject use than other schools.

TABLE 9. 13: PARTICIPATION IN THE NCTE "INTEGRATION OF ICT IN THE PRIMARY CURRICULUM" COURSE AND USE OF ICT.

Number of teachers having done the NCTE "Integration of ICT" course.	No teachers, n=2401	One teacher, n=211	More than one teacher, n=143	T-test, first and third categories, *p*-value
% teachers using ICT in their teaching	68.5	69.7	73.8	.044
Average ICT access score	18.3	19.4	20.1	.008
Average Subject use score	11.9	13.7	13.6	.000

At post-primary level, NCTE offered a specific course aimed at teachers of Mathematics, and focused on the integration of ICT into Mathematics. Participation in this course was associated with a significantly higher subject use score, particularly when more than one teacher in the school attended the course. As might be expected, given the small numbers of Mathematics teachers within a school, attendance at the course was not associated with significant increases in the percentage of teachers using ICT or the average access score.

TABLE 9. 14: PARTICIPATION IN THE NCTE "ICT IN THE TEACHING OF MATHEMATICS" COURSE AND USE OF ICT, POST-PRIMARY SCHOOLS

Number of teachers in the school having done the NCTE "ICT in the teaching of mathematics" course.	No teachers, n=523	One teacher, n=44	More than one teacher, n=43	T-test, first and third categories, *p*-value
% teachers using ICT in their teaching	20.5	15.8	23.6	NS
Average ICT access score	9.6	10.1	9.5	NS
Average Subject use score	7.9	7.2	11.0	.000

As this course was focused on one subject, it provided a unique opportunity to examine the relationship between participation in the course and use of ICT in that subject. Among the schools where no teachers had done the ICT in Mathematics course, less than half reported any use of ICT in Mathematics. For those schools where one teacher had done the course 64% reported some use of ICT in Mathematics, but the majority of these reported only occasional use (defined as "A few times a year"). For those schools where more than one teacher did the course, 84% reported use of ICT in Mathematics, and 30% reported frequent or regular use.

TABLE 9. 15: PARTICIPATION IN THE ICT IN THE TEACHING OF MATHEMATICS COURSE AND FREQUENCY OF USE OF ICT IN MATHEMATICS

Number of teachers in the school having done the NCTE "ICT in the teaching of mathematics" course	No teachers, n=523	One teacher, n=44	More than one teacher, n=43
% Never	56.5	36.4	16.3
% Occasionally (A few times a year)	34.3	52.3	53.5
% Frequently (Approx. Monthly)	5.4	6.8	14.0
% Regularly (Weekly or more)	3.8	4.5	16.3
% Making some use of ICT in Mathematics (Occasional, Frequent or Regular)	43.5	63.6	83.8

Thus the data provides two examples of specific teacher skill interventions which were significantly associated with higher subject scores. At both primary and post-primary levels, presence of teachers with postgraduate qualifications in ICT in education was associated with higher subject use scores, even though the numbers involved were low. This suggests that postgraduate qualifications in ICT in education provide teachers with the skill, confidence and vision to develop appropriate integrated use of ICT, and that this is reflected in greater use of ICT in school subjects in their schools. This finding is consistent with findings from the IEA[1] and the US[1] suggesting that courses providing a high level of pedagogical education for teachers are closely associated with classroom use.

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[1] I.A.M. Janssen Reinen and Tjeerd Plomp, "Educating the Educators" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), pp134-5.

The second intervention associated with higher subject scores was short courses focused specifically on integration. At primary level the course focused on integration was associated with an increase in teacher use, access scores, and subject use scores. At post-primary level the course focused on Mathematics dealt with a small number of teachers, but was associated with higher use in Mathematics, and with higher subject use scores. These findings are again consistent with the data from the early IEA survey, which indicated that the majority of computer-related topics taught in the classroom had earlier been included in the training provided to teachers. The study reported that the "content of training is apparently an important reference for what is actually taught in the lessons".[2] The data from this survey further suggest that the impact of such specialised courses may be greater when more than one teacher attends the course.

9.1g In-school ICT courses

Some of the schools organised in-school ICT courses, either as NCTE funded courses, or as separate initiatives. Such courses offer a series of possible benefits. As they are organised in-school they may attract a larger proportion of the teachers than would otherwise attend, and so may contribute to a critical mass of skilled teachers. Secondly, by being organised in-school this may be seen as an indication of support for ICT from the school, thus encouraging teachers to proceed. Thirdly in-school courses may become a platform for whole-school discourse and planning about ICT, because of the concentration of teachers from the school in one course.[3]

These data provide some evidence to support these suggestions. At both primary and post-primary levels, schools that organised in-school ICT training had significantly higher subject scores than other schools. In the primary schools the

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[1] Henry. J. Becker, *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use.* Teaching, Learning and Computing: 1998 National Survey Report #1. Center for Research on Information technology and Organizations (February 1999), p19.

[2] I.A.M. Janssen Reinen and Tjeerd Plomp, "Educating the Educators" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p133.

[3] For further commentary on the importance of teacher-teacher discourse, see section 4.2i.

average subject score for schools that had organised in-school training was 13, compared with 11.8 for other schools. The average access score in these schools was not significantly greater than that in other schools.

Primary schools that had organised in-school training reported significantly fewer of their teachers using ICT in their teaching. This apparent anomaly may be a result of in-school training occurring mainly in the larger schools, while more of the smaller schools reported usage by all teachers.

TABLE 9. 16: IN-SCHOOL COURSES AND ICT USE, PRIMARY SCHOOLS

The school had organised staff training in the school	Yes	No	T-test, *p*-value
% teachers using ICT in their teaching	65.0	70.1	.001
Average ICT access score	18.7	18.4	NS
Average Subject use score	13.1	11.8	.000

Over two thirds of the post-primary schools had organised ICT courses in the school. These schools had significantly higher proportions of teachers using ICT and significantly higher subject use scores than other schools, but there was no significant difference in access score.

TABLE 9. 17: IN-SCHOOL COURSES AND ICT USE, POST-PRIMARY SCHOOLS

The school had organised staff training in the school	Yes. N=415	No. N=205	T-test, *p*-value
% teachers using ICT in their teaching	21.6	17.9	.006
Average ICT access score	9.9	9.2	NS
Average Subject use score	8.4	7.3	.014

It is interesting that the provision of basic skills training was not associated with higher subject use scores, but that provision of similar basic training in-school was. This lends some support to Fullan's suggestion that in-school courses are more likely to have an impact on practice.[1]

[1] Michael Fullan, *Successful School improvement* (Buckingham: Open University Press, 1992), chapter 2.

9.1h Teachers' home computers and Internet access

As reported in chapter 4, teachers' home access to the ICT may play an important role in encouraging school use of ICT. For teachers, home access may provide the time to explore the technology and gain confidence in using it. This may not only increase skills, but may increase teachers' perceptions of the potential of the technology in their teaching.[1] Recognition of the importance of teachers' home access is reflected in schemes to encourage or subsidise home computer purchase by teachers in many countries, including Sweden,[2] the Netherlands[3] and the UK.[4]

In Ireland there was no such scheme, but many teachers had home access to computers and home Internet access. In primary schools there was a strong positive relationship between teachers' home access to computers and the Internet, and the use of ICT in the school. The schools where high proportions of teachers had home computer and Internet access had significantly more of their teachers using ICT, significantly higher access scores, and significantly higher subject use scores.[5]

Post-primary schools where a greater percentage of the teachers had home computers also reported that more of the teachers made use of ICT in their teaching. In the lowest quartile, made up of schools where less than 38% of the teachers had home computers, only 16% used ICT in their teaching. By contrast in the highest quartile, where over 67% of the staff had home computers, 25% used ICT in their teaching.

In post-primary schools, home computer and Internet access were not associated with access scores. Subject scores were significantly higher in schools where high

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[1] See section 4.2c.

[2] Submission of the Swedish Government to the OECD expert group on ICT and the Quality of Learning, 2000, unpublished. Section 2.5.

[3] Submission of the Netherlands Government to the OECD expert group on ICT and the Quality of Learning, 2000, unpublished. Section 2.5.

[4] Submission of the UK Government to the OECD expert group on ICT and the Quality of Learning, 2000, unpublished. Section 2.5.

[5] Data tables in appendices N1 and N2.

proportions of the teachers had home Internet access, but not where teachers had home computers.[1]

Summary

These patterns almost replicate the pattern associated with teacher skill. In both primary and post-primary schools, home access was associated with higher proportions of teachers using ICT in their teaching. In the primary schools it was also associated with access and subject use. In the post-primary schools home access was not related with access scores, but home Internet access was associated with higher subject scores.

There are two interesting aspects to this pattern. Firstly the difference between primary and post-primary schools is again very obvious. Both teacher ICT skill and home access were associated with higher access and subject scores in primary schools but not in post-primary schools. This recurring difference suggests that the barriers to integration of ICT are greater, or at least different, at post-primary level.

The second interesting feature is that home Internet access was significantly related to subject scores, while home computer access was not. A similar difference between Internet and other computer activities appeared in primary schools, where teacher Internet skill was significantly related to subject use, while computer skill was not. This distinction between the Internet and computers in general suggests that in some way the Internet is more highly associated with subject use of ICT than other uses of computers.

[1] Data tables in appendices N3 and N4.

9.2 School Level Factors

The previous section has explored the teacher level factors associated with ICT usage, such as teacher ICT skill, training and home access. This section is concerned with the other part of the meso-level, the school level factors. The central hypothesis of this section is that the usage of ICT in schools is not entirely determined by the individual teacher, and therefore not influenced solely by teacher ICT skill and attitudes. Rather, it is suggested that some features of the school may encourage or discourage teacher ICT use. This section examines a series of potential influencing factors, such as the school principal, the existence of an ICT plan, a designated ICT co-ordinator, the provision of ICT equipment for teacher use, the location of the computers and participation in ICT projects.

9.2a The School Principal

As noted in chapter 4, several studies have pointed to the key role of the principal in the development of ICT in the school.[1] In the 2000 survey there was no direct measure of principals' ICT skill or interest. Instead the level of ICT usage of the school principal was measured by a single question, which asked whether the principal used e-mail. Responses were on a 3-point scale where the three categories were labelled "Never", "Occasionally" and "Frequently". While the majority of principals used e-mail occasionally, only 21% of primary principals and 25% of post-primary principals reported using e-mail regularly.

In both primary and post-primary schools there was a significant association between principals' ICT usage and the usage of ICT in the school. At primary level the schools where the principal used e-mail frequently had significantly greater proportions of their teachers using ICT and had significantly higher access and subject use scores. At post-primary level the principal's use of e-mail was significantly associated with the proportion of teachers using ICT and with subject use score, but not with access score.

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[1] See section 4.2d.

TABLE 9. 18: ICT USE BY SCHOOL PRINCIPAL AND SCHOOL ICT USE, PRIMARY

School principal uses e-mail	Never. N=711	Occasionally. N=1325.	Frequently. N=538	T-test, never and frequently, *p*-value
% teachers using ICT in their teaching	63.2	69.7	73.6	.000
Average ICT access score	16.8	18.7	20.9	.000
Average Subject use score	11.3	12.1	13.7	.000

TABLE 9. 19: ICT USE BY SCHOOL PRINCIPAL AND SCHOOL ICT USE, POST-PRIMARY

School principal uses e-mail	Never. N=157	Occasionally. N=277	Frequently. N=143	T-test, never and frequently, *p*-value
% teachers using ICT in their teaching	18.7	20.5	23.5	.014
Average ICT access score	9.8	9.5	10.0	NS
Average Subject use score	7.3	8.1	9.21	.005

9.2b The School ICT Plan

It is likely that adapting to the potential of ICT in schools will require adjustment in time-tabling, classroom layout, subject boundaries and teacher duties. Managing these changes requires a clear vision of the direction and a holistic view of ICT in the school plan.[1] In the 2000 survey most schools had an ICT plan, but as these were a requirement of the funding many of these plans may have been token plans with little real meaning for the school. The survey attempted to distinguish those plans that had done more than satisfy the funding requirement by asking schools to indicate whether the plan was updated regularly.

Over one third of primary schools had ICT plans that were updated regularly. These schools had significantly higher proportions of the teachers using ICT, and had significantly higher access and subject use scores.

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[1] See section 4.2l.

TABLE 9. 20: REGULARLY UPDATED SCHOOL ICT PLAN AND ICT USE, PRIMARY

School ICT plan	The school ICT plan was updated regularly. N=1024	The school ICT plan was not updated regularly. N=1731	T-test, *p*-value
% teachers using ICT in their teaching	73.6	65.7	.000
Average ICT access score	19.7	17.7	.000
Average Subject use score	13.5	11.3	.000

One third of post-primary schools also reported an ICT plan that was updated regularly. These schools had significantly higher access and subject use scores than other schools, but did not have significantly more of their teachers making use of ICT in their teaching.

TABLE 9. 21: REGULARLY UPDATED SCHOOL ICT PLAN AND ICT USE, POST-PRIMARY

School ICT plan	The school ICT plan was updated regularly. N=213	The school ICT plan was not updated regularly. N=407	T-test, *p*-value
% teachers using ICT in their teaching	22.0	19.6	NS
Average ICT access score	10.3	9.3	.020
Average Subject use score	9.4	7.3	.000

9.2c The role of the School ICT co-ordinator

The majority of schools, 70% of primary and 83% of post-primary schools, had a designated co-ordinator in 2000. However the designation of co-ordinator may mean different things in different schools, ranging from an active change agent to an almost token responsibility as part of a salary package.

In the 2000 survey a series of questions examined the role of the ICT co-ordinator in the school. The schools indicated the presence of a co-ordinator, whether the co-ordinator was allocated a post of responsibility, and whether the co-ordinator was released from some teaching to allow time for ICT work. These may be considered as a hierarchy of indicators of the commitment to the ICT co-ordinator in the school.

While the majority of the primary schools had a designated ICT co-ordinator, this post was designated as a post of responsibility in only 28% of the schools, and the co-ordinator was released from some teaching duties in only 4% of schools.

In primary schools the role of the ICT co-ordinator was negatively related to the proportion of teachers using ICT in their teaching. Schools with an ICT co-ordinator were not significantly different from those without, but schools where the ICT co-ordinator was a designated post of responsibility had significantly lower proportions of teachers using ICT than other schools. Those schools where the co-ordinator was released from some teaching duties to allow time for ICT had even lower proportions of teachers using ICT.

TABLE 9. 22: ICT CO-ORDINATOR AND TEACHERS USING ICT, PRIMARY

% teachers using ICT in their teaching	The school has an ICT co-ordinator N=1922	The co-ordinator is a designated position of responsibility N=780	The co-ordinator is released from some teaching duties N=122
% in schools where this statement is true.	68.5	62.9	59.5
% in other schools.	69.9	71.5	69.4
Chi square, *p*-value	NS	.000	.002

The status of the ICT co-ordinator was positively related to the ICT access score. Schools with a co-ordinator had significantly higher access scores than those without. However primary schools where the co-ordinator was a designated post of responsibility had significantly *lower* access scores, and schools where the co-ordinator had some release from other duties had slightly, but not significantly, higher access scores.

TABLE 9. 23: ICT CO-ORDINATOR AND ICT ACCESS SCORE, PRIMARY

Average ICT access score	The school has an ICT co-ordinator N=1922	The co-ordinator is a designated position of responsibility N=780	The co-ordinator is released from some teaching duties N=122
Score in schools where this statement is true.	18.8	17.9	19.0
Score in other schools.	17.6	18.7	18.5
Chi square, *p*-value	.001	.010	NS

The status of the ICT co-ordinator was significantly associated with the subject use score. Schools without an ICT co-ordinator had an average subject use score of 10.8, while those with a co-ordinator with some release time had an average of

13.8. Having a co-ordinator, having a designated post for the co-ordinator and having release time for the co-ordinator were all significantly related to increases in the subject use score.

TABLE 9. 24: ICT CO-ORDINATOR AND SUBJECT USE SCORE PRIMARY

Average Subject use score	The school has an ICT co-ordinator N=1922	The co-ordinator is a designated position of responsibility N=780	The co-ordinator is released from some teaching duties N=122
Score in schools where this statement is true.	12.7	12.8	13.8
Score in other schools.	10.8	11.9	12.0
Chi square, *p*-value	.000	.000	.000

Thus in primary schools the presence and status of the ICT co-ordinator were associated with increased use of ICT in the school, as indicated by the access score, and increased use of ICT in curricular subjects, as indicated by the subject use score. However the increased role of the co-ordinator was also associated with lower proportions of other teachers in the school making use of ICT. One explanation for this pattern may be that in some primary schools the ICT co-ordinator was responsible for teaching all classes in a computer room, thereby reducing the numbers of other teachers involved in ICT work. If this is the case, then the enhanced status of ICT co-ordinators may be the result of the co-ordinators doing the work themselves, rather than acting as enablers for other teachers to do so.

Post-primary

Although 83% of post-primary schools had an ICT co-ordinator, less than half had assigned a post of responsibility to the ICT co-ordinator and only 17% had released the co-ordinator from some teaching duties.

The presence of an ICT co-ordinator was not significantly associated with the proportion of teachers using ICT in their teaching. However in those schools where additional support was provided for the co-ordinator, in terms of a post of responsibility or release time, the proportion of teachers using ICT was significantly higher.

TABLE 9. 25: ICT CO-ORDINATOR AND TEACHERS USING ICT, POST-PRIMARY

% teachers using ICT in their teaching	The school has an ICT co-ordinator N=513	The co-ordinator is a designated position of responsibility N=286	The co-ordinator is released from some teaching duties N=103
Score in schools where this statement is true.	20.7	22.5	26.1
Score in other schools.	19.0	18.6	19.3
Chi square, *p*-value.	NS	.003	.004

The status of the ICT co-ordinator was not significantly associated with access scores.[1] Post-primary schools with an ICT co-ordinator had significantly higher subject use scores than other schools. Those where the co-ordinator was a post of responsibility had scores which were higher again, and those with a co-ordinator with some release time were still higher.

TABLE 9. 26: ICT CO-ORDINATOR AND SUBJECT USE SCORE, POST-PRIMARY

Average Subject use score	The school has an ICT co-ordinator N=513	The co-ordinator is a designated position of responsibility N=286	The co-ordinator is released from some teaching duties N=103
Score in schools where this statement is true.	8.3	8.6	9.1
Score in other schools.	7.1	7.6	7.9
Chi square, *p*-value.	.043	.015	.039

These data again highlight the difference between the primary and post-primary schools. In the primary schools the provision of post of responsibility and time for the co-ordinator was associated with fewer teachers using ICT in their teaching, while in the post-primary schools it was associated with more teachers making use of ICT.

In the post-primary schools the presence and status of a co-ordinator was not related to access to ICT. However in the primary schools the presence of a co-ordinator was associated with increased access to ICT, while a post of responsibility was associated with lower access scores. Again this may reflect a pattern of co-ordinators acting as service teachers, although there is no support for

[1] Data table in appendix N5.

this theory in the schools where the co-ordinator was released from some teaching duties, which showed no significant difference in access scores.

There was some evidence to support Drury's view of the importance of the co-ordinator as the agent for encouraging integration of ICT.[1] In both primary and post-primary schools the presence and status of a co-ordinator were associated with significantly higher subject scores.

9.2d School provision of ICT resources for teacher use

The importance of teacher-teacher collaboration in helping each other to learn about ICT and to develop appropriate classroom uses for the technology has been underlined in a series of studies.[2] One way in which schools could foster peer learning in use of ICT is the provision of ICT facilities for use by teachers. At primary level 13% of schools provided e-mail facilities and accounts for their staff in 2000. These schools had significantly higher access and subject use scores than other schools, but there was no significant difference in the proportion of teachers using ICT.[3] One quarter of post-primary schools provided e-mail facilities and accounts for staff. In these schools significantly more of the staff made use of ICT in their teaching, and the schools had significantly higher access and subject use scores.[4]

One third of post-primary schools provided computers in a staff room for teacher use. These schools reported significantly higher subject use scores than other schools. Provision of computers in staff areas was not used as an indicator in primary schools because of the large number of primary schools without a staff room.

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[1] Cyril Drury, *Implementing Change in Education: The Integration of Information Technology into Irish post-primary schools* (Unpublished MSc Theses, University of Leicester, 1995), chapter 7.

[2] See section 4.3i.

[3] Data table in appendix N6.

[4] Data table in appendix N7.

TABLE 9. 27: COMPUTERS IN STAFF ROOM AND ICT USE, POST-PRIMARY

Computers in staff room	The schools does not provide computers in a staff room N=205	The school provides computers in a staff room. N=415.	T-test, *p*-value
% teachers using ICT in their teaching	20.9	20.2	NS
Average ICT access score	10.1	9.4	NS
Average Subject use score	7.4	8.4	.018

The three available indicators of facilities provided for teachers all showed a significant association with increased subject use scores. The provision of e-mail facilities for teachers was associated with higher access scores in both primary and post-primary schools, and with a greater proportion of teachers using ICT in post-primary schools.

9.2e Location of computers in the school

In primary schools the presence of computers in the classrooms was highly related to the proportion of teachers using computers. Nearly half of the primary schools reported having a computer in each classroom. These schools had an average of 78% of their teachers using ICT, compared with only 55% of the teachers in schools with computers in less than two-thirds of classrooms (Quartile 1). The presence of classroom computers was also positively related to the access and subject use scores.

TABLE 9. 28: PROPORTION OF CLASSROOMS WITH COMPUTERS AND ICT USE, PRIMARY

Quartiles of proportion of classrooms with computers	Q1 0-66% N=567	Q2 67-99% N=319	Q3+4 100% N=1,370	T-test, Q1 and Q3, *p*-value
% teachers using ICT in their teaching	55.2	61.0	77.9	.000
Average ICT access score	16.4	16.9	20.4	.000
Average Subject use score	11.9	12.0	12.6	.017

By contrast the presence of a computer room in primary schools was not significantly related to either access or subject use scores. In addition schools with a computer room had fewer of their teachers involved in using ICT in their teaching. Those schools with computer rooms of between 10 and 20 computers had a significantly smaller proportion of their teachers using computers than schools without a computer room.[1]

In the post-primary schools only a small proportion of classrooms had computers. Those schools where more of the classrooms had computers had higher proportions of teachers using ICT, and higher access and subject use scores. However the number of computers in computer rooms was not significantly related to any of these variables.[2]

TABLE 9. 29: PROPORTION OF CLASSROOMS WITH COMPUTERS AND ICT USE, POST-PRIMARY

Quartiles of proportion of classrooms with computers	Quartile 1 0-7%	Quartile 2 8-12%	Quartile 3 13-18%	Quartile 4 19%+	T-test, Quartiles 1 and 4, *p*-value
% teachers using ICT in their teaching	15.5	20.4	23.3	26.2	.000
Average ICT access score	8.5	9.9	10.9	9.9	.041
Average Subject use score	7.2	8.8	8.6	8.8	.020

Thus for both primary and post-primary schools, the presence of computers in the classroom was positively associated with the proportions of teachers using ICT and with access and subject scores. The presence of a computer room was not associated with access of subject use scores at either level, and was negatively associated with the proportions of teachers using computers in primary schools.

9.2f Participation in projects

In many countries the strategy for diffusion of ICT into schools has included the use of pilot projects. Such approaches are argued to have many advantages,

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[1] Data table in appendix N8.

[2] Data table in appendix N9.

including sharing of control[1] and allowing new ideas to develop at school level.[2] In Ireland a scheme of pilot projects comprising the Schools Integration Project (SIP) aimed to develop good practice in ICT use in schools:

> *The Schools Integration Project (SIP) is one the major initiatives of Schools IT 2000. Its intention is to foster whole school development in relation to information and communication technology (ICT) integration. In order to achieve this, pilot projects will be established in a number of 'lead' schools working in partnership with the education centres, the community , industry, businesses, and appropriate third level institutions. The outcomes of these pilot projects will help to determine models of best practice for the use of ICTs across the Irish education system*[3]

Even before the start of IT 2000, some schools were engaged in ICT projects supported from various public and private sources. If the SIPs and other ICT projects were successful in their aim of integrating ICT into teaching, then it might be expected that the participating schools would have higher levels of teacher use, and higher subject scores. The 2000 survey distinguished between schools involved in SIP projects and those involved in other ICT projects.

In view of Fullan's suggestion that a key determinant of change is in the dynamics of the school and Rosenholtz' classification of 'stuck' and 'moving' schools[4] it is possible to imagine that some schools would have the capability to adapt to change quickly regardless of the focus of the change. If this were the case, it might be envisaged that schools which had successfully undertaken any major innovative project in recent years would display a similar capacity to adopt ICT, and would have higher ICT usage than schools not involved in any innovation. To examine this possibility, the survey also asked schools to indicate whether they had been involved in any innovative project not related to ICT.

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[1] Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), pp333-335.

[2] Michael Fullan, *Successful School improvement* (Buckingham: Open University Press, 1992), p47.

[3] Description of the SIP programme, taken from the NCTE website at www.ncte.ie/sip.

[4] See section 4.2i.

The primary schools involved in ICT projects did not have significantly higher proportions of their teachers using ICT, but they did have higher access and subject use scores. However the schools involved in non-ICT projects had similarly higher access and subject use scores.

TABLE 9. 30: PARTICIPATION IN PROJECTS AND ICT USE, PRIMARY

Note: Significances are the differences between each category and the schools not involved in any project.	1. The school is not involved in any project N=2357	2. The school is involved in an innovative project, not related to ICT N=151	3. The school is involved in an ICT project, but not a SIP. N=77	4 . The school is involved in a SIP project. N=170
% teachers using ICT in their teaching	68.4	73.3	65.4	72.4
T-test, *p*-value		NS	NS	NS
Average ICT access score	18.2	20.4	20.7	20.3
T-test, *p*-value		.001	.006	.001
Average Subject use score	11.8	14.1	14.8	13.6
T-test, *p*-value		.000	.000	.000

At post-primary level, participation in projects was not associated with a significant increase in either teacher use of ICT or access scores. Schools participating in the SIP projects showed significantly higher subject scores, but this was not true for other ICT projects or non-ICT projects.

TABLE 9. 31: PARTICIPATION IN PROJECTS AND ICT USE, POST-PRIMARY

Note: Significances are the differences between each category and the schools not involved in any project.	1. The school is not involved in any project N=408	2. The school is involved in an innovative project, not related to ICT N=80	3. The school is involved in an ICT project, but not a SIP. N=38	4 . The school is involved in a SIP project. N=94
% teachers using ICT in their teaching	20.6	20.5	18.0	19.2
T-test, *p*-value		NS	NS	NS
Average ICT access score	9.6	9.5	9.6	10.0
T-test, *p*-value		NS	NS	NS
Average Subject use score	7.5	8.5	8.7	9.8
T-test, *p*-value		NS	NS	.000

These data suggest that project participation was not associated with the proportion of teachers making use of ICT in their teaching. In fact in the post-primary schools there were slightly fewer teachers using ICT in schools participating in projects. This disappointing trend may indicate that projects had been concentrated on the work of a small number of teachers rather than spread through the entire school.

As with other variables there was a marked difference between the primary and post-primary schools in terms of access. In the primary schools participation in projects of all types was significantly associated with higher access sores, while in post-primary schools there was no significant difference.

Also in the primary schools all types of projects were significantly associated with higher subject use scores, while in the post-primary schools this was only true for SIP projects.

9.3 Growth in use of ICT in curricular subjects 1998-2000

Integration of ICT into curricular subjects is an important aim of ICT strategy, as it provides the opportunities for the pedagogical benefits to arise.[1] The use of ICT in curricular subjects may be seen as an indicator of the adoption of an integrated approach to ICT. However it is acknowledged that integration is difficult to achieve and that levels of curricular use have often been disappointing.[2] Previous sections have examined the use of ICT within curricular subjects in 2000 and identified factors associated with high subject use. This section examines the changes in use of ICT in curricular subjects over time, using data from both the 1998 and 2000 surveys.

A conventional adoption model would suggest that if the innovation is beneficial, then early adopters will gain the benefits and will therefore be in a position to innovate further, thus widening the gap between themselves and late adopters.[3] In the context of schools there may be few economic benefits to integration of ICT, but it might be hypothesised that the early adopters would experience educational benefits, and gain the experience and confidence to further integrate ICT.

Examination of this question is limited by the design of the 1998 survey. In 1998 schools were asked to indicate whether or not ICT was used in each of a list of subjects, but were not asked to record the frequency of usage. Thus in order to analyse the changes between 1998 and 2000 matching indicators from both surveys were required. For this reason a "subject count" was used. This is simply the number of subjects from the list provided, in which ICT was used.

In the post-primary schools the subject count includes eight subjects (Mathematics, Languages, Science, Art, History, Geography, Business and Religion). In primary

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[1] W.J. Pelgrum, "Obstacles to the Integration of ICT in Education: results from a worldwide educational assessment". *Computers and Education* Vol. 37 (2001), p163

[2] I.A.M. Janssen Reinen and Tjeerd Plomp, "The Decision Phase: Starting to Use Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p4.

[3] Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), p382.

schools count is based on six subjects, because two of the subjects on the list in 1998 (Business Studies and Religion) were not included in the 2000 survey.

There are a number of limitations to the subject count. Firstly, the list of subjects at post-primary level excludes some of the subjects where very high use was reported such as technical graphics. English was not listed as a subject in the1998 survey, but some schools may have included use in English under languages. A further limitation is the lack of any indication of the volume of use, as a result of which any change in the frequency of use is unrecorded. Despite these methodological difficulties, these data provide an opportunity to examine changes in subject use of ICT over time.

9.3a Primary schools

In the primary schools there was an overall increase in the number of subjects in which ICT was used. Between 1998 and 2000 the average subject count rose from 2.3 to 4.2. By 2000, 75% of primary schools reported using ICT in 4 or more subjects.

There was a significant correlation between 1998 subject counts and 2000 subject counts, suggesting that in general those schools with high levels of use in subjects in 1998 retained some of their leading position by 2000. However the overall pattern was one of narrowing the gap between high and low users of ICT. Those schools that had made no use of ICT in subjects in 1998 also made good progress and the majority of them (70%) used ICT in 4 or more subjects in 2000.

Despite the general increase, there were some schools where subject count did not increase. In 425 primary schools (15% of the total) there was no change, and a further 15% had a lower subject count in 2000 than in 1998. Some schools had dramatic reductions. There were 22 schools that reported use of ICT in 4 or more subjects in 1998, but no subject use in 2000.[1]

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[1] Cross tabulation in appendix N10.

Despite the widely held view of ICT as primarily an issue of equipment supply,[1] many studies have indicated that integration of ICT into teaching is not primarily related to the level of equipment.[2] Similarly in the Irish primary schools the level of computer equipment, as indicated by pupil-computer ratio, was not significantly related to the change in subject count. However those schools that had above average increases in subject count had significantly more Internet-connected computers than schools where subject count declined.

The change in subject count was also associated with a series of teacher skill indicators. The schools with above-average increases in subject use had more teachers who had done some training, more teachers who had done NCTE phase2, more teachers with Internet skill, and more teachers with home computers.[3]

Some of the factors which were strongly associated with high subject use scores (see previous section), were not associated with greater increases in subject count between 1998 and 2000. In fact both the school principal's use of e-mail and the presence of a teacher with a postgraduate qualification in ICT in education were associated with a smaller than average change between these two dates. However both of these factors were associated with higher subject counts in 1998. Thus both of these variables were associated with schools with a higher than average subject count before the start of IT 2000, but that on average had made less gains in the period.

This raises the possibility that in primary schools these two variables may have been associated with the "early adoption" of subject use of ICT. This pattern would

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[1] Larry Cuban, *Teachers and Machines. The Classroom Use of Technology Since 1920* (New York: Teachers College Press, 1986), p25. Also
Dan Davis. "Implementation and Educational Uses of Computers", in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p113.

[2] National Center for Educational Statistics, *Teachers' Tools for the 21st Century: A report on teachers' use of technology* (2000), also
OECD/CERI. ICT and the Quality of Learning. Educational Multimedia Software Quality Group. Meeting of Experts (15-16 April 1999).

[3] Data table in appendix N11.

be consistent with the importance attached to school leadership[1] and teacher education[2] in other studies. However it must be noted that these data provide no evidence as to the direction of causality. It might be hypothesised that computer literate principals or highly ICT educated teachers had encouraged subject use in the schools, but it could equally be envisaged that schools with a culture of ICT use might encourage principals to become computer literate or teachers to undertake courses.

TABLE 9. 32: PRINCIPAL'S USE OF E-MAIL AND ICT USAGE 1998 AND 2000, PRIMARY SCHOOLS.

Principal use of e-mail (in 2000)	Average of subject count 1998	Average of subject count 2000	Average of subject use score 2000	Average change in subject count 1998 to 2000
Never	1.9	4.0	11.3	2.2
Occasionally	2.3	4.3	12.1	1.9
Frequently	2.8	4.5	13.7	1.7
All schools	**2.3**	**4.2**	**12.2**	**1.9**

TABLE 9. 33: TEACHERS WITH A POSTGRADUATE QUALIFICATION IN ICT IN EDUCATION AND ICT USAGE 1998 AND 2000, PRIMARY SCHOOLS

Teachers with postgraduate qualifications in ICT in education (in 2000)	Average of subject count 1998	Average of subject count 2000	Average of subject use score 2000	Average change in subject count 1998 to 2000
No teacher. N=2450.	2.2	4.2	11.9	2.0
One or more teachers. N=304.	2.9	4.5	13.4	1.5
T-test, *p*-value	.000	.000	.000	.001

ICT co-ordinators and ICT usage

The data also provides further evidence of the significance of an ICT co-ordinator. The presence of a co-ordinator was strongly related to change in subject count between 1998 and 2000. But as the presence of a co-ordinator was recorded in both the 1998 and 2000 surveys, a more detailed analysis is possible.

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[1] Michael Fullan, *Successful School improvement* (Buckingham: Open University Press, 1992), p50.

[2] Henry. J. Becker, *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use.* Teaching, Learning and Computing: 1998 National Survey Report #1. Center for Research on Information Technology and Organizations (February 1999), pp17-18.

Schools without an ICT co-ordinator had low subject counts in 1998 and had an average increase of 2.2, resulting in an average subject count of 3.8 by 2000. The schools that had a co-ordinator in 1998 and 2000 (the early adopters of a co-ordinator) had higher subject counts in both surveys, but with a smaller increase between the two dates.

Schools that had no co-ordinator in 1998, but had in 2000 (termed "Late" in appointing a co-ordinator) showed a greater increase in subject count during the period than other schools. Thus schools that appointed a co-ordinator early had high subject counts in 1998, while those that appointed a co-ordinator late had low initial counts but made greater gains in the period.

Further indication of the association between co-ordinator and subject use can be found in the schools that had a co-ordinator in 1998 but not in 2000. These schools that "dropped" their co-ordinator had a high level of subject use in 1998 with a subject count of 2.6, but between 1998 and 2000 they had the smallest increase in subject count and fell back relative to other schools.

TABLE 9. 34: ICT CO-ORDINATORS AND ICT USAGE 1998 AND 2000, PRIMARY SCHOOLS

Group	ICT co-ordinator	Average of subject count 1998	Average of subject count 2000	Average of subject use score 2000	Average change in subject count 1998 to 2000
None	No co-ordinator 1998 or 2000. N=510	1.6	3.8	10.5	2.2
Drop	Co-ordinator 1998 but not in 2000. N=323	2.6	4.0	11.2	1.4
Early	Co-ordinator in both 1998 and 2000. N=1090	2.9	4.4	13.0	1.6
Late	Co-ordinator 2000. N=832	1.8	4.3	12.2	2.5
T-test, None and Drop, *p*-value		.000	NS	NS	.000
T-test, None and Early, *p*-value		.000	.000	.000	.000
T-test, None and Late, *p*-value		NS	.000	.000	.013
T-test, Early and Late, *p*-value		.000	.005	.001	.000

Thus in summary, those primary schools with an ICT co-ordinator in 1998 reported significantly greater usage of ICT in more subjects than those without. Those schools that appointed a co-ordinator between 1998 an 2000 made rapid progress and almost caught up. By contrast those that ceased to have a co-ordinator between 1998 and 2000 (termed "Drop" schools) fell back relative to other schools and by

2000 their position was not significantly different from those that had never had a co-ordinator.

9.3b Post-primary schools

In the post-primary schools the increase in subject count was smaller. The average rose from 1.7 in 1998 to 2.6 in 2000. Although the overall trend was upwards, 27% of schools had a reduction in subject count between 1998 and 2000, while a further 18% had no change. On average the schools with higher subject counts in 1998 had slightly higher counts in 2000, but this trend was weak. A total of 221 schools, over one third of the total, had no use of ICT in subjects in 1998. Of these schools 25% used ICT in 4 or more subjects by 2000, but another 25% had no use of ICT in subjects in 2000.

As reported in other studies,[1] equipment indicators were not significantly associated with the change in the use of ICT in subjects. Neither the ratio of students per computer nor that of students per Internet computer were associated with the amount of change in subject count.

The OECD has noted the central role of the teacher in making progress in the use of ICT in schools.[2] It was not surprising therefore that there were significant associations between the change in subject count and some of the teacher skill variables. The schools with the greatest increases in subject count had significantly more teachers with computer and Internet skills, and more of their teachers used ICT in lesson preparation and in teaching. However there were no significant associations with other teacher skill indicators such as the percentage of teachers with home computers or home Internet connections, or with participation in NCTE phase 2 or ICT courses in general. This difference between teacher skill and teacher participation in courses may reflect the extensive use of short training courses for

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[1] Dan Davis. "Implementation and Educational Uses of Computers", in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p113.

[2] OECD, *Education Policy Analysis 1999* (Paris: OECD, 1999), p58.

teachers, which others have suggested may be too short to have a meaningful impact.[1]

There were also no significant associations between change in subject count and variables related to school structures, such as participation in projects, presence of an ICT co-ordinator, principal's use of e-mail or presence of a teacher with a postgraduate qualification in ICT in education.[2]

One school level indicator associated with change in subject count in post-primary schools was the presence of a school ICT plan. The pattern of change in subject count with ICT planning followed the same pattern as reported for ICT co-ordinators in primary schools. That is, the data indicates a rise in subject count coinciding with development of a plan. Schools that had an ICT plan in 1998 had higher 1998 subject counts. Those that developed a plan between 1998 and 2000 had low 1998 counts but showed the greatest increase between 1998 and 2000. In the same period those that dropped their ICT plan showed an average decline in subject count.

TABLE 9. 35: ICT PLAN AND USE OF ICT IN SUBJECTS, POST-PRIMARY SCHOOLS

Group		N	Subjects Count 1998	Subjects Count 2000	Subject use score 2000	Average change in subject count 1998 to 2000
No	No plan	232	1.3	2.1	6.7	0.7
Late	Plan in 2000	278	1.8	2.9	8.8	1.1
Early	Plan in both 1998 and 2000	86	2.2	2.9	9.2	0.7
Drop	Plan in 1998 but not 2000	24	3.0	2.8	8.7	-0.2
T-test, No and Late, *p*-value			.008	.000	.000	NS
T-test, No and Early, *p*-value			.000	.002	.001	NS
T-test, Early and Late, *p*-value			NS	NS	NS	NS

School type

There were marked differences in the changes in subject count between different types of post-primary school. In 1998 there was no significant difference between secondary and vocational schools in terms of subjects count, but between 1998 and

[1] Michael Fullan, *Successful School improvement* (Buckingham: Open University Press, 1992), p34.

[2] Data table in appendix N12.

2000 vocational schools increased their subjects counts by only 0.2, while secondary schools increased their counts by an average of 1.1. As a result by 2000 secondary schools had significantly higher subject counts and subject use scores.

TABLE 9. 36: SCHOOL TYPE AND USE OF ICT IN SCHOOLS SUBJECTS 1998 AND 2000

	Subject Count 1998	Subject Count 2000	Subject use score 2000	Average change in subject count 1998 to 2000
Secondary. N=331	1.7	2.8	8.4	1.1
Vocational.N=163	1.8	2.0	6.5	0.2
Community College. N=49.	1.4	2.4	8.2	1.0
Community School. N=60.	2.1	3.2	9.6	1.2
Comprehensive. N=15.	2.4	2.7	10.1	0.3
Significance of differences between: (t-test)				
Secondary and vocational	NS	.000	.000	.000
Vocational and Community schools	NS	.000	.000	.015
Vocational and Comprehensive schools	NS	NS	.005	NS

9.3c Variation in subject counts within Secondary schools

As the variations with school type may mask other significant relationships between structural factors and use of ICT within school types, a further analysis was conducted including only secondary schools. In secondary schools where the principal made frequent use of e-mail the subject counts were higher in 2000. However the differences in subject count in 1998 and in the change between 1998 and 2000 were not statistically significant.

TABLE 9. 37: PRINCIPAL'S USE OF E-MAIL AND ICT USAGE 1998 AND 2000, SECONDARY SCHOOLS

Principal use of e-mail:	Subject Count 1998	Subject Count 2000	Subject use count 2000	Average change in subject count 1998 to 2000
Never	1.4	2.4	7.8	0.9
Occasionally	1.7	2.9	8.5	1.2
Frequently	1.9	3.3	10.0	1.4
T-test, Never and Frequently, *p*-value	**NS**	**.009**	**.016**	**NS**

Presence of teachers with postgraduate qualifications in ICT in education was also related to subject count in 2000, but not significantly related to use in 1998 or change between 1998 and 2000.

ICT co-ordinators and ICT usage

In the secondary schools as with primary schools, the pattern suggested that the appointment of a co-ordinator was associated with a rise in subject count. Secondary schools without an ICT co-ordinator had low subject counts and low increases in count during the period. Those that had a co-ordinator in 1998 had high subject counts in 1998, and had a greater than average gain in subject count between 1998 and 2000. Those schools that appointed a co-ordinator "late" (i.e. between 1998 and 2000), had lower counts in 1998 but high increases between 1998 and 2000, and by 2000 had narrowed the gap. Schools that had ceased to have a co-ordinator between 1998 and 2000 had low growth in subject use and fell back relative to those that retained a co-ordinator.

TABLE 9. 38: ICT CO-ORDINATORS AND ICT USAGE 1998 AND 2000, SECONDARY SCHOOLS

Group	ICT co-ordinator	Subject Count 1998	Subject Count 2000	Subject use count 2000	Average change in subject count 1998 to 2000
None	No co-ordinator 1998 or 2000.	1.0	1.6	5.5	0.6
Late	Co-ordinator 2000.	0.9	2.5	7.8	1.6
Early	Co-ordinator in both 1998 and 2000.	2.0	3.1	9.1	1.1
Drop	Co-ordinator 1998 but not in 2000.	1.9	2.7	8.6	0.8
T-test, None and Late, *p*-value		NS	.048	.023	NS
T-test, None and Early, *p*-value		.005	.001	.001	NS
T-test, Early and Late, *p*-value		NS	NS	NS	NS
T-test, None and Drop, *p*-value		NS	NS	.023	NS

9.3d Participation in projects

Primary schools Participation in Projects and subject use of ICT

The use of pilot projects as a mechanism to develop appropriate methodology of the integration of ICT in schools was an important part of Irish ICT strategy.[1] It might therefore be expected that schools involved in projects would show a greater change in subject count during the life of the project.

The case of the SIP projects is the most straightforward, as there was no SIP activity before the 1998 survey. SIP schools certainly showed higher subject counts in 2000. On average SIP schools used ICT in 4.5 subjects in 2000, compared with 4.1 for other schools. However the SIP schools also had higher average subject scores in 1998, before the start of the SIP project, and their increase in subject count was smaller than that of other schools. This suggests that at least part of the increase in "integration" resulting from the SIP programme was due to selection of schools which were already making progress in this direction.

[1] Description of the SIP programme, taken from the NCTE website at www.ncte.ie/sip.

Schools involved in other ICT pilot projects show a similar pattern with higher subject counts in 1998. However in this case the analysis is more complex, as some of these projects were in operation before 1998.

Those schools that became involved in a project between 1998 and 2000 display a pattern very similar to the SIP schools. They had a higher than average subject count in 1998, and retained some of this advantage in 2000, despite a smaller increase in subject count than other schools.

The schools involved in a project in 1998 but not in a project in 2000 (the drop schools) show a different pattern. They had higher subject counts in 1998 than the SIP and other project schools, but had a very small improvement in subject count between 1998 and 2000, and as a result fell back relative to the other project schools by 2000. A very small number of schools were involved in ICT projects in both 1998 and 2000. These schools had a similar pattern to the previous group, with a high 1998 subject count and a very small increment by 2000.

TABLE 9. 39: PARTICIPATION IN PROJECTS AND USE OF ICT IN SUBJECTS, 1998 AND 2000, PRIMARY SCHOOLS

	Subject Count 1998	Subject Count 2000	Subject use score 2000	Average change in subject count 1998 to 2000
Not in a project	2.1	4.1	11.8	2.0
Involved in a project, not related to ICT	2.9	4.7	14.1	1.8
Involved in a SIP project.	3.0	4.5	13.6	1.5
Involved in another ICT project, not SIP	3.2	4.6	14.8	1.4
Early: In an ICT project in both 1998 and 2000. N=23	4.3	4.8	14.7	0.4
Late: In an ICT project in 2000, but not in 1998. N=87	3.0	4.5	14.3	1.6
Drop: In an ICT project in 1998, but not in 2000. N=101	3.9	4.4	14.0	0.5

Three interesting patterns emerge from these data. Firstly the primary schools that became involved in SIP or other ICT projects between 1998 and 2000 had higher subject counts before the projects began. Secondly the projects did not appear to result in use of ICT in more subjects. In fact, those schools not involved in any project showed the greatest increases in subject count, followed by those involved in non-ICT projects. Thirdly there was little to suggest that long term involvement in a project was associated with sustained growth in subject count. Those schools getting involved in a project between 1998 and 2000 showed a substantial increase

in subject count (1.5 for SIP, 1.6 for other projects), but those involved in projects throughout the period showed very low growth in subject count, little more than that in schools that dropped from projects.

Post-primary schools: Participation in Projects and subject use of ICT

Similar patterns arose in the post-primary schools. Those schools that became involved in projects after 1998 had higher than average subject counts in 1998, suggesting that entry to projects was in some way selecting the schools which had made some progress with ICT.

There was little evidence that project participation resulted in use of ICT in more subjects, as the schools that got involved in projects after 1998 did not show significantly greater increases in subject count than schools not involved in any project. Hence it seems that most of the difference in subject counts was a result of the participation of schools with higher counts in the projects, rather than a result of the projects themselves.

A major difference between the primary and post-primary schools was in the schools that had been involved in projects before 1998. The "early" post-primary schools had a growth in subject count almost as great as schools not involved in any project, and by 2000 had the highest subject counts and subject use scores. By contrast those schools that dropped from projects had no increase in subject count and ended the period with the lowest subject use scores.

TABLE 9. 40: PARTICIPATION IN PROJECTS AND USE OF ICT IN SUBJECTS, 1998 AND 2000, POST-PRIMARY SCHOOLS

	Subject Count 1998	Subject Count 2000	Subject use score 2000	Average change in subject count 1998 to 2000
Not in a project N=380	1.5	2.3	7.6	0.9
Early: In an ICT project in both 1998 and 2000. N=51	2.6	3.4	10.3	0.8
Late: In an ICT project in 2000, but not in 1998. N=161	2.0	3.0	8.7	1.0
Drop: In an ICT project in 1998, but not in 2000. N=28	2.0	2.0	6.8	0.0

9.3e Change in subject count 1998 to 2000

This section has examined the changes in subject use of ICT between 1998 and 2000, using the limited indicator of subject counts. For both primary and post-primary schools, the subject count increased markedly during the period 1998 to 2000, increasing by more than 50% in both cases. Analysis of the changes during the period has revealed a series of interesting associations, although they do not offer evidence that these associations reflect causal relationships, or even about the direction of the relationship.

As reported in other studies,[1] for both primary and post-primary schools growth was not significantly related to the level of computer equipment. However, in the primary schools there was a significant relationship between high growth and favourable ratios of pupils to Internet-connected computers.

Also in accord with findings from other countries,[1] the main indicators associated with above average growth in subject count were broadly indicators of teacher capacity to use ICT. In the primary schools there were significant relationships with home computer access, Internet skill and participation in training. In the post-primary schools there were significant relationships with computer skill and Internet skill, but not with home access. In both primary and post-primary schools high growth in subject count was associated with higher proportions of the teachers making use of ICT.

In the primary schools some of the school level factors that were earlier linked with high subject use, were associated with schools that had higher than average subject counts in 1998 but made smaller increases in the period. Four factors in particular were associated with this pattern of early adoption and low growth, namely:

- participation in projects,
- having a designated ICT co-ordinator,

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[1] National Center for Educational Statistics, *Teachers' Tools for the 21st Century: A report on teachers' use of technology* (2000).

- having at least one teacher with a postgraduate qualification in ICT in education, and
- the school principal's use of e-mail.

The suggestion that these traits may characterise the schools that were making use of ICT before IT 2000 began is consistent with Rogers' characterisation of early adopters. In this classical model, early adopters are characterised as less dogmatic, less fatalistic[2] and more highly educated.[3] The early adopters are also more highly "connected" than later adopters. They are likely to have more social participation, have greater exposure to mass media, and to seek information more actively than others.[4] It might easily be imagined that schools that chose to participate in projects, where the principal had adopted a relatively new technology, where teachers had undertaken postgraduate study in the area of ICT and where the school had proactively set up structures to deal with ICT might match Rogers' view of an early adopter.

The adoption patterns described above did not appear as strongly in the post-primary schools. This may have been in part because of the very substantial variation with school type within the post-primary category. Secondary schools had a significantly greater growth than vocational schools despite having almost identical subject counts in 1998. This variation with school type tended to mask other patterns, and when secondary schools are considered in isolation, similar associations appeared, although weaker and less consistent than in the primary schools

Further indications of the importance of particular characteristics were provided in the cases of those that were recorded in both the 1998 and 2000 surveys. In these cases it was possible to distinguish those schools that had made a change during the

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[1] Henry. J. Becker, *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use.* Teaching, Learning and Computing: 1998 National Survey Report #1. Center for Research on Information Technology and Organizations (February 1999), p19.

[2] Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), p258.

[3] Ibid., pp251-2.

[4] Ibid., p259.

period from those with the characteristic before 1998. This was possible in the case of participation in projects, presence of a school plan, and presence of an ICT co-ordinator. These three variables tended to follow the same pattern in that they were associated with higher subject counts in 1998, but smaller increases between 1998 and 2000.

Schools that did not have the characteristic in 1998 (late schools) also had higher subject counts in 1998. Thus for example the schools that developed a school ICT plan between 1998 and 2000 had higher subject counts in 1998. This suggests that these characteristics have a complex relationship with ICT usage.

TABLE 9. 41: SUMMARY OF FACTORS PRIMARY SCHOOLS

	Participation in projects	There is a designated ICT co-ordinator	The school has an ICT plan.	Principal uses e-mail	One of more teachers has a postgraduate qualification in ICT in Education
Negatively related to growth in subject use 1998-2000	Yes	Yes	Not significant	Yes	Yes
Positively related to subject count in 1998	Yes	Yes	Yes	Yes	Yes
Positively related to subject count in 2000	Yes	Yes	Yes	Yes	Yes
"Late" schools had higher subject counts in 1998	Yes	Yes	Yes	N/A	N/A
"Drop" schools had slower growth than early or late schools.	Yes	Not significant	Late only.	N/A	N/A

TABLE 9. 42: SUMMARY OF FACTORS SECONDARY SCHOOLS

	Participation in projects	ICT co-ordinator is designated	The school has an ICT plan.	Principal uses e-mail	One of more teachers has a postgraduate qualification in ICT in Education
Negatively related to growth in subject use 1998-2000	Yes	Not significant	Not significant	Not significant	Not significant
Positively related to subject count in 1998	Yes	Not significant	Yes	Yes	Yes
Positively related to subject count in 2000	Yes	Yes	Yes	Yes	Not significant
"Late" schools had higher subject counts in 1998	Yes	Yes	Yes	N/A	N/A
"Drop" schools had slower growth than early or late schools.	Yes	Not significant	Yes	N/A	N/A

Rogers'[1] suggestion of the normal pattern of innovation being a "virtuous cycle", with the early adopters experiencing more benefits and therefore gaining the potential to innovate further, is not supported by these data. Instead those characteristics associated with early adoption were also associated with slower than average growth during the period, as other schools caught up.

There were also interesting difference in the patterns in primary and secondary schools. Cuban has suggested that it is easier for elementary schools to adopt technology[2] because their structures allow more flexibility in terms of timing teacher contact and curriculum.[3] This distinction has been observed in many

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[1] Ibid., p382.

[2] Norman Woelfel and Keith Tyler, *Radio and the School* (World Book Co, 1945), pp60-61, quoted in Larry Cuban, *Teachers and Machines. The Classroom Use of Technology Since 1920* (New York: Teachers College Press, 1986), p23

[3] Larry Cuban, *Teachers and Machines. The Classroom Use of Technology Since 1920* (New York: Teachers College Press, 1986), p64.

countries[1] including the UK, where there are higher rates of use of ICT in primary schools.[2] The Irish primary schools followed this general pattern, and had a greater average increase in subject count than post-primary schools.

The factors related to rate of change were different in primary and post-primary schools. Internet infrastructure played a more significant part in the primary schools, as did teacher skill and teachers' home access to ICT. In the post-primary schools the rate of change was most associated with school type, participation in projects and ICT planning.

There were also indications that the speed of change was greater in primary schools. In the primary schools the overall increase in subject count between 1998 and 2000 was greater. In addition, primary schools that became involved in projects after 1998 showed significant gains by 2000. In the post-primary schools there was a smaller increase associated with projects begun after 1998, but a continued increase associated with projects begun before 1998. This pattern is consistent with the hypothesis that the change in subject use is slower in post-primary schools.

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[1] I.A.M. Janssen Reinen and Tjeerd Plomp, "The Decision Phase: Starting to Use Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p40.

[2] Department for Education and Employment, *Survey of Information and Communications Technology in Schools 1998* (Statistical Bulletin Number 11/98, November 1998), paragraphs 40-41.

9.4 Early and late adoption of ICT

Much of the research interest has focused on the early adopters of innovations. In particular there has been interest in the area of the adoption curve where around 10% of the population have adopted. After this point, Rogers suggests, the innovation takes off, and it is probably impossible to stop.[1] Rogers' idealised model distinguishes between innovators and the early adopters. The former he considers to be the very early adopters, roughly 2.5% of the population, who are often very innovative but may have little credibility of influence on others. The main body of early adopters, approximately 13.5% of the population, are more respected and often opinion leaders.[2] Rogers' model also considers the other side of the curve, or those who are the last to adopt. These individuals, labelled the late adopters or laggards, are characterised as the most change averse, traditional and suspicious of innovation.

The focus of this section is an examination of the characteristics of the early and late adopters of ICT in Irish schools. This first raises the question of what is considered to be adoption of ICT. The measure often used by policy makers defines adoption in terms of equipment levels, while in view of the pedagogical rationale described earlier the level of integration of ICT into teaching is a key indicator. For the purposes of analysis adoption was analysed twice using these two separate indicators. For clarity in writing, the schools with high levels of equipment are described as "early investors", while those with high levels of subject use of ICT are called "early adopters", and similarly for late investors and adopters.

In Rogers' model early and late adopters were defined in terms of standard deviations from the mean time of adoption. This presented two difficulties for this study. Firstly as the study was based on surveys at two fixed points in time, the exact time of adoption could not be determined. Secondly, because the

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[1] Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), p245.

[2] Simplified from Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983), pp247-250.

distributions of some of the indicators were skewed, standard deviation was an impractical measure. Instead early and late adopters were defined as the most extreme 10% of the population. Using this principle, the early investors were defined as the 10% of schools with the most favourable computer:pupil ratio in 1998. Similarly early adopters were defined as the 10% of schools with the highest subject count in 1998. Late investors were defined as the 10% of schools with the least favourable computer:pupil ratio in 2000,[1] while late adopters were the 10% of schools with the lowest subject use scores in 2000.

TABLE 9. 43: DEFINING CRITERIA FOR EARLY AND LATE ADOPTER AND INVESTOR SCHOOLS

	Early Investor	Early Adopter	Late Investor	Late Adopter
Primary	Less than 15 pupils per computer 1998.	Subject count of 6 in 1998.	More than 28.7 pupils per computer, 2000.	Subject use score of 5 or less, 2000.
Post-primary	Less than 6.92 students per computer 1998.	Subject count of 6 or more in 1998.	More than 21.93 students per computer, 2000.	Subject use score of 2 or less, 2000

These adopter groups were examined in terms of a range of variables used earlier. These may be classified into three main groups. Firstly there are context characteristics, such as school type, size, location and the gender of students. Secondly there are school level variables, such as the presence of a ICT plan or an ICT co-ordinator, and the computer use of the principal. Finally there are teacher level variables, such as the level of skill of the teachers.

The use of subject count in 1998 as the determinant of "early adoption" of ICT does not do justice to the long history of ICT in Irish schools. Clearly, as the use of computers in schools was pioneered in the 1970s and possibly earlier, the true early adopters were those early enthusiastic teachers. However for the purposes of this study the intention is to identify the schools that were in the lead in terms of use of ICT within subject areas in advance of the Schools IT 2000 programme, and hence subject count in 1998 is an appropriate indicator.

[1] Note that schools with no computers at all were excluded from this analysis.

9.4a The Early Investors

Early investment was associated with some of the school-context characteristics. At primary level, single-sex boys' schools were over-represented among the early investors, as were smaller schools. At post-primary level the school type was one of the most significant characteristics associated with early investment. Vocational schools were particularly over-represented and accounted for 75% of the early investors, while secondary schools were under-represented. At post-primary level most of the early investor schools were mixed. Boys' schools were under-represented, and there were no single-sex girls' schools in the early investor group. Schools designated disadvantaged were also over-represented among the early investors, as were smaller schools.[1]

Some of the school level factors were also significantly associated with early investment. In primary schools early investment was associated with participation in ICT pilot projects and with presence of an ICT plan. In the post-primary schools early investment was associated with the principal's use of e-mail, but not with project participation or ICT planning.

TABLE 9. 44: SCHOOL CHARACTERISTICS OF THE EARLY INVESTOR SCHOOLS, PRIMARY

	Not early investors N=1393	Early investors N=162	Chi square, *p*-value
% with an ICT co-ordinator in 1998	58.8	65.6	NS
% involved in an ICT pilot project 1998	6.0	12.7	.002
% with an ICT plan in 1998	15.2	23.9	.005
% where the principal was a frequent user of e-mail in 2000	22.2	27.5	NS

TABLE 9. 45: SCHOOL CHARACTERISTICS OF THE EARLY INVESTORS, POST-PRIMARY

	Not early investors N=466	Early investors N=51	Chi square, *p*-value
% with an ICT co-ordinator in 1998	78.5	74.5	NS
% involved in an ICT pilot project 1998	15.0	9.8	NS
% with an ICT plan in 1998	19.5	27.5	NS
% where the principal was a frequent user of e-mail in 2000	23.7	40.0	.026

[1] Data tables in appendices N13 to N15.

Teacher skill was associated with early investment in the post-primary schools, but not in the primary schools.

TABLE 9. 46: TEACHER CHARACTERISTICS OF THE EARLY INVESTORS, PRIMARY

	Not early investors N=1393	Early investors N=162	Chi square, *p*-value
% of teachers with some ICT skill in 1998	75.3	87.0	NS
% of teachers with some Internet skill in 1998	18.6	33.2	NS

TABLE 9. 47: TEACHER CHARACTERISTICS OF THE EARLY INVESTORS, POST-PRIMARY

	Not early investors N=466	Early investors N=51	Chi square, *p*-value
% of teachers with some ICT skill in 1998	54.2	96.6	.007
% of teachers with some Internet skill in 1998	24.4	44.8	.062

9.4b The Early Adopters

The previous section has examined the schools that had high levels of equipment in 1998, termed the early investors. This section is concerned with the "early adopters" of ICT as a part of subject teaching. In both primary and post-primary schools there was little overlap between the early investors and the early adopters, and there was no statistical association between the two (chi square test).

TABLE 9. 48: EARLY ADOPTERS AND EARLY INVESTORS, PRIMARY SCHOOLS

	Not early adopters	Early adopters	Total
Not early investors	1,229	164	1,393
Early investors	135	27	162
Total	1,364	191	1,555

TABLE 9. 49: EARLY ADOPTERS AND EARLY INVESTORS, POST-PRIMARY SCHOOLS

	Not early adopters	Early adopters	Total
Not early investors	431	35	466
Early investors	46	5	51
Total	477	40	517

Early adoption of ICT was associated with few of the context characteristics. In primary schools the early adopters were significantly larger than other schools, with an average of 165 pupils compared with 137 for other schools. However early adoption was not significantly associated with disadvantage, location or gender of pupils.

At post-primary level early adoption was not associated significantly with any of the context variables. The early adopters were not significantly associated with any particular school type. Nor were they associated with any specific social group, although disadvantaged schools and girls' were slightly under-represented, while mixed schools were over-represented.[1]

Early adoption in primary schools was strongly associated with the school level variables. Sixteen percent of the early adopter primary schools were involved in ICT pilot projects, nearly five times the proportion of other schools. Significantly more of the early adopter schools had ICT co-ordinators and ICT plans in 1998. The 1998 survey did not collect data on the principal's use of ICT, but the early adopter schools reported that nearly twice as many of their principals were frequent e-mail users in 2000.

At post-primary level, early adoption was not significantly associated with any of the school level characteristics. However within secondary schools, there was a significant association between early adoption and both the presence of an ICT co-ordinator and an ICT plan.[2]

At primary level significantly more of the teachers in the early adopter schools had ICT skill and Internet skill. However for both post-primary schools and secondary schools there was no significant relationship between early adoption and teacher skill.

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[1] Data tables in appendices N16 to N18.

[2] Data tables in appendices N19 to N21.

TABLE 9. 50: TEACHER CHARACTERISTICS OF THE EARLY ADOPTER SCHOOLS, PRIMARY

	Not early adopters N=2501	Early adopters N=253	T-test, *p*-value
% of teachers with some ICT skill in 1998	69.9	84.6	.000
% of teachers with some Internet skill in 1998	17.2	29.5	.000

TABLE 9. 51: TEACHER CHARACTERISTICS OF THE EARLY ADOPTER SCHOOLS, POST-PRIMARY

	Not early adopters N=578	Early adopters N=42	T-test, *p*-value
% of teachers with some ICT skill in 1998	57.6	70.0	NS
% of teachers with some Internet skill in 1998	26.1	33.6	NS

TABLE 9. 52: TEACHER CHARACTERISTICS OF THE EARLY ADOPTER SCHOOLS, SECONDARY

	Not early adopters N=298	Early adopters N=33	T-test, *p*-value
% of teachers with some ICT skill in 1998	53.5	74.1	NS
% of teachers with some Internet skill in 1998	21.9	39.0	NS

9.4c Progress of the early investors by 2000

If early involvement with ICT was laying the foundations for sustained growth in ICT usage, then it might be expected that the early schools would have higher than average ICT indicators in 2000. If the presence of ICT equipment in a school was a catalyst for educational use of ICT, then it would be expected that the early investor schools would have higher subject usage indicators in 2000. To examine these questions the schools that had been innovative in 1998 were compared with other schools in 2000.

As in other analyses, the pattern for primary schools was very different from that in post-primary schools. In primary schools the early investors had retained their advantage in terms of equipment by 2000, and had more favourable pupil computer ratios than other schools, and similarly favourable ratios of pupils to networked

computers. Significantly more of their teachers had attended NCTE phase 2, and more were using ICT in their teaching. They also had higher access and subject use scores than other schools, and a higher proportion of their classrooms had computers.

TABLE 9. 53: PRIMARY SCHOOLS: THE POSITION OF THE EARLY INVESTORS BY 2000

	Not early investors N=1393	Early investors N=162	T-test, *p*-value
Average pupils per computer 2000.	19.2	8.6	.000
Average pupils per networked computer 2000.	106.4	46.0	.000
Percentage of teachers using ICT in their teaching 2000.	66.4	75.1	.002
Percentage of teachers who had attended NCTE Phase 2.	55.4	64.0	.007
Average access score 2000	18.9	20.4	.037
Average subject use score 2000.	12.4	13.7	.013
Percentage of classrooms with computers 2000.	78.1	84.8	.009

Significantly more of the early investor primary schools used the Internet as a resource, allowing pupils to use it for research. In addition more of them had a website, had the website maintained by pupils and carrying pupils' work. There was no significant difference between early investor schools and other schools in the proportion of ICT time spent on the Internet or word processing.

TABLE 9. 54: USE OF THE INTERNET IN 2000 BY THE EARLY INVESTOR SCHOOLS, PRIMARY

	Not early investors N=1393	Early investors N=162	Chi square, *p*-value
% where pupils use the Internet for research 2000.	62.4	70.4	.046
% with a school website 2000	17.0	26.5	.003
% with a pupil maintained website 2000	4.2	9.9	.001
% with a website carrying student work 2000	9.0	21.0	.000

Post-primary schools

The post-primary schools that had been early investors in 1998 had more favourable equipment levels than other schools in 2000. They had fewer students per computer and better levels of networked computers. In these schools more of the teachers reported using ICT in their teaching, and the average access score was

higher. However there was no significant difference in the subject use score, nor in any of the indicators of student use of the Internet.

TABLE 9. 55: POST-PRIMARY SCHOOLS: THE POSITION OF THE EARLY INVESTORS BY 2000

	Not early investors N=466	Early investors N=51	T-test, *p*-value
Average students per computer 2000.	14.0	3.6	.000
Average students per networked computer 2000.	86.1	30.7	.000
Percentage of teachers using ICT in their teaching 2000.	13.0	14.1	.000
Percentage of teachers who had attended NCTE Phase 2.	34.6	44.9	NS
Average access score 2000	9.6	11.9	.010
Average subject use score 2000.	8.4	7.5	NS
Percentage of classrooms with computers 2000.	14.8	16.7	NS

TABLE 9. 56: USE OF THE INTERNET IN 2000 BY THE EARLY INVESTOR SCHOOLS, POST-PRIMARY

	Not early investors N=466	Early investors N=51	Chi square, *p*-value
% where students use the Internet for research 2000.	82.8	92.2	NS
% with a school website 2000	46.4	39.2	NS
% with a student maintained website 2000	15.9	5.9	NS
% with a website carrying student work 2000	11.4	7.8	NS

TABLE 9. 57: INDICATORS OF ICT IN 2000 IN THE EARLY INVESTOR SECONDARY SCHOOLS

	Not early investors N=257	Early investors N=28	T-test, *p*-value
Average students per computer 2000.	16.7	8.5	.000
Average students per Internet computer 2000.	94.5	59.3	NS
Percentage of teachers using ICT in their teaching 2000.	17.5	21.0	NS
Percentage of teachers who had attended NCTE Phase 2.	34.4	37.6	NS
Average access score 2000	9.2	12.6	.001
Average subject use score 2000.	8.4	10.4	NS
Percentage of classrooms with computers 2000.	11.4	12.8	NS

9.4d Progress of the early adopters by 2000

The primary schools that had been early adopters in 1998 remained in an above-average position with regard to ICT in 2000. Although they had significantly less equipment than other schools, they had more of their teachers using ICT in their teaching and had higher access scores and subject use scores. They also had computers in a greater proportion of their classrooms. The early adopter primary schools were also making more use of the Internet in 2000. More of them allowed pupils to use the Internet for research and more used the Web as a means of publication of student work. However there were no significant differences in the proportion of ICT time spent on the Internet by early adopter and other schools.

TABLE 9. 58: INDICATORS OF ICT IN 2000 IN THE EARLY ADOPTER PRIMARY SCHOOLS

	Not early adopters N=2501	Early adopters N=253	T-test, *p*-value
Average pupils per computer 2000.	15.1	18.4	.000
Average pupils per networked computer 2000.	25.9	28.0	NS
Percentage of teachers using ICT in their teaching 2000.	68.4	72.7	.043
Percentage of teachers who had attended NCTE Phase 2.	58.5	56.5	NS
Average access score 2000	18.2	21.2	.000
Average subject use score 2000.	11.8	14.7	.000
Percentage of classrooms with computers 2000.	80.1	84.7	.015

TABLE 9. 59: USE OF THE INTERNET IN 2000 BY THE EARLY ADOPTER SCHOOLS, PRIMARY

	Not early adopters N=2501	Early adopters N=253	Chi square, *p*-value
% where pupils use the Internet for research 2000.	60.2	77.9	.000
% with a school website 2000	13.2	27.3	.000
% with a pupil maintained website 2000	3.3	9.5	.000
% with a website carrying pupil work 2000	7.2	18.6	.000

The position was very different in the post-primary schools. The early adopters in 1998 were not significantly different from other schools in any of the equipment or usage indicators in 2000.

TABLE 9. 60: INDICATORS OF ICT IN 2000 IN THE EARLY ADOPTER POST-PRIMARY SCHOOLS

	Not early adopters N=578	Early adopters N=42	T-test, *p*-value
Average students per computer 2000.	13.0	13.7	NS
Average students per internet computer 2000.	84.0	87.2	NS
Percentage of teachers using ICT in their teaching 2000.	20.3	22.6	NS
Percentage of teachers who had attended NCTE Phase 2.	35.4	34.8	NS
Average access score 2000	9.6	10.5	NS
Average subject use score 2000.	8.0	8.8	NS
Percentage of classrooms with computers 2000.	15.5	13.9	NS

TABLE 9. 61: USE OF THE INTERNET IN 2000 BY THE EARLY ADOPTER SCHOOLS, POST-PRIMARY

	Not early adopters N=578	Early adopters N=42	Chi square, *p*-value
% where students use the Internet for research 2000.	16.6	11.9	NS
% with a school website 2000	45.8	50.0	NS
% with a student maintained website 2000	14.9	16.7	NS
% with a website carrying student work 2000	10.7	11.9	NS

TABLE 9. 62: INDICATORS OF ICT IN 2000 IN THE EARLY ADOPTER SECONDARY SCHOOLS

	Not early adopters N=298	Early adopters N=33	T-test, *p*-value
Average students per computer 2000.	15.9	16.0	NS
Average students per internet computer 2000.	101.7	64.0	NS
Percentage of teachers using ICT in their teaching 2000.	17.7	18.5	NS
Percentage of teachers who had attended NCTE Phase 2.	33.4	40.5	NS
Average access score 2000	9.5	10.2	NS
Average subject use score 2000.	8.3	9.3	NS
Percentage of classrooms with computers 2000.	11.8	11.4	NS

9.4e The Late Investor Schools

This section examines the characteristics of the "late investor" schools, those that had the lowest levels of equipment per student in 2000. As well as having lower levels of equipment, these schools also reported lower levels of usage of computers.

They had significantly lower proportions of their teachers making use of ICT, and had significantly lower access scores. The primary schools also had significantly lower subject use scores, but this was not the case for post-primary schools.[1]

Some of the school context factors used earlier were associated with late investor schools. In particular school size was significantly associated, as more of the larger schools were late investors. Late investor schools were also significantly associated with urban and suburban areas, while rural areas were under-represented. However it is likely that these two patterns were linked, as rural schools were generally smaller. Disadvantaged schools were under-represented among the late investors.

At post-primary level school type was strongly associated with late investor schools. The majority of late investor schools (86%) were secondary schools, while all other types were under-represented. Single-sex schools were over-represented among the late investors at post-primary level, although this difference was not significant among secondary schools, suggesting that it may have been a feature of school type rather than gender.[2]

At primary level a number of the school level characteristics were significantly associated with late investor schools. Schools where the principal was not an e-mail user were over-represented, as were those where there was not an ICT plan and those with a co-ordinator who was assigned a post of responsibility. At post-primary level only the e-mail use of the principal was significantly associated with late investor schools.

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[1] Data tables in appendices N22 to N24.

[2] Data tables in appendices N25 to N28.

TABLE 9. 63: SCHOOL CHARACTERISTICS OF THE LATE INVESTOR SCHOOLS, PRIMARY

	Not late investors N=2,392	Late investors N=265	Chi square, *p*-value
% with an ICT co-ordinator in 2000	69.4	70.6	NS
% with an ICT co-ordinator as a post of responsibility in 2000	26.2	41.9	.000
% with an ICT plan in 2000	71.3	61.1	.001
% with a regularly updated ICT plan in 2000	38.2	29.4	.005
% involved in an ICT pilot project 2000	7.3	5.8	NS
% where the principal never used e-mail in 2000	26.4	36.3	.000
% where the principal frequently used e-mail in 2000	21.9	13.5	.000

TABLE 9. 64: SCHOOL CHARACTERISTICS OF THE LATE INVESTOR SCHOOLS, POST-PRIMARY

	Not late investors N=535	Late investors N=58	Chi square, *p*-value
% with an ICT co-ordinator in 2000	82.4	81.0	NS
% with an ICT co-ordinator as a post of responsibility in 2000	45.0	46.6	NS
% with an ICT plan in 2000	59.6	55.2	NS
% with a regularly updated ICT plan in 2000	34.8	31.0	NS
% involved in an ICT pilot project 2000	25.1	18.4	NS
% where the principal never used e-mail in 2000	27.1	32.7	.080
% where the principal frequently used e-mail in 2000	25.5	11.5	.080

Late investor primary schools had significantly fewer teachers with computer skill or Internet skill, and fewer of their teachers had attended NCTE Phase 2. The post-primary late investors had fewer teachers with computer skill, and fewer who had attended Phase 2.

TABLE 9. 65: TEACHER CHARACTERISTICS OF THE LATE INVESTOR SCHOOLS, PRIMARY

% of teachers with some ICT skill in 2000	97.8	89.3	.000
% of teachers with some Internet skill in 2000	87.0	76.3	.000
Percentage of teachers who had attended NCTE Phase 2.	60.1	45.7	.000

TABLE 9. 66: TEACHER CHARACTERISTICS OF THE LATE INVESTOR SCHOOLS, POST-PRIMARY

% of teachers with some ICT skill in 2000	79.3	71.7	.047
% of teachers with some Internet skill in 2000	66.5	59.4	NS
Percentage of teachers who had attended NCTE Phase 2.	35.9	27.8	.021

9.4f Late Adopter Schools

As in the case of early adopters, there was little overlap between the late adopters and the late investor schools.[1]

At primary level, late adoption was not significantly associated with any of the context characteristics recorded. That is, there was no significant difference associated with size, location, gender or disadvantage.[2]

At post-primary level the major related factor was school type. Secondary schools were significantly under-represented among the late adopters, while vocational schools and community colleges were over-represented. The late adopter post-primary schools were also smaller on average than other schools, but there were no significant associations with other context characteristics. However among secondary schools, both boys' and girls' schools were over-represented.

TABLE 9. 67: SCHOOL TYPE AND LATE ADOPTERS

	Not late adopters N=548	Late adopters N= 72	Chi square, *p*-value
% Secondary schools	54.4	45.8	.042
% Vocational schools	25.2	34.7	.042
% Community Colleges	7.3	12.5	.042
% Community schools	10.2	5.6	.042
% Comprehensive schools	2.7	-	

[1] Data tables in appendices N29 and N30.

[2] Data table in appendix N31.

TABLE 9. 68: CONTEXT OF THE LATE ADOPTER SCHOOLS, POST-PRIMARY

	Not late adopters N=548	Late adopters N= 72	Chi square, *p*-value
% designated disadvantaged	28.3	27.8	NS
% in urban areas	28.3	37.5	NS
% in suburban areas	15.0	12.5	NS
% in small towns	37.8	26.4	NS
% in rural areas	17.7	22.2	NS
% boys schools	16.4	25.0	NS
% girls schools	21.4	16.7	NS
% mixed schools	62.2	58.3	NS
Average size of schools	451.1	386.3	.017

TABLE 9. 69: CONTEXT OF THE LATE ADOPTER SCHOOLS, SECONDARY

	Not late adopters N=298	Late adopters N= 33	Chi square, *p*-value
% boys schools	28.5	54.4	.004
% girls schools	38.3	33.3	.004
% mixed schools	33.2	12.1	.004

There were significant differences between the school characteristics of the late adopting schools and other schools. At primary level, late adoption was significantly associated with lack of a co-ordinator, lack of an ICT plan, and lack of involvement in projects. In addition more of the late adopter schools had principals who did not use e-mail. The late adopter primary schools also had computers in fewer of their classrooms.

At post-primary level there were fewer significant associations. Late adoption was associated with lack of an ICT plan, and with plans which were not updated regularly, but not with the other school level variables.

TABLE 9. 70: SCHOOL CHARACTERISTICS OF THE LATE ADOPTER SCHOOLS, PRIMARY

	Not late adopters N=2450	Late adopters N= 305	Chi square, *p*-value
% with an ICT co-ordinator in 2000	71.6	54.8	.000
% with an ICT co-ordinator as a post of responsibility in 2000	29.4	19.3	.000
% with an ICT plan in 2000	72.4	51.5	.000
% with a regularly updated ICT plan in 2000	38.9	23.0	.000
% involved in an ICT pilot project 2000	9.3	5.9	.009
% involved in a pilot project 2000, any type including ICT or other.	15.2	8.2	.009
% where the principal never used e-mail in 2000	26.1	40.2	.000
% where the principal frequently used e-mail in 2000	22.0	11.4	.000
Percentage of classrooms with computers 2000.	81.0	76.6	.019

TABLE 9. 71: SCHOOL CHARACTERISTICS OF THE LATE ADOPTER SCHOOLS, POST-PRIMARY

	Not late adopters N=548	Late adopters N= 72	Chi square, *p*-value.
% with an ICT co-ordinator in 2000	83.8	75.0	NS
% with an ICT co-ordinator as a post of responsibility in 2000	46.9	40.3	NS
% with an ICT plan in 2000	61.5	37.5	.000
% with a regularly updated ICT plan in 2000	36.9	15.3	.000
% involved in an ICT pilot project 2000	25.4	17.9	NS
% where the principal never used e-mail in 2000	26.3	34.3	NS
% where the principal frequently used e-mail in 2000	25.3	20.9	NS
% of classrooms with computers 2000.	15.6	14.3	NS

Late adoption was not associated with lower levels of teacher ICT skill, except in the case of post-primary schools, where low teacher Internet skill was associated with late adoption. However the absence of a teacher with a postgraduate qualification in ICT in Education was significantly associated with late adoption in primary schools and secondary schools.

TABLE 9. 72: TEACHER CHARACTERISTICS OF THE LATE ADOPTER SCHOOLS, PRIMARY

% of teachers with some ICT skill in 2000	97.0	96.3	NS
% of teachers with some Internet skill in 2000	86.0	83.3	NS
% of teachers who had attended NCTE Phase 2.	58.4	57.6	NS
% of schools where one or more teachers had a postgraduate qualification in ICT in Education	11.7	5.9	.002

TABLE 9. 73: TEACHER CHARACTERISTICS OF THE LATE ADOPTER SCHOOLS, POST-PRIMARY

% of teachers with some ICT skill in 2000	79.9	73.0	NS
% of teachers with some Internet skill in 2000	67.4	59.0	.034
% of teachers who had attended NCTE Phase 2.	35.6	32.9	NS
% of schools where one or more teachers had a postgraduate qualification in ICT in Education	42.5	31.9	NS

TABLE 9. 74: TEACHER CHARACTERISTICS OF THE LATE ADOPTER SCHOOLS, SECONDARY

% of teachers with some ICT skill in 2000	79.4	72.9	NS
% of teachers with some Internet skill in 2000	67.1	59.7	NS
% of teachers who had attended NCTE Phase 2.	34.9	26.5	NS
% of schools where one or more teachers had a postgraduate qualification in ICT in Education	41.9	18.2	.008

9.4g Early and Late schools

This section has examined the early and late adopters of ICT by focusing on the schools that had made the greatest progress in 1998 and the schools that had made the least progress by 2000. Two definitions of progress were examined in parallel. The first was progress as indicated by level of computer equipment, and the schools identified on this basis were termed the early and late investors. The second indicator was the use of ICT in curricular subjects, and the schools identified via these criteria were termed early and late adopters.

The data revealed little relationship between levels of computer equipment and use of ICT in curricular subjects. There was little overlap between early investors and adopters, and little overlap between late investors and adopters. Early and late investment were strongly associated with variables concerned with the context of

the school, such as school type and size. There were some associations with school and teacher level variables, but these were less consistent. By contrast early and late adoption were more associated with school and teacher variables. In primary schools there was no significant association between either early or late adoption and any of the context characteristics. At post-primary level there was no associated between early adoption and context characteristics, but late adoption was associated with some school types (vocational schools and community colleges) and with smaller schools.

Becker,[1] Pelgrum[2] and others have suggested that high levels of equipment might be associated with a more constructivist style of teaching. This vision of ICT as an agent for transformation in teaching is suggested in many national ICT strategies, including the Schools IT 2000 programme. The Schools IT 2000 framework suggests that ICT can accelerate trends towards information handling and problem solving, help to make schools more collaborative, and that therefore "integration of ICTs into classrooms should be seen as an important goal for Ireland".[3] Such a catalytic effect involving change teaching is dependent on the use of ICT in curricular areas, rather than for teaching ICT skills.

If the presence of computers is indeed having a catalytic effect, then it might be expected that those schools with high levels of equipment in 1998 would be found to have greater than average use of ICT in curricular areas two years later. This was the case in primary schools. The early investors in 1998 had significantly higher levels of access and subject use in 2000. They also had significantly higher levels of use of the Internet, both as a resource and as a means of publication. The

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[1] Henry Becker. *Findings for the Teaching, Learning and Computing Survey: Is Larry Cuban Right?* School Technology Leadership Conference of the Council of Chief State Schools Officers. Washington D.C. (2000), p28.

[2] W.J. Pelgrum, "Curriculum and pedagogy" in *ICT and the Emerging paradigm for Life Long Learning: a Worldwide Educational Assessment of Infrastructure, Goals and practices*, ed. by W.J. Pelgrum and R.E. Anderson. (Amsterdam: International Association for the Evaluation of Educational Achievement, 1999), p116.

[3] An Roinn Oideachais agus Eolaíochta. *Schools IT 2000, A Policy Framework for the New Millenium* (1997), p16.

Internet usage is particularly interesting as this was a relatively unfamiliar technology in 1998, and so high use of it in 2000 suggests that these schools became relatively innovative.

However there was little evidence of this in post-primary schools. The early investor schools had higher access scores in 2000, but not significantly higher subject use scores. They did not show greater performance on the Internet use indicators either. These suggest that post-primary early investor schools were making use of their computers, but do not provide evidence of greater use in curricular areas or for constructivist publication work.

The conventional model of innovation envisages that early adopters of an innovation will gain the benefits from that innovation, and therefore continue to develop, widening the gap between themselves and other individuals.[1] If this pattern occurred in schools it might be expected that the early adopters of ICT would continue to innovate and that these schools would retain higher than average use of ICT by 2000. This pattern appeared for the primary schools. The early adopter primary schools had higher subject use scores in 2000, and showed higher levels of use of the Internet for both research and publication. However in the post-primary schools there was no significant relationship between early adoption and the subject use score in 2000 or the use of the Internet.

As with other analyses conducted earlier, the examination of early and late schools reveals considerable differences in behaviour between primary and post-primary schools. In the primary schools adoption of ICT was associated with all of the available school level indicators, and with teacher skill. At post-primary level early adoption was associated with none of these factors. In primary schools, late adoption was also associated with school level variables, but not with teacher skill. At post-primary level late adoption was not associated with any of the school level variables except the absence of an ICT plan, but was associated with lower levels of teacher ICT skill.

This pattern suggests that for primary schools the adoption of ICT, when defined in terms of subject use, was largely determined at school level. Teacher skill was

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[1] Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983).

associated with the early adopters, but lack of teacher skill was not associated with late adoption. Hence teacher skill may have provided an impetus for early adoption, but lack of skill was not related to late adoption, so it cannot be seen as a significant barrier.

In the post-primary schools the adoption of ICT appears to have been much less determined at school level, and more determined by individual teachers or other factors not measured. None of the school level factors was significantly associated with early adoption, while only one (planning) was associated with late adoption. In addition adoption was not stable, and the schools that had high subject usage in 1998 did not have significantly higher subject scores in 2000. These patterns are consistent with the suggestion that in post-primary schools the use of ICT is largely at the discretion of the individual teacher, and less related to whole-school decisions.

9.5 Conclusion

In view of the importance of ICT in the education strategies of many countries, it is not surprising that many studies have focused on the factors associated with successful adoption.[1] This study has examined the factors associated with adoption of ICT in three parallel analyses. The first was an examination of the static picture provided by the 2000 survey. The second concentrated on the use of ICT in curricular areas, as measured by a subject count, and measured the change in subject count between 1998 and 2000. The third strand selected the early and late adopter schools, and focused on the traits that distinguished these schools from other schools.

The static analysis identified a series of factors associated with the use of ICT in schools. The tables below show the factors associated with the greatest difference in the access and subject scores and in the proportion of teachers using ICT.

One of the key patterns is that there was little correlation between the access scores and the subject scores. Even in primary schools the access and subject use scores

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[1] See section 4.5b.

were associated with different factors. The greatest differences in the proportion of teachers making use of ICT were associated with teacher skill variables, particularly teacher Internet skill. Access scores were also associated with teacher skill, particularly teacher computer skill and teacher participation in NCTE phase 2. At post-primary level there were associations with some school level variables, including the proportion of classrooms with computers, and the presence of an ICT plan. However subject scores were associated with a different set of variables. At primary level the strongest associations were with school level variables, while at post-primary level the strongest associations were with teacher skill variables and participation in projects.

TABLE 9. 75: TOP THREE INDICATORS ASSOCIATED WITH THE GREATEST DIFFERENCE ICT USE (IN RANK ORDER): PRIMARY SCHOOLS[1]

% of teachers using ICT in their teaching	Access Score	Subject score
Teacher Internet skill	Teacher skill	ICT co-ordinator status
Teacher skill	Principal e-mail use	Principal e-mail use
Teachers doing Phase 2	Teachers doing Phase 2	Staff e-mail

TABLE 9. 76: POST-PRIMARY SCHOOLS

% of teachers using ICT in their teaching	Access Score	Subject score
Teacher Internet skill	Teachers doing Phase 2	Teachers doing Mathematics course
Classroom computers	Classroom computers	Teacher Internet skill
Teacher skill	ICT plan updated regularly.	Participation in ICT projects

9.5a Teacher training and pedagogy

While many commentators have noted the importance of skill development for teachers,[2] these data suggest that skill development alone is not sufficient to ensure integration of ICT. At both primary and post-primary levels, participation in ICT training was associated with higher access scores and more teachers reported using ICT, but not associated with higher subject scores.

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[1] For a full ranking of factors associated with use, see appendices N35 to N40.

[2] OECD, *Education Policy Analysis 1999* (Paris: OECD, 1999), p58.

This finding echoes the research in the US[1] and UK[2] which have reported that having completed basic skills training was not sufficient to ensure that teachers could integrate ICT effectively in the classroom. By contrast teacher participation in postgraduate courses in ICT in education were associated with higher subject use scores, in both primary and post-primary schools. The very small numbers of teachers doing these courses were associated with a disproportionate change in subject scores. Similarly short courses specifically aimed at integration, although attended by small numbers of teachers, were significantly associated with higher subject use scores. These provide strong support for the idea that it is those courses which help teachers to develop a pedagogical vision for how ICT can be used in the classroom that have the greatest impact on integration of ICT.[3]

There is also some evidence that teacher participation in postgraduate courses was associated with early adoption in primary schools. Primary schools where one or more teachers had engaged in a postgraduate course in ICT in education had higher subject counts in 1998, and were under-represented among the late adopters.

9.5b Teacher Internet skill

The data provides some suggestion that Internet skill may be associated more strongly with ICT integration than other computer skills. The pattern was inconsistent, but there were a series of associations that were significant for Internet skill but not for other computer skills. In primary schools Internet skill was associated with subject use score, while other computer skills were not. In post-primary schools both were significantly associated with subject use, but the relationship with Internet skill was stronger. In post-primary schools home Internet access was significantly associated with subject use, but home computer access was not.

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[1] National Center for Educational Statistics, *Teachers' Tools for the 21st Century: A report on teachers' use of technology* (2000).

[2] OFSTED, *ICT in Schools, The Impact of Government Initiatives* (Interim Report, April 2001), p13.

[3] I.A.M. Janssen Reinen and Tjeerd Plomp, "Educating the Educators" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), pp134-5.

The change in subject count in primary schools between 1998 and 2000 was associated with teacher Internet skill but not with computer skill. Also in post-primary schools late adoption of ICT was associated with lower levels of teacher Internet skill.

These patterns may point to a particular role for the Internet in integration. This may be a result of the trend suggested by Becker, that teachers who had attended Internet training were more likely to perceive it as useful in the classroom.[1] It may be that the Internet is one of the areas where classroom applications are more obvious to teachers once they have been trained in its use.

9.5c Classroom computers

The data offers strong support for the suggestions from the IEA[2] and Becker[3] concerning the association between the location of computers in the classroom and subject use of ICT. In both primary and post-primary schools the access and subject scores were associated with a higher proportion of classrooms having computers. This was in stark contrast to the presence of a computer room, which was not associated with access or subject scores, and in primary schools was negatively associated with the proportion of teachers making use of ICT.

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[1] Henry. J. Becker, *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use.* Teaching, Learning and Computing: 1998 National Survey Report #1. Center for Research on Information Technology and Organizations (February 1999), p19.

[2] W. J.Pelgrum. "Hardware and Software Provision in relation to the Integrated Use of Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p61.

[3] Henry. J. Becker, *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use.* Teaching, Learning and Computing: 1998 National Survey Report #1. Center for Research on Information Technology and Organizations (February 1999), p12.

9.5d The principal

Studies from both the IEA[1] and Fullan[2] have highlighted the role of the school leadership in the adoption of ICT. In this survey a question about the frequency of e-mail use by the principal provided the sole indicator of the principal's ICT skill and use. Frequent e-mail use by the school principal was associated with the proportion of teachers making use of ICT and with the subject scores in both primary and post-primary schools.

Although the IEA study identified school principals as one of the most important initiators of ICT in schools,[1] these data suggest that principals played a more significant role in adoption in primary schools. In the primary schools frequent e-mail use by the principal was associated with a higher subject count 1998, indicating that these schools had made more use of ICT in curricular areas before the start of Schools IT 2000. Primary schools where the principal used e-mail frequently were over-represented among the early adopters, and under-represented among the late adopters. In the post-primary schools there was far less evidence of a relationship between the principal's use of e-mail and the use of ICT in curricular subjects. Although principal's e-mail use was associated with higher subject scores in 2000, it was not significantly associated with higher subject count in 1998, or with early or late adoption.

Principal's use of e-mail was significantly associated with early and late investment in post-primary schools, suggesting a relationship between the computer literacy of the principal and the pattern of spending in the school. In the primary schools there was a "barrier" type relationship between principal's e-mail use and investment, where e-mail use was associated with late investor schools, but not with early investor schools.

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[1] I.A.M. Janssen Reinen and Tjeerd Plomp, "The Decision Phase: Starting to Use Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p36.

[2] Michael Fullan, *Successful School improvement* (Buckingham: Open University Press, 1992), p49.

This data affirms the important role of the principal in the adoption of ICT. Subject use of ICT was associated with principal's e-mail use at both primary and post-primary levels. However there is stronger evidence of the pedagogic role of the principal in primary schools. E-mail use by the principal was associated with early innovation in curricular use of ICT in the primary schools, but not in post-primary, while in the post-primary schools these was stronger evidence of an association between the principal's e-mail use and equipment levels.

9.5e Primary and post-primary

One of the recurring themes through this analysis has been the difference between primary and post-primary schools. Many of the structures of primary education appear to make adoption of ICT easier in primary schools than in post-primary. Cuban has suggested that scheduling patterns, curriculum and exam pressures make adoption more difficult in post-primary schools.[2]

A number of studies have reported that, despite higher equipment levels in post-primary schools,[3] fewer post-primary teachers make use of ICT.[4] Two factors may contribute to this pattern. Firstly, more post-primary schools treat ICT as a separate discipline, while in primary schools it is more frequently integrated across the curriculum.[5] Secondly, post-primary schools may perceive ICT as less relevant to

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[1] I.A.M. Janssen Reinen and Tjeerd Plomp, "The Decision Phase: Starting to Use Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p36.

[2] See section 4.2m.

[3] W. J.Pelgrum. "Hardware and Software Provision in relation to the Integrated Use of Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p51.

[4] Department for Education and Employment. *Survey of Information and Communications Technology in Schools 1998*. Statistical Bulletin Number 11/98, (November 1998), paragraphs 40-41.

[5] Department for Education and Employment (DFEE), November 1999. Statistics of education: Survey of information and communications technology in schools (1999).

their work,[1] possibly as a result of difference in philosophy between the two levels.[1]

The Irish data indicates a similar difference between primary and post-primary. The primary schools had a higher rate of participation in training than the post-primary schools, and showed a greater increase in teacher skill. By 2000 the primary schools had a higher average subject score, despite having lower levels of equipment.

The suggestion that more of the post-primary schools treat ICT as a separate topic, and the domain of specialist teachers, is supported by the data. In primary schools teacher ICT skill was associated with higher access scores, but this was not the case in post-primary schools. Similarly teachers' home computer access was associated with access scores in primary schools but not post-primary.

The data also suggests that primary schools are likely to adopt ICT as a school, while in post-primary schools adoption may be at the discretion or interest of individual teachers. In the primary schools subject score was most strongly associated with three school level variables; the status of the IT co-ordinator, the principal's use of e-mail and the provision of e-mail facilities for staff. In post-primary schools the indicators most strongly associated with subject score were the number of teachers doing the "Integration of ICT into Mathematics" course, teacher Internet skill, and participation in ICT projects.

This suggestion that adoption was more dependent on individual teachers in post-primary schools is also supported by data from the early adopters. Early adopter post-primary schools were not significantly associated with any of the school or teacher level indicators. Furthermore the post-primary early adopter schools were not significantly different from other schools by 2000, while the primary early adopters had retained their leading position.

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[1] European Commission. *European youth in a Digital Age: eEurope 2002 Benchmarking.* Draft Working document of the Commission services Based on the Eurobarometer surveys of February 2001, p23.

These seem to indicate that in the primary schools the adoption of ICT is more likely to be associated with school level variables, such as the principal and the co-ordinator, and to be consistent over time. By contrast at post-primary level the adoption of ICT seems to be more associated with the skill and interest of individual teachers, and highly variable over time.

9.5f Towards a model of the changes in subject use

The static analysis of subject use in 2000 indicates that subject use of ICT was associated with a series of teacher level factors. For both primary and post-primary schools the level of subject use in 2000 was associated with participation in NCTE courses, teacher Internet skill and teachers' home Internet access. Subject use was also associated with schools where one or more teachers had a postgraduate qualification in ICT in education, or had participated in the courses specifically focused on integration. Schools where training was held in-school also had significantly higher subject scores.

There were also indications of the importance of a series of school level variables. Higher subject use was associated with schools where the principal was a frequent user of e-mail. Higher subject scores were also associated with schools which had an ICT plan, an ICT co-ordinator and where the school provided e-mail facilities for teachers. Subject scores were also associated with schools where more of the classrooms had computers, but not related to the number of computers in computer rooms.

The analysis of change in subject use, albeit confined to the limited indicator of subject count, distinguished between the factors associated with subject use before 1998 and those which were associated with increase in subject use between 1998 and 2000. The factors associated with the greatest increases in subject count were indicators of teachers' ICT skill and capacity. In primary schools, the factors were participation in training, Internet skill and home computer access. In post-primary schools the factors associated were teacher computer skill and Internet skill.

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[1] W. J.Pelgrum. "Hardware and Software Provision in relation to the Integrated Use of Computers" in W.J.Pelgrum and Tj. Plomp, eds. *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p48.

While the school level factors were not associated with increases in subject count between 1998 and 2000, they were associated with higher subject counts in 1998. E-mail use by the school principal, presence of an ICT co-ordinator and the presence of a school plan were all associated with higher than average subject counts in 1998.

Various explanations for this pattern present themselves. One possible explanation is that adoption of ICT is a staged process, and that in the early stage of the process the school level variables such as a computer literate principal, are important, while at a later stage the skills of the teachers play a relatively larger part. In this model it might be envisaged that in the early stages of adoption the innovation requires support from the principal. The innovation also needs a champion, in the form of an enthusiastic principal or a visionary teacher. Such visionary teachers might be likely to arise from a postgraduate qualification specifically focused on ICT in education. Schools in this phase might reasonably designate a teacher as co-ordinator, and might draw up an ICT plan. However it may be that innovation by one or two enthusiasts has a limited impact, and that further development of the use of ICT is dependent on developing the ICT skills of many of the teachers. This **process** view carries with it the suggestion that school level factors are more important at the start of an innovation.

A second possible explanation lies in the history of ICT policy in Ireland. Before 1998 schools operated in a policy vacuum with regard to ICT. The government White Paper on Education[1] had made little reference to ICT, and although equipment was provided to schools (especially post-primary schools) under a variety of schemes[2] there was little official encouragement for school to integrate ICT into subject areas. In this context it is likely that those schools with ICT enthusiastic principals and those where a teacher had a particular interest in ICT and a vision of its potential, would be the most likely to make early use of ICT in subjects. Such schools might also be most likely to have a designated ICT co-ordinator, and to have thought out an ICT plan. With the start of IT 2000 in 1998, a

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[1] An Roinn Oideachais. *Charting Our Education Future.* White Paper on Education (1995).

[2] An Roinn Oideachais. *Submission by the Department of Education to the Information Society Steering Committee* (September 1996).

mass training programme began and very large numbers of teacher attended. The volume of teachers attending training, and the associated publicity and parent interest, may have provided an impetus for innovation even in schools without an enthusiastic principal or visionary teacher. This **historical** view thus explains the change in the factors related to adoption in terms of the changes in policy, rather than any inherent process of adoption.

Both the process view and the historical view appear to match both the data collected in the surveys and the patterns of usage reported by the schools in the qualitative study. It is possible that elements of both may come into play at the same time.

Both of these candidate explanations for the emerging pattern stress the importance of the school principal and/or a visionary teacher in the process. This suggestion is strongly supported by the data. In the 2000 survey the subject score remained associated with both principal e-mail usage and the presence of a teacher with a postgraduate qualification in ICT. The enduring association of subject usage with these factors, despite the participation of over 70% of teachers in ICT training, is an indication of their importance. Further indication of the importance of the principal and visionary teacher can be found in the analysis of late adopting schools. At primary level late adoption was not significantly related to the level of teacher skill or participation in training, but was associated with both low e-mail use by the principal and the absence of a teacher with a postgraduate qualification in ICT in education.

CHAPTER 10

DISCUSSION

The analysis of the survey data in the preceding chapters has been in three main parts.

The first part, in chapter 7, examined the social patterns in ICT in schools, and particularly on the kind of ICT experiences provided for students from disadvantaged backgrounds. The second part, in chapter 8, focused on the gender pattern as indicated by the differences between single-sex boys' and girls' schools. Both of these chapters have reported variations in the use of ICT in schools which were not associated with the amount of equipment and therefore seemed to be the result of decisions taken within the school.

The third part of the analysis, in chapter 9, looked at what the data could contribute to an understanding of these in-school decisions. Factors associated with use of ICT and with subject use of ICT were identified. These factors were then tested by comparison with the changes between 1998 and 2000, in order to distinguish between factors associated with growth in usage of ICT and factors which followed growth in ICT usage. Finally these factors were examined through the lens of Rogers' model of diffusion of innovations.

The purpose of this chapter is to draw together these strands of the analysis and to consider the possible explanations for the patterns emerging. In the attempt to explain the patterns, more of the findings from the case study visits conducted in 1999 are included. These case studies provide suggestions about the causes of patterns and illustrate some of the issues, but of course make no claim to be representative.

The first part of this chapter is concerned with the differential adoption of ICT in schools, and examines in turn the patterns with relation to equipment, access to ICT and type of use of ICT. These analyses indicate patterns of access and type of use that appear to reinforce the existing digital divide, at least with respect to socio-economic status and gender.

The presence of patterns which can not be explained by variation in level of equipment strongly suggests that at least some of the variation is a result of

decisions about ICT taken within the school. Hence, the second part of this chapter is concerned with an examination of how the use of ICT is determined at school level.

10.1 Rationale and background

During the late 1990s most developed countries had government programmes aimed at developing the place of ICT in schools. By 1999 the OECD estimated that total expenditure on ICT in education accounted for between one and two percent of overall education spending.[1] Expenditure on ICT grew rapidly, and by 1999 had already overtaken expenditure on printed resources in schools in the US.[2] In many countries pupil-computer ratios halved between 1995 and 1998.[3]

This study began by distinguishing three major rationales for the introduction of ICT in schools.[4] The first, the economic or vocational rationale, is concerned with the use of computers to teach computing skills either to equip learners to gain employment or to provide for the needs of the economy. The second, the social rationale, is rooted in the view of ICT as an essential life skill. Following this argument, the role of ICT in schools is partly to ensure that all learners have the opportunity to develop ICT skills, thus preventing the development of an unequal pattern of skill. The third was the pedagogical rationale, centred on the use of ICT within curricular areas for the purposes of improving the quality of learning. This study has examined the development of ICT in Irish schools between 1998 and 2000 in the light of these last two rationales. It has focused on two main issues, the social and gender patterns in the adoption of ICT in schools, and the extent to which ICT has been used in curricular subjects.

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[1] OECD, *Education Policy Analysis 1999,* (Paris: OECD, 1999), p49.

[2] Ibid., p49.

[3] W.J. Pelgrum, "Obstacles to the Integration of ICT in Education: results from a worldwide educational assessment", *Computers and Education*, Vol. 37 (2001), p167.

[4] See section 1.1.

While social equality is frequently cited as a reason for the location of technology in schools, there are serious questions about whether schools reduce the inequalities, or simply reinforce existing patterns. James puts the issue thus:

> *Although education authorities worldwide increasingly see investment in information and communication technology (ICT) as a top policy priority, these positive developments are accompanied by worrying new questions. How far have major learning gaps opened up between those with access to computers, multimedia and the Internet, and those without? To what extent are affluent students and schools reinforcing their educational advantages over those in poverty?*[1]

There is evidence from a number of countries including the UK, US and Ireland, that home use of computers is greater among the better-off and better educated.[2] The children of families with home computers have a substantial advantage as they may get far more time on a computer at home than they do at school. Students with a home computer are also more likely to experience a broader range of uses of the computer at home, and more actively seek out the more interesting uses in school.[3] Even among those with home access, those from the families of higher socio-economic status have been observed to make more use of educational applications.[4] Such differences may foster inequalities in both skills and attitudes to computers that continue long after the student has left school.[5]

It might be expected that schools could counter the unequal pattern of home access by providing equal access for all, or even deliberately favouring the most disadvantaged, it appears than in many education systems the schools attended by

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[1] Edwyn James, "Information and Communication Technology (ICT) and the Quality of Learning." *International Journal of Education Policy, Research and Practice.* Vol. 1 No. 3 (2000), p324.

[2] See section 2.1.

[3] See sections 2.2 and 2.3.

[4] Becker, Henry. J. *Who's Wired and Who's Not.* Report from the 1998 TLC survey published on the Web at http://www.crito.uci.edu/tlc/html/findings.html pp14-15.

[5] Neil Selwyn, "The effect of using a home computer on students' educational use of IT", *Computers and Education*, Vol. 31 (1998), p225.

the children of the wealthy also have the best ICT infrastructure.[1] US data has shown that inner city schools,[2] large schools,[3] and schools attended by poorer children[4] or children from ethnic minorities[5] had lower levels of computer equipment. Such variation in the US may be attributed to variations in local taxes and hence in resources available for education. However similar patterns have been recorded in the UK, where the funding of schools is more centrally controlled.[6] This variation may be due on part to parent contributions to the school,[7] which in some cases can be a substantial proportion of the school budget.[8] In Ireland it is possible that variations in parent contributions may have generated similarly unequal provision,[9] although no official statistics are available.

The case for the importance of ICT as a life skill depends particularly on the role of the Internet in making an Information society, in which meta-cognitive skills of

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[1] See section 2.2a.

[2] President's Committee of Advisors on Science and Technology, *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States* (March 1997), section 7.3.

[3] National Center for Educational Statistics. *Internet Access in Public Schools and Classrooms 1994-98*, NCES 99-017 (February 1999), p3.

[4] R. E. Anderson and A. Ronnkvist, *The Presence of Computers in American Schools*, Teaching, Learning and Computing: 1998 National Survey Report #2. Center for Research on Information Technology and Organizations (June 1999).

[5] National Center for Educational Statistics. *Internet Access in Public Schools and Classrooms 1994-98*, NCES 99-017 (February 1999), p3.

[6] Department for Education and Employment. *Survey of Information and Communications Technology in Schools 1998*. Statistical Bulletin Number 11/98 (November 1998), section 20.

[7] European Commission. *European youth in a Digital Age: eEurope 2002 Benchmarking.* Draft Working document of the Commission services Based on the Eurobarometer surveys of February 2001, p11.

[8] Department for Education and Employment. *Survey of Information technology in Schools 1996.* Statistical Bulletin no. 3 (March 1997), p11.

[9] Brian Trench. "Computers in Schools: A level Playing Field?" *Education and the information age*. Conference papers ed. by Máirtín O Fathaigh (October 2001), pp41-58.

information handling, evaluation and synthesis[1] become more important. The EU has declared achieving universal digital literacy a major target, and sees schools as a major mechanism in this process.[2] But there are indications that work with the Internet in schools may also be unequally distributed in favour of the most privileged groups.[3] Even if equality of Internet access were provided, Venezky argues that the activities requiring higher-order thinking are most likely to occur in the schools of the high achievers.[4]

In parallel with the social patterns in access and use of ICT, it is possible that a similar inequality may occur on gender lines. There is evidence both internationally and in the UK that boys are more likely to have home computer access than girls.[5] Even when there is a home computer, boys are more likely to make use of it, and spend more time using it. Studies have reported that these gender differences are also found within schools, with girls having less computer time, and engaging in a narrower range of activities.[6]

Integration of ICT into other curricular subjects

The second area of investigation in this study is the extent of the penetration of ICT into curricular areas. The ICT plans of many countries, including Ireland,[7] anticipated pedagogical benefits from the use of ICT. As James notes:

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[1] See section 1.1a.

[2] European Commission, *eEurope 2002: An Information Society for All* Draft Action Plan (2000), p14.

[3] Henry J. Becker. *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use.* Teaching, Learning and Computing: 1998 National Survey Report #1. Center for Research on Information technology and Organizations (February 1999), p14.

[4] Richard L. Venezky, "The Digital Divide Within Formal School Education: Causes and Consequences" in *Learning to Bridge the Digital Divide*, (Paris: OECD, 2000), p75.

[5] See section 3.3a.

[6] See section 3.4.

[7] An Roinn Oideachais agus Eolaíochta, *Schools IT 2000, A Policy Framework for the New Millenium* (1997), p15.

> *Countries across the OECD have invested very substantially in ICT in education, both in terms of resources and expectations. The hope is that the more thorough integration of ICT throughout the education process will result in significant gains in the quality of learning and the qualities that learners come to possess.*[1]

ICT has been claimed to offer a series of benefits in teaching and learning, independent of the value of learning about the technology. Key claims include:

- That ICT can support active and collaborative learning.
- That ICT can develop problem-solving skills.
- That ICT can increase higher-order thinking.
- That ICT can promote a constructivist learning environment in the classroom.[2]

While these educational aims could be achieved independently of ICT,[3] many have anticipated that the integration of ICT will act as a driver of change.[4] Some studies have demonstrated an association between constructivist approaches and classroom use of ICT.[5] However others have questioned whether this is happening and suggested that many teachers' use of ICT is poorly integrated with other work.[6] Concerns about the gap between the claims and the practice has sparked interest in

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[1] Edwyn James, "Information and Communication Technology (ICT) and the Quality of Learning." *International Journal of Education Policy, Research and Practice.* Vol. 1 No. 3 (2000), p318.

[2] Oliver McGarr. "IT Across the Curriculum in Irish Post-Primary Schools." *Education and the information age.* Conference papers ed. by Máirtín O Fathaigh (October 2001), p32.

[3] Ibid., p33.

[4] W.J. Pelgrum and R.E. Anderson, eds. *ICT and the Emerging paradigm for Life Long Learning: a Worldwide Educational Assessment of Infrastructure, Goals and practices* (Amsterdam: International Association for the Evaluation of Educational Achievement, 1999).

[5] Henry Becker, *Findings for the Teaching, Learning and Computing Survey: Is Larry Cuban Right?* School Technology Leadership Conference of the Council of Chief State Schools Officers, Washington D.C. (2000), p28.

[6] OFSTED, *ICT in Schools. The Impact of Government Initiatives*, Interim Report (April 2001), p 8.

the characteristics of the successful adopters, and the barriers to adoption in schools.[1]

10.1a Schools IT 2000

In Ireland the government launched a national initiative on ICT in schools in 1997 and it began operation in 1998. The IT 2000 programme began with stated aims that included both the social and the pedagogical justifications. The plan declared that it was important that "young people, regardless of social or economic background, should have equal access to new technologies." At the same time it anticipated that ICT would have an impact on learning by "providing rich, exciting and motivating environments for learning". A catalytic effect was also anticipated, with the use of computers accelerating positive trends towards "increased emphasis on information handling and problem solving".[2]

During the two-year period 1998-2000, Schools IT 2000 provided grants to schools to purchase equipment, organised in-service ICT training for teachers, organised a series of pilot projects and provided support services including a national Internet resource site (Scoilnet). At the early stages in the programme schools received a substantial part of the equipment, with initial grants to schools totalling £15 million and the one free computer per school from Telecom Eireann being distributed in Spring 1998.

The period from 1998 to 2000 was one of rapid growth in the ICT infrastructure in Irish schools. The total number of computers in Irish schools rose from 37,000 in 1998[3] to 59,500 in 2000.[1] These increases in equipment brought the ratio of student per computer in primary schools from 37 in 1998 to 18 in 2000. In post-primary schools the ratio reduced from 16 to 13 in the same period. The table below shows how these figures compare with those of selected other countries,

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[1] See section 4.5b.

[2] An Roinn Oideachais agus Eolaíochta, *Schools IT 2000, A Policy Framework for the New Millenium* (1997), p15.

[3] From 1998 data provided from Telecom Eireann survey.

illustrating that even following these increases, the level of computer equipment in Irish schools was relatively modest by comparison with many developed countries.

TABLE 10. 1: IRELAND'S EQUIPMENT LEVELS IN CONTEXT.[2]

	Pupils per computer, primary schools	% of primary schools with Internet access.	Students per computer, post-primary schools	% of post-primary schools with Internet access.
USA 1998[3]	6.3	87	5.2	94
Canada	8	88	7	98
Finland	12	87	10	96
Singapore	12	100	8	100
England 2000[4]	12.6	86	7.9	98
Norway	13	56	9	81
New Zealand	14	77	8	89
Israel	16	35	14	53
England 1998	17.6	17	8.7	83
Ireland 2000[5]	**18**	**100**	**13**	**100**
France	25	24	17	55
Ireland 1998	**37**	**14**	**16**	**73**
Italy	88	28	16	73
Cyprus	183	17	216	11

One of the significant changes during the period was the very sudden increase in Internet connectivity. In 1998 only 14% of primary schools and 73% of post-

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[1] Total number reported in 2000 adjusted to compensate for schools that did not respond to the survey.

[2] Unless otherwise indicated country data from W.J. Pelgrum, "Obstacles to the Integration of ICT in Education: results from a worldwide educational assessment", *Computers and Education*, Vol. 37 (2001), p168. Data collection for this survey was conducted between November 1998 and February 1999.

[3] R. E. Anderson and A. Ronnkvist, *The Presence of Computers in American Schools*, Teaching, Learning and Computing: 1998 National Survey Report #2. Center for Research on Information Technology and Organizations (June 1999).Published on the Web at: http://www.crito.uci.edu/TLC/findings/ p4 and 10. Figures for post-primary are for "middle schools".

[4] English data for 1998 and 2000 from: Department for Education and Employment, *Survey of Information and Communications Technology in Schools, England 2000*. Statistical Bulletin Issue No 07/00 (October 2000).

[5] Irish data from 2000 survey and 1998 survey.

primary schools had Internet access. During 1998 almost all schools were provided with free access by Telecom Eireann.[1]

10.1b Methodology

As described in chapter 5, this study is based on three sources of data. The first was a survey of all schools, with the exception of fee-paying Catholic schools, carried out by Telecom Eireann with the co-operation of National Centre for Technology in Education (NCTE) and the Department of Education and Science. This survey was conducted in Spring of 1998, after the announcement of IT 2000, but before any of the grants or equipment had been distributed. Raw data from this survey were made available for this study.

In Spring/Summer of 1999, following the distribution of grants and one year of training and other activities, thirty case studies of schools were developed. These case studies were based on visits to a stratified sample of schools, interviews with principals, ICT co-ordinators, some interviews with teachers and some class observation. The interviews were accompanied by a written survey of all teachers in each of the schools.

In the Spring of 2000 a second quantitative survey was sent to all schools, again with the exception of fee-paying Catholic schools. The data from the 1998 and 2000 surveys were matched by school roll number to allow tracking of the changes in particular groups of schools.

The surveys achieved relatively high response rates. The 1998 survey had an overall response rate of 97.7%, possible because the response was associated with the provision of free equipment and services from Telecom Eireann. The 2000 survey had a response rate of 86%, following both written and telephone reminders to schools.

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[1] Nominally all schools were provided with an additional telephone or ISDN line, a computer, an ISP account and call credits equivalent to one hour per day online. Most schools were connected during Summer 1998. In a small number of schools where running new lines was required there may have been some delays, and some may not have been completed. Exact data is unavailable. Source: Telecom Eireann (Eircom) personnel.

10.2 Narrowing the gaps in equipment

The 1998 data revealed a series of patterns in the distribution of computers in schools. When measured in terms of students per computer, there were inequalities in terms of social disadvantage, school location, size, gender and type. There were very significant changes in some of these patterns during the period, and most of the differences were substantially reduced.

The relationship between level of equipment and the socio-economic status of the students was examined by comparing schools that were designated disadvantaged with other schools. While this provided an objective criterion for distinguishing disadvantage, it is a limited indicator, as there are almost certainly wide variations in socio-economic status between schools that are not designated.

Using this indicator, the data strongly indicated that Irish schools did not follow the pattern reported in the US, where disadvantaged schools had lower levels of ICT equipment.[1] On the contrary, the disadvantaged schools were better equipped than other schools, at both primary and post-primary levels. They remained better equipped in 2000, although the other schools had narrowed the gap considerably.

The data also provided some support for Trench's suggestions that disadvantaged schools might have more obsolete computers.[2] In both primary and post-primary schools the disadvantaged schools had CD ROM capability on a slightly smaller proportion of their computers, suggesting that they were older machines. However this did not reflect smaller spending in disadvantaged schools, as they showed higher levels of peripherals, and had more developed networking and Internet connectivity.

Studies in the US and UK have reported that rural schools tend to be better equipped than urban or suburban schools, but that this may be more closely related

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[1] Becker, Henry. J. *Who's Wired and Who's Not.* Report from the 1998 TLC survey published on the Web at http://www.crito.uci.edu/tlc/html/findings.html, pp14-15.

[2] Brian Trench. "Computers in Schools: A level Playing Field?" *Education and the information age.* Conference papers ed. by Máirtín O Fathaigh (October 2001), p53.

to their size than their location.[1] The data generally supported this hypothesis. At both primary and post-primary levels, rural schools were better equipped than urban schools. However in 1998 the rural primary schools were over-represented among the schools with no computer at all. Although the differences associated with school size were greater than those associated with location, analysis suggested that much of the variation was associated with size rather than location.

There were also gender patterns in ICT equipment. In the primary schools, boys' schools had more computers per pupil than girls' schools or mixed schools. At post-primary level the mixed schools were best equipped. In 1998 the girls' schools had slightly more equipment, but they were overtaken by the boys' schools by 2000.

At post-primary level there were differences between school types. In 1998 vocational schools were the best equipped, while secondary schools were in the worst position with less than half of the number of computers per student in vocational schools. By 2000 the gap had narrowed, but secondary schools remained well behind the level of equipment in vocational schools.

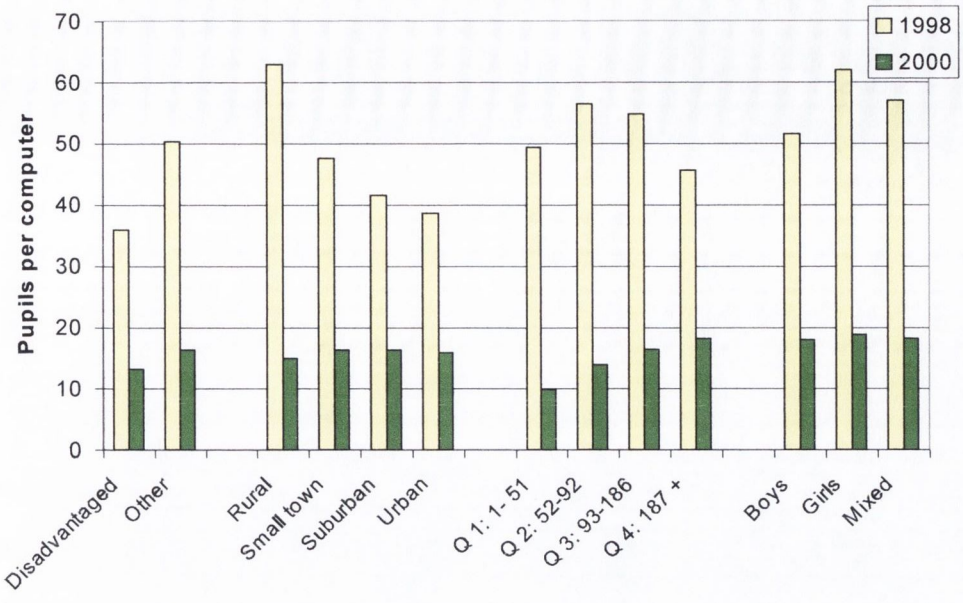
[1] See section 2.2d and 2.2e.

TABLE 10. 2: PATTERNS IN STUDENTS PER COMPUTER, 1998 AND 2000 (SEE ALSO GRAPHS 10.1 AND 10.2)

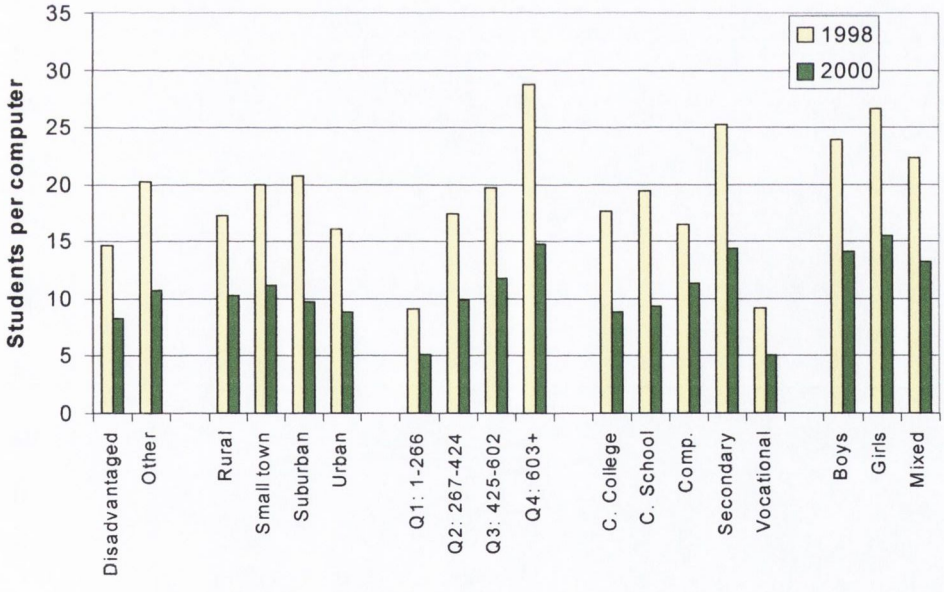
Primary	Pupils per computer 1998[1]	Pupils per computer 2000	Post-primary	Students per computer 1998	Students per computer 2000
Disadvantaged	50.2	15.9	Disadvantaged	20.7	11.0
Other	58.0	18.9	Other	25.4	13.8
Location					
Rural	50.8	16.6	Rural	22.8	11.5
Small town	60.5	18.7	Small town	22.7	12.4
Suburban	64.1	20.2	Suburban	30.1	14.2
Urban	60.9	21.9	Urban	23.9	13.9
Size					
Q 1: 1- 51	26.7	11.2	Q1: 1-266	13.7	7.6
Q 2: 52-92	44.5	16.9	Q2: 267-424	19.2	11.9
Q 3: 93-186	62.5	21.2	Q3: 425-602	28.2	14.6
Q 4: 187 +	74.6	23.0	Q4: 603+	35.1	18.0
Gender					
Boys	51.6	18.0	Boys	30.7	15.2
Girls	62.1	18.8	Girls	29.5	16.9
Mixed	57.0	18.1	Mixed	20.4	11.0
			C. College	18.5	10.7
			C. School	28.9	11.3
			Comp.	18.1	11.7
			Secondary	29.3	15.9
			Vocational	13.6	8.1

Thus the overall picture was that between 1998 and 2000 the inequalities in computer equipment were reduced and in some cases removed. In the process, some trends can be identified. Firstly, the primary schools made a very substantial increase in equipment, both in absolute terms and relative to post-primary schools. In 1998, almost 20% of primary schools had no computer at all and many others had only one. By 2000, all schools had at least one computer, the average was nine computers, and the pupil-computer ratio had fallen from 51 to 17. Secondly the rural primary schools made very dramatic progress, reducing their pupil-computer

[1] The figures shown for primary schools in 1998 exclude the 20% of primary schools that had no computers at all.



GRAPH 10.1. PRIMARY SCHOOLS: PUPILS PER COMPUTER



GRAPH 10.2. POST PRIMARY SCHOOLS: STUDENTS PER COMPUTER

ratio from 63 to 15. Thus is could be said that during this period the greatest development of ICT equipment was in primary schools, and particularly in the small rural primary schools.

There was also a more general pattern of reduced inequality in equipment provision. Across all the categories investigated, during this period there was a narrowing of gaps between those with the best equipment in 1998 and those with the least. In addition within both the primary and post-primary schools there was a reduction in the inter-quartile range of student-computer ratio. Thus the general pattern was that the schools that had least computer equipment in 1998 made the greatest progress.

This period may be seen as one of mainstreaming of ICT. Before 1998 the adoption of ICT had been largely at the discretion of individual schools, and while many had invested heavily in computers, others had not. During this period all schools acquired at least some equipment, thus potentially accelerating the normal adoption process. In terms of Rogers'[1] model of adoption, this may be described as the period when the "late majority" of primary schools adopted ICT, at least in terms of having equipment. In the post-primary schools, by 1998 the late majority had already adopted ICT, and the period saw the adoption by the small number of laggards.

10.2a Causes of the reduction of inequalities

Part of the pattern of change between 1998 and 2000 may be attributed to the structure of the grants distributed to schools. Each school received one computer from Telecom Eireann, and an initial capital grant weighted towards smaller schools.[2] In a two-teacher primary school with 50 pupils and no computers, this would have provided at least two computers, allowing one computer per classroom, and resulting in a pupil-computer ratio of 25:1 or better. By contrast in a post-primary school with 500 pupils and 30 computers, these grants would have

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[1] Everett Rogers, *Diffusion of Innovations*, Third Edition (New York: The Free Press, 1983).

[2] As noted in section 7.1d, grants distributed in 1998 were calculated as £2000 plus £5 per pupil. This means that a school with 100 pupils received £2500, while a school with 500 pupils received £4500.

provided four additional computers.[1] This biasing of the grants towards the smaller schools therefore provided proportionally greater support for small schools, and thereby to rural and primary schools.

The structure of the IT 2000 grants provides an explanation for some of the major patterns noted earlier, such as the relative improvement of the primary schools, and particularly the smallest schools. However it does not adequately explain the changes within the post-primary schools, and in particular the narrowing of the gap between secondary and vocational schools. Three other factors may have contributed to this pattern, namely:

- The self-limiting effect of renewal and consolidation.
- The computer room model of provision.
- The domino effect of parent contributions.

Computers can become obsolete quickly in times of rapid development in software. During the late 1990s the development of the Internet and multimedia made increasing demands on computer power, shortening the life-cycle of computers. In the US, the average life of a school computer in 1998 was estimated at four years.[2] The cost of renewal is therefore a very important part of computer budgets, and obviously falls more heavily on the schools with the most computers and the schools that invested earlier. The effect of this can be seen in the case study schools. In some of the post-primary schools that had made substantial investment in advance of IT 2000, the grants were used to upgrade older computers,[3] or to consolidate through purchase of peripherals or networking.[4] Thus if all schools receive equal ICT funding, the demands of renewal are greater in the case of the leading schools, and so limit their expansion. By contrast the newly-adopting

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[1] Figures calculated assuming the average cost of a multimedia computer in 1998 at £1500.

[2] [2] R. E. Anderson and A. Ronnkvist, *The Presence of Computers in American Schools*, Teaching, Learning and Computing: 1998 National Survey Report #2. Center for Research on Information Technology and Organizations (June 1999), p6.

[3] See for example school SD3, where the grant was spent on upgrading memory in all machines in the computer room.

[4] See for example school SW2.

schools have a temporary "honeymoon period" where equipment is all recent and under warranty and so can devote all their resources to additional equipment purchase.

A second factor which may influence the level of equipment in schools is the adoption of a computer room model. When schools aggregate the computers into one location they can ensure that the scarce resources are available to more of the students.[1] In the case study post-primary schools this "time-sharing" model of resource allocation was often associated with whole class groups moving to the computer room. Where the activities in the computer room require that each student has a computer, this model depends on having a room with enough computers for one class. All of the post-primary case study schools had adopted this model, and thus their focus had been on developing a computer room with enough computers for a normal class.[2] Once a computer room is full, there is little advantage in additional computers, without either a paradigm shift to a model of distributed computer provision, or a substantial leap to a second computer room. Hence the adoption of a computer room model of provision may act as an impetus to the schools with the least equipment, but remove the pressure from schools that have reached a full computer room.

Parent contributions may form a third factor influencing the distribution of equipment. The survey data indicate that a substantial part of school ICT expenditure was not provided through IT 2000 grants. Between 1998 and 2000 the total number of computers in use in Irish schools grew by 24,000, while the IT 2000 programme provided funding for approximately 14,000.[3] The case study schools suggest that much of this additional expenditure was in post-primary

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[1] [1] R. E. Anderson and A. Ronnkvist, *The Presence of Computers in American Schools*, Teaching, Learning and Computing: 1998 National Survey Report #2. Center for Research on Information Technology and Organizations (June 1999). p7.

[2] For example schools SW1 had only 16 computers, but had designed a computer room for 30.

[3] The total number of computers in use in 1998 was reported as 36,000. By 2000 this was estimated at 59,500 (adjusted for non-responding schools). The total equipment grant distributed was £15 million, equivalent to 10,000 computers at £1500 each. In addition Telecom Eireann distributed 4,000 computers.

schools. In the case study primary schools few (five of 15) had any ICT expenditure in 1998-99 other than the grants received. However for the post-primary schools the ICT grant was typically a small part of the school ICT expenditure. Almost all of the case study post-primary schools had spent much more than the NCTE grant over the previous few years, and by 1999 the equipment provided through IT 2000 accounted for only 10% of the computers in use.

Although there is no data in the surveys about the source of the additional funding, the case study schools suggest that most of it came from fund raising through parents. Only three of the 15 post-primary schools studied had received any donations from business or other external agencies, and in all three cases the amounts were a small proportion of their expenditure.[1] Most of the post-primary case study schools reported financial support from parents. This was particularly true in the secondary schools, where seven of the nine schools had used parents as a source of funding. None of the VEC schools, and only one of the three community schools reported fundraising from parents.

Cuban[2] and Fullan[3] have both noted similar parent-reliant patterns of spending, often in advance of adequate state expenditure. Parents may also provide pressure for the use ICT[4]. Many of the case study post-primary schools noted that parent pressure was a factor in their decisions. School SG1 noted that the parents were very "keen on ICT". In school SD1 the principal felt under pressure to timetable ICT, saying "Parents want this, but you can only do so much". Other studies have noted that once the majority of schools in an area have computers there is

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[1] SD2 received some help from a local community partnership. SG3 had some small cash donations, and SD4 had received some old computers.

[2] Larry Cuban, *Teachers and Machines. The Classroom Use of Technology Since 1920.* (Nw York: Teachers College Press, 1986), p76.

[3] Michael Fullan. *Successful School Improvement* (Buckingham: Open University Press, 1992), p51.

[4] Ibid., p36.

increasing pressure for the remainer to invest,[1] possibly in order to attract students.[2] The case study schools also revealed some of this type of inter-school competition, as in the case of SW3, which identified fear of losing students as a major reason for investment in ICT.

The impact of the parents as a resource was particularly dramatic in some of the schools with the least equipment.[3] Parent resourcing is also self limiting, as it is dependent on parent perception of a need for computers, and thus may reduce once parents feel the school has adequate equipment. Parent contributions are also influenced by parent income. There was a very clear illustration of this in the case study schools, where some in disadvantaged areas did not ask parents for contributions,[4] while those in middle class areas were extremely well supported.[5]

10.2b Explanations for the variation in equipment

In 1998 primary schools were in the middle of the diffusion process, and many had no computers at all. Small and rural schools were over-represented among those schools with no computers. This is consistent with Rogers' expectation that the larger units and those in urban areas (most connected) will be the first to adopt an innovation.

By 2000 all schools had some computers, and the small schools had more favourable equipment ratios than other schools. This pattern of advantage for the

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[1] W. J.Pelgrum. "Hardware and Software Provision in relation to the Integrated Use of Computers" in W.J.Pelgrum and Tj. Plomp, (eds). *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p43.

[2] Kjell Dennersten, *Examples of successful use of ICT in Swedish schools.* A paper prepared for the OECD educational software quality group. Paper H9 (2000).

[3] School SW1 had 4 computers in 1998, and 173 students per computer. During 1998/99 it raised money from parents and equipped a computer room, bringing the student-computer ratio to 42.

[4] SD2 and SW2, for example.

[5] For example SD3.

small schools is consistent with the patterns reported in US studies.[1] Three possible explanations for this pattern are:

- That small schools were better equipped for reasons associated with their size.
- That smaller schools were better equipped because they had a closer relationship with parents and so were able to attract more additional funding.
- That smaller schools were better equipped because of the weighting of the IT 2000 grants towards smaller schools.

Although the IT 2000 grants may have had some influence, these cannot be the sole cause of the pattern, as small post-primary schools were better equipped than large schools in 1998. Similarly among the primary schools with some computers, the small schools had more favourable ratios in 1998. The hypothesis that small schools may attract more parent support is more difficult to examine. However, in the case study primary schools there was evidence of parent contribution in only a minority of schools, and most schools had spent only what they received in the IT 2000 grants.

The combination of these two patterns suggests a two-stage model of adoption of ICT in schools. It is likely that during the diffusion process, the larger schools and suburban and urban schools invested first in ICT, in line with Rogers' theory. However, once all schools had become involved, the smaller schools may have been more easily able to attain favourable equipment ratios.

The gender pattern is less easily explained in terms of diffusion theory. At primary level boys' schools were better equipped than girls' schools, and at post-primary level the boys' schools overtook the girls' schools during the period. The girls' and boys' schools were of approximately similar size and in similar locations. There is little to suggest that there was a difference in parent income, and in many cases the same parents may have had children in both girl's and boys' schools. Hence it seems likely that the gender pattern arose from attitudinal differences. That is, that the boys' schools attached a greater importance to ICT than the girls' schools.

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[1] National Center for Educational Statistics. *Internet Access in Public Schools and Classrooms 1994-98*, NCES 99-017 (February 1999), p3.

The third dimension to the ICT equipment pattern was that of SES, and the study reported than both disadvantaged schools and vocational schools were better equipped than other schools. This pattern is almost certainly explained by the additional funding received by these schools, and requires little further elaboration.

Finally, these data have revealed a general pattern of narrowing of the gaps between the best-equipped and least-equipped schools. The TLC study in the US in 1998 revealed a similar pattern of narrowing gaps between school types, but with the basic pattern of inequalities persisting.[1] It is possible that this pattern may be associated with phases in the adoption process. It is possible that during a period of rapid adoption the most enthusiastic or best-funded schools take the lead, but that these gaps narrow later as the leading schools devote their resources to other priorities.

10.3 Access to ICT

Simply having computers in a school is of little importance. Clearly, they need to be used to be of value. The analysis of access to ICT revealed that there were substantial inequalities in access in 1998. By 2000, despite very significant increases in the overall level of access, many of these differences remained.

In examining access, three dimensions of access were considered. Firstly, the volume of access to ICT in school hours was measured using the access score. The second dimension was access to school ICT facilities outside school hours, which is of importance given the unequal access to home ICT equipment. Thirdly, the pattern of access was examined on a class by class basis.

Access scores might be expected to vary with the level of equipment in schools, as schools with more equipment are obviously in a position to provide greater access. This was the case for school size and location, where the variation in access scores reflected the patterns of equipment reported earlier. However for both social

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[1] R. E. Anderson and A. Ronnkvist, *The Presence of Computers in American Schools*, Teaching, Learning and Computing: 1998 National Survey Report #2. Center for Research on Information Technology and Organizations (June 1999).

disadvantage and gender there were variations in access which could not be explained in terms of equipment availability.

In view of the social rationale for ICT in schools, with its stress on redressing imbalances in home ICT access, it might be expected that providing ICT access to students would be a particular priority for disadvantaged schools. This seemed to be the case in the disadvantaged post-primary schools, which provided significantly more access to ICT to their students, particularly in 6th, 2nd and 3rd years. However there was little evidence that the disadvantaged primary schools were providing additional access to their pupils, despite having more computers. Disadvantaged primary schools had in fact slightly lower access scores than other schools.

Provision of access to ICT outside of school hours might also be seen as a measure to redress the inequality in home access. However very few schools of any type provided ICT access outside school hours. Out-of-hours access was even less frequent in disadvantaged schools at primary and junior cycle levels. However the disadvantaged schools provided more out-of-hours access at senior cycle level.

TABLE 10. 3: AVERAGE ACCESS SCORES, 2000

Primary	Average access score	Post-primary	Average access score
Disadvantaged	17.8	Disadvantaged	11.3
Other	18.7	Other	9.3
Location			
Rural	19.6	Rural	9.8
Small town	17.0	Small town	10.1
Suburban	17.7	Suburban	8.3
Urban	16.6	Urban	8.4
Size			
Q 1: 1- 51	20.7	Q1: 1-266	10.1
Q 2: 52-92	19.2	Q2: 267-424	10.4
Q 3: 93-186	17.1	Q3: 425-602	9.1
Q 4: 187 +	17.3	Q4: 603+	8.0
Gender			
Boys	15.3	Boys	9.7
Girls	17.5	Girls	8.7
Mixed	18.9	Mixed	9.9
		C. College	10.4
		C. School	9.7
		Comp.	6.8
		Secondary	9.5
		Vocational	9.8

The amount of access to ICT also varied with type of school. Although the vocational schools had nearly three times as many computers per student, the average access score in vocational schools was only slightly higher than that in secondary schools. There were also differences in the pattern of access. In secondary schools there was a decline in the proportion of classes getting frequent access to ICT in examination years. While this trend occurred in vocational schools too, it was less marked, and it was only in the two examination years that the vocational schools had higher rates of frequent access than secondary schools.

Consideration of these patterns in the context of social disadvantage reveals a disappointing picture. For all categories of post-primary schools, access to ICT was greater in the senior cycle, which is after the end of the period of compulsory schooling and therefore not likely to reach the most educationally disadvantaged. Although disadvantaged primary schools and vocational schools had significantly

more equipment than other schools, this was not translated into significantly higher access scores. Disadvantaged schools provided more access after school hours only for the senior post-primary cycle, which is outside the period of compulsory schooling. Thus the most disadvantaged learners, attending disadvantaged schools or vocational schools and leaving school early, appeared to receive less access to ICT in their time in school than other learners.

While all categories of post-primary schools provided less ICT access to examination classes, this effect was less marked in disadvantaged and in vocational schools. This may be a result of ICT being used to support subject learning in these schools, or ICT being seen as an alternative to curricular learning. This theme will be explored in more detail later.

Girls' primary schools had higher access scores than boys' schools, despite slightly lower levels of equipment. The girls' primary schools provided higher access for all classes from junior infants to 6th class. However the boys' schools provided higher access for learning support and remedial classes, and provided greater out of hours access. Boys' post-primary schools had higher access scores than girls' schools. Boys' schools provided more access to ICT for all junior cycle classes, while girls' schools provided more access for senior classes. Boys' schools also provided greater out of hours access for senior classes. While there was no clear pattern of advantage for either sex, this suggests that there were some differences in the way boys' and girls' schools made use of ICT.

10.4 Differences in type of usage

Even access to equipment does not ensure equality of experience. As examined in chapter 2.3, evidence of differential types of use of ICT with different social groups has lead to the fear that "systematic differences in the character of technology usage may be as problematic as lack of access to computing and networking hardware".[1] Central to this fear is the possibility that the "emergent" or

[1] President's Committee of Advisors on Science and Technology, *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States* (March 1997), section 7.1.

constructivist learning which can be facilitated by use of ICT may be most used with the students who are already educationally advantaged. While this study did not include any measures of constructivist or other teaching, the study did collect data on three areas that provide indicators of the type of use made of ICT. These three areas are:

- The subjects where ICT is used.
- The applications used.
- Use of the Internet

10.4a The subjects where ICT was used

There is some evidence from the US to suggest that students of lower socio-economic status have their use of ICT concentrated into "core" academic subjects, such as English and Mathematics[1]. Becker suggests that this variation may be a result of teachers of low SES students making use of ICT for remedial work and "mastering skills just taught", while the teachers of higher SES students were making more use of ICT for presentation or analysis of information.[2]

The Irish data revealed the same pattern of concentration on core subjects. At primary level more of the disadvantaged schools reported regular use of ICT in Learning support, Mathematics, Language, and English. More of the other (non-disadvantaged) schools reported regular use of ICT in History, Geography and extra curricular activities.

At post-primary level more of the disadvantaged schools reported regular use of ICT in English, but more of the other schools reported regular use in careers, Arts, Music and learning support. More of the vocational schools used ICT regularly in Technology, while significantly more of the secondary schools reported regular use of ICT in a whole range of subjects, including Mathematics, Geography, History, Religion, Careers, Arts and Music.

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[1] Becker, Henry. J. *Who's Wired and Who's Not.* Report from the 1998 TLC survey published on the Web at http://www.crito.uci.edu/tlc/html/findings.html p5.

[2] Ibid., p6.

10.4b Subjects where ICT was used and gender

There were some differences between boys' and girls' schools in terms of the subjects in which ICT was used. At primary level the girls' schools showed more concentration of ICT use in the core subjects, while at post-primary level the girls' schools made more use of ICT in subjects traditionally associated with girls. At primary level, slightly more of the girls' schools reported use of ICT in Mathematics, English and Languages. More of the boys' primary schools used ICT in History and Geography. In all cases the differences were small, except in Social, Environmental and Scientific Education (SESE) where ICT was used in 45% of girls' schools and 38% of boys' schools (chi square, p=.033).

At post-primary level more of the boys' schools used ICT in Technology, while more of the girls' schools used ICT in Art and Music. With the exception of these three subjects, the differences in ICT usage in subject areas were small and not statistically significant. Boys' schools reported slightly more use of ICT in science and technology, both reported equal use in Business, and girls' schools reported greater use in all other subject areas.

10.4c Type of use of ICT and SES

There is some evidence from other countries of a difference in the type of use of ICT with the social characteristics of the students. In general the trend is that lower-SES students are more likely to be taught about computers than to use computers in the course of other learning.[1] Even when ICT is used within other learning, it may be used in different ways. Work in the early 80s found a consistent pattern of poor and minority students spending more of their time on drill and practice programmes.[2] Later work found a similar difference, with teachers of low

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[1] President's Committee of Advisors on Science and Technology, *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States* (March 1997), section 7.2.

[2] H. J. Becker. *School Uses of Microcomputers: Reports from a national Survey*. No 3. 1983. Cited in Sutton, Rosemary E. "Equity and Computers in the Schools: A Decade of Research", *Review of Educational Research*, Vol. 61, No 4. (Winter 1991), p482.

achieving classes making more use of "drill and practice" exercises, and teachers of high achieving classes making more use of spreadsheets, databases and e-mail.[1]

Similar differences in type of use were found in the Irish schools. Designated disadvantaged schools devoted a greater proportion of their ICT time to word processing, especially at post-primary level. They also devoted more time to skill games, especially at primary level and in transition year. The non-disadvantaged schools spent more of their ICT time on the Internet and on spreadsheets and database.

The pattern at transition year is of particular interest, as this is a time when there is less obvious curriculum pressure and schools have an opportunity to shape the programme according to their own beliefs. In transition year disadvantaged schools spent more of their ICT time on word-processing, CD ROMs, skill games and graphics. Other schools gave more time to all of the other activities, including programming, the Internet and simulations.

TABLE 10. 4: TYPE OF USE OF ICT IN DISADVANTAGED AND OTHER SCHOOLS

Average of percentage of ICT time spent on each activity.	Junior Primary	Senior Primary	Junior Post-primary	Transition Year	Senior Post-primary
Word processing disadvantaged	27.4	34.3	54.0	39.9	46.0
Word processing other	26.9	33.5	49.0	38.7	41.2
Skill games disadvantaged	34.1	18.6	12.8	8.9	8.2
Skill games other	29.6	18.0	12.8	7.4	6.8
Spreadsheet/database disadvantaged	6.4	9.0	15.7	17.9	16.3
Spreadsheet/database other	10.1	9.4	16.0	19.2	17.9
Internet disadvantaged	8.3	11.2	12.8	15.5	14.5
Internet other	12.2	13.0	13.7	17.1	15.3

A similar difference in type of use was found between vocational and secondary schools. Vocational schools spent more of their ICT time on word processing, CD ROMs and graphics, while secondary schools spent more time on the Internet, careers guidance and programming.

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[1] Becker, Henry. J. *Who's Wired and Who's Not.* Report from the 1998 TLC survey published on the Web at http://www.crito.uci.edu/tlc/html/findings.html, p6.

Research in the US has noted in particular that high SES students are more likely to engage in computer programming (as opposed to lower level computer related tasks) that low-SES students[1]. This pattern was also replicated in the Irish schools. Although few schools included programming at all, where it was taught it accounted for a smaller proportion of the total ICT time in disadvantaged schools. This was true at all levels from junior primary to senior cycle post-primary, and also in vocational schools.

TABLE 10. 5: PROGRAMMING IN DISADVANTAGED AND OTHER SCHOOLS

Average of percentage of ICT time spent on each activity.	Junior Primary	Senior Primary	Junior Post-primary	Transition Year	Senior Post-primary
Programming disadvantaged	1.0	8.5	0.6	3.5	5.8
Programming other	18.9	11.5	4.2	6.4	7.6

10.4d Type of Use and Gender

There were also gender differences in the type of use of ICT. In girls' schools a higher proportion of the ICT time was devoted to word processing, and a smaller proportion was spent on the Internet. This reflects the pattern reported in other studies, where boys were seen to perform a wider range of activities with the computer,[2] and spend more time with each activity, with the exception of word processing.[3] Becker and Sterling have elaborated further on this pattern. Their data suggest that fewer girls made use of all kinds of computer applications with the

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[1] President's Committee of Advisors on Science and Technology, *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States* (March 1997), section 7.2.

[2] Ingeborg Janssen Reinen, and Tjeerd Plomp. "Information Technology and Gender Equality: A Contradiction in Terminis?", *Computer and Education*, Vol. 28 No. 2 (1997), p75

[3] Ingeborg Janssen Reinen and Tjeerd Plomp, "Gender and Computers: Another Area of Inequity in Education?", in *Schools, Teachers, Students and Computers: a Cross National Perspective* ed. by W.J. Pelgrum, I.A.M. Reinen Janssen and Tj. Plomp, (Amsterdam: IEA, December 1993), p114.

exception of word processing, and that even in the case of word processing it was only in the older students that the girls exceeded boys.[1]

TABLE 10. 6: GENDER DIFFERENCES IN US IN-SCHOOL COMPUTER USE[2]

Figures are "percent girls" of the students involved.	K-6	Middle school	High School
Word processing	36	40	60
Elective programming	22	38	41
Game playing	37	28	20

The Irish schools reflected parts of this pattern. Girls' schools spent more of their ICT time on word processing. This was true at all levels except junior primary classes. Girls' schools also devoted more of their ICT time to CD ROM resources at all levels. The boys' schools spent more of their ICT time on the Internet and simulations at all levels (Graphs 10.3 and 10.4).

There was some evidence to support the hypothesis that girls' schools placed more emphasis on word processing, as found in the US[3] and in international studies.[4] However the differences were small and only statistically significant at junior cycle post-primary and transition year levels. There was little evidence to support the suggestion from the IEA study[5] that the girls' schools were focused on a narrower range of uses of ICT. The girls' schools reported greater usage in four of the ten categories provided. However the girls' schools reported lower usage of the type of ICT which might be considered "high tech", including the Internet, simulations, senior cycle graphics and programming. Those areas where the girls' schools

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[1] H.J. Becker and C.W. Sterling, "Equity in School Computer Use: National Data and Neglected Considerations", *Journal of Educational Computing Research,* Vol. 3 No 3 (1987), p302.

[2] Ibid., p302.

[3] Ibid.

[4] Ingeborg Janssen Reinen and Tjeerd Plomp, "Gender and Computers: Another Area of Inequity in Education?", in *Schools, Teachers, Students and Computers: a Cross National Perspective* ed. by W.J. Pelgrum, I.A.M. Reinen Janssen and Tj. Plomp, (Amsterdam: IEA, December 1993), p114.

[5] Ingeborg Janssen Reinen, and Tjeerd Plomp. "Information Technology and Gender Equality: A Contradiction in Terminis?", *Computer and Education*, Vol. 28 No. 2 (1997), p75

reported high usage included the areas where the learner requires less technical skill such as CD ROM resources, skill games and careers databases.

10.4e Internet use

From an equality viewpoint, the use of the Internet in schools is of particular interest. It is important because it is a relatively new technology, which is growing rapidly and becoming an increasingly important medium[1]. It is also a growing medium, doubling in size every year[2] and likely to increase in size as telecommunications costs fall.[3] Because of the nature of the Internet, is has been seen at times as an "equaliser" in terms of access to resources. It is easy to argue that Internet access provides access to a range of resources for small and isolated schools that would never be available through conventional libraries.

But the importance of the Internet goes beyond its intrinsic value as a medium. Writers such as Negroponte have argued that the developments in technology have a profound impact on the economic and social structures of society.[4] The concept that development in ICT might have a significant impact on the way we live has been abbreviated into the concept of an "information society". The development of an information society goes beyond technical skills, and involves different kinds of learning, thinking and working skills. The information society is seen as more flexible, more participatory and more decentralised.[5]

Equipping young people with the skills to function within such a society is seen as a key objective for European education systems.[6] However the skills required in an

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[1] Jupiter Communications Survey, cited in OECD, *E-Learning, The Partnership Challenge* (Paris, OECD, 2001), p14.

[2] OECD, *E-Learning, The Partnership Challenge* (Paris, OECD, 2001), p25.

[3] Ibid., pp15-16.

[4] Nicholas Negroponte, *Being Digital,* (London: Hodder and Stoughton, 1995).

[5] *Chair's conclusions from the G-7 Ministerial Conference on the Information Society (February 1995).*

[6] European Commission. *eEurope 2002: An Information Society for All,* Draft Action Plan (2000), p14.

information society may not be a larger set of facts or specific skills, but the capacity to readily acquire new knowledge, to solve new problems, and to employ creativity and critical thinking.[1]

Use of the Internet can be seen as addressing these needs in a variety of ways. Firstly, Internet use can help to develop the technical skills of Internet use. More importantly, the Internet can be used in the classroom to develop the meta-cognitive skills[2] identified as critical for the information age.[3] Thus the development of ICT, and particularly the Internet can be seen as both creating a need for meta-cognitive skills, and providing a mechanism for developing them in schools.

In order to avoid the emergence of a digital divide, working with the Internet is of greatest importance for those social groups least likely to have home access. However, as with other aspects of ICT, there is evidence from the US to suggest that the Internet is used more extensively with the high achievers than with the educationally disadvantaged. In analysis of a 1998 survey Becker records that teachers who were teaching students with high levels of prior achievement made more use of the Internet, perceived it as being of higher value, and allowed students to use it more for research.[4]

Internet access in schools is relatively recent. Only five of the countries participating in the SITES study had Internet access in all schools by 1999.[5]

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[1] President's Committee of Advisors on Science and Technology, *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States* (March 1997), Summary.

[2] Roy Pea. *New directions for Child Development.* (1985), pp75-96, cited in Jane M Healy. *Failure to Connect.* (New York: Simon and Schuster, 1998), p138.

[3] Bryn Holmes, Tim Savage and Brendan Tangney. *Innovation in Learning in the Information Society: A Comparative International Study.* A report by the Centre for Research in I.T. in Education for the Lifelong Learning Group of the Information Society Commission. (2000), p5.

[4] Henry J. Becker. *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use.* Teaching, Learning and Computing: 1998 National Survey Report #1. Center for Research on Information technology and Organizations (February 1999), p14.

[5] W.J. Pelgrum, "Obstacles to the Integration of ICT in Education: results from a worldwide educational assessment", *Computers and Education*, Vol. 37 (2001), p167.

Ireland was particularly well served with Internet access as a result of the IT 2000 initiative, and has near universal access by the end of 1998. However there were inequalities in the use of the Internet in the Irish schools. Disadvantaged schools reported spending a smaller proportion of their ICT time on the Internet at all levels from junior primary to senior cycle post-primary.

TABLE 10. 7: USE OF THE INTERNET IN DISADVANTAGED AND OTHER SCHOOLS

Average of percentage of ICT time spent on each activity.	Junior Primary	Senior Primary	Junior Post-primary	Transition Year	Senior Post-primary
Internet disadvantaged	8.3	11.2	12.8	15.5	14.5
Internet other	12.2	13.0	13.7	17.1	15.3

This evidence was reinforced by the pattern of other Internet related indicators. Fewer of the disadvantaged schools provided e-mail accounts for their students, and fewer allowed their students to use the Internet for research.

TABLE 10. 8: INTERNET USE INDICATORS 2000

% of schools where: * Differences with an asterisk were statistically significant.	Primary Disadvantaged	Primary Other	Post-primary Disadvantaged	Post-primary Other
The school provides e-mail accounts for students	4.4	5.2	17.1	19.3
Some students use the Internet for research	55.8*	62.7	80.6	84.9

The vocational schools also spent a smaller proportion of their ICT time on the Internet than the secondary schools. Although more of the vocational schools reported that their students used the Internet for research, more of the secondary schools provided their students with e-mail accounts.

TABLE 10. 9: USE OF THE INTERNET IN POST-PRIMARY SCHOOLS, 2000

% of ICT time	Junior classes post-primary	Transition Year	Senior classes post-primary
Secondary school	14.6	16.9	15.7
Vocational school	11.8	15.8	13.3
T-test, *p*-value	.048	NS	NS

Publication

The Internet also provides schools with a forum where work can be published, providing a useful mechanism for focusing learning on an authentic task. This type of work can be highly motivating, and provide creative and engaging learning experiences. Web publication has been associated with constructivist approaches by teachers and more than any of the other Internet indicators used, may be an indicator of a constructivist approach.[1] Despite the value of such activities, Becker has recorded that these too are more likely to be done with students with higher levels of prior achievement.[2]

The Irish schools partly replicated this pattern. At post-primary level, fewer of the disadvantaged schools had a website, or had student work on their website. At primary level more of the disadvantaged schools used their websites to publish pupil material, although this difference may be a result of the larger size of the disadvantaged primary schools and their participation in externally funded projects.

TABLE 10. 10: INTERNET PUBLICATION INDICATORS 2000

% of schools where: * Differences with an asterisk were statistically significant.	Primary Disadvantaged	Primary Other	Post-primary Disadvantaged	Post-primary Other
The school has a website.	22.1*	13.4	44.6	46.7
The website carries project or curricular work done by pupils	13.4*	7.5	9.7	11.2

10.4f Internet use and gender

Valentine has argued that the Internet appeals to girls more than to boys, because of its focus on communication. She has suggested that the Internet may change the

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[1] Henry J. Becker. *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use.* Teaching, Learning and Computing: 1998 National Survey Report #1. Center for Research on Information technology and Organizations (February 1999), p23.

[2] Ibid., p14.

culture of ICT and reduce the gender gap in ICT interest.[1] However this data provided little to support this hypothesis. On the contrary, single sex boys' schools at all levels reported spending a greater proportion of their ICT time on the Internet.

TABLE 10. 11: PROPORTION OF ICT TIME SPENT ON THE INTERNET

Average of percentage of ICT time spent on the Internet	Junior Primary	Senior Primary	Junior Post-primary	Transition Year	Senior Post-primary
Boys' schools	11	12	15	19	16
Girls schools	7	11	12	15	14

At primary level significantly more of the boys' schools had a website, and had pupil involvement in the content and maintenance of the site. At post-primary level more of the boys' schools had a website, and significantly more had student involvement in maintenance of it. Despite the greater number of websites in boys' schools, the same proportion of both boys' and girls' schools (12%) had curricular work produced by students on their website.

In general the gender gap in Internet use was greater at primary level. There is also some evidence to suggest that the boys' and girls' may lay emphasis on different types of Internet use, with the boys' engaging more in the technical aspects of Internet use and the girls focusing more on curricular use. At post-primary level, many more of the boys' schools reported student maintenance of the website, although the same proportion of boys' and girls' schools reported a website carrying student curricular work.

TABLE 10. 12: GENDER PATTERN IN WEB PUBLICATION

	% of boys' schools, Primary	% of girls' schools, Primary	% of boys' schools, Post-primary	% of girls' schools, Post-primary.
The school has a website	27	12	55	43
The website is maintained by pupils	8	2	25	11
The website carries pupils project or curricular work.	14	5	12	12

[1] Gill Valentine, Sarah Holloway and Nick Bingham, "Children's social networks, Virtual Communities and On-line Spaces". Report of the Cyberkids research project, published on-line (1999) at www.shef.ac.uk/~g/staff/valentine_gill/about.htm

10.4g Social and gender inequalities

The analyses of social and gender inequalities outlined above are limited in a number of ways. The data were collected at school level and hence records the general position within each school, potentially masking intra-school inequalities. In addition the indicators used are measures of usage, but as Venezky points out, usage of an application can be done in different ways and involve different levels of intellectual challenge:

> *The role of school academic standards in student ICT skill acquisition has largely been ignored, yet looms as large as equipment differences in the skill acquisition equation. Schools that have high standards encourage their students to do more sophisticated learning with ICT than schools with lower standards. In the lower standards setting, students might use word processors and spreadsheets for mundane tasks, and occasionally search the World Wide Web for information, using simple searches and a single search engine. In schools with higher standards, students use spreadsheets to simulate different planting options in agriculture or policy options in government, build their own web pages, and manage forums. When they search the WWW, they use complex searches and a variety of different search engines.*[1]

Nevertheless that data provides a valuable picture of the relative position of different types of school. The schools attended by the most socially disadvantaged groups, the designated disadvantaged schools, were not disadvantaged in terms of ICT equipment. On the contrary both disadvantaged schools and vocational schools were better equipped than average. However the significant advantage of these school in terms of equipment was not reflected in greater access scores. At primary level the disadvantaged schools actually provided less access to ICT, as indicated by composite access scores. At post-primary level the disadvantaged schools provided slightly more access than other schools, but vocational schools provided less access than secondary schools, despite their greater equipment levels.

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[1] Richard L. Venezky. "The Digital Divide Within Formal School Education: Causes and Consequences" in *Learning to Bridge the Digital Divide*, (Paris: OECD, 2000), p75.

The schools attended by the socially disadvantaged students also provided a qualitatively different contact with ICT. Disadvantaged and vocational schools provided access to ICT in a narrower range of subjects, often focused on the "core subjects" of English and Mathematics. They used a different mix of applications, with a greater focus on word processing and on drill and practice software. These schools also spent a smaller proportion of their ICT time on the Internet, and at post-primary level were less likely to have had student work published on the Web. All of these patterns are consistent with the suggestion that socially or educationally disadvantaged students are more likely to experience ICT as a reinforcement of core material, while the advantaged were more likely to work with ICT for presentation, exploration or analysis.[1]

Hence the survey provided no evidence to support the suggestion that the additional equipment and funding in disadvantaged schools was translated into a better quality experience of ICT in education in those schools. On the contrary there were a series of indications suggesting that in fact the experience of ICT in those schools was more limited and had fewer of the features associated with the "emergent practices".[2]

The survey also revealed gender patterns, but these were less significant and less consistent. Single sex girls' schools were less well equipped than boys' schools, although the girls' schools provided greater access to ICT at primary level. There were also qualitative differences in the use of ICT. Girls' schools were slightly more focused on a different range of subjects and spent more of their ICT time on word processing and CD ROM, and less of their time on the Internet.

These findings indicate that despite the narrowing of gaps in terms of equipment, there remains cause for concern about inequalities in the use of ICT in schools. The social rationale for the presence of ICT in schools envisages schools acting to counter the inequalities in ICT skills existing in society. The groups "at risk" of

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[1] See section 2.3.

[2] W.J. Pelgrum, "Curriculum and pedagogy" in W.J. Pelgrum and R.E. Anderson, eds. *ICT and the Emerging paradigm for Life Long Learning: a Worldwide Educational Assessment of Infrastructure, Goals and practices* (Amsterdam: International Association for the Evaluation of Educational Achievement, 1999), p92.

falling on the wrong side of a digital divide are the socially disadvantaged and girls. Neither of these groups received significant additional access to ICT within schools. For both groups, more of their access was at the senior end of the post-primary system, thus excluding the early school leavers. There was little indication of special measures to redress inequalities in home access. Boys' schools provided more out-of-hours access than girls' schools, and the disadvantaged schools provided less out-of-hours access than other schools, except for senior cycle post-primary. The real benefits of access to ICT may lie in the development of meta-cognitive skills and the gains in confidence, motivation and quality of thinking. If this is the case, then these benefits are likely to arise from the use of ICT within subjects, the use of the Internet and the adoption of the "emergent practices". Disadvantaged schools, and to a lesser extent girls' schools, showed fewer indications of Internet use and of the use of ICT within subjects. Thus if there are significant benefits in the pedagogical use of ICT, then the disadvantaged were particularly badly served by the ICT use in schools in 2000.

10.5 The construction of ICT policy in schools

The mismatch between the pattern of equipment provision and that of type of use confirms that the usage of ICT in a school is not a product of funding or national policy, but of a policy constructed in the school. This construction may not be a formal process. Few of the case study schools had engaged in a process of consultation or planning to reach their final ICT plan. Instead, it was more common that the construction of ICT was determined by undocumented factors, such as teacher perceptions of student and parent needs, beliefs about ICT and about the pedagogical implications of ICT. Such construction of ICT is likely to be in the realm of what Daniels has termed "soft" technologies. In his view the hard technologies are the equipment, software and connectivity, while the soft technologies are approaches, methods and reflective practices which put these technologies to use. He argues that:

> *Hard technologies change. Indeed, they change quite rapidly. Some years ago, videoconferencing was all the rage. Now to hear some people talk, you would think the Web is the only learning medium that exists. In a few years, the pattern of technology available and fashions in media use will have changed again. To cope with these changes you need a sound framework of soft technologies to ensure you employ the*

> *hard technologies effectively...if we get the soft technologies right the hard technologies will take care of themselves.*[1]

The case study schools provided some indication of the range of different constructions of ICT. In one primary school the pupils were not taught any of the operation of the computer and all use was of a suite of curricular software products.[2] In others all pupils were withdrawn from class on a rota basis to receive training focused only on computer skills.[3] In some schools use of the computers was mainly outside of class time,[4] while others scheduled all classes to use computers every week.[5] Some schools used external, often untrained, teachers to take computer classes,[6] while in others all use of ICT was by class teachers.[7]

The primary schools also had different aims for ICT. One school focused entirely on use of software, with no attempt to teach ICT skills. Others focused entirely on skills, with no curricular input. In one school the stated aim was to reach European Computer Driving License (ECDL) standard by 6th class.[8] For many the use of ICT included both skills and some curricular use.[9]

There was little evidence that the primary schools were clear about either what was expected of them with regard to ICT, or the potential benefits. Some admitted to

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[1] John Daniels. "Technology is the Answer: What was the question?" (1999), available at www.open.ac.uk/ves-speeches/teched99.htm

[2] School PW1 used only a software package called PC Genius, which was used to rehearse basic skills in literacy and numeracy.

[3] School PG1 used parent contributions to employ a person part time to teach computer skills.

[4] School PW1 only allowed use outside class time. PW2 had most use before and after school.

[5] School PD2 for example.

[6] Schools PG1 and PG2 employed external trainers. PD3 used a worker on a community employment scheme.

[7] School PW4, for example scheduled each class to go to the computer room with their teacher once a week.

[8] School PD3.

[9] For example PD5, PG5 and PW5.

being "a bit at sea" about what to do.[1] One school had Internet access but had "no idea what to do" with it.[2] One specifically said that there ought to be guidelines or a curriculum for ICT.[3]

The post-primary schools were more homogenous in their construction of ICT in that all had computers in computer rooms,[4] but they differed in the ages at which access to ICT was provided. In some of the schools there was no access for junior cycle classes,[5] while others provided no access for senior classes.[6] One school allowed no access for any of the mainstream classes, and devoted its computer room to PLC and LCVP students.[7] The post-primary schools were very clearly focused on ICT skills. For the 15 case study schools teaching ICT skills was the main use of ICT. Most reported their belief that there were no other learning gains from ICT. For the few that believed there were other learning gains, these mainly lay in motivation of students[8] and in developing the self-esteem of weak learners.[9] In a few cases the use of ICT was specifically focused on weaker learners, either through the use of ICT with remedial groups,[10] or as an alternative to examined subjects.[11] There was little evidence that the post-primary schools had engaged in a process of research or planning of their ICT usage. Only four of the fifteen case

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[1] School PG3.

[2] School PG5.

[3] School PG2.

[4] All had at least one computer room, and 4 of the 15 schools had two.

[5] Schools SW2 and SW3 provided no access for Junior cycle, and SW4 used ICT only for remedial work and occasional other activities with junior classes.

[6] Schools SW1, SD1 and SG3 provided no access for fifth or sixth year classes except for career guidance.

[7] School SW5.

[8] Schools SG4, SW1, SG4 and SW4.

[9] Schools SD4 and SG5.

[10] School SG5 reported that the English teacher was "doing great things" with weak learners.

[11] School SW3 offered ICT instead of French for weak learners.

study post-primary schools had a written school plan,[1] while in the others the construction of ICT was done "in my head" by the principal,[2] or delegated "to my men",[3] the ICT enthusiasts.

While addressing inequalities with regard to ICT is a stated aim in many education systems, in practice few schools have specific policies relating to equality.[4] Although many of the schools responding to the 2000 survey indicated that social and gender equality were priorities, none of the case study schools had any positive discrimination strategies. In the absence of clear policies or central guidelines, the variety of constructions of ICT leaves plenty of room for concern. The absence of any access to ICT in junior cycle in some post-primary schools could result in some early school leavers being particularly disadvantaged.

The use of ICT in post-primary schools may be characterised into four different, but sometimes overlapping, constructions of ICT, as follows:

- ICT as a life-skill. This was the theme most frequently described in the case study schools, and was reflected in the teaching of ICT applications to all students. In some cases this was provided as an option outside of school hours.[5]
- ICT skills as an alternative for weak or unmotivated learners. In this approach ICT skills training was offered to weak groups, sometimes as an alternative to other subjects.
- ICT as a remedial tool. In some schools, ICT was used in teaching of curricular subjects to weak groups of students.[6]
- ICT as an educational tool. In this model ICT is integrated into subject areas to support teaching and learning. In practice there were few examples of this and

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[1] Schools SG2, SG3, SW1 and SW4.

[2] School SG1.

[3] School SW3.

[4] Adapted from Ingeborg Janssen Reinen, and Tjeerd Plomp. "Information Technology and Gender Equality: A Contradiction in Terminis?", *Computer and Education*, Vol. 28 No. 2 (1997), p77.

[5] Schools SD3 and SW1.

[6] In school SG5, for example, ICT was used in English with weak learners.

where this occurred in the case study schools it was often at the discretion of an individual teacher.[1]

These models of ICT use were not mutually exclusive and most of the post-primary schools adopted some mix of these. However these differing views of ICT may offer some explanations for the patterns of use reported earlier. The view of ICT skills as an alternative for weaker students offers some explanation for the greater use of ICT with examination classes in disadvantaged and vocational schools. The use of ICT as a remedial tool may explain the greater concentration of ICT into the "core subjects" in disadvantaged and vocational schools.

10.6 Factors associated with the construction of ICT in schools

In the absence of specific guidelines or a curriculum determining the use of ICT, schools have developed a variety of patterns of use. The case study schools revealed little evidence that these school level constructions of ICT were based on research, literature or examination of good practice. Instead in many cases the use of ICT was a function of the principal's thinking, or that of the ICT co-ordinator. The previous section has demonstrated that this ad hoc construction of ICT within schools appears to disadvantage those students already on the wrong side of the digital divide. This section is concerned with the mechanism of that construction, and attempts to identify the factors influencing the way ICT is used in schools.

10.6a Parent attitudes

School-level thinking may be heavily influenced by parents' views of ICT. As Callan has asserted:

> *The form of teacher/pupil relationships is influenced by the expectations communicated through teacher/parent relationships. What informs these relationships is public conceptions of what school knowledge is important, what the role of the teacher ought to be in the*

[1] In school SG1, for example, Mathview was used by one of the Mathematics teachers.

> *transmission of knowledge, and what it means to prepare young people for social and working life.*[1]

While the main survey did not examine parent inputs, many of the case study schools mentioned parent pressure to include ICT, sometimes even at a cost to other subjects. This pattern is in line with the suggestion that there is a "halo effect" around ICT, where computer use is seen to be of high value, regardless of the type of use.[2]

The suggestion that parent pressure for the use of ICT was often uncritical[3] and concentrated on the vocational skills rather than the higher-order activities[4] was supported in the case study schools, where much of the parent pressure for ICT was for vocational reasons. As Selwyn has suggested, this parent construction of ICT may undermine the educational potential of the technology.[5]

10.6b Equipment

The Schools IT 2000 programme,[6] along with the ICT plans of many other countries,[7] anticipated that ICT would have an impact on the quality of teaching and learning in schools. While this study did not record the teaching and learning strategies used in schools, it measured the extent of usage of ICT within subject areas, which were treated as an indicator of the extent of integration of ICT into subject areas.

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[1] Jim Callan, *Principal-Staff relationships: A critical element in developing school curricula and teacher culture,* Paper presented at the ESHA Conference (1998).

[2] Jane M Healy. *Failure to Connect.* (New York: Simon and Schuster, 1998), p71.

[3] Michael Fullan, *Successful School Improvement* (Buckingham: Open University Press, 1992), p51.

[4] Jane M Healy. *Failure to Connect.* (New York: Simon and Schuster, 1998), p106.

[5] Neil Selwyn, "Promoting Mr Chips: The construction of the teacher /computer relationship in educational advertising." *Teaching and Teacher Education,* Vol. 17 (2001), pp 3-14.

[6] An Roinn Oideachais agus Eolaíochta, *Schools IT 2000, A Policy Framework for the New Millenium*, (1997), p15.

[7] Edwyn James, "Information and Communication Technology (ICT) and the Quality of Learning." *International Journal of Education Policy, Research and Practice.* Vol. 1 No. 3 (2000), p318.

Subject usage of ICT was not directly associated with equipment levels. The best equipped schools in 1998 were not the schools with the highest use of ICT in subjects, and the least equipped schools in 2000 were not the schools with the least use of ICT in subjects. These two findings were true for both primary and post-primary schools. These patterns strongly suggest that merely having technology in use in a school does not ensure that it is integrated into subjects and that integration is not associated with a particular technology density.

However the IT 2000 strategy anticipated that ICT would have a catalytic effect acting as a driver of change in teaching and learning.[1] The existing research offers a variety of views on the likelihood of such a catalytic effect. Scrimshaw argues that teachers for the most part incorporate ICT by adopting those elements that serve their existing teaching style, rather than entirely changing to match the opportunities the technology may offer.[2] However Becker has suggested that long term access to technology is associated with teacher use in the classroom.[3]

The study provided no evidence that there was such a catalytic effect in post-primary schools. The schools which had the highest equipment levels in 1998 retained their advantaged in equipment in 2000, but did not have higher subject use scores, despite their prolonged period of high equipment levels.

The situation was different in the primary schools, and there was some association between high levels of equipment in 1998 and high subject use in 2000. The early investor primary schools had significantly higher subject use scores in 2000, more of them used the Internet as a resource and more of them had a website carrying pupil work. This suggests that sustained access to ICT in a primary school may have an impact on the use of ICT in curricular subjects.

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[1] An Roinn Oideachais agus Eolaíochta, *Schools IT 2000, A Policy Framework for the New Millenium*, (1997), p15.

[2] Peter Scrimshaw, *Preparing for the Information Age: Synoptic Report of the Education Departments' Superhighways Initiative* (London: Department for Education and Employment, 1997).

[3] Henry Jay Becker, *Internet Use by Teachers: Conditions of Professional Use and teacher Directed Student Use.* Teaching Learning and Computing 1998. Survey Report No 1. Center for Research on Information Technology and Organizations (1999), p15.

10.6c Teacher skill and training

While equipment may have had some influence on the subject use of ICT, the data revealed a series of variables related to teachers' ICT skills and experience that appeared to have a stronger association with subject use.

However there was little evidence that participation in basic ICT skills courses had an impact on subject use. Although 83% of primary teachers and 65% of post-primary teachers had done at least one of the IT 2000 ICT courses by 2000, the proportion of teachers in a school that had attended the courses was not significantly associated with subject use score. This pattern reflects that of other studies, where the value of short skill-based courses has been called into question[1] because of findings that many teachers who are confident enough to use ICT in their lesson preparation do not use it in their teaching.[2]

Although participation in the short courses was not associated with subject use, teachers' computer skill was significantly associated with subject use in post-primary schools and teachers Internet skill was associated with subject use in both primary and post-primary schools. This finding suggests that the short courses may not have been sufficient to bring teachers to a level of skill where they were confident enough to use ICT in the classroom, and is consistent with fears about the impact of short technical courses expressed by Drury[3] and Fullan.[4]

While participation in short technical courses was associated with an increase in teacher skill, but not in subject use, participation in courses that provided insights into the pedagogical application of ICT was strongly associated with subject use. At both primary and post-primary levels, schools where any one teacher had done, or was in the process of doing, a postgraduate course in ICT in education had significantly higher subject use scores than other schools. Similarly schools where

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[1] OECD. *E-Learning, The Partnership Challenge*, (Paris: OECD, 2001), p54.

[2] National Center for Educational Statistics, *Teachers' Tools for the 21st Century: A report on teachers' use of technology* (2000).

[3] Cyril Drury, *Implementing Change in Education: The Integration of Information Technology into Irish post-primary schools.* (Unpublished MSc Theses, University of Leicester, 1995),chapter 2.

[4] Michael Fullan, *Successful School Improvement* (Buckingham: Open University Press, 1992), p34.

one or more teachers had attended the short courses specifically targeted as curriculum integration also had significantly higher subject scores. This finding supports the view that appropriate uses of technology are not obvious to teachers who have attended purely technical training,[1] and that many teachers find it difficult to integrate ICT meaningfully into their teaching.[2] It also reinforces that view that the classroom use is highly related to specific training in how to use the technology in the classroom,[3] and that the pedagogical content of training is an important reference for classroom use.[4]

As was the case in Fullan's study in Ontario,[5] organisation of training courses within the school was an important factor. At both primary and post-primary levels, schools that organised in-school ICT training had significantly higher subject scores than other schools.

10.6d The Internet as a catalyst

Becker has demonstrated a link between the Internet and constructivist teacher pedagogy. His study concluded that "the more constructivist the teacher the greater their average use and the more positively they viewed the Internet".[6] This finding prompted the suggestion that the Internet may have a greater effect on classroom

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[1] Peter Scrimshaw, *Preparing for the Information Age: Synoptic Report of the Education Departments' Superhighways Initiative* (London: Department for Education and Employment, 1997), paragraph 133.

[2] OFSTED. *ICT in Schools. The Impact of Government Initiatives*, Interim Report (April 2001), p13.

[3] Henry J. Becker. *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use.* Teaching, Learning and Computing: 1998 National Survey Report #1. Center for Research on Information technology and Organizations (February 1999), p19.

[4] I.A.M. Janssen Reinen and Tjeerd Plomp, "Educating the Educators" in W.J.Pelgrum and Tj. Plomp, (eds). *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p133.

[5] Michael Fullan, *Successful School Improvement* (Buckingham: Open University Press, 1992), chapter 2.

[6] Henry J. Becker. *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use.* Teaching, Learning and Computing: 1998 National Survey Report #1. Center for Research on Information technology and Organizations (February 1999), p23.

use of ICT than other applications of ICT, but that this effect may be limited to those teachers with a constructivist outlook.[1]

This study offers some support for the hypothesis that the Internet is more highly associated with subject use of ICT than other applications of computers. Evidence to support this is available from two areas. Firstly teacher Internet skill was more strongly associated with subject use than computer skill. This was true in a series of different places. In primary schools the proportion of teachers with Internet skill was significantly associated with subject use score in 2000, and with the increase in subject count between 1998 and 2000, while the proportion of teachers with computer skill was not significantly associated with either. In post-primary schools the proportion of teachers with Internet skill and with home Internet access were both more strongly associated with subject use than computer skill and home computer access. Also in post-primary schools late adoption of ICT was associated with lower proportions of teachers with Internet skill.

Secondly the categories of schools which reported high subject use in 2000 also reported that a greater proportion of their ICT time was devoted to the Internet, and more of them used websites to publish student work. Disadvantaged schools at both levels and vocational schools had lower subject scores than other school types and also spent a smaller proportion of their ICT time online, and fewer of them used their websites to publish student work.

One possible explanation for this association of the Internet with subject use of ICT is that teachers may find it easier to see classroom uses for the Internet. Becker's own study found that teachers who were trained in the use of the Internet were much more likely to see it as relevant to teaching, suggesting that the classroom applications were immediately apparent. This is not the case with other aspects of ICT, where many more teachers use ICT in their preparation than in their teaching[2]

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[1] Ibid., p23.

[2] National Center for Educational Statistics, *Teachers' Tools for the 21st Century: A report on teachers' use of technology* (2000).

and many have difficulty in managing the technology so that effective subject learning takes place.[1]

It must be acknowledged that the use of the Internet does not necessarily indicate the presence of a constructivist learning environment. Some of the Internet use is of limited value, with students simply searching for material to print without any higher-order thinking.[2] However the association of Web publication with Internet use and subject use of ICT points to at least some of the Internet use involving student project work.

10.6e The school principal

The use of ICT in schools is not entirely dependent on the individual teacher. School factors have long been recognised as important in any development.[3] One of the school levels factors is the level of engagement of the school principal in the adoption of ICT.[4] The case study school provides an illustration of a principal who was completely disengaged, and computer illiterate. In this school there was no ICT plan, the principal was unconvinced of the value of ICT, and there was no use of ICT in curricular subjects. Although this school was proud of a tradition of experimentation in science, ICT was not seen as having a role to play in experimentation or project work.[5]

The Irish data also confirmed the importance of the principal. Analysis of this issue was based on a question asking about the school principal's use of e-mail, which was used as a proxy for ICT skill and awareness. Where the principal used e-mail frequently, the school tended to assign a higher priority to the aim of integrating ICT into subject areas. Schools where the principal used e-mail

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[1] OFSTED. *ICT in Schools. The Impact of Government Initiatives.* Interim Report (April 2001), p13.

[2] Ibid., p 8.

[3] Jim Gleeson. "Achieving Core Usage of ICT in Education – the Challenge of Systems change." *Education and the information age.* Conference papers ed. by Máirtín O Fathaigh (October 2001), pp89-103.

[4] Michael Fullan, *Successful School Improvement* (Buckingham: Open University Press, 1992), p49.

[5] School SW3.

frequently had more of their teachers making use of ICT, and higher subject use scores.

TABLE 10. 13: PRINCIPAL'S USE OF E-MAIL AND PRIORITY ASSIGNED TO INTEGRATION OF ICT

Percentage of schools	Primary (chi square, p =.000)			Post-primary (chi square, p =.035)		
Principal e-mail use:	Frequently	Occasionally	Never	Frequently	Occasionally	Never
Very High Priority	37.4	23.7	19.4	32.2	22.0	18.5
High Priority	54.8	63.7	60.8	46.9	54.2	55.4
Low Priority	5.6	10.2	14.1	14.7	20.9	21.0
Very Low Priority	0.4	0.7	1.7	0.0	0.4	1.9

10.6f School Planning

The adoption of a constructivist or project oriented style of teaching and learning is likely to require changes in the fabric of schools. As the OECD declared:

> *The single homogenous class and the instructional modes associated with it are not conducive to co-operative teamwork or to innovative approaches to learning... The organisation of the school day and of individual lessons should provide greater scope for more creative and imaginative problem solving, skills enhancement and practice oriented approaches to learning.*[1]

Large-scale integration of ICT into curricular areas, particularly if associated with adoption of a more constructivist orientation, will require adjustment in time-tabling, classroom layout, subject boundaries and teacher duties. Managing these changes requires a clear vision of the direction and a holistic view of ICT in the school plan.[2] While most Irish schools reported an ICT plan in 2000, this was a requirement of the IT 2000 funding, and may have had little real meaning within the school. In the case study schools, visited in 1999, only a minority reported an

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[1] OECD, *Reviews of National Policies for Education: Ireland*, (Paris: OECD, 1991), p62.

[2] NCREL (North Central Educational Laboratory). *Critical Issue: Providing Professional Development for Effective Technology Use*. 2000 published on the Web at www.ncrel.org/

ICT plan and in some cases the staff were not aware of the plan. However in those schools where there was an ICT plan that was updated regularly, there was significantly greater use of ICT in subject areas.

TABLE 10. 14: REGULARLY UPDATED SCHOOL ICT PLAN AND ICT USE

Subject use scores.	The school ICT plan was updated regularly.	The school ICT plan was not updated regularly.	T-test, *p*-value
Primary schools	13.5	11.3	.000
Post-primary schools	9.4	7.3	.000

10.6g The role of the School ICT co-ordinator

Drury has argued that the ICT co-ordinator plays a key role in the adoption of ICT, acting as a change agent within the school.[1] Pelgrum has expressed a similar view, demonstrating that where there was an ICT co-ordinator with expertise in both ICT and instruction, the perception of lack of teacher knowledge as a barrier was significantly lower.[2] The Irish data further support this view, as for both primary and post-primary schools the presence of a co-ordinator was associated with significantly higher subject scores.

Within schools there is often a teacher designated to act as ICT co-ordinator. In the UK in 1998 almost all schools had an ICT co-ordinator (94% of primary schools and 96% of secondary schools).[3] In Ireland the majority of schools, 70% of primary and 83% of post-primary schools, had a designated co-ordinator.

Lack of time for the ICT co-ordinator to devote to the task is a potential barrier.[4] The role of the ICT co-ordinator has evolved with the technology,[1] and this

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[1] Cyril Drury, *Implementing Change in Education: The Integration of Information Technology into Irish post-primary schools.* (Unpublished MSc Theses, University of Leicester, 1995), chapter 7.

[2] W.J. Pelgrum, "Obstacles to the Integration of ICT in Education: results from a worldwide educational assessment", *Computers and Education*, Vol. 37 (2001), p175.

[3] Department for Education and Employment. *Survey of Information and Communications Technology in Schools 1998.* Statistical Bulletin Number 11/98 (November 1998), paragraph 45.

[4] Cyril Drury, *Implementing Change in Education: The Integration of Information Technology into Irish post-primary schools.* (Unpublished MSc Theses, University of Leicester, 1995), chapter 7.

individual is now expected to be familiar with the thinking about pedagogy and technology. In addition, in many schools the co-ordinator is also responsible for the maintenance of the computers.[2] The data indicate that in schools where time was available for the ICT co-ordinator to do their work, the subject scores were significantly higher than in other schools.

TABLE 10. 15: ICT CO-ORDINATOR AND SUBJECT USE SCORE PRIMARY

Average Subject use score	The school has an ICT co-ordinator N=1922	The co-ordinator is a designated position of responsibility N=780	The co-ordinator is released from some teaching duties N=122
Yes	12.7	12.8	13.8
No	10.8	11.9	12.0
Chi square, *p*-value	.000	.000	.000

TABLE 10. 16: ICT CO-ORDINATOR AND SUBJECT USE SCORE, POST-PRIMARY

Average Subject use score	The school has an ICT co-ordinator N=513	The co-ordinator is a designated position of responsibility N=286	The co-ordinator is released from some teaching duties N=103
Yes	8.3	8.6	9.1
No	7.1	7.6	7.9
Chi square, *p*-value	.043	.015	.039

10.6h School provision of ICT resources for teacher use

Schools that made ICT available for staff use also had higher subject use scores. This was true for primary and post-primary schools that provided e-mail facilities for staff, and for post-primary schools that provided computers for staff use.[3] This may simply reflect the increased skill with ICT that teachers are able to develop because of increased access. However the high proportion of teachers with home

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[1] Peter Scrimshaw, *Preparing for the Information Age: Synoptic Report of the Education Departments' Superhighways Initiative* (London: Department for Education and Employment, 1997), paragraph 163.

[2] This was the case in 41% of primary schools and 58% of post-primary schools in 2000.

[3] Provision of computers for staff use was not relevant in primary schools as the dominant model in primary schools means that teachers have no free periods, and have access to classroom computers outside of teaching time.

access to computers suggests that simple access is not a major problem. It is possible that teacher in-school use of ICT is providing opportunities for peer learning, and for teacher professional discourse about ICT. Such inter-teacher interactions are likely to be highly influential,[1] and contribute to teacher learning about technology[2] and high ICT use.[3]

10.6i Location of computers

Having computers in the classroom was associated with greater use of ICT in subjects. For both primary and post-primary schools the presence of computers in the classroom was positively associated with subject scores. This pattern offers strong support for the findings from the IEA[4] and Becker,[5] which associated the presence of classroom computers with use of ICT.

The presence of a computer room was not significantly associated with subject use scores at either level. In primary schools the concentration of computers in a single room was associated with a smaller percentage of teachers using the computers, presumably because it facilitated the model of a specialist computer teacher. This pattern may be explained by the contention that the aggregation of computers in shared places such as computer rooms may make more efficient use of the resource,

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[1] Conrad Shayo, Lorne Olfman and Ruth Guthrie. *Integration of IT into school curricula: perceptions of kindergarden to highschool teachers.* Proceedings of the ACM SIGCPR Conference (2000).

[2] National Center for Educational Statistics, *Teachers' Tools for the 21st Century: A report on teachers' use of technology* (2000).

[3] Michael Fullan, *Successful School Improvement* (Buckingham: Open University Press, 1992), p36.

[4] W. J.Pelgrum. "Hardware and Software Provision in relation to the Integrated Use of Computers" in W.J.Pelgrum and Tj. Plomp, (eds). *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p61.

[5] Henry J. Becker. *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use.* Teaching, Learning and Computing: 1998 National Survey Report #1. Center for Research on Information technology and Organizations (February 1999), p12.

but may make it more difficult to integrate computer activities into other learning activities.[1]

The importance of classroom computers in subject use of ICT is particularly relevant in view of the dominance of the computer room model in schools. Almost all of the post-primary schools had a computer room, and a substantial number of primary schools also had computer rooms. In the case study primary schools six of the 15 primary schools had their computers in a computer room. In one case this room contained only two computers.[2] In four of these six schools the computer room had been established since 1998, and before that the computers were not kept in a central location. This apparent trend towards computer rooms in primary schools is contrary to that reported in the US, where the between 1992 and 1998 the proportion of computers in classrooms increased.[3]

The Irish data also revealed that disadvantaged primary schools had more of their computers in computer rooms than other schools. This finding is consistent with the association between classroom computers and subject use, and with the lower subject use in disadvantaged schools. This may reflect a greater emphasis on the teaching of computer skills, as in the case of school PD3, a disadvantaged primary school with a computer room where ICT skills were taught by workers on community employment schemes. Alternatively it may reflect a concern for security, as evidenced by school PD4, where all computers were confined to a room with additional security.

10.6j Participation in projects

Pilot projects, where a small number of schools are encouraged to experiment with ICT, were seen as a key component of the IT 2000 strategy.[4] Fullan has argued for

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[1] [1] R. E. Anderson and A. Ronnkvist, *The Presence of Computers in American Schools*, Teaching, Learning and Computing: 1998 National Survey Report #2. Center for Research on Information Technology and Organizations (June 1999). p7.

[2] School PG1.

[3] Ibid., p7.

[4] Description of the SIP programme, taken from the NCTE website at www.ncte.ie/sip.

the value of such projects in allowing new ideas to develop at school level, hence making appropriate use of ICT more likely.[1]

Participation in projects was certainly associated with greater subject use of ICT. At both primary and post-primary levels, schools engaged in pilot projects had significantly higher subject use scores. However schools that became involved in a project between 1998 and 2000 had higher subject counts than average in 1998. This indicates that at least part of the high subject use associated with project participation was a result of the selection of schools rather than the impact of project participation.

Furthermore, schools that were involved in non-ICT projects also had higher than average subject scores, and in the case of primary schools, had higher scores than schools involved in SIP projects. This pattern lends some support to Rosenholtz' classification of 'stuck' and 'moving' schools.[2] Using this classification, it is probable that the 'stuck' schools are unlikely to become involved in a project or to adopt ICT in more than a superficial way. By contrast the dynamic schools are more likely to become involved in a project, and also more likely to fully adopt an innovation such as ICT. Hence for primary schools the data suggest that the impact of the ICT pilot projects was to encourage subject use of ICT in schools which were likely to have adopted it successfully in any case.

This pattern was much weaker in post-primary schools, where SIP schools had significantly higher subject scores than other schools, but the schools participating in other projects did not. However, even at post-primary level there was little difference between the subject scores of schools involved in non-ICT projects and those involved in non-SIP projects.

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[1] Michael Fullan, *Successful School Improvement* (Buckingham: Open University Press, 1992), p47.

[2] S. Rosenholtz. "Teachers Workplace: The Social Organisation of Schools" (Longman, 1989), cited in Michael Fullan, *Change Forces* (London: Falmer Press 1993), p85.

TABLE 10. 17: PARTICIPATION IN PROJECTS AND ICT USE

Figures with an * are significantly different from those of schools involved in no project.	The school is not involved in any project	The school is involved in an innovative project, not related to ICT	The school is involved in an ICT project, but not a SIP.	The school is involved in a SIP project.
Primary Schools Average Subject use score	11.8	14.1*	14.8*	13.6*
Post-primary schools. Average Subject use score	7.5	8.5	8.7	9.8*

10.7 Differences between primary and post-primary schools

Throughout this study a series of differences between primary and post-primary schools have emerged. As in other countries,[1] post-primary schools had higher levels of computer equipment in both 1998 and 2000. They also had a more developed ICT infrastructure. They had more Internet connectivity, and more of them had school networks.

Despite higher equipment levels in post-primary schools and their longer history of ICT use, there was less evidence of integrated use of ICT in post-primary schools. A smaller proportion of post-primary teachers made use of ICT in their teaching, and the subject scores for post-primary schools were lower than those of primary schools. This is consistent with a general pattern reported in other studies, which

[1] W. J.Pelgrum. "Hardware and Software Provision in relation to the Integrated Use of Computers" in W.J.Pelgrum and Tj. Plomp, (eds). *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p51.

report lower subject use of ICT in post-primary schools,[1] and fewer post-primary teachers making use of ICT.[2]

This pattern may be explained in part by a greater concentration on the acquisition of basic skills. Data from the IEA[3] and the UK[4] reveal that more post-primary schools treat ICT as a separate discipline, while in primary schools it is more frequently integrated across the curriculum. A similar pattern appeared in the case study schools, where all post-primary schools identified skills as the main priority, while the primary schools expressed a variety of aims. This is consistent with the greater emphasis on computer rooms in post-primary schools, and their lower subject use scores. The construction of ICT as a skills area is likely to run counter to the use of ICT as a facilitator of a more open or constructivist learning environment. The recent SITES study found that student-controlled learning was generally higher in primary than post-primary schools, while skills acquisition was higher in secondary schools, across a range of countries.[5]

Post-primary schools may perceive ICT to be less relevant to their teaching. The recent Eurobarometer study found that in post-primary schools the greatest barrier to the use of the Internet was a perception that it was not relevant.[6] This may result

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[1] W. J.Pelgrum. "Hardware and Software Provision in relation to the Integrated Use of Computers" in W.J.Pelgrum and Tj. Plomp, (eds). *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p48.

[2] Department for Education and Employment, *Survey of Information and Communications Technology in Schools 1998*. Statistical Bulletin Number 11/98 (November 1998), paragraphs 40-41.

[3] Dan Davis. "Implementation and Educational Uses of Computers", in W.J.Pelgrum and Tj. Plomp, (eds). *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p77.

[4] Department for Education and Employment, *Statistics of education: Survey of information and communications technology in schools 1999*, (November 1999).

[5] W.J. Pelgrum, "Obstacles to the Integration of ICT in Education: results from a worldwide educational assessment", *Computers and Education*, Vol. 37 (2001), pp170-171.

[6] European Commission. *European youth in a Digital Age: eEurope 2002 Benchmarking*. Draft Working document of the Commission services Based on the Eurobarometer surveys of February 2001, p23.

from a difference in philosophy between the two levels.[1] Cuban's contention is that it is difficult for schools to adopt technology because of a series of cultural and structural factors in schools, but that these inhibitors are stronger at post-primary level.[2]

One of the inhibitors identified by Cuban is the pressure of external measures of performance such as examinations which restrict the flexibility of post-primary schools to vary the methodology or the allocation of time to different tasks.[3] As a result, he suggests, in primary schools content is of secondary importance, and the focus in on the development of broad skills. By contrast in second level schools the focus is on the content.[4]

The survey data show a marked drop in access to ICT in examination years. Conversely access to ICT was greatest in transition year and in first year, the years where least examination pressure might be expected. The smaller drop in access to ICT in examination years in disadvantaged schools is consistent with this pattern, as it is possible that the pressure of examinations is lower in those schools.

These findings lend support to the view that the existing examination structure is acting as an inhibitor to the adoption of ICT as a facilitator of learning. As Gleeson asserts:

> *The dominant paradigms of teaching, learning and assessment must be questioned and schools must begin to operate as dynamic wholes - rather than fragmented institutions – if ICT is to realize its potential for the promotion of teaching and learning in Ireland. Unless this issue is addressed, it is unlikely that the meaningful integration of ICT will occur and its use may be mainly confined to computer applications, some project work for non-examination classes, some use with SEN*

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[1] W. J.Pelgrum. "Hardware and Software Provision in relation to the Integrated Use of Computers" in W.J.Pelgrum and Tj. Plomp, (eds). *The IEA study of Computers in Education: Implementation of an Innovation in 21 Education Systems* (Oxford: Pergamon Press, 1993), p48.

[2] Larry Cuban, *Teachers and Machines. The Classroom Use of Technology Since 1920.* (Nw York: Teachers College Press, 1986), p64.

[3] Ibid.

[4] Larry Cuban, "Computers Meet Classroom: Classroom Wins" *Teachers College Record,* Vol. 95 no. 2, TCR ID 82 (1993), p12.

students and improving the quality of teachers' classroom presentations.[1]

The differences between primary and post-primary schools go beyond the presence of external examinations. Cuban points to structural differences, which may also inhibit the adoption of ICT. Primary schools frequently use a "single teacher" model, where one teacher spends much of the day with the same class, while post-primary schools typically schedule different teachers for blocks of time during the day.[2] This latter model may make integration of ICT more difficult in two ways. Firstly because different people may teach each subject, any cross-curricular work or linkage between subjects is more difficult. Secondly, because the time is fragmented into different periods, open-ended or time-consuming activities are more difficult to arrange.[3]

The case study schools provide illustrative examples of these pressures in action. In all of the post-primary schools ICT was taught by specialist teachers in scheduled periods. Where there were other uses of ICT these also occurred within scheduled periods or outside of school hours. In many of the primary schools the computers were located in classrooms. Where they were concentrated in a central space, the classes were often brought to the computer room by their class teacher, although there were some schools where teachers not comfortable with ICT swapped classes with colleagues for those times.[4] In a minority of primary schools

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[1] Jim Gleeson. "Achieving Core Usage of ICT in Education – the Challenge of Systems change." *Education and the information age.* Conference papers ed. by Máirtín O Fathaigh (October 2001), p100.

[2] Larry Cuban, *Teachers and Machines. The Classroom Use of Technology Since 1920.* (Nw York: Teachers College Press, 1986), p64.

[3] Larry Cuban, "Computers Meet Classroom: Classroom Wins" *Teachers College Record,* Vol. 95 no. 2, TCR ID 82 (1993), p12.

[4] Class exchanges of this kind were reported in PD5 and PW4.

an external person taught ICT, although in one case this was done with the class teacher present as well.[1]

The "specialist computer teacher" model lends itself to the concentration of computers into a computer room. This model means that the use of computers is dependent on the skill of the specialist teacher, rather than on the skill of each class teacher, and so provides less pressure for class teachers to develop their skills. All three of these patterns can be seen in the survey data. The primary schools had more of their computers in classrooms and fewer in computer rooms. In primary schools, teacher skill was associated with average access scores, but this was not the case in post-primary schools. In addition primary school teachers had a higher take up of the training courses provided, and increased their ICT skills by a greater amount between 1998 and 2000. A similar pattern of greater take up of training has been reported in the UK.[2]

10.7a School level and teacher level factors

In primary schools, subject use of ICT was associated with a series of school level factors, including the status of the IT co-ordinator, the principal's use of e-mail and the provision of e-mail facilities for staff. In post-primary schools the indicators most strongly associated with subject score were teacher level factors, such as the number of teachers doing the "Integration of ICT into Mathematics" course, teacher Internet skill, and participation in ICT projects. This pattern may also be associated with the "class teacher" model of ICT in many primary schools. Where each class teacher is involved in working with ICT, the school needs to develop a co-ordinated approach to ICT to avoid repetition of skills training or software packages, and to ensure progression from year to year.[3] Because each teacher is involved, the school

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[1] Schools PD4, PD3, PD5 and PG1 had ICT taught by external personnel, but in PD4 this person worked with the class teacher.

[2] Department for Education and Employment. *Survey of Information and Communications Technology in Schools, England 2000.* Statistical Bulletin Issue No 07/00 (October 2000), p10.

[3] In school PG4 the teachers had a software library with recommended ages for each item. The classes progressed through content-rich software and later made use of computers mainly for project work.

has to develop a curriculum for ICT. By contrast where schools adopt the "specialist teacher" model, there is little need for central planning or whole staff discussion of ICT.

This is also consistent with the finding that the school principal played a more significant role in subject use of ICT in primary schools. In the primary schools frequent e-mail use by the principal was associated with a higher subject count 1998. Primary schools where the principal used e-mail frequently were over-represented among the early adopters, and under-represented among the late adopters. In the post-primary schools, principal's use of e-mail was significantly associated with early and late investment in post-primary schools, but not with early and late adoption.

CHAPTER 11

CONCLUSION

This study began with rationales for the investment in ICT in schools. Two of these rationales, the social and the pedagogical, were the particular focus of study. The social rationale, with its emphasis on ensuring inclusion of all in the information age, carried an implicit commitment to equality. The pedagogical rationale carries with it the implication that ICT can make a difference to the quality of the learning experience. If these aims are to be achieved, schools should act to redress the existing inequalities in ICT experience, or at least not act to increase the imbalance, and ICT should be used in schools in support of teaching and learning in curricular areas. This study has examined the progress of ICT in Irish schools against these two criteria.

The data for the study was drawn primarily from two large-scale surveys of Irish schools. These were conducted at the beginning of the Schools IT 2000 initiative in 1998 and after the main phase of activity in the programme in 2000. Both surveys received very high response rates.[1] The surveys were supported by a series of 30 case studies of schools, conducted in 1999.

These surveys provide valuable data about ICT in Irish schools. Unlike many national surveys they are based on complete national surveys rather than on samples of schools, and the high response rates make these particularly useful. The surveys examined the population of schools before and after a major national ICT initiative. 1998 and 2000 data were matched on a school-by-school basis, enabling a detailed examination of the changes in schools during the period. This methodology has provided robust evidence of the patterns of use in schools, and had revealed a series of associations between school and teacher variables and the use of ICT. However this methodology does not provide evidence of causal relationships, and is restricted to identification of associations.[2]

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[1] The 1998 and 2000 surveys had response rates of 97.7%, and 86% respectively.

[2] The limitations of this research are considered in more detail in section 5.5d.

Key findings

The data revealed that there were substantial inequalities in the computer provision in schools in 1998, with small rural schools in particular being at a disadvantage. However by 2000, following the provision of equipment weighted towards smaller schools, this pattern had reversed and it was the larger schools that were least well equipped, mirroring the pattern in other developed countries.[1]

Unlike other countries,[2] schools that were designated as disadvantaged were not worse off in terms of equipment either in 1998 or 2000. In fact, both disadvantaged schools and vocational schools were significantly better equipped than other schools. However this positive discrimination in terms of equipment was not matched by significantly better access to ICT in disadvantaged or vocational schools.

Although the schools attended by the disadvantaged were generally better equipped than other schools, they reported making less use of ICT in curricular subjects and their subject use was focused more on "core subjects" such as English and Mathematics. This mirrors patterns reported in the US,[3] and may indicate greater use of ICT in reinforcement activities. This suggestion is reinforced by the greater use of reinforcement software in disadvantaged schools, and a similar pattern of emphasis on drill and practice software with weaker learners in US schools.[4]

One of the key areas of ICT use in schools is the Internet. It is important for social reasons because the Internet as a resource is central to the concept of an Information Society, and therefore skills in its use are particularly important. Moreover it is seen as having a potential pedagogical impact, both through the

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[1] National Center for Educational Statistics. *Internet Access in Public Schools and Classrooms 1994-98*, NCES 99-017, (February 1999), p3.

[2] R. E. Anderson and A. Ronnkvist, *The Presence of Computers in American Schools*, Teaching, Learning and Computing: 1998 National Survey Report #2. Center for Research on Information Technology and Organizations (June 1999).

[3] Henry J. Becker, *Who's Wired and Who's Not.* Report from the 1998 TLC survey published on the Web at http://www.crito.uci.edu/tlc/html/findings.html, p5.

[4] Ibid., p6.

meta-cognitive skills developed in Web searching, and through the constructivist projects which can be facilitated by Web publication. However the survey data reveal that disadvantaged and vocational schools spent less of their ICT time on the Internet, and were less likely to engage in Web publication.

A parallel analysis compared the situation of ICT in boys' and girls' single-sex schools. Although the boys' schools had only slightly more equipment, they reported using ICT in different ways. Girls' schools generally reported more emphasis on word processing, and less use of the Internet than boys' schools. Although the girls' schools used a range of types of software, they reported lower usage of the type of ICT that might be considered "high tech", including the Internet, simulations, senior cycle graphics and programming. Those areas where the girls' schools reported high usage included the areas where the learner requires less technical skill such as the use of CD ROM resources, skill games and careers databases.

The groups that are traditionally associated with lower use of ICT, the socially disadvantaged, and to lesser extent girls, were not found to be at a disadvantage in terms of the equipment in their schools. However, there were indications that these groups received a qualitatively different experience of ICT, with less emphasis on the "information age" skills, and on the use of ICT in support of "emergent practices" in teaching and learning. Thus the practices in schools are neither neutral nor acting to reduce the digital divide. In fact, the practices recorded in 2000 leave grounds for serious concern that schools may reinforce existing inequalities by offering the highest level ICT experience to the groups already associated with high ICT use.

The existence of these differences in the use of ICT leads to two major conclusions. Firstly, the use of ICT in support of "emergent practices" in teaching and learning was not explained by high levels of equipment. Secondly, the quality of use of ICT, and the variation with socio-economic status and gender, were not determined by central policy, but constructed at school level.

Although no single factor was found to explain the variation in subject use of ICT, a series of factors was found to be associated with high subject use. There was some evidence to suggest that the basic skills courses provided as part of IT 2000

did not equip teachers to make use of ICT in their subject teaching. However teacher participation in postgraduate courses focused on ICT in education, and in specialist courses aimed at ICT integration, were both associated with greater subject use of ICT. These findings support the hypothesis that the provision of basic skills is not sufficient to ensure integration of ICT, and that courses that develop a pedagogical understanding are important.

The study also highlighted the role of the school principal. Where the school principal made regular use of e-mail, schools assigned a higher priority to the integration of ICT into subject areas, and had significantly higher subject scores. High subject use of ICT was also associated with school planning, the status of the ICT co-ordinator, and the location of computers in classrooms.

These findings suggest that where there is leadership within the school, and the school has planned and made provision for ICT, then ICT can be integrated into curricular subjects. However the data also indicated that the overall level of subject use of ICT was low, and accounted for only a small proportion of ICT use. Particularly in post-primary schools the dominant model of ICT was as a separate subject taught to develop ICT skills.

The Impact of IT 2000

The study provides an insight into the changes in ICT in Irish schools during the early part of Schools IT 2000. During this two-year period the number of computers in use in Irish schools grew by more than one third, and three quarters of the teachers undertook some training in ICT. The effect of these initiatives was seen in an increase in the average access to computers provided in schools and a narrowing of the gaps between the best-equipped and least-equipped schools.

IT 2000 had a particular impact in primary schools, where equipment levels increased dramatically, and where many schools engaged with ICT for the first time. In some ways primary schools overtook the post-primary schools during this periods, with big increases in teacher ICT skill and subject use of ICT. This may have generated imbalances in the system, particularly where post-primary schools choose to introduce ICT only at senior cycle level.

However much of the increased access to ICT was in skills classes. There was little to suggest that the vision of ICT as a pedagogical tool had been adopted in the majority of schools. Although there was some increase in subject use of ICT between 1998 and 2000, this was not in proportion to the increase in equipment or access. In both primary and post-primary schools skills training remained one of the main foci of ICT use.

There was also little evidence that the strategy had succeeded in addressing the social agenda. None of the case study schools reported positive discrimination actions. The survey data revealed higher out-of-hours access to ICT in non-disadvantaged schools. The schools attended by the disadvantaged made less use of the most motivational applications of ICT, and the girls' schools made less use of the applications traditionally associated with boys'.

The variety of constructions of ICT, particularly in primary schools, was indicative of a degree of confusion about how ICT should be used. Some of the case study schools said they were unclear about what they were supposed to be doing with computers, and even the post-primary schools had configured their computer use in different ways.

This lends support to Trench's assertion that IT 2000 emphasised infrastructure more strongly than the content of education, and in particular failed to deliver accompanying changes in curriculum and syllabi.[1] It could also be argued that the strategy did not succeed in changing the dominant paradigms in education, without which Gleeson argues that ICT cannot realise its true educational potential.[2]

Policy implications

These findings have some implications for future ICT policy. Firstly, the system of grants weighted towards smaller schools seems to have had the effect of increasing the relative level of equipment in the smallest schools. However, given that the

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[1] Brian Trench. "Computers in Schools: A level Playing Field?" *Education and the information age*, conference papers ed. by Máirtín O Fathaigh (October 2001), p42.

[2] Jim Gleeson. "Achieving Core Usage of ICT in Education – the Challenge of Systems change." *Education and the information age*, conference papers ed. by Máirtín O Fathaigh (October 2001), p100.

smallest schools were better equipped than average by 2000, there is little argument for continuation of such a weighting. If anything, grants should now be weighted towards larger schools.

Secondly the study has provided indications of the importance of teacher education initiatives which develop the pedagogical skills of teachers in the use of ICT in the classroom. Both postgraduate courses and courses specifically aimed at integration of ICT were associated with subject use, to a greater extent than the much larger volume of basic skills courses. These findings strongly suggest that future courses should have a greater pedagogical focus.

A third implication for policy makers arises from the data highlighting the role of school principals. The use of e-mail by the school principal was associated with a series of indicators of the development and use of ICT in the school. It is likely that the school principal has a major influence over investment in computers, the appointment of an ICT co-ordinator and the development of a school plan. In this context initiatives aimed at developing the ICT skill and understanding of school principals seem to offer attractive possibilities.

As in other countries, Irish ICT policy has relied on pilot projects to develop appropriate methodologies. Involvement in pilot projects was associated with greater use of ICT in curricular subjects. These pilots have successfully demonstrated that greater curricular use of ICT is possible, even in the post-primary schools. However the schools involved in pilot projects were already making more use of ICT before the projects began, and schools involved in non-ICT projects also adopted ICT to a greater degree than other schools. These patterns suggest that the ICT pilots may have been working with the progressive or innovative schools, and further underline the principle that the adoption of ICT is associated with school factors as much as equipment and external pressures. The success of projects in innovative schools does little to demonstrate that the projects could be replicated on a wider scale, and this remains one of the key concerns about pilot projects.

The study also provided indications that the curriculum, and in particular examinations, were barriers to adoption of ICT. There was greater use of ICT in curricular areas in primary schools, and a strong pattern of lower use in post-

primary examination classes. Similar patterns have been reported in the UK,[1] where ICT use is constrained by examinations. These patterns underline the need for review of curriculum and examinations if ICT is to be thoroughly integrated in a manner consistent with the IEA "emergent practices" for teaching and learning.[2]

These findings suggest that the existing ICT strategy has been successful in improving the level and distribution of equipment in schools, and in providing basic training for teachers. There is no doubt that equipment will continue to be an issue. In the SITES project, even schools with high levels of equipment recorded lack of equipment as a barrier.[3] However these Irish data have highlighted the important role of the teachers and the school in the construction of ICT. In view of this, building a pedagogical vision for ICT would seem an important element of an ICT strategy. Such a strategy might include teacher education activities with a strong pedagogical focus, support for teachers to undertake more substantial courses, activities to support the development of ICT thinking in school principals, and curricular changes compatible with the integration of ICT.

Underlying assumptions

This study has examined the patterns of use of ICT in Irish schools. Demonstration of the educational value of ICT is beyond the scope of this study, but yet the significance of these findings depends greatly both on the assumption that ICT is of value, and the interpretation of that value. Throughout the study three different assumptions of the value of ICT have been used.

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[1] Department for Education and Skills, *ImapCT2. Emerging findings from the Evaluation of the Impact of Information and Communications Technologies on Pupil Attainment.* Preliminary report (2001), published at www.becta.org.uk, p14.

[2] W.J. Pelgrum, "Curriculum and pedagogy" in W.J. Pelgrum and R.E. Anderson, eds. *ICT and the Emerging paradigm for Life Long Learning: a Worldwide Educational Assessment of Infrastructure, Goals and practices* (Amsterdam: International Association for the Evaluation of Educational Achievement, 1999), p92.

[3] W.J. Pelgrum. "Obstacles to the Integration of ICT in Education: results from a worldwide educational assessment". *Computers and Education*, Vol. 37 (2001), p177.

This study began with an examination of patterns of in-school ICT equipment and access to that equipment. This examination was informed by the social rationale for the use of ICT in education.[1] This rationale carries with it the assumption that ICT is a worthwhile life skill and that those without the skill will be disadvantaged in their life-chances as a result. This assumption is not unchallenged, and critics such as Stoll and Healy[2] have questioned the value of ICT skills training in schools. They have suggested that ICT skills training is often limited to trivial operational skills and that this may displace activities of greater educational value.

The study has also assumed that ICT can be of educational value in schools. While much of the later part of the study is concerned with analysis of factors associated with the use of ICT within subject areas, the study has made no attempt to demonstrate that such use of ICT is of educational value. Similarly the study has made assumptions about the kinds of ICT use which are of value. The discussion of social patterns in ICT usage, for example, makes the implicit assumption that use of simulations and Web authoring projects are more likely to involve higher-order thinking than drill and practise software.

The third assumption has involved acceptance of the "information society" view of ICT.[3] In this view the society of the future will require people to have greater meta-cognitive skills, but place less emphasis on memory of traditionally-important knowledge. This view places particular importance on ability to find, assess and apply information, and on problem solving and analytical skills. This conception of the needs of society is often associated with a belief that education should become more focused on developing these kinds of skills, as described in Pelgrum's "emergent practices.[4]

This study has not attempted to demonstrate the impact of ICT in these three areas. Firstly, there has been no attempt to measure the impact of ICT skills training on either student ICT skill or on life-chances. Secondly, there has been no measure of

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[1] See section 1.1a.

[2] See section 1.2a.

[3] See section 1.2.

[4] See section 4.6b.

the impact of pedagogical use of ICT on the quality of learning in subject areas. Finally, the study has not sought to demonstrate that the use of ICT was associated with the development of meta-cognitive skills.

In the light of these assumptions, the major findings of this study may be summarised as follows:

1) If the role of ICT in schools is to provide access to ICT in order to propagate universal ICT skill, there was little evidence of major inequalities by 2000.

2) In so far as ICT supports teaching and learning of subject areas, it appears that students from low SES backgrounds were less likely to experience this type of use of ICT in school.

3) If the benefit of ICT is in facilitating a more constructivist or project-centred learning environment, this study does not provide direct measures of this kind of work. However, in so far as this kind of work is indicated by use of the Internet and in publication of student work on the Web, it appears that this occurred less frequently in the schools with students from disadvantaged backgrounds and in single-sex girls' schools.

Cause for concern?

These findings suggest that there may be a digital divide between schools, but that the divide is no longer between schools that use ICT and those that do not, but a variation in the type of use of ICT within schools. It might be argued that this pattern might be a logical and appropriate outcome of schools matching their use of ICT to student needs and abilities. However to take such a position involves the invidious assumption that social disadvantage implies less potential to benefit from higher-order educational activities. Such an assumption also contradicts a body of literature pointing to the role of ICT in motivating and challenging learners traditionally alienated from schooling, and achieving results beyond conventional expectations.[1]

This study also provides some evidence which appears incompatible with the suggestion that disadvantaged schools use of ICT was a logical response to their

[1] See for example ACOT research at http://www.apple.com/education/k12/leadership/acot/

students' needs. The data indicated that the use of ICT within curricular areas was highly associated with teacher participation in postgraduate courses in ICT in education, and participation in specific courses aimed at ICT integration. The strong association between participation in training and the use of ICT within subjects does not suggest that the schools not using ICT in subjects were making informed decisions based on their students' needs.

This study therefore suggests that there is cause for concern that different social groups may have different types of experience of ICT in schools, in ways which result in the higher-order benefits arising from the use of ICT being experienced more frequently by those from more privileged backgrounds.

This conclusion is of particular significance in the light of the US research suggesting that the schools serving disadvantaged students also focus more on lower order uses of ICT[1]. However this work was done in a context where these schools were also less well equipped than other schools, and hence this finding is open to two interpretations. It might be argued that the lower order uses of ICT were associated with the lower levels of equipment. Alternatively, it might be argued that the lower order uses were associated with teacher beliefs about their disadvantaged students. This study was conducted in an environment where the disadvantaged schools had greater levels of equipment. Yet despite this, there was evidence that they were also focused on the lower order uses of ICT. This strongly suggests the second alternative, that the type use of ICT was a product of teacher beliefs rather than equipment levels.

This conclusion calls into question the existing policy with regard to ICT provision, which appears to rely heavily on the assumption of a "catalytic effect " of ICT in encouraging educational change.[2] As in many other countries, ICT policy to date has devoted much of its budget to provision of equipment and basic skills training for teachers. This study has suggested that these initiatives have limited impact. In primary schools there was some evidence that long term presence of equipment

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[1] See section 2.3.

[2] Such an effect is anticipated in the Schools IT 2000 framework document, An Roinn Oideachais agus Eolaíochta, *Schools IT 2000, A Policy Framework for the New Millenium* (1997), p15.

might be associated with greater subject use of ICT, but that there was little evidence that the presence of computers alone encouraged subject use of ICT in post-primary schools.

The study has suggested that a more profitable direction for policy would be to focus on building the vision of the potential of ICT in teachers and school principals. Teachers with postgraduate qualifications in ICT were associated with greater use of ICT in subjects in their schools. Subject use of ICT was also greater in schools where the principal was computer literate, and where school ICT planning took place. These suggest that by 2000 the type use of ICT in schools was determined more by the thinking within the schools than by the presence of equipment.