

An abstract graphic on the left side of the page. It features a vertical rectangular area with a light orange to light blue gradient. Inside this area, there are several thick, stylized arrows in shades of brown and orange. One arrow points upwards and to the right, while another points downwards and to the left, creating a sense of movement or flow.

The Impact of new technologies on distance learning students

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Bibliography

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Bibliography on the Impact of new technologies on distance learning students

Introduction

It is known that the United States of America spends many billions of dollars annually on the provision of educational technology to American schools, colleges and universities. All the 27 Departments of Education in the European Union, in like manner, spend millions of euros each year on the provision of educational technology.

In the light of this massive expenditure the research on the impact of technology on learning, what actually happens when students use technology in their education, is inadequate. The extant literature of the impact of technology on learning is fragile and inconclusive. This was the view of the World Bank in March 2005 (*Impact of ICTs on learning and achievement*). In the UK in January 2004 Cox et al (*A review of the research literature relating to ICT and achievement*) reach the same conclusion. In the USA in 2005 similar findings come from the University of California at Santa Barbara.

A detailed search of the literature shows that what research there is is nearly all on the impact of technology on children in American schools. The North Central Regional Educational Laboratory in Napperville, Illinois in the United States comments:

Because effective use of technology must be supported by significant investments in hardware, software, infrastructure, professional development, and support services, over the last decade, we as a nation have made a more than \$66 billion investment in school technology. This unprecedented level of investment in educational technology has raised expectations of legislators and the public who are now looking for returns on this investment, and therefore are calling for evidence regarding the efficacy and cost-effectiveness of technology in K-12 schools.

This emphasis on K-12 (Kindergarten through to High School Matriculation) in the literature highlights one of the difficulties in this study, where the focus is squarely on the impact of technology in adult learning.

There is little or nothing on adult education, on lifelong learning or on distance learning. This research situation is unacceptable in an area that is costing European governments millions of Euros annually.

One of the major manifestations of the use of technology in education is distance education. In distance education the use of technology is essential. It is not a supplement. What the first distance educators did was to break with the 2000 year history of the provision of education by interpersonal communication, between the teacher and the taught, in the learning group, and to replace it with the teacher separated from the learning group, using an apersonal form of communication, mediated by technology.

Today distance education is a rich and complex sector containing five major fields of education and training provision which are detailed here for the first time:

- Distance education – the provision of education and training at a distance by Open Universities, distance education institutions and distance education departments of conventional institutions
- E-learning – e-learning is the provision of education and training via the WWW for students who study mainly as individuals using LMSs (or VLEs) like WebCT, Moodle and Blackboard
- Synchronous e-learning systems – these are the provision of education and training on the WWW to students who study mainly in groups using LMSs like Centra or Horizon Wimba
- The use of the WWW for the provision of education and training on university and college campuses, either as a supplement to lectures and ILT (Instructor Led Training) given on campus or, alternatively, as a substitute for lectures when the courseware is provided on the WWW in the institution in place of lectures
- Mobile learning – the provision of education and training on PDAs (including palmtops and handhelds), smartphones and mobile phones.

The issues raised on the impact of technology on learning in adult learning, lifelong learning and distance learning are so important that the European Commission has agreed to fund a Leonardo da Vinci References Material project on the topic.

The project partners are:

- Ericsson Education Ireland, the international training centre of the major telecommunications company
- Distance Education International, an Irish research and development in distance education institution, based in Dublin, Ireland
- The FernUniversität in Hagen, the German Open University
- The University of Plovdiv, a major Bulgarian university
- Università degli Studi Roma III, a major Italian university with extensive experience of the evaluation of educational outcomes
- Corvinno, the Technology Transfer Centre of the Corvinus University of Budapest in Hungary.

The methodology to be used in the project is based on the *Identifying and implementing educational practices supported by rigorous evidence* of the US Department of Education, Institute of Education Sciences of December 2003, probably the most recent and most authoritative educational research methodology available at present.

Bibliography

The bibliography comprises 75 items. Literature was collected in English, German, Italian and Hungarian. Efforts were made to identify sources in Bulgarian as well, but without success.

The 75 bibliographical items may be grouped for purposes of analysis, under six headings:

- Major classical studies
- Impact of technology on student achievement
- Reviews of the literature
- Identification of issues
- Methodology
- Bibliographies.

Major classical studies

These items are major studies of the impact of technology on education which have become standard works of reference and have stood the test of time. Amongst the studies in this category are:

1. Bates A J (2002) *Technology, Open Learning and Distance Education*. London: Routledge (Routledge Studies in Distance Education Series)

Bates' work both at the Open University of the United Kingdom and at the University of British Columbia was well known and influential.

2. Collis B (1996) *Telelearning in a Digital World: the Future of Distance Learning*. London: Thompson Computer Press.

Collis has been an influential author and this book published at the beginnings of the World Wide Web heralded the success of e-learning.

5. Kozma R (2003) Technology and classroom practices: an international study. *Journal of Research on Technology in Education* Vol 36, September 2003.

Kozma is a well-known American educational technologist and an expert on technology in education.

20. Keegan, D. (1996) *Foundations of distance education*. (3rd edition). London: Routledge

Classic formulation of the theory and practice of distance education.

25. Gagné, R.M., Wager, W.W., Golas, K., Keller, J.M. (2004) *Principles of Instructional Design* 5th edition. Wadsworth Publishing

Major study by Gagné on the nature of the educational transaction.

27. Reigeluth, C. (Ed.) (1999) *Instructional Design Theories and Models: A new paradigm of Instructional Theory (Vol2)*. New Jersey: Lawrence Erlbaum Associates.

Important study by Reigeluth on the nature of instructional theory.

Impact of technology on student achievement

This is a large grouping of studies which detail the impact of technology on student achievement. Included in this grouping would be the following references:

3. Schachter J (1999) Impact of technology on student achievement – what the most current research has to say. Miliken Exchange on Education Technology, Santa Monica.

Important 1999 study of the impact of technology on student achievement.

4. Grace J and Kenny C (2003) A short review of information and communication technologies and basic education in Less Developed Countries—what is useful, what is sustainable? *International Journal of Educational Development* 23 627–636

Study of the impact of technology on learning in the Third World.

8. The World Bank (2005) *Impact of ICTs on learning and achievement* <http://www.infdev.org/> (The World Bank)

World Bank view of the impact of technology on learning and of the literature.

12. Davenport T (2002) *E-learning and the attention economy: here, there, and everywhere* (Linezine)

Davenport concludes that e-learning is frequently organized with no human interface and this is how it achieves its economies.

19. Oliver M (2005) *The impact of technology-enhanced learning on roles and practices in higher education*. London Knowledge Lab, Institute of Education, University of London.

Report of European Commission project on the impact of technology on learning.

22. Alessi, S.M. & Trollip, S.R. (2001). *Multimedia for Learning 3rd edition*. Needham Heights and Bacon

General principles of learning.

23. Holmes, B and Gardner, J (2006). *E-Learning Concepts and Practice*. London and Thousand Oaks Ca, Sage Publications.

The enhancement of the learning experience through e-learning.

24. Mayer, R. E. (ed.) (2005) *The Cambridge Handbook of Multimedia Learning*, Cambridge, Cambridge University Press.

How people learn in computer-based environments.

26. Roberts, T.S., (ed.) (2006) *Self, Peer and Group Assessment in E-Learning*. Information Science Publishing.

Important study of what works in e-learning.

28. Dick, W., Carey, L. & Carey, J.O. (2001) *The Systematic Design of Instruction (5th ed.)*. Addison-Wesley Educational Publishers Inc.

Well known study using a systems approach to the design of instruction.

29. Bromme, R, Hesse, F.W, Spada, H. (Eds.) (2006). *Barriers and Biases in Computer-Mediated Knowledge Communication*. New York: Springer.

Communication in the computer-mediated environment.

30. Gredler, M.E. (2005) *Learning and Instructions, Theory into Practice*. Upper Saddle River, NJ: Pearson.

Contemporary learning theories, inspired by Vygotsky.

31. Juwah, C. (2006) *Interactions in Online Education*. New York and London. Routledge.

The quality of interaction in online education.

56. Vertecchi, B. (1991) 'Un doppio mastery learning per l'Istruzione a Distanza'. *Istruzione a Distanza*. Vol. III/2, pp 1-9

Application of Bloom's taxonomy to distance education. In Italian.

57. Vertecchi, B. (1991) 'Una valutazione analogica per individualizzare l'istruzione', *Istruzione a Distanza*. Vol. III/3, pp 1-12

The importance of individualization in distance education. In Italian.

Reviews of the literature

The next grouping of studies in the bibliography is items which provide a review of the literature on the impact of technology on learning. These are:

6. Cox et al (2004) *A review of the research literature relating to ICT and attainment* commissioned by the UK government DfES (Department of Education and Skills)

UK government study of the research on the impact of technology on learning in UK schools.

7. Kimble, C. (1999). *The impact of technology on learning: Making sense of the research* [policy brief]. Aurora, CO: Mid-continent Regional Educational Laboratory

Study of the research on the impact of technology on learning in American schools.

11. Ringstaff C and Kelley L (2002) *The learning return on our educational technology investment: a review of findings from research*. West Ed: San Francisco.(West Ed Policy Program)

Study of the research on the expenditure on technology in American education and its impact on learning.

74. Szücs, A. (2005) Distance education and e-learning in Central and Eastern Europe - a snapshot on the history and perspectives of the new EU member countries, Lline - Lifelong Learning in Europe 1/2005.

Study on the success of distance education and e-learning in Central and Eastern Europe.

75. Gáspár, P. (2004) Factors and Impacts in the Information Society: Hungary and the New Member States, ICEG European Center.

Study on the success of distance education and e-learning in the new European Union states of Central and Eastern Europe.

Identification of issues

The issues to be identified in this grouping are the importance of studies of the impact of technology on learning by adults, whether it be in contexts of adult learning or lifelong learning or distance learning. These studies include:

9. Noguchi Y (2005) *How women and men use the Internet* (Washington Post)

Article in the Washington Post on the impact of technology on men and women.

32. Twining, P. (2002) *Enhancing the Impact of Investments in 'Educational' ICT*, PhD, Milton Keynes: Open University.

33. Twining P (2001) ICT and the nature of learning, in Paechter, C., Edwards, R., Harrison, R. & Twining, P. (Eds) *Learning, Space and Identify: Challenges of the Information Age*, pp.102-120, London: Paul Chapman Publishing Ltd. ISBN: 0-7619-6939-X.

34. Twining P (2001) Pedagogic re-engineering: issues surrounding the use of new media to support a move from 'didactic' to 'constructivist' models of transaction on an Open University course, in Selinger, M. & Wynn, J. (Eds) *Educational Technology and the impact on teaching and learning*; pp.53-59, Abingdon: Research Machines PLC.

These three studies by Twining highlight that there has been a substantial level of investment in ICT in education over the last thirty years, but it has failed to have a proportionately large impact on learning. The purpose of this research was to identify ways of enhancing the impact of future investments in ICT in education.

42. Baumgartner, P., Kalz, M. (2005) Wiederverwendung von Lernobjekten aus didaktischer Sicht. in *Auf zu neuen Ufern! E-Learning heute und morgen*. Münster: Waxmann Verlag

- Presentation of context independence and pedagogical setting of learning objects. In German.*
47. Schulmeister, R. (2003) *Lernplattformen für virtuelles Lernen*, München: Oldenburg Verlag
- Evaluation of learning platforms and their use in virtual education. In German.*
48. Schulmeister, R. (2001) *Virtuelle Universität. Virtuelles Lernen*, München: Oldenburg Verlag.
- Current uses of digital media in higher education. In German.*
52. Gallina, V. & Vertecchi, B. (2004) *Prevention and diagnosis of Illiteracy. A research project in the Campania region of Italy*. Milano: FrancoAngeli
- Study of illiteracy in Campania in Italy.*
53. Gallina, V. & Vertecchi, B. (2006) *La cultura degli adulti. Il profilo della popolazione sammarinese*. Milano: FrancoAngeli.
- Study of the population of San Marino, including sociological characteristics, education and use of technology. In Italian.*
58. Vertecchi, B. (1994) 'Dove va l'Istruzione a Distanza', *Istruzione a Distanza*. Vol. VI/10, pp 1-8
- Study of the future of distance education. In Italian.*
61. Vertecchi, B. (1995) 'Le fonti di una didattica a distanza', *Istruzione a Distanza*. Vol. VIII/1-2, pp 1-14.
- Analysis of the characteristics of distance education. In Italian.*
63. Hutter, O; Magyar, G; Mlinarics, J (2005): *E-learning, 2005*, Műszaki Könyvkiadó
- In-depth overview of Hungarian e-learning. In Hungarian.*
64. Ehlers, U., Pawlowski, J. (Eds.) (2006): *Handbook on Quality and Standardisation in E-Learning*, New York: Springer.
- Quality and standardization in e-learning systems.*

Methodology

The studies in the bibliography, as might be expected, contain a considerable number of items on the methodology of the impact of technology on learning. These are:

10. Institute of Education Sciences (2003) *Identifying and implementing educational practices supported by rigorous evidence*. (US Government Institute of Education)

Methodology for carrying out scientific studies on the impact of technology on learning.

21. Arnedillo-Sanchez, I., Sharples, M and Vavoula, G. (2007) *Beyond mobile learning workshop*. Dublin: Trinity College (Kaleidoscope Mobile Learning SIG)

Authoritative presentation of methodologies for mobile learning.

35. UNESCO ICT in Education Website (2005) *Indicators for Assessing ICT Impact in Education*.

36. UNESCO (2003) *Consultative Workshop on Performance Indicators for ICT in Education Manila, Philippines, 28-30 August 2002 UNESCO Asia and Pacific Regional Bureau for Education, 2003, 91p*

37. UNESCO Bangkok, (2003) *Developing and Using Indicators of ICT Use in Education/compiled by UNESCO Asia and Pacific Regional Bureau for Education, Bangkok, and Southeast Asian Ministers of Education Organization Regional Centre for Educational Innovation and Technology, Metro Manila, Philippines.*

The UNESCO ICT in Education Website provides a comprehensive resource on developing indicators in education, including many useful links and sections on Standards for evaluation, Assessment tools for ICT in education, Assessing eReadiness, Achievements of ICT use in education and Factsheets. Monitoring and assessing the different ways of using ICT in education gives us the information needed to continuously improve policies, programmes and technologies.

39. Wagner, D. Day B., James, T. Kozma, R., Miller, J. & Unwin, T. (2005). *Monitoring and Evaluation of ICT in Education Projects: A Handbook for Developing Countries*. Pre-publication draft for circulation at the World Summit on the Information Society, Tunis, November 2005, prepared by infoDev.

An introduction and guide for busy policymakers and practitioners grappling with how to understand and assess the ICT-related investments underway in the education sector, focused on developing countries.

40. Newhouse, P (2002) *Measuring the Impact of ICT on Teaching and Learning Prepared for the Department of Education and Training*, Western Australia.

41. Newhouse, P., Trinidad, S., Clarkson, B. (2002) *Quality Teaching and Learning Practice with ICT Prepared for the Department of Education and Training*, Western Australia.

Newhouse's two publications focus measuring and demonstrating the impact of ICT in schools. The second has an additional focus on teacher training for the use of technology in schools in Western Australia.

42. Baumgartner, P., Kalz, M. (2005) Wiederverwendung von Lernobjekten aus didaktischer Sicht. in *Auf zu neuen Ufern! E-Learning heute und morgen*. Münster: Waxmann Verlag

Deals with the reuse of learning objects from a pedagogical perspective. In German.

44. Kerres, M. (2001) *Multimediale und telemediale Lernumgebungen*, München, Oldenburg Verlag

45. Kerres, M., Kalz, M., Stratmann, J., de Witt, C. (2001) *Didaktik der Notebook-Universität*, Münster: Waxmann Verlag

Kerres' two publications discuss the design and implementation of educational media, especially notebooks in the second publication. In German.

46. Miller, D. (2003, Hrsg.) *E-Learning; Eine multiperspektivische Standortbestimmung*, Bern: Haupt Verlag

This anthology spans a spectrum of disciplines ranging from philosophy and educational policies over theory and methodology education, didactics and sociology to economy. Part 1 comprises theoretical foundations of e-learning including detailed psychological, emotional and social aspects of learning processes. Part 2 addresses selected applications undertaken at Swiss universities. Part 3 takes the perspective of students and particularly stresses the daily routine of virtual learning. As seed money is rapidly declining and university resources are cut back as well, a high risk is seen in the loss of further and necessary innovation carried on by highly motivated individuals. In German.

49. Seufert, S, Euler, D. (2005) *Nachhaltigkeit von eLearning-Innovationen: Fallstudien zu Implementierungsstrategien von eLearning als Innovationen an Hochschulen*. St. Gallen: Swiss Centre for Innovations in Learning, SCIL-Arbeitsbericht 4

The authors investigate the question how universities can ensure the sustainability of e-learning innovations in view of constantly reduced seed money and similarly declining institutional resources in a series of case studies.

50. Simon, H. (2003) 'Lernen im digitalen Themenraum. Explorative Lernen im Internet aus kunsthistorischer Sicht', *Zeitenblicke*. Vol. 2, Nr. 1

The author considers the link network of hypertext or hypermedia an inherent part of Internet based learning materials.

51. Peters, O. (2006): Der Wandel der Bedingungen des Lehrens und Lernens: das Verdrängen und Ausschließen des mündlichen Dialogs beim Online-Lernen. GDW-Ph 66, Dezember 2006

As the amount of classes taking place in virtual learning spaces increases, the resulting pedagogical paradigm shift affects an unseen change of awareness. In German.

57. Vertecchi, B. (1991) 'Una valutazione analogica per individualizzare l'istruzione', *Istruzione a Distanza*. Vol. III/3, pp 1-12

Study of possible distance education methodologies. In Italian.

66. Koper, R.; Tattersall, C. (2005) (Eds.): *Learning Design: A Handbook on Modelling and Delivering Networked Education and Training*. 2005, ISBN: 978-3-540-22814-1

To be successful, e-learning must offer effective and attractive courses and programmes to learners, while at the same time providing a pleasant and effective work environment for staff members who have the task to develop course materials

67. Nyíri, K. (2002) Towards a Philosophy of M-Learning, Presented at the IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE 2002), August 29-30, 2002, Växjö, Sweden.

A theoretical approach to mobile learning.

68. Iverson, K., (2005) *E-Learning Games: Interactive Strategies for Digital Delivery*, New York: Prentice Hall

Contains games, simulation exercises, experiential activities, and other active learning approaches that will guide its users as they create engaging, interactive web based courseware.

69. Brusilovsky, P. (2003) Adaptive Navigation Support in Educational Hypermedia: the Role of Student Knowledge Level and the Case for Meta-Adaptation. *British Journal of Educational Technology*, v34 n4 p487-97, Sep 2003

Adaptive hypermedia systems build a model of the goals, preferences and knowledge of each individual user, and use this model throughout the interaction with the user, in order to adapt to the needs of that user.

70. Stash, N, De Bra P (2004) *Incorporating Cognitive Styles in AHA! (The Adaptive Hypermedia Architecture) Web-based Education*, 2004

Adaptive educational hypermedia environments use properties of the application domain (e.g. conceptual structure of a course, with prerequisite relationships) to perform adaptation based on the user's browsing behaviour.

71. Guerra T, Heffernan D.(2004) "The Guerra Scale", Learning Circuits, March 2004.

A useful methodology in that, going up one level in the scale, there is an increase in complexity, functionality, development times, programming capacity, course design capacity and the attention of the experts in the field.

72. Hamilton, L. S, Klein, S. P and Lorie, W. (2000) *Using Web-Based Testing for Large-Scale Assessment*. Rand Corp, National Science Foundation, Arlington, VA. 2000.

An approach to large-scale assessment that uses tests that are delivered to students over the Internet and that are adapted to each student's own level of proficiency.

Bibliographies

A number of the entries are in themselves bibliographies, thereby greatly increasing the literature available from the bibliography.

15. Brown D (1999) *83 professors assess the impact of technology on learning*. First Annual Congress on Assessment: Winston-Salem, North Carolina

Lists 83 studies of the impact of technology on learning.

16. South Carolina Department of Education (2004) *Research: the impact of educational technology*. Columbia: South Carolina.

21 research studies on the impact of technology on learning

18. Spurlin J (2003) *On-line bibliography of the impact of technology on learning*. North Carolina State University.

This is a bibliography on the subject of the impact of technology on learning with citations, references and synopses of at least 40 research studies.

I

1. Bates A J (2002) *Technology, Open Learning and Distance Education*. London: Routledge (Routledge Studies in Distance Education Series)

A major book on the impact of technology on learning for adults of 266 pages. It was widely quoted and became a standard work in the field. A second edition was published by Routledge in 2005 with the title changed to *Technology, E-learning and Distance Education*.

In *Technology, Open Learning and Distance Education*, A. W. (Tony) Bates clearly explains the diversity and application of modern technology used in higher education. Bates has had extensive experience working at the Open University in the UK, Britain's largest and most innovative educational and training organization, and, until recently, the Open learning Agency in British Columbia. Currently he is the Director of Distance Education and Technology at the University of British Columbia. His book is written as much for policy makers and senior education administrators as it is for faculty and curriculum specialists.

Tony Bates believes that major changes in post secondary and workplace training systems are needed to develop a more highly skilled workforce. However, he is cautious about quality and cost effectiveness as various technologies are considered for the teaching and learning process. Bates suggests a decision-making framework, the ACTIONS model, that evaluates technology for: Accessibility for learners; Cost structure; Teaching application; Interactivity or ease of

use; Organizational impact on the educational institution; Novelty; and Speed to which courses can be developed for the technology. These evaluative criteria are used throughout the book as each technology is discussed.

2. Collis B (1996) *Telelearning in a Digital World: the Future of Distance Learning*. London: Thompson Computer Press.

A major book of 651 pages on all aspects of the impact of technology on learning. Collis is a Canadian but she works at the University of Enschede in the Netherlands. The major topics covered are: what are the technologies for being connected?; telelearning and the family; telelearning and the professional; telelearning and K-12; telelearning and the post-secondary instructor; the planning of telelearning in educational institutions; telelearning and the educational technologist; telelearning: the future. The focus is more on adults than on children.

3. Schachter J (1999) *Impact of technology on student achievement – what the most current research has to say*. Miliken Exchange on Education Technology, Santa Monica.

Schachter states that the 'research on the impact of technology on learning is in its infancy'. He gives a competent analysis on what the current research has to say about the impact of technology on student achievement. Published in 1999, his study still has value today. Main examples analysed are from children in US schools.

4. Grace J and Kenny C (2003) *A short review of information and communication technologies and basic education in Less Developed Countries—what is useful, what is sustainable?* *International Journal of Educational Development* 23 627–636 www.elsevier.com/locate/ijedudev

Information and communication technologies such as radio and television have long been used in education. The advent of the technology of the Internet has created pressure for Internet access in primary and secondary schools across the world. This paper reviews some of the available evidence on the impact and cost of such technologies in developing countries. It concludes that while there is strong evidence for the efficacy and efficiency of interactive radio instruction, the evidence on the impact of computer-supported education remains mixed, and costs are prohibitive for many LDCs (less developed countries). The focus is mainly on primary and secondary schools in third world countries.

5. Kozma R (2003) *Technology and classroom practices: an international study*. *Journal of Research on Technology in Education* Vol 36, September 2003.

This study examines the findings from 174 case studies of innovative pedagogical practices using technology from 28 participating countries. The study looks at how classrooms worldwide are using technology to change the practices of teachers and students. Within many of these classrooms, the use of technological tools and resources supports students as they search for information, design products, and publish results. Teachers create structure, provide advice, and monitor progress. Beyond these commonly exhibited practices, the study identifies specific patterns of classroom interaction with technology.

6. Cox et al (2004) *A review of the research literature relating to ICT and attainment* commissioned by the UK government DfES (Department of Education and Skills) on children. <http://www.becta.org.uk> (Becta)

This is an extensive (60 pages) UK government study on the literature on the impact of technology in UK schools. The main findings are:

The evidence from the research literature is much more extensive and more reliable in some areas than in others. There is a more substantial literature base for educational research in science and mathematics into pupils' understanding, alternative conceptions, learning strategies, etc, than there is in the other subjects. Therefore there are more studies of the effects of specific ICT uses on attainment in these subjects. As a consequence of the greater body of evidence, the strongest and most substantiated results for the effects of ICT on pupils' attainment are in science, mathematics and English.

NB: The evidence is that specific uses of ICT, such as using simulations in science, modelling in mathematics or word processing in English, have had a positive effect on pupils' learning, but this does not mean that all and/or any ICT application has been shown to have this effect.

The evidence from the literature shows a positive effect of *specific* uses of ICT on pupils' attainment in almost all the subjects, especially mathematics, science and English. Evidence in other subjects has not yet been substantiated by a series of independent studies. For example there is evidence that using computer database software has a positive effect on pupils' learning of information-handling skills, but there are not many studies yet to support this. Studies reported in the literature have identified a range of factors which influence the outcomes of pupils' learning.

**7. Kimble (1999). *The impact of technology on learning: Making sense of the research* [policy brief]. Aurora, CO: Mid-continent Regional Educational Laboratory
http://www.mcrel.org/PDFConversion/PolicyBriefs/PB_ImpactTechnology.html**

An examination of information from studies on the use of technology in classrooms yields three general observations. First, research studies and meta-

analyses provide evidence of the positive impact of technology on student learning under specific conditions. Second, because research findings often reflect a narrow set of conditions, they require careful interpretation if used to support broad decisions about technology integration. Third, research methods to determine technology's impact on student learning are changing, due to rapid changes in the technology itself and the way it is used.

What can be concluded from a review of studies on the instructional value of technology? Some research studies show technology has a positive impact when drill and tutorial software is used. Others demonstrate an increase in student learning when computers are used for problem solving with a focus on authentic, real-world situations requiring local and global collaboration. Still other studies show technology can make a positive difference in the quality and quantity of writing through the use of improved processes and content. When technology is properly implemented in the classroom, according to research results, it can result in increased student self-confidence and eagerness to learn.

8. The World Bank (2005) *Impact of ICTs on learning and achievement*
<http://www.infdev.org/> (The World Bank)

An authoritative and critical study from the World Bank.

It is generally believed that ICTs can empower teachers and learners, promote change and foster the development of '21st century skills, but data to support these beliefs are still limited. There is widespread belief that ICTs can and will empower teachers and learners, transforming teaching and learning processes from being highly teacher-dominated to student-centered, and that this transformation will result in increased learning gains for students, creating and allowing for opportunities for learners to develop their creativity, problem-solving abilities, informational reasoning skills, communication skills, and other higher-order thinking skills. However, there are currently very limited, unequivocally compelling data to support this belief.

ICTs are very rarely seen as central to the overall learning process. Even in the most advanced schools in OECD countries, ICTs are generally not considered central to the teaching and learning process. Many ICT in education initiatives in LDCs seek (at least in their rhetoric) to place ICTs as central to teaching and learning.

An enduring problem: putting technology before education. One of the enduring difficulties of technology use in education is that educational planners and technology advocates think of the technology first and then investigate the educational applications of this technology only later.

The positive impact of ICT use in education has not been proven. In general, and despite thousands of impact studies, the impact of ICT use on student achievement remains difficult to measure and open to much reasonable debate.

9. Noguchi Y (2005) *How women and men use the Internet* (Washington Post)

This is a report from the *Washington Post* on 29 December 2005 on the latest research on how women and men use the Internet. The main findings are:

"I think the real interesting story is the young women, because that is the one age cohort where there are many more women online," said Deborah Fallows, who wrote the report based on findings from surveys conducted over the past five years. "The younger women are just much more comfortable with the Internet."

The report found that 86 percent of women ages 18 to 29 were online, compared with 80 percent of men in the same age group. Among African Americans, 60 percent of women are online, compared with 50 percent of men.

Percentage of men and women who go online

	Men	Women
Online overall	68%	66%
Age		
18-29	80	86
30-49	76	79
50-64	63	66
65+	34	21
Education		
No high school diploma	32	27
High school	58	56
Some college	79	79
College graduate or graduate degree	89	89
Race		
White	70	67
Hispanic	67	66
Black	50	60
Other	72	66
Annual household income		
< \$30,000	49	48
\$30,000 - \$50,000	66	76
\$50,000 - \$75,000	84	87
> \$75,000	90	95
Marital status		
Married	72	75
Not married	62	56
Parental status		
Parent (of child under 18)	81	80
Non-parent	61	57

In other age groups, the disparity is only slight, with women outpacing men by 3 percentage points. However, among the older group, those age 65 and older, 34 percent of men are online, compared with 21 percent of women.

10. Institute of Education Sciences (2003) *Identifying and implementing educational practices supported by rigorous evidence.*

<http://www.ed.gov/print/rschstat/research/pubs/rigorousetid/guide.html>

(US Government Institute of Education)

Authoritative study from the United States Department of education on methodological requirements for Identifying and implementing educational practices supported by rigorous evidence.

11. Ringstaff C and Kelley L (2002) *The learning return on our educational technology investment: a review of findings from research.*

West Ed: San Francisco.(West Ed Policy Program)

<http://www.aacompcenter.org/cs/wested/view/tpc/12>

As numerous researchers have pointed out measuring the impact of technology use on student achievement is fraught with difficulties. Classrooms are not experimental laboratories where scientists can compare the effectiveness of technology to traditional instructional methods while holding all other variables constant. Moreover, few reliable, valid, and cost-effective assessments exist that measure students ' higher-order thinking skills, problem-solving ability, or capacity to locate, evaluate, and use information — skills that many researchers and teachers believe can be enhanced through technology use. Technology has also been shown to increase student motivation and engagement, prepare students for jobs, and enhance students ' ability to work collaboratively, but we have few, if any, tools and methods to measure impact in these domains. Thus, it is not surprising that the impact of technology on education continues to be debated by educators and researchers alike.

Debates aside, there is a substantial body of research that suggests that technology can have a positive effect on student achievement under certain circumstances and when used for certain purposes. However, there is no magic formula that educators and policymakers can use to determine if this "return " is actually worth the "investment." Perhaps,, rather than asking, "Is technology worth the cost?" the more important question is,, "Under what conditions does technology have the most benefits for students?" The research presented in this paper seeks to answer this question, and offers some suggestions — related to issues such as teacher training,, access to technology, and long-term planning — that policymakers should seriously consider as they seek to enhance student learning through technology use.

12. Davenport T (2002) *E-learning and the attention economy: here, there, and everywhere* (Linezine) <http://www.linezine.com/5.2/articles.htm>.

"eLearning and the Attention Economy: Here, There and Everywhere?" by Thomas H. Davenport. Discusses the attention (a scarce resource) crisis in terms

of how much information is available and how we manage it. How much attention is devoted to learning (in many cases as much as 17 years) and attending to attention (how you manage your attention).

Davenport concludes that e-learning is frequently characterized by the absence of a human tutor in the system and this is how it achieves its cost-effectiveness.

13. NCREL (2001) *Using technology to improve student achievement*. North Central Regional Educational Laboratory: Napperville, Illinois
<http://www.ncrel.org/sdrs/areas/issues/methods/technlgy/te800.htm>

Because effective use of technology must be supported by significant investments in hardware, software, infrastructure, professional development, and support services, over the last decade, we as a nation have invested more than \$66 billion investment in school technology (QED, 2004). This unprecedented level of investment in educational technology has raised expectations of legislators and the public who are now looking for returns on this investment, and therefore are calling for evidence regarding the efficacy and cost-effectiveness of technology in K-12 schools.

While complex factors have influenced the decisions for where, what, and how technology is introduced into our nation's school systems, ultimately, the schools will be held accountable for these investments. How can schools ensure that the promise that technology holds for student achievement is realized? What factors need to be in place to support the effective use of technology? What resources can school districts use to help them plan for technology that will have a positive impact on student achievement, and how can they justify that investment?

To answer these questions, educators need to look at the research on technology and student achievement and the contextual factors that affect learning goals. In this updated briefing, current research perspectives are examined and findings on using technology to improve student achievement are presented.

14. Bransford, Brown and Cocking (1999) *Technology to support learning in How people learn*. National Academy of Sciences.

This is Chapter 9 of a major book by the authors called *How people learn* and published by the National Academy of Sciences in the USA.. The authors conclude:

Because many new technologies are interactive, it is now easier to create environments in which students can learn by doing, receive feedback, and continually refine their understanding and build new knowledge. The new technologies can also help people visualize difficult-to-understand concepts, such as differentiating heat from temperature. Students can work with

visualization and modeling software that is similar to the tools used in nonschool environments, increasing their understanding and the likelihood of transfer from school to nonschool settings. These technologies also provide access to a vast array of information, including digital libraries, data for analysis, and other people who provide information, feedback, and inspiration. They can enhance the learning of teachers and administrators, as well as that of students, and increase connections between schools and the communities, including homes.

15. Brown D (1999) *83 professors assess the impact of technology on learning*. First Annual Congress on Assessment : Winston-Salem, North Carolina. www.wfu.edu/~brown/dgbrown.htm

This is the first written public report on a major study of 93 computer-intensive courses taught in 36 of Yahoo's 100 most wired campuses. The professors who designed and taught these courses were asked why, after observing the results of their change to computer-enhanced instruction, they continued to spend the extra time and effort that computer enhanced teaching requires. From their answers it has been possible (inductively) to (1) craft a typology for the assessment of the impact of technology upon learning, and (2) collect a rich array of specific measured results. This brief paper is divided into 3 parts: the typology, stories about five outstanding efforts to measure results, and the measured results from the 93 courses.

16. South Carolina Department of Education (2004) *Research: the impact of educational technology*. Columbia: South Carolina.

A listing of 21 research studies on the impact of technology on learning by the Department of Education of South Carolina.

The overriding message that can be gleaned from most current research on the implementation of computer-based technology in K–12 education is that technology is a means, not an end; it is a tool for achieving instructional goals, not a goal in itself. And yet, many schools and districts have invested in computer-based technology before establishing clear plans for how to use this important tool.

In today's world, computer-based technology is not a frill, but an important component of any modern curriculum. During the last decade, technology expenditures tripled in K–12 schools in the United States; estimates suggest that over \$6 billion was spent in 1999–2000.

The world outside the United States is rich with lessons about how technology can be used in schools. This study presents a groundbreaking overview of technology in schools around the world.

17. Virginia Tech (1998) *Impact of technology on learning symposium* scheduled Virginia: Virginia Tech University.

Announcement of "The Impact of Technology on the Learning Environment," a two-day symposium scheduled for March 30-31, 1998 at Virginia Tech University, focused on the way information technology changes learning in higher education, K-12 education, corporate training, and other learning communities. Deals with higher education and corporate training, besides schools.

**18. Spurlin J (2003) *On-line bibliography of the impact of technology on learning*. North Carolina State University.
http://www.fis.ncsu.edu.upa/bibliography/show_all.asp**

This is a major bibliography on the subject of the impact of technology on learning with citations, references and synopses of at least 60 research studies. The focus is all aspects of the impact of technology on learning ranging from the use of computers in school classrooms to the use of all forms of technologies in adult education.

19. Oliver M (2005) *The impact of technology-enhanced learning on roles and practices in higher education*. London Knowledge Lab, Institute of Education, University of London.

This is a European Commission project on *The impact of technology-enhanced learning on roles and practices in higher education*. The lead partner is the Institute of Education at the University of London. The other partners are from the University of Lancaster (United Kingdom), University of Sofia (Bulgaria), University of Bergen (Norway) and the University of Twente (Netherlands).

This project, which commenced in January 2005, will explore the impact of introducing new forms of technology into the roles and practices of those working in Higher Education, focusing primarily on teachers. There are two objectives: To explore the impact of new forms of technology on roles and practices, and To identify the kinds of intervention best suited to supporting staff within the processes of change that surround the introduction of technology-enhanced learning.

The focus is on adults in higher education and not on school children.

20. Keegan, D. (1996) *Foundations of distance education*. (3rd edition). London: Routledge.

This is a comprehensive study of the field of distance education. The book treats successively the concept of distance education, theories of distance education, synthesis of distance education systems and evaluation of distance education systems. There are chapters on the study of distance education, the differences

between non-traditional, open and distance education and the definition of distance education. A presentation of the leading theorists of the time follows. This is followed by a new theoretical formulation and a typology of distance education systems. The economics of distance education are presented and there are case studies of selected systems, including the Chinese Dianda system. The book quickly became a standard text for degrees in distance education at universities around the world.

21. Arnedillo-Sanchez, I., Sharples, M and Vavoula, G. (2007) *Beyond mobile learning workshop*. Dublin: Trinity College (Kaleidoscope Mobile Learning SIG)

Proceedings of a mobile learning workshop held at the CSCL Alpine Rendez Vous in Switzerland. Sharples introduces the proceedings thus: Mobile Learning is relatively new in the field of TEL, and therefore it has different meanings for different communities. For our interdisciplinary research group, it means learning: with portable technologies, with a focus on the technology (which could be in a fixed location, such as a classroom); across contexts, in which the focus is on the learner, using portable or fixed technology; across locations and transitions, focusing on learning in a mobile world and on the mobile society.

II

22. Alessi, S.M. & Trollip, S.R. (2001). *Multimedia for Learning*. 3rd edition. Needham Heights and Bacon.

The third edition of this book is organised in 3 parts. Part 1 discusses General Principles of learning including learning principles and approaches such as Behavioural, Cognitive and Constructivist Psychology Principles. Also in Part 1, the authors turn their attention to a review of software characteristics. Part 2 covers Methodologies such as Tutorials, Hypermedia, Drills, Simulations and Games. Part 3 is concerned with Design and development issues.

23. Holmes, B and Gardner, J (2006). *E-Learning Concepts and Practice*. London and Thousand Oaks Ca, Sage Publications.

In *e-Learning: Concepts and Practices* Holmes and Gardner examine e-learning as an essential component of education. The examples cited allow for an examination of e-learning in a global context. Of particular interest are the focus on knowledge based economies, learner empowerment and the enhancement of the learning experience through e-learning.

24. Mayer, R. E. (ed.) (2005) *The Cambridge Handbook of Multimedia Learning*, Cambridge, Cambridge University Press.

The Handbook is concerned with research and theory in the field of multimedia learning. The editor defines the focus as being on how people learn from words and pictures in computer-based environments, to establish what works and to explain how it works.

25. Gagne, R.M., Wager, W.W., Golas, K., Keller, J.M. (2004) *Principles of Instructional Design 5th edition*. Wadsworth Publishing

This text on for instructional design is based in cognitive psychology and information-processing theory. Nine stages of instructional design procedure are outlined. Learning in a social and cultural context is the main focus of the text as well as “the affordances of new technologies and learning environments”.

26. Roberts, T.S., (ed.) (2006) *Self, Peer and Group Assessment in E-Learning*. Information Science Publishing

This text covers both secondary and university level courses over a wide variety of subject areas from second language learning to engineering. There are 13 contributions from researchers involved in the area.

27. Reigeluth, C. (Ed.) (1999) *Instructional Design Theories and Models: A new paradigm Of Instructional Theory (Vol2)*. New Jersey: Lawrence Erlbaum Associates.

The editor describes instructional theory as helping people learn better. Vol 2 of the text provides a summary of the new methods of instruction. Each chapter contains a foreword that summarizes the major elements of each instructional-design theory.

Overall, the volume fulfills a number of important functions and provides a positive direction for moving ahead with efforts to instantiate learning environments that reflect modern views of learning and social, affective development. It brings together an impressive array of theorists focused on issues of instructional-design for fostering cognitive, physical, and affective areas of education and training. (*Contemporary Psychology*)

28. Dick, W., Carey, L. & Carey, J.O. (2001) *The Systematic Design of Instruction (5th ed.)*. Addison-Wesley Educational Publishers Inc.

The authors view instruction as a systematic process in which all components: teachers, learners, materials and learning environment, are crucial to the learning process. The authors present a systems approach model to be applied to the

design of instruction. Chapter 5 is of particular interest, focusing as it does on Learner Analysis and Collection of Data for Learner Analysis.

29. Bromme, R, Hesse, F.W, Spada, H. (Eds.) (2006). *Barriers and Biases in Computer-Mediated Knowledge Communication*. New York: Springer.

The text examines restrictions and new possibilities for communication in the computer-mediated environment. Contributions are from the fields of psychology, education and Computer sciences. Chapters include: Collaborative Knowledge Construction in Computer-Mediated Environment , How to support Synchronous net-based learning Discourses and Technology affordances for Intersubjective learning and how they may be exploited.

30. Gredler, M.E. (2005) *Learning and Instructions, Theory into Practice*. Upper Saddle River, NJ: Pearson.

The text examines contemporary learning theories with an emphasis on the work of the Russian psychologist, Vygotsky.

31. Juwah, C. (2006) *Interactions in Online Education*. New York and London: Routledge.

The text examines the quality of interactivity in online learning. Part 1 examines Theoretical and pedagogical perspectives in e-learning. Part 2 examines the Design and learning environment with a focus on designing interaction as a dialogue game. Part 3 examines interactions in the areas of online discussions, teaching by videoconferencing and Interaction in online peer learning.

III

32. Twining, P. (2002) *Enhancing the Impact of Investments in 'Educational' ICT*, PhD, Milton Keynes: Open University.

There has been a substantial level of investment in ICT in education over the last thirty years, but it has failed to have a proportionately large impact on learning. The purpose of this research was to identify ways of enhancing the impact of future investments in ICT in education. A proposition about one way to do this emerged from the literature. Empirical examination of this proposition highlighted deficiencies in the model and suggested that developing a framework for describing computer use in education would be a more productive approach. Existing frameworks were examined in the light of the data from the first three case studies, revealing significant weaknesses with them. This analysis resulted in the development of a set of criteria for evaluating frameworks for describing computer use in education. A new framework, the Computer Practice Framework (CPF), was then devised, based on key dimensions evident within the first three case studies. The CPF was evaluated against the criteria through further

fieldwork in schools and higher education. This led to the refinement of the CPF and indicated that using it as a conceptual framework for thinking about computer use in education could help to create shared visions of the purposes underpinning investments in computer use in education. Using the CPF to support vision building, school development, curriculum planning, communication and shared understandings can enhance the likelihood of such investments having their intended impacts. The development of the CPF thus represents an original contribution to the field, which has the potential to enhance the impact of investments in ICT in education.

33. Twining P (2001) ICT and the nature of learning, in Paechter, C., Edwards, R., Harrison, R. & Twining, P. (Eds) *Learning, Space and Identify: Challenges of the Information Age*, pp.102-120, London: Paul Chapman Publishing Ltd. ISBN: 0-7619-6939-X.

This book looks at the theoretical potential impact of ICT on the design of an undergraduate distance education course at the Open University. Presents evidence from the developmental testing of that course about the actual impact of the ways in which ICT was incorporated in the course and the practical implications of this.

34. Twining P (2001) Pedagogic re-engineering: issues surrounding the use of new media to support a move from 'didactic' to 'constructivist' models of transaction on an Open University course, in Selinger, M. & Wynn, J. (Eds) *Educational Technology and the impact on teaching and learning*, pp.53-59, Abingdon: Research Machines PLC.

In the context of the Open University in the United Kingdom - and developing a new course – evidence was needed that the proposed use of new technology would significantly enhance student learning and hence justify the costs of software development and integration with other course materials. Theoretical evidence was provided from a number of sources - literature on computer use and pedagogical re-engineering; theoretical analysis of the proposed course components using Laurillard's Media Mix Model and Twining's Computer Practice Framework. This evidence suggested that the proposed use of new technology would alter practice in a way that would enhance student learning (assuming a social constructivist view). Developmental testing of the course provided further evidence to support the conclusions reached in the original theoretical analysis, but also highlighted limitations with the theoretical analyses in terms of their focus. Neither framework identified all of the changes that close integration of new technologies would have on the student learning experience.

35. UNESCO ICT in Education Website (2005) *Indicators for Assessing ICT Impact in Education*. <http://www.unescobkk.org/index.php?id=662>

The UNESCO ICT in Education Website provides a comprehensive resource on developing indicators in education, including many useful links and sections on Standards for evaluation, Assessment tools for ICT in education, Assessing eReadiness, Achievements of ICT use in education and Factsheets. Monitoring and assessing the different ways of using ICT in education gives us the information needed to continuously improve policies, programmes and technologies. Therefore the development of performance indicators for assessing ICT Impact in Education has been one of the major supporting elements in the ICT in Education programme.

36. UNESCO(2003) *Consultative Workshop on Performance Indicators for ICT in Education Manila, Philippines, 28-30 August 2002 UNESCO Asia and Pacific Regional Bureau for Education, 2003, 91p.*

To study and assess the actual impact of the utilisation of ICT, UNESCO is conducting the "Performance Indicators on ICT for Education Programme", an international undertaking funded by the Japanese Funds-in-Trust (JFIT). The Project will develop a structure of indicators to measure ICT use in education and provide a basis for policy planning and programme improvements, specifically demonstrating how ICT is raising standards in education, serving as a catalyst for educational change.

37. UNESCO Bangkok, (2003) *Developing and Using Indicators of ICT Use in Education/compiled by UNESCO Asia and Pacific Regional Bureau for Education, Bangkok, and Southeast Asian Ministers of Education Organization Regional Centre for Educational Innovation and Technology, Metro Manila, Philippines.*

The material presents Introduction: Indicators and Rationale of Use , Using Indicators to Assess Impact of ICT in Education, Methods of Collecting Indicators, Various Software or Database Systems for Storing Indicators, ICT Indicators Used in Different Countries, Comparison of ICT Indicator Themes in Selected Countries, Studies on the Use and Impact of ICT in Education.

38. Haddad, W., Draxler, A. (eds) (2002) *Technologies for Education: Potential, Parameters and Prospects*, Prepared for UNESCO by Knowledge Enterprise, Inc. www.KnowledgeEnterprise.org

Drawing on the wealth of worldwide knowledge and experience, this book analyses the rationales and realities of ICTs for education, examines the options and choices for applying them and identifies a series of case studies to illustrate aspects of integrating ICTs into learning systems in different environments. How

ICTs can promote improvements in educational reach and delivery is considered, along with issues of content, learning outcomes, teaching, quality and relevance in developing countries.

39. Wagner, D., Day, B., James, T., Kozma, R., Miller, J., & Unwin, T. (2005). *Monitoring and Evaluation of ICT in Education Projects: A Handbook for Developing Countries*. Pre-publication draft for circulation at the World Summit on the Information Society Tunis, November 2005, prepared by infoDev.

This publication – *Monitoring and Evaluation of ICTs in Education: A Handbook for Developing Countries* – is intended as an introduction and guide for busy policymakers and practitioners grappling with how to understand and assess the ICT-related investments underway in the education sector. This short but comprehensive work is specifically designed to meet the needs of developing countries, and it is hoped that its publication will help to stimulate further efforts in this emerging and very important field.

40. Newhouse, P. (2002) *Measuring the Impact of ICT on Teaching and Learning. A review of the literature*. Perth, Western Australia: Specialist Educational Services.

These documents identify current research on strategies related to measuring and demonstrating the impact of ICT in schools. measuring and demonstrating the impact of ICT in schools. The Impact of ICT on Learning and Teaching - This literature review set out to identify and evaluate relevant strategies in local, national and international research and initiatives related to measuring and demonstrating the impact of ICT in schools with regard to: students, learning and the learning environment; teachers and teaching strategies; organisational change; and other areas relevant to teaching and learning in WA government schools. A Framework to Articulate the Impact of ICT on Learning in Schools - This document provides a framework to articulate the areas of impact of ICT in schools and strategies for monitoring and evaluating each of the areas of impact at the school and system levels.

41. Newhouse, P., Trinidad, S. and Clarkson, B. (2002) *Quality Teaching and Learning Practice with ICT Prepared for the Department of Education and Training*, Perth, Western Australia: Specialist Educational Services.

These documents identify the current research on the characteristics of effective learning and teaching with ICT and stages of teachers' progress as they develop successful practices. Quality Pedagogy and Effective Learning with Information and Communications Technologies (ICT) - A review of the literature on the progression of teachers in their integration of ICT in learning and teaching processes. Teacher Professional ICT Attributes Framework - This framework describing and monitoring the progression of teachers in their integration of ICT

in learning and teaching processes was developed from the review of the literature above.

IV

42. Baumgartner, P., Kalz, M. (2005) Wiederverwendung von Lernobjekten aus didaktischer Sicht. in *Auf zu neuen Ufern! E-Learning heute und morgen*. Münster: Waxmann Verlag

(English Title: *Reuse of Learning Objects from a Pedagogical Perspective*)

This paper aims to reconcile the contradiction between context independence of learning objects, which is necessary to enable their re-use in multiple application contexts, and its pedagogical setting, which is necessary to make a learning object particularly useful for specific groups of learners. The authors suggest separating the information content of an object from pedagogical context including learning objective, recommended activities or elaborate pedagogical scenarios. The former is called information object, the latter educational object. An information object has a structure and preserves information in the form of a closed set of related digital assets including text, visual, audio, video or animated data, or computer simulated processes. If well designed, information objects can be re-used in different pedagogical situations by associating concrete pedagogical facets with an Information object. The article presents the conceptual foundations developed for the design and implementation of a novel learning object repository, CampusContent, which is currently developed at FernUniversität in Hagen.

43. Geißler, S., Hampel, T., Keil-Slawik, R. (2004) 'Kooperatives Lernen als integrativer Ansatz für eine mediengestützte Bildung', *i-com*. Vol 2., 5-12 <http://www.i-com-media.de/> (26 March 2007)

(English Title: *Cooperative Learning as an Integrative Approach towards media-supported Education*)

The authors characterize current e-learning environments that just provide functions to combine the production, publication and reception (mostly reading) of learning material but do not allow students to modify or integrate it into other contexts as "one-way road to learning". They propose the concept of virtual knowledge spaces that allows them to support a great variety of individual and cooperative forms of learning by distinguishing a conceptual, a technical, and a presentational perspective. The prototype of a learning environment that adopts this model and is designed for a class on software ergonomics aims to illustrate the practical consequences and benefits of this multi-perspective approach.

44. Kerres, M. (2001) *Multimediale und telemediale Lernumgebungen*, München, Oldenburg Verlag

(English Title: Multimedia and Telemedia learning Environments)

This book systematically presents the process of designing and implementing educational media. It consists of four parts: 1) media pedagogy, 2) learning theories including programmed instruction, tutoring systems and situated learning, 3) design issues addressing questions like intended objectives, potential obstacles, characteristics of users, advantages for users, pedagogical design of content, knowledge types and cognitive processes, structuring and navigation design and 4) the implementation of multimedia learning environments. According to the author, the use of digital media in education is triggered by an education problem and this problem can only be solved if the design of educational media precisely reflects the concrete conditions of the actual pedagogical field. The intended target group includes students in computer science and pedagogical disciplines, educational media designer educators and managers.

45. Kerres, M., Kalz, M., Stratmann, J., de Witt, C. (2001) *Didaktik der Notebook-Universität*, Münster: Waxmann Verlag

(English Title: *Pedagogy of Notebook Universities*)

From a media pedagogical perspective, this book examines the potential of notebooks for the innovation of higher education. In particular, it aims to identify the added value of this type of mobile computer equipment for teaching and learning and what impact the introduction of notebooks has on the daily life and work in a campus university. The contributions of this book cannot provide a comprehensive answer to these questions because of insufficiently broad experiences in German speaking universities at the time of publication. As the authors also consider it too early to provide a comprehensive pedagogical setting for this technology, the book presents a range of scenarios in which notebooks were systematically used in teaching and learning processes. These scenarios serve to reveal accepted advantages by reporting on experiences and evaluation results. They also demonstrate that successful implementations imply an extensive re-organization of higher education and of digital media, communication and information services towards integrated information management supporting teaching and learning, examination, administration, research, publication and other academic needs.

46. Miller, D. (2003, Hrsg.) *E-Learning; Eine multiperspektivische Standortbestimmung*, Bern: Haupt Verlag

This anthology spans a spectrum of disciplines ranging from philosophy and educational policies over theory and methodology education, didactics and

sociology to economy. The book is separated in three parts. Part 1 comprises theoretical foundations of e-learning including detailed psychological, emotional and social aspects of learning processes. Particular emphasis is put on a critical evaluation of the social isolation of learners, which is often raised by e-learning opponents. A concluding resume of this part sketches some political demands including sufficient financial resources, cooperation between educational institutions, blending of different methodological approaches, integrated evaluation and quality assurance. Position statements and experience reports of students are also included here. Part 2 addresses selected applications undertaken at Swiss universities. The authors of these articles do not hide their reservation against political ignorance, economic misjudgement and bureaucratic monopolisation of e-learning efforts ("Changes begin with visions and end in bureaucracy."). Part 3 takes the perspective of students and particularly stresses the daily routine of virtual learning. As seed money is rapidly declining and university resources are cut back as well, a high risk is seen in the loss of further and necessary innovation carried by highly motivated individuals.

47. Schulmeister, R. (2003) *Lernplattformen für virtuelles Lernen*, München: Oldenburg Verlag

(English Title: *Learning Platforms for Virtual learning*)

This book combines current research about the evaluation of learning platforms with pedagogical reflections about their use in virtual education. It also serves as basic textbook. The first part comprehensively takes stock of learning platforms used around the world and emphasizes criteria and methods to evaluate such platforms. The results of a usability study undertaken with five systems in more than thirty projects are presented. The second part explains facets of pedagogical design of complex learning systems, presents a taxonomy of learning objects and addresses pedagogical questions including: How to distinguish and compare pedagogical scenarios? How to design the structure of digital learning materials? How can the navigation through dynamic pages of networked learning materials be controlled, e.g. by Meta data? What is and how important is interactivity of learning objects?

48. Schulmeister, R. (2001) *Virtuelle Universität. Virtuelles Lernen*, München: Oldenburg Verlag

(English Title: *Virtual University, Virtual Learning*)

This book combines political demands in higher education and forecasts about future market developments related to virtual universities with empirical descriptions of current uses of digital media in higher education. The book aims to identify trends and their strengths and weaknesses and open the debate about useful strategies for personal engagement. Topics include: national and international Trends, theories about types and classes of virtual learning, theories

about particular effects of digital media such as interactivity and self-paced learning, concepts and models of online seminars, standardisation and benchmarking approaches. Schulmeister claims that the presentation of learning content in virtual environments should not follow the systematic form of presentations of scientific content in textbooks but rather use an inductive presentation form as it better fits virtual environments and the hypertext paradigm.

49. Seufert, S, Euler, D. (2005) *Nachhaltigkeit von eLearning-Innovationen: Fallstudien zu Implementierungsstrategien von eLearning als Innovationen an Hochschulen*. St. Gallen: Swiss Centre for Innovations in Learning, SCIL- Arbeitsbericht 4, <http://www.scil.ch/publications/docs/2005-01-seufert-euler-nachhaltigkeit-elearning.pdf> (26 March 2007)

(English Title: *Sustainability of eLearning Innovations: Case Studies about Implementation Strategies for e learning at Universities*).

The authors investigate the question how universities can ensure the sustainability of e-learning innovations in view of constantly reduced seed money and similarly declining institutional resources along a series of case studies. They particularly focus on criteria that have a positive impact on sustainable implementations. After a brief introduction, Chapter 2 presents the design of the empirical research. Chapter 3 presents the results of four case studies undertaken at three Swiss and one German university. These universities have chosen quite different approaches, including: a pedagogy driven reform process used in St. Gallen or a marketing-oriented approach towards e-learning in Stuttgart. Chapter 4 summarises the findings and proposes a modification of the authors' strategy classification model. The report includes an abundance of details resulting from a systematic analysis of the dimensions pedagogy, technology, economy, organisation and culture.

50. Simon, H. (2003) 'Lernen im digitalen Themenraum. Exploratives Lernen im Internet aus kunsthistorischer Sicht', *Zeitenblicke*. Vol. 2, Nr. 1, <http://www.zeitenblicke.de/2003/01/simon/index.html> (26 March 2007)

(English Title: *Learning in Topic Spaces: Explorative Learning in the Internet from a History of Arts Perspective*)

While the reader of a textbook typically follows the presentation sequence given by the author, readers of hypermedia continuously need to decide which link to follow. For authors of such systems this means that their offers must allow its users to construct their knowledge following their own pace and path. The author considers the link network of hypertext or hypermedia an inherent part of Internet based learning materials, which makes them also unsuited for linear presentation on paper. The hyperspace offers better opportunities for the integration of multiple perspectives and multiple directions to navigate in that space. These two dimensions nicely correspond to the observation that the topics investigated in

humanities rarely come with a single opinion but historical, political, economic and social considerations enable different views on the same topic. The author also claims for more professionalism of learning content and suggests getting inspiration from computer game industry (edutainment). He reports on the experiences of an interdisciplinary project that involved competences in media pedagogy, archaeology, and media design and developed an explorative learning environment in archaeology.

51. Peters, O.(2006) Der Wandel der Bedingungen des Lehrens und Lernens: das Verdrängen und Ausschließen des mündlichen Dialogs beim Online-Lernen. GDW-Ph 66, Dezember 2006

(English Title: *About the Change of Teaching and Learning Conditions: Displacement and Exclusion of Oral Dialogs in Online Learning*)

Recent studies show that the significance of online learning is increasing worldwide. Indicators include a growing number of virtual MSc programmes in different countries and the emergence of virtual and cooperative universities. As the amount of classes taking place in virtual learning spaces increases, the resulting pedagogical paradigm shift affects an unseen change of awareness. Some proponents of such educational scenarios even consider traditional classroom conversation outdated. In many publications about online learning the option of face-to-face meetings isn't even mentioned. This observation caused the author to investigate whether such views are correct and he tries to find answers to the question whether this is the beginning of a development that should cause the pedagogical experts' concerns. In the main body of the paper the author first identifies several deficits of dialogs performed in virtual learning spaces based on empirical results and supplements them with scientific reservations. Then he contrasts these findings with a conceptual analysis of the potentials of an oral dialog in classrooms along the dimensions space, time, physical presence, group experiences and others. This elaboration is then put in the context of social sciences to find empirically founded interpretations of the concept and role of dialogs. Different forms of dialogs are dissected before the author concludes that oral dialogs and the physical presence of dialog partners are indispensable in online learning scenarios, too.

V

52. Gallina, V. & Vertecchi, B. (2004) *Prevention and diagnosis of Illiteracy. A research project in the Campania region of Italy*. Milano: FrancoAngeli

The Predil Project aims to provide local institutions (regional, provincial and municipal authorities), employment training policy-makers, trade unions, associations and voluntary groups involved in the social sphere with tools to establish literacy profiles for the adult population and to define the characteristics

of the contexts making up the socio-cultural reference networks of adult citizens in the various areas of the region. The availability of effective tools for interpreting individual training and education needs in Campania is an essential support for active employment policies and in order to work out effective orientation and re-orientation actions in the various territorial contexts.

53. Gallina, V. & Vertecchi, B. (2006) *La cultura degli adulti. Il profilo della popolazione sammarinese*. Milano: FrancoAngeli

This book illustrates the results of a research project about a population sample of San Marino Republic developed by the Observatory on Cultural Profile. Nowadays, it is widely recognized that the adult population in industrialized countries tends to split in two strands: scientific progress and the innovation in economic activities depends on the first strand of population, with high levels in literacy skills, whereas the second, even if capable of consuming, appears progressively destined to have minor roles in cultural, economic and political field. To save and to increase literacy skills through lifelong learning represents a condition for democratic life in a country.

54. Vertecchi, B. (Ed.), Acciaroli, L., Domenici, G., La Torre, M., Nardi, E. & Russo Agrusti, T. (1988) *Insegnare a distanza*. Firenze: La Nuova Italia

The book offers an outline of the first academic programme in distance education realized by the Dipartimento di Scienze dell'Educazione of University of Roma Tre and directed to a public mainly composed by teachers of primary and secondary schools. An evolutive theory descended from these experiences, including already the need for producing automatic solutions for assessment and for students' support in learning.

55. Vertecchi, B. (Ed.), La Torre, M., Marconi A., Nardi, E. & Scalera, V. (1991) *Thesaurus dell'Istruzione a Distanza*. Napoli: Tecnodid

The beginning of distance education is characterized by a great uncertainty in terminology (lexicon) that constituted in many cases an obstacle to comprehension, particularly if essays taken from scientific literature had to be read by different mother tongue speaking students. Therefore, it was important to create a thesaurus which included a distance education lexicon in several different European languages, French, English, German, Spanish and Italian. The thesaurus offers both word correspondences and conceptual summaries of underlying issues.

56. Vertecchi, B. (1991) 'Un doppio mastery learning per l'Istruzione a Distanza', *Istruzione a Distanza*. Vol. III/2, pp 1-9

Starting from mastery learning theory formulated by B.S. Bloom, the article considers the opportunity of adapting educational procedures to the particular

needs of distance education in order to realize strongly individualized solutions and to achieve an high quality in instruction through them. Compared with mastery learning created for direct interaction, this hypothesis designs an organizational procedure that increases the differentiation of the message.

57. Vertecchi, B. (1991) 'Una valutazione analogica per individualizzare l'istruzione', *Istruzione a Distanza*. Vol. III/3, pp 1-12

The aim of this article is to present an assessment theory based on the forecast of the difficulty in learning instead of its measurement *a posteriori*. The objective of this procedure is to accelerate the processes and to improve their quality, removing whenever it is possible time consuming activities to compensate students' errors. The analogical assessment is based on the request of performances that include operations not strictly linked to learning objectives but linked to these in a proximity relationship.

58. Vertecchi, B. (1994) 'Dove va l'Istruzione a Distanza', *Istruzione a Distanza*. Vol. VI/10, pp 1-8.

Facing overwhelming technological innovations, it is right to ask if these represent actual new scenarios or if new tools hide conservative approaches. The doubt is solved positively only in the case of a strong commitment in pedagogical research, not subordinate to the availability of technological tools.

59. Vertecchi, B. (1994) 'Lo sviluppo dell'istruzione a distanza. Invito alla riflessione', *Istruzione a Distanza*. Vol. VI/11-12, pp 1-6

The different stages in distance education development followed the introduction of solutions which could improve the message communication. Since the beginning, this link has been observed. In fact, the introduction of stamps enabled the birth of mail education, as well as radio and then television diffusion represented the starting point for circular messages in transferring learning contents. It is important to investigate the exact added value in distance education and whether it had not ended as a simple adaptation to a change in communications tools.

60. Vertecchi, B. (1995) 'L'Istruzione a Distanza: linee evolutive e tendenze in atto', *Formazione domani*. Vol. XXII/19-20, pp 9-21

The tools available for distance education can rapidly increase their potential in data storing and processing. Since now this increased capacity has been used mainly to speed the message transfer, without modifying its basic structure. It is necessary to investigate whether it is possible to develop separately the distance education, conceptualizing it independently from the market instrumental offer.

61. Vertecchi, B. (1995) 'Le fonti di una didattica a distanza', *Istruzione a Distanza*. Vol. VIII/1-2, pp 1-14

In *The Sources of a Science of Education*, J. Dewey pinpointed the knowledge in Education coming from research in other fields of Human Studies. A similar issue could be raised also in distance education, in order to compose in a consistent framework all the assumptions borrowed from General Pedagogy, Psychology, Sociology, Technology, Computer Science and so on.

62. Vertecchi, B. (1998) 'Una nuova frontiera per l'Istruzione a Distanza: l'individualizzazione del messaggio d'istruzione - A new frontier in distance education: individualized educational messages', *Istruzione a distanza*. Vol. X/10-11

So far, the path followed in learning individualization development has been focussed on varying the message starting from errors retrieved in intermediate (formative) tests. The article presents the hypothesis of reducing errors through adjustments in the linguistic features of the instructional message.

VI

63. Hutter, O; Magyar, G; Mlinarics, J (2005): *E-learning, 2005*, Műszaki Könyvkiadó

This book provides an in depth overview about the Hungarian eLearning scene in 2005. The first issue of a series discuss the following topics: eLearning standards, definitions, development frameworks, working environments. It also includes several case studies and basic practices based on Hungarian eLearning system and content implementations.

64. Ehlers, U, and Pawlowski, J. (Eds.) (2006) *Handbook on Quality and Standardisation in E-Learning*, New York:Springer

Quality and standardisation in e-learning have become crucial success factors for organisations in learning, education and training: E-Learning has changed from an 'early adopter' stage to an integrated part of learning scenarios leading to major changes in educational organisations towards quality orientation.

For building a knowledge society, it is critically important to thoroughly understand quality and standards in e-learning. The handbook provides a cross-national perspective on these issues and draws a clear picture of the situation in quality development and standardisation. It covers topics of a rather foundational nature in quality and standardisation research as well as descriptions of quality approaches, instruments, standards, experiences and best practices. The Handbook is directed to learners, professionals, researchers and policy makers – people creating the next generation of learning.

65. Vladan D. (2006) *Semantic Web and Education*, Springer, 2006, ISBN: 0-387-35416-6

The first section of *Semantic Web and Education* surveys the basic aspects and features of the Semantic Web. After this basic review, the book turns its focus to its primary topic of how Semantic Web developments can be used to build attractive and more successful education applications.

The book analytically discusses the technical areas of architecture, metadata, learning objects, software engineering trends, and more. Integrated with these technical topics are the examinations of learning-oriented topics such as learner modeling, collaborative learning, learning management, learning communities, ontological engineering of web-based learning, and related topics. The result is a thorough and highly useful presentation on the confluence of the technical aspects of the Semantic Web and the field of Education or the art of teaching. The book will be of considerable interest to researchers and students in the fields Information Systems, Computer Science, and Education.

66. Koper, R; Tattersall, C. (2005) (Eds.): *Learning Design: A Handbook on Modelling and Delivering Networked Education and Training* 2005, ISBN: 978-3-540-22814-1

E-learning is still in its infancy. This can be seen both in the limited pedagogical quality and lack of portability of e-learning content, and in the lack of user-friendly tools to exploit the opportunities offered by current technologies. To be successful, e-learning must offer effective and attractive courses and programmes to learners, while at the same time providing a pleasant and effective work environment for staff members who have the task to develop course materials, plan the learning processes, provide tutoring, and assess performance.

To overcome these deficiencies, the IMS Global Learning Consortium Inc. released the Learning Design Specification in 2003. With Learning Design it is possible to develop and present advanced, interoperable e-learning courses embracing educational role and game playing methods, problem-based learning, learning community approaches, adaptivity and peer coaching and assessment methods.

In this handbook Koper and Tattersall have put together contributions from members of the "Valkenburg Group", consisting of 33 experts deeply involved in e-learning and more specifically learning design. The result is a rich and lasting source of information for both e-learning course and tool developers, providing information about the specification itself, how to implement it in practice, what tools to use, and what pitfalls to avoid. The book not only reports first experiences, but also goes beyond the current state of the art by looking at future prospects and emerging applications.

67. Nyíri, K. (2002) Towards a Philosophy of M-Learning, Presented at the IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE 2002), August 29-30, 2002, Växjö, Sweden.

There are two familiar approaches to the issue of mobile learning. The first points out that since the dominant mode of access to the Internet will soon be through wireless devices, e-learning simply becomes m-learning, without any particular changes in content. The second approach stresses that m-learning will characteristically aim at specific kinds of knowledge, namely knowledge that is location-dependent and situation-dependent. The present paper offers a different line of argument. On the Internet e-mail is the most popular application, and mobile devices, too, are used mainly for purposes of person-to-person communication. These observations confirm the view, long entertained in philosophy, that to communicate is an anthropological necessity. Starting from an analysis of the ubiquitous nature of communication the paper refers to the intimate connection between communication and education, and proceeds to examine the historical origins of the separation between school and society; recalls that childhood itself is socially constructed; and points to the advantages of a learning environment containing not just texts but also pictures. In such an environment person-to-person mobile communication by itself becomes learning. Communication is the source from which m-learning emerges.

68. Iverson, K. (2005).: *E-Learning Games: Interactive Strategies for Digital Delivery*, New York:Prentice Hall, 2005

Based on principles of constructivism and grounded in instructional design theory, this book contains games, simulation exercises, experiential activities, and other active learning approaches that will guide its users as they create engaging, interactive web based courseware. E-Learning Games contains openers, closers, practice exercises, simulations, peer learning activities, and idea generators that will engage online learners from their first click—and keep them returning again and again.

69. Brusilovsky, P. (2003) Adaptive Navigation Support in Educational Hypermedia: the Role of Student Knowledge Level and the Case for Meta-Adaptation *British Journal of Educational Technology*, v34 n4 p487-97, Sep 2003

Adaptive hypermedia is an alternative to the traditional “one-size-fits-all” approach in the development of hypermedia systems. Adaptive hypermedia (AH) systems build a model of the goals, preferences and knowledge of each individual user, and use this model throughout the interaction with the user, in order to adapt to the needs of that user. Adaptive navigation support is a specific group of adaptive hypermedia techniques that become especially popular in educational hypermedia systems. This paper provides a brief overview of the

main adaptive navigation support techniques and analyzes the results of most representative empirical studies of these techniques. It demonstrates an evidence that different known techniques work most efficiently in different context. In particular, the studies summarized in the paper have provided evidence that users with different knowledge level of the subject may appreciate different adaptive navigation support technologies. The paper argues that more empirical studies are required to help the developers of adaptive hypermedia systems in selecting most relevant adaptation technologies. It also attempts to build a case for meta-adaptive hypermedia systems, ie, systems that are able to adapt the very adaptation technology to the given user and context.

70. Stash, N, De Bra, P. (2004) Incorporating Cognitive Styles in AHA! (The Adaptive Hypermedia Architecture) Web-based Education, 2004

Adaptive educational hypermedia environments use properties of the application domain (e.g. conceptual structure of a course, with prerequisite relationships) to perform adaptation based on the user's browsing behaviour. This paper adds the idea of including cognitive styles in the adaptation decisions. Research on cognitive styles suggests that taking the styles into account can significantly influence a user's performance in an educational hypermedia system. AHA! provides a general-purpose Web-based adaptive environment. It allows the adaptation of the content of the webpages shown to the individual users and the links on these pages on the basis of arbitrary user characteristics such as (perceived) knowledge, interest or preferences. This paper describes how to incorporate cognitive styles in AHA!. The authors apply recommendations from existing research on the design of hypermedia systems aiming at providing adaptation to cognitive styles. The main objectives they want to achieve are: (1) avoiding the questionnaires for identifying cognitive styles and instead trying to infer aspects of a user's cognitive style by observing his browsing behavior, (2) providing the designers with the ability to associate different teaching strategies with particular cognitive styles which they want to take into account for their adaptive applications. use of Servlet-technology, adaptive applications can be built without any noticeable performance degradation.

71. Guerra T, Heffernan D. "The Guerra Scale", Learning Circuits, March 2004

A very original point of view in terms of e-learning content describes the possible levels of interactive experience of the student in a scale that goes from one to ten, where the first levels are made of the simple reading of on-line PDF files or internet pages that are interconnected, and the final levels represent simulation scenarios attended by experts in the field and virtual realities. This is a very useful representation in that, going up one level in the scale, there is an increase in complexity, functionality, development times, programming capacity, course design capacity and the attention of the experts in the field.

72. Hamilton, L, Klein, S, and Lorie, W. (2000) *Using Web-Based Testing for Large-Scale Assessment*. Rand Corp, National Science Foundation, Arlington, VA. 2000

This paper describes an approach to large-scale assessment that uses tests that are delivered to students over the Internet and that are tailored (adapted) to each student's own level of proficiency. A brief background on large-scale assessment is followed by a description of this new technology and an example. Issues that need to be investigated are outlined. This computerized testing approach has three main features: (1) test items are administered adaptively; (2) the system uses several different types of questions, including selected-response and constructed-response items and (3) the assessment is administered through the Internet rather than relying solely on stand-alone workstations. Among the major advantages of such an approach would be decreased testing time; and improved test security. Computerized adaptive tests (CATs) are also particularly useful for evaluating student growth over time. Issues and concerns with CATs are also discussed. This discussion shows the critical need for cross-disciplinary research to ensure that the use of Web-based testing will truly benefit students. (Contains 38 references.)

73. Observatory on Rights Management for e-Learning in Europe (2005) *DRM solutions addressed to e-Learning environment*.

The objective of this study is to provide an overview of the current state-of-the-art related to the adoption of DRM (Digital Rights Management) technology by content providers for the delivery of digital content in the European educational network.

It has already been mentioned how the application of DRM solutions is relevant to the creation of a single market of digital educational material. This market shall guarantee a minimum level of standardisation and interoperability from the technological viewpoint - and precisely for this reason the standards of description of the content compared to the existing technological solutions for the distribution/delivery of content and the DRM systems available in the market acquire increasingly greater importance. In this market the players shall make strategic choices as regards the licensing model adopted by assessing the sustainability and consistency with the reference target and also harmonise said choices with the national and European standards and regulations in force. All these assessments shall contribute to the drafting of a business model (or more than one business model) most suited to the needs of the educational world but equally economically sustainable for the operators involved, whether they be content providers, aggregators, or distributing intermediaries.

74. Szűcs A. (2005) Distance education and e-learning in Central and Eastern Europe - a snapshot on the history and perspectives of the new EU member countries, *Lline - Lifelong Learning in Europe* 1/2005.

This article intends to offer an inventory on the development and implementation of open and distance learning (ODL) programmes, since the early nineties in Central and Eastern Europe (ECE), principally in the new EU member countries, with focus on the higher education sphere, based mostly on the experience of the home country of the author, Hungary. The paper is also dealing with the impact of the new information and communication technologies on education in the region, including market aspects, governmental and EU initiatives. The main perspective is however rather human resource development and educational, institutional organisational one, investigating how distance education and ICT supported learning, as promising educational methods developed in ECE and what chances were missed.

75. Gáspár, P. (2004) Factors and Impacts in the Information Society: Hungary and the New Member States, ICEG European Center.

The publication is a final analysis of a long-term research project co-ordinated by ICEG European Center. This final Synthesis Report tries to identify the common factors affecting the development of information society and economy in the New Member States and in the three Associated Candidate Countries. The analysis evaluates the weight, role and structure of the info-communication sector in these states, and also identifies their positions compared to the EU-15 countries in fields of consumption of ICT goods and services.

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