

The Future of ICT and Learning in the Knowledge Society

Report on a Joint DG JRC-DG EAC Workshop held in Seville, 20-21 October 2005



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European Commission DG Education and Culture (EAC)

The European Council held in Lisbon on 23 and 24 March 2000 concluded on the need to adapt the European education and training systems to the requirements of a knowledge economy. The development of new basic skills, in particular in Information and Communication Technologies, is one of the main pillars of that strategy. Since then the European Commission has actively contributed to support and complement the EU Member States action in this domain.

DG EAC has played an important role in the joint efforts to attain the above mentioned objective through the eLearning Initiative, eLearning Action Plan and eLearning Programme. This will continue with the new generation of education and training programmes. See for more information:

http://europa.eu.int/comm/education/index_en.html

<http://elearningeuropa.info/>

European Commission Joint Research Centre (DG JRC)

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IPTS is one of the seven institutes of the DG JRC. The mission of IPTS is to provide customer-driven support to the EU policy-making process by researching science-based responses to policy challenges that have both a socio-economic and scientific/technological dimension. The Information and Communication Technology (ICT) unit at IPTS is doing research on the policy aspects of the European Information Society in general and on the socio-economic impacts of Information Society Technologies (IST) in Europe in particular. The KADEIS project focuses on Key Applications for the Development of European Information Society for realising the Lisbon objectives: eGovernment, eHealth, eLearning and eInclusion. The project links the monitoring and forecasting of IST developments with a socio-economic impact analysis of the selected application areas, identifies relevant bottlenecks and suggests policies for IST. See for more information:

<http://www.jrc.cec.eu.int/>

<http://ipts.jrc.cec.eu.int/>

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■ Executive summary

The need for a new vision of learning in the knowledge-based society

At the European Council in March 2000 in Lisbon, Europe set itself a strategic goal for the next decade “to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion”. To achieve this ambitious goal, Heads of States and Government asked for “not only a radical transformation of the European economy, but also a challenging programme for the modernisation of social welfare and education systems”. This was then translated into specific actions such as those under the Education and Training 2010 programme in order “to improve the quality and effectiveness of EU education and training systems; to ensure that they are accessible to all; and to open up education and training to the wider world.”

To realise these objectives, it is acknowledged that a fundamental transformation of education and training (E&T) throughout Europe is needed. This transformation must encompass all the ingredients that make up current education and training systems. A recent mid-term evaluation of the modernisation of E&T recognises that progress is being made by the Member States, but observes that further steps towards realising change for the development of the Knowledge-Based Society (KBS) need to be taken.

There is an urgent need for change, not only to maintain existing levels of education and training in the population, but also to develop the new skills and competences required if Europe is to remain competitive and grasp new opportunities. The development of the information society and the wide-spread diffusion of Information and Communication Technology (ICT) give rise to new digital skills and competences that are necessary for employment, education and training, self-development and participation in society.

Technologies, especially ICT, have a particular role to play in realising these changes. It is difficult and almost impossible to imagine a future learning environment without some sort of ICT, at the forefront or in the background. There is growing awareness in Europe that a new vision of “ICT and learning” is needed that takes into account the shifts and trends that are transforming the way people work, learn, make sense of their world and have fun in a digitalized, networked and knowledge-based society. Preferably, this vision would be realised through a proactive strategy that would envisage and anticipate future learning needs and requirements, rather than an adaptive strategy where reactions to new requirements would be made as they arise.

The objectives of learning

Most debates on the future of learning are focussed on the instrumental objectives of learning, related to the adaptation of learning institutions and the labour force to the requirements of the knowledge economy. Addressing such instrumental concerns is already a serious challenge for all stakeholders involved and, as mentioned above, much still needs to be done to make the necessary changes for the development of the knowledge-based society. But there is more. Learning is also important for its contribution to emancipation, empowerment and self-fulfilment of people. Learning objectives such as social competence, critical thinking, knowledge sharing and cooperation techniques need to be pursued as well.

A reflection on the future of learning in the KBS should not only tackle the instrumental questions but also raise the more theoretical, normative and ethical issues related to learning and education: What do people need to know and learn? Why do we need to learn? What kind of society do we envisage when we expect people to have certain skills and competences? Such questions would

also be more in line with the pro-active strategy mentioned above.

An holistic approach to learning: ICT-enabled lifelong learning

Thinking about the future of learning in the knowledge-based society needs to be holistic as learning will become a lifelong activity that cuts across different learning generations and life spheres such as private, public and work. The focus should therefore be not only on traditional formal learning institutions such as schools and universities; and existing training organisations and training practices for both the unemployed and employed, but it should also embrace other forms of adult education, informal learning and also learning to use ICT.

Living in a knowledge-based society driven by the wide-spread diffusion of ICT does indeed give rise to the need for acquiring new digital competences and ICT skills. The European Commission has already identified “digital competence” as a “key competence” that individuals need to acquire for personal development, active citizenship, social inclusion and employment. It is important to acknowledge this and to confirm that it is not only about “ICT literacy”, i.e. learning to operate the technology, but also about higher-order skills such as knowing and understanding what it means to live in digitalized and networked society. This applies not only to learners but also to teachers and training staff.

Trends and challenges affecting future learning in the knowledge-based society

There are a number of trends and challenges that are expected to shape future learning in the knowledge-based society. Some of the technological trends, in particular Information Society Technology (IST) trends are:

- Broadband internet access that is becoming widespread;

- Weblogging, Short Message Service (SMS) and Multimedia Message Service (MMS) that are becoming major sources for personalisation of information and for connecting with others such as friends and now increasingly also friends of friends (social software);
- The rise of podcasting (both audio and video) that provides opportunities for mobile learning via portable digital media players;
- The availability and use of open source software and open source content (e.g. Wikipedia), and the unlimited and cheap storage of digital information;
- The rise of new internet-native content players that experiment with content services that have clear educational implications.

Other major IST-related technological trends are infrastructure convergence (integrating broadcast, phone, data and other networks), the rise of alternative wireless technologies (e.g. Wifi), content/media convergence (newspapers, music, TV, blogs...), multi-modal devices (e.g. new mobile phones: pictures, email, movies, play radio and... phone). Last but not least, there is the European vision of the future information society labelled as “Ambient intelligence” that encompasses the above by connecting humans, machines and sensors in heterogeneous and ubiquitous networks and by making them user-friendly and people-centric.

Technological trends and challenges will have to match those social trends and challenges that Europe is facing and that have important implications for learning, now and in the future. There is the emergence of new skills and competences, as mentioned above, and also other trends such as the diversification of life trajectories and everyday life practices (e.g. flexible working hours) that are drivers for flexible, module-based learning. The need for adult learning, possibly enabled by ICT, is also confirmed by demographic evolution. Natural population growth and net migration will not be sufficient to satisfy the knowledge-economy

demand for tertiary level educated people. It will therefore be necessary to involve and possibly re-skill more elderly people.

Budgetary pressure on education and training could result in under-investment in the quality of education and could give rise to a privatization trend focussing on high-quality and prestigious but expensive educational programmes. Investing in ICTs for learning could be perceived as an additional cost although they have a significant cost-saving potential as well. There is concern, however, that greater efficiency in education and training could result in less equitable outcomes for all.

Globalisation will also affect learning by encouraging the privatization of education. Established educational brands will compete for the best students world-wide. ICT-enabled learning could, however, also allow students to access high quality education, without the need to move abroad. But while education is affected by globalisation, its implementation usually is local, regional or national. An important challenge for EU policymaking – while respecting subsidiarity – is to align educational systems and curricula in Europe but also to stimulate cross-border learning.

Innovative applications of ICT for learning

This report presents examples of innovative applications to illustrate how ICTs are used and could be used in future learning environments and how they possibly could contribute to making learning better, different, more interesting, pleasant, and more relevant than it is today. These are experience-based learning via immersive virtual worlds; experimental learning via computer-generated simulations; pedagogic veils (products that teach people how to use them) and pedagogic learning objects; cognitive repair and support for people with special needs; Podcasting, Blogging, social proximity and synchronous learning; and Learning Content Management Systems (LMCS).

The potential of such systems will however be greatly increased if they would incorporate a vision of future learning that takes into account the shift towards a digitalised and networked KBS whereby learners become co-producers in the learning process, and not just receivers of learning content; whereby flexibility, user-friendliness (for both teachers and learners) and different “digital” learning styles are combined; and whereby learning is a social process and not an instructorless computer-generated individual activity. More elements of this vision are raised below but it is worthwhile insisting that such ICT potential will only be realised if accompanied by the necessary social and institutional change.

ICT-enabled learning and inclusion

There is already considerable risk that disadvantaged groups and marginalized people will not be able to benefit fully from the new opportunities offered by ICTs, either as competent users of ICTs in general or as learners and trainees in particular. Therefore, dedicated efforts are needed to make sure that everyone is able to acquire the necessary digital competences in the information society and to learn and develop other key competences via ICTs for participation in society. The formulation of learning objectives for emancipation and empowerment are essential preconditions for inclusion, well-being and success in the KBS.

An example would be a “Lifelong Learning Membership Card” that connects learners throughout their lives with educational institutions, or a “Brain Gymclub” where people can go to keep their brains fit. The problem is that such clubs tend to be exclusive rather than open to all. However, ICT-enabled learning could also be inclusive as it could provide learning opportunities to more people, especially disadvantaged people, families and groups. But this will not happen automatically. People would only be motivated to start learning again or to continue learning if it makes sense in their everyday lives, social contexts and social networks. This could pave the way for associating

ICT-enabled lifelong learning initiatives with other social inclusion policies. Of course, the need for a good, basic education for all continues to be as urgent and fundamental as ever.

Learning spaces: A vision of future learning

This report also presents a future vision of learning, called “learning spaces”, that embraces both the potential of ICTs and some of the new requirements for learning in the future. It constitutes a step towards nailing down requirements for learning in the future. It would consist of the following elements:

- Learning spaces are connecting and social spaces: Since learning is a social process, it needs to bring different actors together to share learning experiences. Learning spaces are both physical and virtual spaces that favour a learner-centred learning model but connected with the other actors involved in learning and with other social networks. As such learning spaces should also link learning individuals with learning communities, organisations and even learning cities and learning regions.
- Learning spaces are personal digital spaces: Every learner should have a personal, digital learning space where all learning material is accessible; anywhere, anytime, anyway (multiple devices and media). This personal space would allow the learner to go back and forth, without losing track of what has been learnt in the past. It would broaden the pedagogical scope to a more holistic approach to learning, providing the personal digital space is secure and private.
- Learning spaces are trusted spaces: Learning spaces provide trust and confidence (e.g. on quality and reliability) in a world where learners are connected digitally, and where learning content is co-produced and shared. Thus, it would also embrace the tacit aspects of knowledge creation based on

human interaction and human values and experiences.

- Learning spaces are pleasant and emotional spaces: ICTs could make learning content more attractive (media-rich virtual environments) and learning more emotional (by connecting people); and transform the learning process into a pleasant and emotional experience. Many existing learning settings do not invite people to learn. The current focus is more on the transmission of knowledge, than on learning objectives and learning outcomes.
- Learning spaces are learning spaces: This is not a tautology. Even within the frame of lifelong learning, there is a time to learn and a time to do other things. Learning spaces could help to differentiate between these different moments.
- Learning spaces are creative/flexible spaces: Learning spaces should be creative spaces, rather than focussing exclusively on reproducing knowledge. Learning spaces would also need to be flexible in combining different learning modes and learning styles, depending on the learning object, the learner, the teacher, the environment, etc.
- Learning spaces are open and reflexive spaces: Future learning spaces would need to be open and module-based, enabling people to plug-in again whenever they can. Future learning should enable reflexivity. It should give people the chance to develop the necessary cognitive and affective capabilities to think and reflect upon their own lives and upon living in the modern world.
- Learning spaces are certified spaces: Future learning can only be different from learning today if the current accreditation systems and learning assessment systems are adapted to the requirements of the knowledge-based society. The acquisition of ICT skills, digital competence and other new skills, be it through formal or non-formal education, should be demonstrated, evaluated and also

certified. This would be an incentive for all stakeholders in the learning process.

- Learning spaces as knowledge management systems: The strength of most organisations lies in its people, hence the need to share experience and knowledge amongst colleagues, within the organisation, and even across organisations. Learning spaces could become informal platforms for organisational knowledge management. This could also involve people more closely in human resource management as it helps to put the right person in the right place, at the right time.

The vision of learning spaces puts learners at the centre of learning, but, at the same time, conceives learning as a social process. Learners become co-producers in the learning process and not just consumers of learning content. Guidance and interaction therefore continues to be very important. The role of teachers, tutors and/or trainers will change rather than disappear. It will require dedicated efforts to train and involve them in developing their changing role in the learning process. Learning spaces are not instructorless computer-generated spaces without interaction and community building.

Realising the change

Technological change is fast and full of opportunities but also unpredictable and full of uncertainties, while pedagogy and learning institutions require some stability and certainty to deliver quality and equitability in education. This creates tensions that make it very difficult to manage and implement change in institutionalised learning environments. That is why it is important to acknowledge and take into account that technology alone, however powerful, cannot bring about the necessary change. The potential of new technologies can only be realised when they work with, or rather, are embedded in, a social context that is open to innovation and supported by a favourable policy environment. This also explains why it always takes more time to realise technological change than expected.

People and institutions are not by definition hostile to change, but there should be sufficient incentives to make change attractive. New requirements for learning also demand dedicated efforts to “teach the teachers” and “train the trainers”. The new skills and competences that teaching and training staff must acquire are not only related to ICT literacy, but also to dealing with a learning audience that becomes more diverse in terms of age, ethnicity, language, etc. Moreover, teachers and trainers need to learn to teach differently as learning become more flexible, dynamic and personalised. Many people believe that ICT could be a catalyst for change while it is, at the same time, not the overall solution. In addition, also technological progress is needed so that it meets the expectations.

Future research challenges

Many different areas in the realm of ICT-enabled learning need specific research on how to address the many challenges summarised above. Socio-economic research could focus on the role and contribution of ICT when clarifying the fundamental objectives of future learning, on its impact on cognition and cognitive abilities, on the links between e-identity, self-appreciation, privacy and learning; and on the embedding of learning into ICT mediated daily practices and time patterns. The interrelationship between ICT-enabled learning and social inclusion also requires specific research efforts

Technological research challenges are related to the realisation of the above mentioned elements of learning spaces (e.g. supporting intuitive learning, flexible learning, the merging of physical and virtual learning environments, smart learning content) and to the challenges for learning anywhere, anytime and anyhow (or rather, to learning at the *right place*, *right time* and *right moment*), especially within the frame of lifelong learning. Learning to learn for life is also something we will have to learn.

Dedicated research efforts are also needed to better understand and manage change in

general, and on how to let ICTs play the role of catalysts for change in particular. This includes a re-examination of curricula and assessment and accreditation mechanisms; with a special focus on change agents and leadership. The right change

would provide many opportunities for more and better learning, education and training in the knowledge-based society. A different vision of future learning is emerging and research is needed to better understand it while it is in the making.

■ 1. Introduction

1.1. Structure of the report

The introduction to this report first sets the scene by explaining the objectives of the “Joint Workshop organised by DG EAC and DG JRC-IPTS on the future of ICT and Learning in the Knowledge Society” and the questions it hoped to answer. This is followed by a short working definition of learning enabled by Information and Communication Technology (ICT). Finally a summary of the background paper prepared as a basis for the workshop is given in this chapter (see Annex 2 for full text).

Chapter 2 presents some of the central questions that one cannot avoid when thinking about the future of learning in the Knowledge-Based Society (KBS). These are related to the need for changing existing learning institutions and practices; to the different objectives of learning and to new requirements such as a holistic approach to future learning.

Chapter 3 presents trends and challenges that are expected to shape future learning in the knowledge-based society. There is a section on technological trends, in particular Information Society Technologies (IST), and a section on social trends and challenges, of which some are generic (e.g. ageing society) and others specific to learning and education (e.g. new skills).

Chapter 4 looks at ICT from the point of view of learning. It discusses what role ICT could play in these and other trends and challenges. It contains sections on innovative and potential ICT applications for learning and on learning to use ICT. The issue of social inclusion related to ICT-enabled learning is also raised as it is seen as an important concern for the future of learning.

Chapter 5 looks at learning from the point of view of ICT. It presents a future vision of learning called “learning spaces” which are enabled by ICT and respond to the new requirements

for learning in the future. In contrast with the potential of ICT for learning raised in chapter 4, here the implications of ICT for a different learning environment are discussed.

Chapter 6 addresses the question of implementation. It acknowledges that this new ICT-enabled learning environment will not happen by itself. Dedicated efforts will be needed to implement it, not least because educational institutions are known to be difficult to change.

Chapter 7 presents challenges for future research. Where do we lack knowledge? What needs to be researched in the near future? Both socio-economic and technological research challenges are mentioned, along with issues related to learning content and to realising the necessary change.

Chapter 8 presents this report’s main messages.

Chapter 9 contains two annexes. Annex 1 gives the workshop agenda and Annex 2 contains the full text of the background paper that was prepared for the workshop.

1.2. Setting the scene

The development of the information society and the wide-spread diffusion of ICT give rise to new opportunities for learning and new digital skills and competences that are necessary for employment, education and training, self-development and participation in society. Moreover, as our societies become more knowledge-based, what people need to learn and know changes. There is growing awareness in Europe that a new vision of ICT for learning is needed that takes into account the shifts and trends that are transforming the way people work, learn, train, make sense of their world and have fun in a digitalized, networked and knowledge-based society.

There is an urgent need for fresh views and prospective insights on ICT and learning in the knowledge-based society and, in particular, on the interrelationship between ICT, learning and knowledge. A review of national foresight studies on Information Society Technologies in Europe, undertaken between 2001 and 2004, concluded that learning and education could have great impact on the realisation of the Lisbon goals. This was further emphasized by a 2005 online Delphi exercise with about 400 experts.¹ The importance of learning and education for Europe and the potential of ICT for better learning and education in Europe cannot be underestimated, providing it is accompanied by social and structural reform.²

This is again confirmed in a recent Communication from the Commission on “modernising education and training: a vital contribution to prosperity and social cohesion in Europe”.³ The report recognises the progress made so far by the Member States in adapting their education and training systems to achieve the Lisbon goals. However, it observes that more progress is needed towards realising changes for the development of the knowledge-based society.

The workshop described in this report focussed precisely on these shifts, trends and challenges. It set out to answer two core questions:

- What will learning look like in a future KBS in Europe by 2020?
- What is the role and contribution of ICT?

The workshop objectives were:

- To detail the innovative change potential of ICT for learning in the future KBS;

- To formulate, if possible, a preliminary vision of future learning in the KBS;
- To contribute to the ongoing reflection on the role of ICT in the proposed new Integrated Lifelong Learning Programme,⁴
- To identify future (EU FP7) research needs.

These core questions and objectives are relatively open and broad – on purpose – to enable a pro-active reflection on the fundamental issues that need to be taken into account when thinking about the future of learning in the KBS. Therefore, both the workshop approach and prospective methodology were exploratory. It was not set up as a specific foresight exercise on future learning but rather as an attempt to map the major issues in developing a prospective view or foresight study.

The orientation for this exercise was not just “future learning” but rather “the future of learning in the KBS in Europe by 2020 and the role and contribution of ICT”. Thus, four key words - 2020, Europe, knowledge-based society, and ICT - give a specific scope for the work.

Twenty experts from different backgrounds were invited to discuss these issues, and to share their thoughts and opinions freely, at the workshop which took place on 20-21 October 2005, in Seville. Their names are mentioned in the acknowledgements at the beginning of the report.

The exploratory objective of the workshop is also reflected in the way it was designed (Cf. annex 1: Workshop agenda). It provided lots of opportunities for open discussion

1 See Compagno, R. & Pascu, C., 2005, “Lessons from Foresight on Information Society Technologies”, in “IST at the service of a changing Europe by 2020: Learning from world views”, Publishing House of Romanian Academy of Sciences, ISBN: 973-27-1252-X. Available at: <http://fistera.jrc.es>

2 See for instance also the eLearning Industry Group (eLIG) as a supporter of the eLearning potential for realizing the Lisbon goals and the i2010 Action Plan: <http://www.elig.org>.

3 COM(2005) 549 final/2 ; Brussels, 30.11.2005: http://europa.eu.int/comm/education/policies/2010/doc/progressreport06_en.pdf

4 Proposal for a Decision of the European Parliament and of the Council establishing an integrated action programme in the field of lifelong learning (2007-2013), Brussels, 14.7.2004, COM(2004) 474 final http://www.europa.eu.int/comm/education/programmes/newprog/index_en.html

and brainstorming. A background paper was distributed to the workshop participants beforehand to provide a thought-provoking view on the potentially disruptive changes that are expected for the future of learning in Europe by 2020, with special attention to the role and contribution of ICT to these changes. It was commissioned by DG JRC – IPTS and is annexed to this workshop report.

On the first day of the workshop, presentation and discussion of this paper was followed by open discussions on what we called “From the Cradle to the Grave: Key Priorities for Learning in the EU KBS by 2020”. The objective was to encompass the whole range of learning opportunities and activities throughout the entire lifespan of a citizen. The second day started with a short summary by IPTS of the first day’s discussion, followed by further discussion and validation. Then, the vision developed during the workshop was set into a policy context, by way of a presentation and discussion on the proposed EU Integrated Lifelong Learning Programme (ILLP 2007-2013). The last session of the workshop was reserved for brainstorming (with post-it notes) to identify future Framework Programme and research needs.

1.3. A broad concept: ICT-enabled lifelong learning

There is no single concept of learning through the use of ICT. Many different types can be envisaged: computer-assisted learning, web-learning, computer-classes, online training, distance education, eLearning, virtual learning, digital training, etc. It was proposed at the start of the workshop, and later confirmed, that a broad approach to learning through the use of ICT would be necessary for a complete understanding of the potential of ICT-enabled learning. Such

an approach envisages, for instance, the use of computers and Internet in schools (traditionally regarded as eLearning - in itself a demanding task) but is also broader, encompassing all aspects of learning through the use of ICT.

To emphasise this broad concept, the term **ICT-enabled lifelong learning** will be used in the remainder of this report. It deals with both formal and informal learning (education and training). It covers the use of ICT for learning in traditional education (schools and higher education), at the workplace (e.g. ICT skills), and also for finding work (e.g. re-skilling, up-skilling). Last but not least, it also covers learning to use ICT in everyday life.

The latter is related to what is called digital literacy and digital competence, i.e. having the necessary skills and competence not only to use ICT, but also to master and understand them. It is a necessary new competence in the KBS. The European Commission has already proposed a definition of digital competence and has also included it in its “key competences” that individuals need for personal development, active citizenship, social inclusion and employment:

Digital competence involves the confident and critical use of Information Society Technology (IST) for work, leisure and communication. It is underpinned by basic skills in ICT: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet.⁵

ICT-enabled lifelong learning thus embraces two perspectives: ICT for learning and learning to use ICT. These have to be set in the context of a vision that is based on the characteristics of what constitutes a knowledge-based society, which will be developed in the remainder of this report, and especially in Chapter 2.

5 COM(2005)548 final, Proposal for a Recommendation of the European Parliament and of the Council on key competences for lifelong learning, Brussels, 10.11.2005, page 16. http://europa.eu.int/comm/education/policies/2010/doc/keyrec_en.pdf
See for more details on digital literacy: Report on the consultation workshop “Promoting Digital Literacy”. held in Brussels on 4 November 2004, DG EAC, December 2004. http://europa.eu.int/comm/education/programmes/elearning/workshops/index_en.html

1.4. Summary of the background paper by I. Tuomi

A summary of the background paper is included here (see Annex 2 for the full version).

In the next fifteen years, European citizens will have access to advanced information and communication technologies that have the potential to profoundly change the ways we use, create and learn information, knowledge and skills. We will be able to package material objects in virtual layers of software and information, turn them into extended and informationalized artefacts, and link them to the ubiquitous global net. Our physical spaces will blend material, informational and communicative structures and functionality. Work will become increasingly knowledge-intensive, and productive activities will both concentrate in new geographical regions and, at the same time, become globally distributed. The established institutions of learning will struggle to adapt to the new social and economic realities, and new institutional forms of education and learning will emerge.

Rapid and sustained change in information and communication, media, and transport technologies has already reorganized the world. As a result, our concepts and practices of learning will also undergo fundamental change in the coming years.

The background paper (see Annex 2) describes the ongoing socio-economic transformation, presents scenarios for future educational settings, and reviews examples of innovative uses of information and communication technologies in education and learning. It tries to open the discussion on the future of educational institutions. For example, we have to ask, why do we learn and what do we need to learn? This requires that we revisit some assumptions that underlie our educational institutions, theories and practices.

Debates on the proper objectives of learning will become increasingly visible in the future KBS. This is largely because existing educational institutions need to find new ways to justify and

legitimize themselves. As workers increasingly have to process up-to-date knowledge and mobilize socially and geographically-distributed resources to get their jobs done, knowing becomes an increasingly dynamic and social phenomenon. Knowledge is reproduced, created, and recombined in short cycle-times and in problem contexts that are difficult to reproduce in educational institutions. Rote learning of facts becomes redundant when everyone has access to ubiquitous networks of information. Learning and knowledge creation skills become more and more important for work performance, and educational certificates become less and less relevant. Learning opportunities accumulate fast for some, creating social differences and digital divides, and educational institutions and policymakers struggle to combine innovation, creativity and equal opportunities.

To outline the emerging landscapes for learning, as seen from inside educational institutions, short scenarios for a fictitious International Standard Classification of Education for the year 2020 have been developed. The International Standard Classification of Education (ISCED) was designed by UNESCO in the early 1970's to serve as an instrument for assembling, compiling and presenting education statistics, both within individual countries and internationally. The present classification, ISCED 1997, aims to cover all organized and sustained learning opportunities. Within the framework of ISCED, the term education is taken to comprise all deliberate and systematic activities designed to meet learning needs. Due to its institutional focus, ISCED implicitly categorizes and describes learning institutions where professional teachers work. The ISCED classification is therefore used as a handle to the current systems of education, to try to see how the structures of education will change from an internal point of view.

Educational systems are extremely difficult to change. This has little to do with an abstract tendency for "resistance to change". Change and innovative learning are often against prevailing interests and existing institutional arrangements.

As educational institutions are facing the demands of the knowledge-based society, it is important to understand where, exactly, the sources of inertia in educational systems are. To develop better educational systems, we have to understand how educational institutions learn and why this learning is difficult.

The background paper also describes a number of innovative ICT applications and discusses the different ways in which ICTs will be used in future learning environments. Some illustrative examples of new technologies are

introduced and some new generic application categories for future learning technologies are also proposed. The paper concludes by arguing that learning, knowledge and innovation are at the core of the emerging knowledge-based society. Though ICTs offer radical new opportunities for future learning, action and leadership will be required to realise the change. The possible impact of ICT on the learning process; on different learning cycles and different learning models is discussed in the appendix of the background paper.

■ 2. Learning in the knowledge-based society

The need for change

It is increasingly acknowledged that, in these fast changing times, the way learning and education is currently organised needs to be urgently and drastically rethought. There are many reasons for this, such as the changing requirements of the labour market and labour productivity (economic reasons) and the political targets for the European Union (to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion - European Council, Lisbon, March 2000). Also the drive towards upward job mobility or towards self-fulfilment motivates people to acquire new skills and competences which are currently not available in traditional learning curricula.

In addition, learning objectives will become an increasingly visible issue as we move towards the future knowledge-based society, though what the real nature of this society will be remains an open question. The nature and location of knowledge will be fundamentally different in the KBS and as I. Tuomi argues, consequently, the conventional definition of learning will become inappropriate. Knowledge is not something that exists “out there” and which can be simply grasped by the learner. On the contrary, a distributed model of knowledge is already emerging through the Internet where it becomes more important to know where knowledge is located and who has access to what kind of knowledge and why.

This will require us to re-think the fundamentals of knowledge, learning and education. At the moment, these are still based on the logic and needs of the industrial society. This will have important consequences for the ways we organise and facilitate knowledge in future networked environments. It follows that established learning institutions will have

to adapt to the changing social, economic and technological order. They will need to re-legitimise, re-think and re-position themselves as the nature and status of learning and knowledge changes (Tuomi, Annex 2). This exercise would benefit from a pro-active approach which envisages and anticipates future learning needs and learning requirements, rather than only focussing on adapting their existing institutions to the new requirements of the knowledge-based society. It must also be remembered that these requirements are still in the making.

The objectives of learning

Most of the debates on the future of learning are focussed on the instrumental objectives of learning, related to the adaptation of learning institutions and the labour force to the requirements of the knowledge economy. Addressing such instrumental concerns is already a serious challenge for all stakeholders involved and many are sceptical about whether it can be realised rapidly and easily. However, in addition to instrumental objectives, the workshop participants also recognised the importance of learning objectives, such as social competence, critical thinking, knowledge sharing and cooperation techniques, for emancipation and empowerment. These “virtues” are considered as essential preconditions for well-being and success in the KBS, for social participation and for personal autonomy. It was therefore emphasised that reflection on the future of learning in the KBS should tackle not only the instrumental questions but also the more theoretical, normative and ethical issues related to learning and education.

If we accept this report’s main argument that ICT-enabled learning will have considerable potential for innovative change, providing it is embedded in social and institutional change

the fundamental questions will re-emerge even more strongly. What do we need to learn through ICT-enabled learning, and why? Subsequently, if learning becomes predominantly ICT-enabled, should we favour the “learning to learn” over the “learning to think” theoretical and pedagogical views on learning? Should we support experience-based learning rather than problem-solving learning?

In other words, reflection on the future of learning in the KBS and the role of ICT for learning requires not only an understanding of the instrumental objectives of learning and education in society but also a more explicit view on the fundamentals of learning and even of society. What do people need to know? Why do we learn? What kind of society do we envisage when we embark on changing learning and education institutions?

For instance, stressful conditions could be generated if, in order for societies to remain globally competitive, citizens are constantly required to learn new skills. This could, in a worst-case scenario, result in loss of quality of life for citizens. Ethical matters will therefore play an important part in the development of learning theories. Do we want a better educated workforce or better educated citizens?

Learning has political aims. Equitable democratic participation depends on the ability to competently assess political alternatives, to evaluate arguments, to articulate one’s view in a political discourse. All these capabilities are intimately linked to communicative, media and social competence which must be nurtured through learning.

Though this report cannot answer all these normative and political questions, it is important to raise them. Clearly knowledge, skills and attitudes of workers are important factors in innovation, productivity and competitiveness, together with their motivation, satisfaction and the quality of their work but mutually important are personal fulfilment, social inclusion, and active citizenship.

New requirements for ICT-enabled lifelong learning

Lifelong learning has been an inspirational concept for decades for a variety of economic, social and political reasons. The widespread diffusion of new ICT applications such as internet-based communication and networking as well as applications enabled by mobile and wireless networks (See section 3.1 for an overview) make it possible to revitalise opportunities for lifelong learning. They can have a profound effect on both the content and processes of learning (including the assessment and evaluation of learning outcomes) if accompanied by the necessary social and institutional change.

The pursuit of better learning via ICT *per se* is important, but an emphasis on the benefits that ICT can offer to the pressing needs of society and economy is also crucial. Thus, innovation, competitiveness and inclusion become main foci of ICT for learning in general and of ICT for lifelong learning in particular. This requires going beyond the classical views on eLearning (i.e. learning at a distance using the Internet, mainly to fulfil curricula requirements) to encompass ICT for lifelong learning functions that enable lifelong processes, including keeping up the momentum of motivation to learn at any age. The motivational role that ICT could play is seen as particularly important in a “learning anywhere, any time” context.

This requires a holistic examination of ICT for lifelong learning from various perspectives. These include, amongst others, the development of key competencies (and skills), the need to meet evolving industry requirements whilst enhancing job quality, ICT’s potential to foster a more inclusive society, the permanent input from research both on innovative and emerging technologies as well as on new ways to deliver learning (including teacher/tutor training), the opportunity to reform educational systems and integrate new forms of partnership.⁶

6 The recent eLearning Conference (www.elearningconference.org, Brussels, 19-20 May 2005) addressed some of those perspectives.

■ 3. Trends and challenges affecting future learning in the KBS

3.1. Information society technological trends

Important and possibly disruptive trends can already be observed today which will shape the future KBS and affect the future of ICT-enabled learning. Their more concrete impact on learning will be addressed in Chapters 4 and 5, but here, the focus is on presenting briefly the technology trends:

- Broadband Internet access is becoming more widespread, especially in well-advanced economies, driven by peer-to-peer file sharing and always-on features. The combination of large bandwidth and permanent access can impact the way learning content is consumed and shared with others;
- Weblogs or blogs are becoming a major source of information and communication for Internet users. In combination with RSS (Real Simple Syndication), which is also becoming mainstream, they provide a powerful tool for Internet users to personalise and actualise content and information on the web, with clear implications for learning;
- Podcasting could be a driver for mobile learning. Initially, podcasting featured audio content (e.g. a radio programme) but video files are becoming more and more available via portable digital media players. RSS content can be directly and automatically delivered to personal computers and also to mobile devices via podcasting;
- Short Message Service (SMS) and the more recent Multimedia Messaging Service (MMS) are also becoming important providers of news content (especially eyewitness reports)

and offer ways for people (and thus also learners) to be mobile and share information on the go;

- It is becoming cheaper to store information digitally than on paper. This has many different implications for learning, such as open archiving and sharing of learning content for learners. It can also save costs for learning institutions;
- Open source software and open source content are challenging existing software and content developers, including educational institutions. There is the availability of free content, on Wikipedia, for instance. A different example is the community-based Open Content movement supported by UNESCO which offers educational practitioners opportunities to co-develop educational content;⁷
- New players that have emerged on the Internet only recently, and those that survived the dotcom crash, are now becoming established (e.g. Google, Yahoo, Ebay, and Skype). They regularly launch new and innovative services, that may have implications for learning, such as Google Scholar, Google University Search, Yahoo!igans!, or the Yahoo! Webguide for kids.

Other major ICT-related technological trends that may contribute to a changing learning landscape are infrastructure convergence (integrating broadcast, phone, data and other networks), the rise of alternative wireless technologies (e.g. wireless hotspots), content/media convergence (newspapers, music, TV,

⁷ <http://www.unesco.org/iiep/virtualuniversity/forums.php>. Other examples of free educational content are the Berkeley initiative "Research Now" (<http://researchnow.bepress.com>) and the MIT OpenCourseWare (<http://ocw.mit.edu/index.html>).

blogs...), multi-modal devices (e.g. mobile phones that take pictures and receive radio programmes).

Last but not least, there is the European vision of the future information society labelled “Ambient intelligence” (or ubiquitous computing) that encompasses the above by connecting humans, machines and sensors in heterogeneous and ubiquitous networks and by making them user-friendly and people-centric.⁸ It also has implications for learning, for instance by facilitating social proximity and synchronous media-rich learning (See section 4.1).

The major implications and issues related to these trends for the future of learning in the KBS are discussed in more detail later on in this report. However, technological trends should also be matched with the social trends and challenges that Europe is facing, including those specifically to do with education and training. These are discussed below.

3.2. Social trends and challenges

Europe will face important challenges in the years to come. The following trends and challenges that apply to learning were discussed during the workshop:

Changing skills and competences at work

The changing labour market, the changing nature of labour productivity and also the individual drive towards promotion and better jobs give rise to the need to acquire new skills and competences, especially for knowledge-intensive jobs. As the status of information and knowledge are different in the knowledge-based society (compared to late modern industrial societies), the vision of what knowledge people need to

acquire, and how they can acquire it, also needs to change. Knowing where knowledge is located and who has access to what kind of knowledge and why, is becoming more important in the networked society. Social skills and “relationship capital” are part of the necessary skills for employment in the knowledge economy.

Such skills are increasingly exercised via ICT but not everyone in society has acquired these skills. There is need for a re-skilling and up-skilling of the workforce and the unemployed, to address skill mismatches and to increase ICT literacy.⁹ These efforts need to be an ongoing part of lifelong learning since a dynamic and fast-changing knowledge-based society requires continuous skills updating.

Diversification of life and learning trajectories

Life trajectories in industrial societies were relatively straightforward, linear and well structured, with clear distinctions between work, home and education, evident expectations about the proper sequencing of learning and working periods and an apparent division of labour according to gender, class, income, ethnicity, etc. This has changed and continues to change. Life trajectories are becoming much more flexible, diverse, fluid and transitory.

This has important implications for learning. Most educational institutions are still organised according to an industrial logic, and thus not sufficiently adapted to these changing life trajectories. Immigration, geographic mobility, career breaks, flexible working hours and other factors are demanding more flexibility and more openness to customizable, module-based learning. ICT-enabled learning can provide opportunities for closing the gap between old and new models of learning.

8 See for instance ISTAG Scenarios for Ambient Intelligence in 2010, Edited by Ducatel K., Bogdanowicz M., Scapolo F., Leijten J. & Burgelman J.-C., 2001, IPTS-ISTAG, EC: Luxembourg. www.cordis.lu/ist/istag

9 See for instance K. Ducatel & J.-C. Burgelman, Employment Map, The Futures Project Series No. 13, 1999, European Commission DG JRC-IPTS, Spain, EUR 19033 EN.

Demography, migration and lifelong learning

The demographic changes Europe will be facing over the next decades pose specific challenges for the knowledge economy, its labour force and especially its educational achievements. It will be difficult in an ageing society to deliver the required number of tertiary level educated young people to maintain knowledge-based economic growth. Though general progression in educational attainment drives more young people towards tertiary education, it may be difficult to achieve the necessary number of young educated people, even with the support of positive migration flows.¹⁰

The implications for education and training are clear. There is an urgent need to invest in adult education and lifelong learning. Existing educational systems need to be adapted to a more flexible learning environment in which people continue to learn while at work and later in life, to acquire and maintain the skills and competences needed in a changing knowledge economy. This includes developing the skills and practices to learn continuously.

Demography and migration also affect the role and functioning of teachers, trainers and tutors. In Europe, about 50% of formal teachers are aged 40 or more, and many of them will retire in the next 10-20 years. Teachers will thus not only become older, there will also be fewer of them in the future. Moreover, they will need to learn to cope with a changing learning environment, and a more diverse learning public in terms of, for instance, age, experience, ethnicity, religious preference and language.¹¹

Pressure on current education and training institutions

Governments and stakeholders in the field of education and training are aware of the need to reform education and training in Europe to realise the Lisbon goals. Recent progress towards this aim has been reported, although more reform and change are needed. Though public expenditure in education has not decreased in Europe, there is a belief that the current spending levels are not sufficient to realise the necessary reforms (the EU average is 5.2% of GDP in 2002), especially when the significant differences between countries is taken into account. Moreover, there is little reason to believe that employer investment in continuous training is increasing.¹²

Investing in ICT for learning could be perceived as an additional cost for the institutions involved. Indeed, costs should not be underestimated but most observers would agree that in the longer run, ICT have significant potential for cost-saving as well. Think, for instance, of digital storage of information and digital copying, possible access to worldwide free open content (Cf. *infra*), low-cost networking and others.

Moreover, the use of ICT for better and more efficient internal organisation of educational and training institutions could make them more cost-efficient.¹³ In addition, these institutions should also be seen as learning organisations, and should pursue the best from their human resources.

Greater efficiency in education and training should not be sought at the expense of less equitable outcomes for all.¹⁴ Budgetary pressure

10 Coomans, G., The Demography/Education squeeze in a knowledge-based economy (2000-2020), Work Research Centre, Dublin. Report for DG-JRC IPTS, European Commission, Sevilla, January 2005, Technical Report EUR 21573 EN. <http://fiste.jrc.es/pages/documents/eur21573en.pdf>

11 Report from Education Council to the European Council on the concrete future objectives of education and training systems, 5680/01 EDUC 18, The Council, 14 February 2001, p6. <http://register.consilium.eu.int/pdf/en/01/st05/05980en1.pdf>

12 COM(2005) 549 final/2 ; Brussels, 30.11.2005: http://europa.eu.int/comm/education/policies/2010/doc/progressreport06_en.pdf

13 See for instance: Pelgrum, W. & Law, N., ICT in education around the world: trends, problems and prospects, 2003, UNESCO International Institute for Educational Planning, Paris, pp. 105-122.

14 COM(2005) 549 final/2; Brussels, 30.11.2005: http://europa.eu.int/comm/education/policies/2010/doc/progressreport06_en.pdf

on education and training could result in under-investment in the quality of education and could give rise to a privatization trend focussing on high-quality and prestigious, but expensive, educational programmes.

In addition to budgetary pressures, there is the challenge of involving more people in lifelong learning in Europe. In 2005, only 10% of adults aged 25-64 had received some form of education and training, though this was 2% up against 2000. Moreover, there are important differences between Member States and between different age groups and education levels: e.g. younger people and better educated people are much more active in lifelong learning activities.¹⁵

Globalisation, diversity and alignment

Education in the knowledge-based society cannot escape the globalisation trend. Educational institutions will compete for the best students worldwide, and possibly for those who can afford to study abroad, or access premium educational models and brands. However, ICT-enabled education could counterbalance this by providing access to high quality education without having to move abroad.¹⁶

But while education is affected by globalisation, its implementation is usually local, regional or national. The challenge for EU policymaking is to align educational systems and curricula in Europe and support cross-border learning while, at the same time, respecting subsidiarity. Steps towards this have already been initiated by the Bologna reform of higher education, signed up to by 29 European countries, which aimed at creating a European space for higher education. This should enhance the employability and mobility of citizens and increase the international competitiveness of European higher education.¹⁷ Such reforms, while respecting the principles of autonomy and diversity of national educational systems, are not only beneficial for student and teacher mobility in Europe but could also stimulate the development and diffusion of European eLearning content management systems (CMS) and ICT-enabled access to European learning curricula.

In addition to the trends and challenges mentioned above, there are also the challenges arising from the 2000 Lisbon strategy objectives: i.e. competitive knowledge-based society, economic growth, more and better jobs, and social cohesion. The Lisbon strategy has also been translated into specific actions under the Education and Training 2010 programme.¹⁸

¹⁵ Source Eurostat: <http://epp.eurostat.cec.eu.int>

¹⁶ See also section 4.3 on ICT-enabled learning and inclusion.

¹⁷ <http://europa.eu.int/comm/education/policies/educ/bologna/bologna.pdf>.

¹⁸ http://europa.eu.int/comm/education/policies/2010/et_2010_en.html

■ 4. The role of ICT

Leading on from the broad approach to ICT-enabled learning raised in Chapter 1, two major perspectives are now described below: ICT for learning (4.1) and learning to use ICT (4.2). In addition, section 4.3 deals with the links and implications of both themes for inclusion. The latter was a major concern for most of the workshop participants. This Chapter as a whole deals with the specificities of the role of ICT for future learning in the knowledge-based society.

4.1. ICT for learning

The guiding principle for the potential impact of ICT on learning is the vision that it enables learning *anywhere, anytime and anyhow*. This vision is not new as it is already expressed in those parts of the currently running EU 6th Framework Programme which are devoted to learning, particularly in the Information Society Technologies (IST) programme.¹⁹ Some of the many different applications that can be envisaged in this vision are mentioned below.

In his background paper, Ilkka Tuomi gives an account of a number of innovative applications to illustrate how ICTs are used and could be used in future learning environments. These are summarised below, together with additional ones raised during the workshop. The workshop participants acknowledged these applications' potential and the fact that rapidly evolving technologies are reaching out to the world of learning. They stressed, however, that these applications need to be accompanied by the necessary reforms in learning and education systems, by teacher training and also by other social changes. Though ICTs are strategic enablers of change, they do not lead to it automatically.

Experiential learning in immersive environments

Problem-based learning in the classroom can be significantly enhanced by computer-supported immersive environments where the learner can effectively learn-by-experiencing, and look for solutions to problems by collaborating with others and/or by applying different approaches to a problem. New skills can also be learned via computer games, for instance collaboration strategies. Immersive multi-player online role games are already very popular with computer users.

Experimental learning with simulated worlds

Computer-based simulations are already used extensively in organizational settings - for instance, in design. They allow for "what-if" analyses. As simulation tools become less complex and less expensive, they can be used in learning settings ranging from real-life problem solving to primary education.

Pedagogic veils and intelligent learning objects

As future products will have sensors and become more software-based, they have the potential to become pedagogic. This means that, in the future, the objects themselves will teach the user how they are used, whereas today teachers, professionals and salespersons often have to explain this to people. In addition to pedagogic objects, intelligent learning objects can also be specifically designed for learning. Portable computers for children already exist for this purpose and could be significantly enhanced in the future.

¹⁹ <http://www.cordis.lu/ist/telearn/index.html>

Cognitive repair and support (for people with special needs)

People with neurological and cognitive problems can have difficulties with learning. ICT-based techniques could be developed to help these people address their problems, e.g. dyslexia. Cognitive technologies could also be used to compensate the effects of ageing, thus creating new opportunities for learning.

Podcasting

The market for podcasting and audio books is growing, with clear implications for education, especially now that they have become more audiovisual (Cf. Section 3.1 on IST trends). Workshop participants saw a lot of potential for education everywhere, including remote and distant locations, and even on the move.

In addition to the above mentioned ICT-enabled learning applications presented by Tuomi, other promising uses discussed during the workshop described below.

Blogging

Blogging (Cf. Section 3.1 on IST trends) has become one of the most popular applications for many, mainly young, Internet users. Its popularity and familiarity could be used in formal education to motivate young people. Furthermore, the diary mode of these websites and their use of hypertext and other links make weblogs particularly attractive for adult learning and training. Blogs can be used both by educators/trainers and by learners. They could be connected together in a "learning space" and could become part of formal certification (Cf. chapter 5). They also have interactive features that favour collaborative knowledge building.²⁰

Social proximity and synchronous learning

Future intelligent environments, also described as Ambient Intelligence (Aml), could play an increasingly significant role in social learning and the exchange of knowledge, particularly with user-friendly interfaces working on ubiquitous, interoperable networks. Aml could prove to be relevant for such a purpose, as it will be able to integrate and communicate context-dependent knowledge more easily than current-day technologies can. Social learning might be facilitated in an Aml environment since it can bring people from different backgrounds, cultures and contexts closer together. The intelligent environment would facilitate the sharing of experiences by making the necessary translations.²¹

Such an application would entail a shift in ICT-enabled learning from a-synchronous and stand-alone learning (e.g. putting a student in front of a computer in an isolated box) to synchronous computer-supported social learning that brings learners together and merges real and virtual environments.

Learning Content Management Systems (LMCS)

ICT can also contribute to providing better education by enabling educational institutions to function better. Learning Management Systems (LMS) for the administration of learning and training programmes already exist. Future applications are being developed that allow these to be merged with content management systems (CMS) which are used for managing learning content into Learning Content Management Systems (LCMS).²²

However, the potential of such systems would be greatly increased if they incorporate the new vision of learning whereby learners become

20 See for instance the open source software for collaborative work called Wiki's: <http://www.wikipedia.org>

21 See for instance Van Bavel R, Punie Y, Tuomi I, ICT-Enabled Changes in Social Capital. The IPTS Report, Special Issue on Building the Information Society in Europe: the contribution of socio-economic research, Issue 85: 28-32, 2004.

22 A preliminary study on the current state of e-learning in lifelong learning, Cedefop Panorama series, authored by Ken Page (Calmar International Ltd) and edited by Eila Heikkilä (Cedefop), Luxembourg, European Communities, 5169 EN, 2006.

co-producers in the learning process, and not just receivers of learning content. Flexibility, user-friendliness (for both teachers and learners) and different “digital” learning styles would be combined; and learning would be a social process rather than an instructorless computer-generated individual activity (Cf. Chapter 5).

Teach the teachers or train the trainers

A key factor for realising the potential of these and other applications will be the involvement of both educational practitioners and learners as much as possible in the development of such programmes. User-oriented design and development of ICT applications is needed to make sure that quality and effectiveness are guaranteed. If teachers and trainers are not convinced of the value and utility of ICT-enabled learning programmes, they will not be motivated to use them. To that end, it is also important to foresee teacher/trainer/tutor training, not just in the competent use of ICT, but also in its pedagogical use. An interesting example is the European Pedagogical ICT License.²³

4.2. Learning to use ICT

Living in a knowledge-based society driven by the wide-spread diffusion of ICT gives rise to the need to acquire new competences and master new skills related to the use of ICT. The European Commission has already done significant work during recent years on digital literacy and digital competence, and has recently declared the latter as a “key competence” that individuals need for personal development, active citizenship, social inclusion and employment.

A definition of digital competence was given in the introductory chapter of this report.

It consists of not only learning to use ICT but also really mastering them. This implies, for instance, understanding how ICT applications and services function. It does not necessarily mean technical know-how but rather understanding what it means to use digital technologies in everyday life.

Workshop participants confirmed that it is not only about “computer literacy”,²⁴ i.e. learning to operate the technology, but rather about higher-order skills such as knowing where to search for certain information, how to process and evaluate information, how to assess the reliability and trustworthiness of websites and other online sources, and many others. It is especially important, when dealing with educational content, to be able to assess the quality and reliability of knowledge and to contextualise it.

Particular concern was expressed about learning to deal with harmful and potentially risky content, both for parents, educators and trainers and for children, students and learners. Specific ICT skills in protecting privacy and maintaining security are important in this respect.

In addition to these cognitive skills, networking skills related to building, maintaining and developing social interaction via ICT are also necessary. This implies the importance of building social capital via ICT or “relationship capital” as it was labelled during the workshop. It also deals with sharing information, knowledge, and other resources.

Learning to use ICT is mainly concerned with the acquisition of ‘ICT user skills’. The European e-Skills Forum defines further categories, such as “ICT practitioner skills” which refer specifically to ICT-related jobs and “e-Business skills”, i.e. the capability to exploit opportunities provided by ICT for business and organisations.²⁵ These are not addressed in this report.

²³ <http://www.epict.org>

²⁴ See for instance European Computing Driver Licence: <http://www.ecdl.com>.

²⁵ The Supply and Demand of e-Skills in Europe, by Rand Europe (E. Frinkling, A. Ligtoet, P. Lundin, W. Oortwijn), Prepared for the European Commission and the European e-Skills Forum, September 2005. <http://europa.eu.int/comm/enterprise/ict/policy/doc/eskills-2005-10-11.rand.pdf>

4.3. ICT-enabled learning and inclusion

The emerging knowledge-based society and the wide-spread use of ICT generate the need for new digital skills and competences for employment, education and training, self-development and participation in society. There is, however, a considerable risk that already disadvantaged groups and marginalized people will not be able to benefit fully from the new opportunities offered by ICT, as competent users of ICT in general and as learners and educators in particular.

Therefore, dedicated efforts are needed to make sure that everyone is able to acquire the necessary digital competence in the information society and to learn and develop other key competences via ICT for participation in society. Learning objectives for emancipation and empowerment, such as social competence, critical thinking, knowledge sharing and cooperation techniques, are considered to be essential preconditions for inclusion, well-being and success in the KBS.

Workshop participants expressed concerns that future visions of ICT-enabled learning have a tendency to favour a privileged and even elite model of learning and education. The weblog, for instance, is a remarkable and potentially powerful new tool for learning, but does this mean that everyone needs to have a weblog? The experience-oriented learning model that lies behind blogging is not for everyone. Many people would still want or would need to rely on other means of learning.

A similar risk related to ICT-enabled lifelong learning was identified - namely, that only more educated people would have access to and benefit from a "Lifelong Learning Membership Card". This idea builds upon alumni associations but with a more learning-oriented connection between individuals and educational institutions. A "Brain Gymclub" was also mentioned - a

club where people can go to keep their brains fit, providing opportunities and tools for mental development. The club could be physical or virtual, but probably should encompass elements of both. However, membership of such clubs tends to be exclusive rather than open to all.

Though there are risks of exclusion with ICT-enabled lifelong learning, it could also be strongly inclusive providing the necessary social and institutional framework conditions are met. It can offer learning opportunities to more people, providing ICTs are made user-friendly or "granny-proof". ICTs also can be promoted in ways that boost the self-esteem of marginalised groups because software-based services are open to mistakes and allow lots of trial-and-error. People who need to learn to write could be more confident learning via computers than they would be learning on paper. Moreover, in contrast with the above mentioned risk of exclusion, people also learn outside formal learning settings, for instance when using different media such as newspaper and television.

ICT-enabled learning should be designed so that it embraces disadvantaged people, families and groups. It can offer new chances to those who want to learn again and to those who were not able to benefit from traditional obligatory education and training, or who were not able to perform at school. ICT-enabled learning could allow them to plug-in again though this will not happen automatically. People will only be motivated to learn again if the ICTs in question are embedded into their everyday lives, social contexts and social networks. Past experiments have shown that lack of motivation and social support are major reasons for the failure of new learning projects, with or without ICT.

This would imply that ICT-enabled lifelong learning initiatives are associated with other social inclusion policies. There continues to be an urgent and strong need to provide a good, basic education for all. Other key competences²⁶ which

26 Cf. EU proposal COM(2005)548 final, Proposal for a Recommendation of the European Parliament and of the Council on key competences for lifelong learning, Brussels, 10.11.200. http://europa.eu.int/comm/education/policies/2010/doc/keyrec_en.pdf

are not necessarily ICT-based such as literacy, communication and mathematics still need to be acquired. Workshop participants believe it is important to strike a good balance between non-computer based education and ICT-enabled learning.

States have an obligation to provide learning and education for all, and especially for those

who have difficulties accessing education, be it because they live in remote areas (hence the notion of distance education), because they are disabled or have learning problems (hence the notion of special schools and programmes). It would be great if ICT can increase and improve opportunities for these people but if they cannot, then other specific plans must be made to prevent that people are excluded from learning.

■ 5. Learning spaces: A vision of future learning

Given the pressure on existing learning institutions and learning models, ICTs offer important opportunities for developing a different view of how learning could look in the future knowledge-based society. During the workshop, the concept of “learning space” was raised and discussed as a way to embrace a different view of future learning. ICTs are key enablers for realising future learning spaces, although they are not the sole drivers.²⁷

The vision of learning spaces presents a desirable and necessary future that does not exist today. It puts learners at the centre of learning, but, at the same time, conceives of learning as a social process. Learners become co-producers and not just consumers of learning content. Guidance and interaction therefore continue to be very important. The role of teachers, tutors and/or trainers will change rather than disappear. It will require dedicated efforts to train and involve them in developing their changing role in the learning process. Learning spaces are not instructorless, computer-generated spaces without interaction and community building.

Future learning spaces could take many different forms, hence the plural and dynamic aspect of learning spaces, meaning that in reality, they are by no means, carved in stone. They would, however, need to consist of the following elements:

Learning spaces are connecting social spaces

Learning is a social, rather than individual process. It involves different actors such as

teachers, learners, learning institutions, learning content providers, and also family, friends, colleagues and other peers (including virtual ones - via chatting, for instance). The place where all these actors meet and interconnect for learning purposes or for sharing experiences could be conceived as a learning space. An individual's learning space could be, for instance, a personal space on the Internet that contains all relevant learning information. However, it would also have to be a physical space where teachers and learners can meet.²⁸

Learning spaces should also link learning individuals, learning communities, learning organisations and even learning cities and learning regions. The architecture of learning spaces should specifically provide meeting points, different from traditional class-room teaching style settings.²⁹

There will continue to be a need for teachers, tutors and/or trainers but they should be involved in developing a very different role in the future learning process, and receive specific training. Educational practitioners and peer learners will be connected through learning spaces and they will meet both in the physical and in the digital world, at the *right time* and the *right place* according to their needs - not necessarily anywhere and anytime. Thus, learning spaces will not be only instructorless and computer-generated but will offer instead communication, interaction and community. It is probably the lack of interaction and social support and guidance systems that made earlier generations of eLearning applications less convincing.

27 In a recent speech from CNED Rector Jean-Michel Lacroix at the “Open Classroom” symposium of the EDEN and EENET networks, the notion of “espace éducatif” was also raised, enabled but not determined by ICT, as a new way to provide learning for all actors in society and the economy. See <http://www.cned.fr/fr/index.htm>.

28 It can for instance also connect different educational institutions such as schools. The latter is already supported by the eTwinning part of the eLearning program. It promotes common values, intercultural dialogue and tolerance. See <http://www.etwinning.net>.

29 An example would be learning environments as built for the new Glasgow Caledonian University: <http://www.realcaledonian.ac.uk/>

Each personal learning space is under the control of the individual learner. This favours a more learner-centred learning model and provides autonomy for the learner. Learners become co-producers in the learning process and not just consumers of learning content. However, the learning space is not individualised in the sense that it is isolated from others. Guidance and interaction continue to be very important. It should be a social space where one is connected to others. The workshop coined the term “relationship capital” to indicate this, and also to embrace the tacit aspects of knowledge creation that emerge through human interaction, values and experiences.

Learning spaces are personal digital spaces

Every learner (and also every teacher/trainer/tutor) should have a personal, digital learning space where all learning material is accessible; anywhere, anytime, any way (multiple devices and media). This personal space would make it possible to go back and forth, without losing track of what has been learnt in the past. It would broaden the pedagogical scope to a more holistic approach to learning.

In addition, people should be able to use this learning resource to develop themselves as independent thinkers. A learning space should provide for self-esteem as this is of crucial importance not only for learning but also for personal identity and happiness. It should enable the learner to express different partial identities, which are not necessarily linked to each other. These identities may be kept invisible to others, if the learner so desires. It should therefore be a secure and private space.³⁰

Other parts of this space could be reserved for demonstrating experience, achievements and

career history. It could even encompass new forms of accreditation, as mentioned in the following paragraphs. The learning space may also be linked to a personal learning device (like a small portable computer or PDA) which students would carry with them during their formal education.

Learning spaces are trusted spaces

Social systems would also provide trust and confidence in a world where learners are connected to each other digitally, and learning content is shared amongst learners and even co-produced. Grassroots, bottom-up, open source content has the advantage of giving access to unlimited learning content but questions can be raised about its quality, value and reliability. The recent controversy around the online free encyclopaedia Wikipedia provides a good illustration of this issue.³¹

Indeed, a key question in the information society is that, as activities become more ICT-mediated, the conventional “truth checkers” begin to lose their grip on the collective ability to make judgements. In a digital world, usually, alternative social systems of trust are established to compensate for the absence of authority, familiarity and physical presence. An example is the reputation system offered by the online marketplace eBay, where each buyer and seller is given a reputation score which fosters trust between people who do not know each other.³²

Learning spaces are pleasant and emotional spaces

Learning today is often thought of by learning institutions and teachers to be functional and instrumental, and is perceived that way by learners. This is probably because these actors see

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- 30 For instance a virtual private space called “virtual residence”. See Beslay, L. & Punie, Y. (2002), ‘The virtual residence: Identity, privacy and security’, The IPTS Report, Special Issue on Identity and Privacy, No. 67, September 2002, 17-23.
- 31 The magazine Nature organised a blind peer review at the end of 2005, to compare Wikipedia and Britannica’s coverage of science and revealed numerous errors in both encyclopaedias while the difference in accuracy was not particularly great. Published online: 14 December 2005.
See <http://www.nature.com/news/2005/051212/full/438900a.html>
- 32 <http://pages.ebay.co.uk/aboutebay.htm>

learning as an information exchange process that needs to be measured and assessed. The focus is on the transmission of knowledge rather than on learning objectives and learning outcomes which can be achieved in different ways - for instance, through collaboration and play. Some would even argue that in such an environment, people would be more motivated, and, as a result, would learn better. ICT could make learning content more attractive (e.g. media-rich virtual environments and simulations) and more emotional (e.g. by connecting people). The objective is to make learning as pleasant and emotional as possible and desired. Many existing learning processes and settings do not invite people to learn.

Learning spaces are learning spaces

This is not a tautology. Currently, schools have different functions. According to some, the controlling function is becoming more predominant, at the expense of the learning function. This is partly the result of working patterns and family structures. For example, schools provide care facilities for children from households where both parents work and have time constraints. Learning spaces would differentiate between learning and controlling. This would make sense for learners at home as well as at school, as there too, boundaries are blurring. ICT can be used not only for entertainment and pleasure but also for learning and work.

Learning spaces are creative/flexible spaces

Learning spaces should be creative spaces, rather than focussing exclusively on reproducing knowledge. They should also be flexible in combining different learning modes and styles, depending on the learning object, the learner, the teacher, the environment, etc. In some cases, the learning mode could be more traditional (e.g. a lecture that is available via podcast) and in others, it could be a more personalised, human-machine

interaction. Then again, it could be group-work (both in real-life and digital) or face-to-face (bilateral) interactions.

Also depending on the context and situation, either problem-oriented or experience-oriented learning styles could be favoured. The flexibility offered by learning spaces would provide a bridge and more organic links between currently distinct forms of learning: individual learning, community learning, collective learning, learning communities. Different learning modes are often linked to different learning environments, but as boundaries are blurring between private, public, working and learning life, learning spaces need to be flexible enough to incorporate these shifts.

Flexibility in learning styles and forms will depend on the ability of teaching staff to incorporate such requirements into the learning curriculum, hence the importance of teacher training.

Learning spaces are certified spaces

Future learning can only be different from learning today if the current accreditation and assessment systems are adapted to the requirements of the knowledge-based society. The acquisition of ICT skills, digital competence and other new skills through formal, and especially informal, education should be demonstrated, evaluated and also certified. The ePortfolio initiative is an interesting example:

An *ePortfolio* is a personal digital collection of information describing and illustrating a person's learning, career, experience and achievements. ePortfolios are privately owned and the owner has complete control over who has access to what and when. It is at the same time a tool for learning and a tool for assessment. ePortfolio has been developed and promoted by IfEL (European Institute for E-Learning). In line with the EU Lisbon objectives, IfEL has set the goal that "by 2010 every citizen will have an ePortfolio".³³

33 www.eife-l.org/portfolio/index_html?set_language=en

This could pave the way for changing current evaluation systems that are exclusively based on individual performance, for instance by taking into account the connections and links with other learners and learning content. Such a change would be an incentive for all stakeholders in the learning process to embrace ICT and pedagogy.

Learning spaces are open and reflexive spaces

Future learning spaces would be different from current learning systems that are usually strictly regulated in terms of access and termination. Closed learning systems have a tendency to duplicate social stratification and social inequalities. Offering a more open, module-based system of learning would enable people to plug-in whenever they can or want to and could, therefore, be more inclusive.

Future learning should enable reflexivity. It should give people the ability to slow-down the speed of life, to stop for a while, and to develop the necessary cognitive and affective capabilities to think and reflect upon their own lives and upon living in a modern world.

In terms of learning, controversy and contradiction should not be eliminated since they are very often the basis for critical and innovative thinking. In the background paper by Tuomi (Annex 2), Protagoras is quoted: “wise men never agree as truths are many”. Learning spaces should

embrace this and include both grassroots, open source content and proprietary learning content in dedicated and protected spaces. Both are complementary, as one of the participants said: “It is not Wikipedia versus Britannica but both”.

Learning spaces as knowledge management systems

The strength of most organisations lies in their people. Innovation and creativity, if they are to blossom, must come from the people, although organisations need to provide the necessary structures and incentives. Employees should be willing to share experience and knowledge with other colleagues within the organisation, and even across organisations. Learning spaces could become informal platforms for sharing expertise and knowledge at the organisational level.

This could also include human resource management as it helps to put the right people in the right places. Competence and skills mapping systems have been used for some time in organisations, but these standardised systems have difficulty keeping up with fast changing skills and competences. Learning spaces could be a way to address this, providing they are really designed for flexibility and change. This would also require more convergence between the different disciplines of ICT, knowledge management and educational science.

■ 6. Realising the change

It was said many times during the workshop that learning institutions are difficult to change. Some would even argue that they are resistant to change, although such a broad statement unfortunately ignores the many innovative projects that are being undertaken by institutions and individuals throughout Europe.³⁴ At the same time technological change is evolving rapidly. Five years ago, few people had ever heard about weblogs, whereas now they are regarded as almost mainstream media in the realm of social and political communication. But the success of new applications does not happen by itself. Technology in itself is not able to change society and its social institutions. Technological change can only reap benefits if it is embedded within its societal context.

This is also the case for ICT and learning. ICT-enabled learning is more likely to be successful if it is accompanied by social and institutional change in educational settings. Social innovation and social engineering is what seems to distinguish the Finnish model of innovation from other countries where technology is at the centre.³⁵

The entire learning system and all its stakeholders need to be involved to realise the change: educators, trainers, teachers and their institutions; learners, students and their families; organisations (public and private including SME's), employees and employers; technology and content providers; researchers, academics and innovators; and policymakers and governmental institutions at all levels (local, regional, national, EU). The importance of multi-stakeholder involvement has

already been acknowledged in a joint statement from the EU Commissioners Reding and Figel at the 2005 eLearning Conference in Brussels.³⁶

People and institutions are not by definition hostile to change, but there should be sufficient incentives to make change possible.³⁷ The benefits of ICT-enabled learning should be emphasised more strongly but the technologies also have to match the expectations they create. A realistic assessment of costs should be carried out as well. Incentives should be provided to all stakeholders involved - for instance: time-saving via distance education for learners; greater effectiveness and flexibility in learning courses for educators and trainers; more efficiency and more learners for learning institutions; more and better jobs for policymakers and, finally, better skilled workforces for companies.

Highlighting benefits is, however, not enough. Sufficient time, space, energy and resources need to be dedicated to the implementation of ICT-enabled learning. It is of crucial importance to train the teachers, tutors and/or trainers because of their changing role in the learning process. Setting up ICT-enabled learning programmes or learning themselves to use the educational possibilities of ICT should not be an additional workload for teachers. Moreover, school heads should not only support such programmes but also create the necessary atmosphere and attitudes towards a learning environment that is innovative and open to change. Leadership based on shared values and relationships is regarded as important for the successful implementation of ICT-enabled learning.

34 See for instance projects funded under the EU eLearning programme (http://europa.eu.int/comm/education/programmes/elearning/index_en.html) and the FP6 IST programme (<http://istresults.cordis.lu>), amongst others.

35 See for instance: Markkulu, M., eLearning in Finland. Enhancing knowledge-based society developments, Report of the One-Man-Committee appointed by the Ministry of Education, Gummerus Kirjapaino Oy, Jyväskylä, Finland, 2004.

36 <http://www.elearningconference.org>

37 See also background paper in annex: section on tectonics of change.

There are different views on how to realise the change. Some argue that ICT-enabled learning should be implemented bottom-up, others are more in favour of a top-down approach where attitudes and knowledge of ICT for learning cascade down, for instance from headmasters to teachers to students. The latter, however, would seem to contradict the observation that currently many students are better skilled in ICT than some of their teachers (and some of their parents as well). The argument that we need to learn from what youngsters are doing today with ICT was voiced several times during the workshop: “Learn from the digital generation to understand the potential of ICT for learning”.³⁸

Other views on realising change compare small incremental ways of initialising change with big projects that make a difference. Incremental change strategies risk being unable to supersede institutional protectionism and immobility, while big projects risk resistance in everyday working practices. There is probably no single best method

for realising institutional change in learning but most workshop participants agreed that a holistic and systematic view is necessary involving all relevant stakeholders.

Successful experimentation and best practice do not automatically result in permanent applications of ICT-enabled learning, especially when public authorities are concerned that projects run the risk of going against equity, against providing learning opportunities for all.

Changing educational and training systems is not easy. Some of the workshop participants argued that there is need for a “Copernican revolution in education” resulting in new educational models and systems. The problem is that “changing education is like moving a graveyard: there is no support from the inside”. This could possibly be one of the biggest challenges for learning in the future. But the widespread diffusion of ICT could also be a catalyst for change providing it is accompanied by social and institutional change.

38 See for an American view: Oblinger, D. & Oblinger J. (eds.) *Educating the Net Generation*, 2005, Eduhouse Publisher, Available at <http://www.educause.edu>.

■ 7. Future research challenges

ICT for lifelong learning in the future will be faced with a number of research challenges involving not only technological, social, economic and political issues but also learning processes and implementation issues. A research agenda is needed that covers the complexity of the foreseeable changes and especially their interrelationships. Participants were invited to brainstorm on these research challenges, and a tentative attempt has been made to group the resulting key claims and messages below. It was not the intention to be exhaustive.

Socio-economic

Learning in the future by means of ICT needs an approach that is as holistic as possible in that the different economic, social and individual goals that could be achieved are balanced. Research is needed on how this balance can be achieved and on how these different goals are interrelated. For instance, the needs of the labour market should not eclipse individual development needs (e.g. self-fulfilment, sense of purpose...), social ones (e.g. increased inclusion, integration of migrants) or political ones (e.g. enhancement of democratic participation).

Another element of this holistic approach is related to lifelong learning and especially its de-compartmentalisation. There is a need to evaluate, how future ICT for lifelong learning will affect lives, individuals and communities and even the wider value system. ICTs incorporate certain values; hence the question is how these would affect values and power relations in the learning process. A related issue is the status of

knowledge. If, in the future, it becomes possible to beam knowledge directly into our brains, what then are the learning requirements and what are the values incorporated in the knowledge?

There are other important cognitive questions such as how to diagnose and deal with cognitive and other disabilities in future environments where technologies can “repair” certain disabilities.

The development of digital identities (e-identity, digital self and self-appreciation) will undoubtedly interfere and interact with novel learning activities and methods, with potential psycho-social impacts on individuals. For instance, if weblogs, in their future evolved form, are adopted as a major (but not the sole) ICT application for learning, then the repercussions of e-identity on the interfaces between the individual and the educational system, and society in general will be considerable. Issues like intellectual property rights and reliability of information would have to be dealt with. Solutions like e-portfolios will also have important ramifications that deserve research, probably leading to ex-ante instruments that preserve rights, reliability, privacy, confidence and trust, to mention some evident facets.

Indeed, prospective research is required to understand the privacy invasion potential of new digital technologies in order to develop relevant safeguards.³⁹ This is also relevant in terms of implications for future learning. In future learning scenarios, the application of these technologies can be very powerful but can also entail serious acceptance barriers if suitable solutions for these privacy, security and ethical threats are not found.

39 See for instance SWAMI project: <http://swami.jrc.es>

Technological

Ambient technologies and ubiquitous computing appear to be the “natural” technological components of ICT for lifelong learning because they have certain benefits like user-centeredness (hence supporting learner-centric approaches and links between learners), interactivity (anytime, anywhere) and user-friendliness (anyhow). These raise technological issues such as how to realise these benefits for broadband learning, mobile learning and multi-modal learning.⁴⁰

There are also specific requirements for transforming the “anytime, anywhere and anyhow” vision in terms of learning into learning at the “right time, the right place and with the right technologies”. This gives rise to the question which technologies are needed to realise the “learning spaces” as provisionally envisioned in chapter 5 of this report.

A more robust ontology is also needed that allows us to match technological requirements such as distributed storage of learning objects with specific user requirements.

The development of learning content management systems would also benefit from technological progress as this would allow them more flexibility, user-friendliness (for both teachers and learners) and different “digital” learning styles, in contrast with a single digitised form of existing analogue learning models. It would also take into account the changing position of learners in the learning process (where learners become co-producers and not just receivers of content) and fit well with a more user-oriented way of developing new learning technologies.

New and disruptive technological developments occur frequently in innovation-intensive knowledge-based societies. Many of these developments are reshaped and used differently to the way originally intended. Others

achieve sudden global success leveraged by the active role played by users and by massive use. Research on how technological innovations in the field of learning are being diffused and reshaped by learners and other actors could help to understand these processes.

The learning process

Consideration of “why-when-where” to learn will lead to the generation and acquisition of new learning habits, both for the learners and the teachers/trainers. Research could identify the changing role of learners, teachers and other actors in the learning process. A related question for exploration is how ICT could motivate people to learn again, and to learn lifelong, also at a later age.

The evolving nature of what we will learn and what we should learn needs to be researched. This research must be prospective to ensure that we understand the policy options available for the preparation of the future learning environment. Educational policy makers must be aware of the changing needs in a dynamic KBS, including the new key skills needed (generic skills, tacit skills, social skills) while keeping an eye on policies to constantly improve teaching and learning at schools by means of ICT. Schools should not be an obstacle to learning. Digital competence including the definition of what this means now and in the future, is particularly important for improvement of teaching and learning.

The impact of flexible lifelong learning on time patterns requires investigation. It will – and already does, in the general context of the information society – question how people structure their days, weeks, leisure, learning (and non learning) time, and their time schedules in general.

Learning spaces will need to be reshaped into drastically new forms, ranging from physical

40 See for instance FP6 Kaleidoscope Network of Excellence (<http://www.noe-kaleidoscope.org>) and papers presented at the 2005 eLearning Conference, such as the one from F. Cardinali on “Narrowcasting & Ambient Learning”: http://www.elearningconference.org/key_speaker/cardinali.htm

to ICT networking novel architectures (how do we organize the exchange of knowledge including physical spaces?). “Mental gyms” have been mentioned as a metaphor for a model of lifelong learning.

One of the most recent successful applications is blogging, which has emerged as a powerful e-tool. It has now spread globally, and is changing patterns of “traditional” e-communication. The educational implications of blogging should be further investigated. Self-representation, an important aspect of blogging, could then be taken into account as well. It represents a major disruption in ways individuals present themselves and their knowledge, experience and talents to society.

Learning-content questions are even more important now that learning content is changing. The issue of open source content and the notion of learners as co-producers of content raise questions related to quantity, selection, quality and reliability.

This research poses questions on the consequences of changing learning content. For example, what new assessment methods should be researched physical and virtual learning tools converge? Exploring how to implement adaptive assessment tools enabled through ICT deserves attention. Assessment tools apply not only to individual assessment (micro-level) but also to the accountability of schools and educational institutions (meso-level) and educational planning as a whole (macro-level). Finally, new content management and publishing models such as ambient smart content or “smarties” will influence learning in the future, offering opportunities for individualised augmented learning while barriers to social learning can be generated by the same token.

Managing the change

Although individual projects in Europe are being developed that envisage innovative learning models, the majority of traditional educational institutions have a tendency to be resistant to change, hence the importance of managing change. There are signs that change is possible (e.g. the reform of higher education and opening-up of universities). More research is needed to better understand and manage change in the learning realm.

Especially research on drivers for change could prove to be useful. These should include an assessment of some the key components of education such as assessment and evaluation, which should be carried out for both learners and educators/trainers and their institutions; accreditation and certification, especially when trying to take on board informal learning; and the crucial role of leaders, both in the political and the educational systems arenas. The question on how to let ICTs play the role of catalysts for change could also be raised, while recognising that ICTs are not the only solution.

Management challenges can be overcome by means of novel models and processes of information sharing and collaboration in a knowledge-based society which makes intensive use of ICTs. For instance, creating a model for European adult education will entail the need for collaboration and sharing of experience between change managers throughout the European Union. Research can contribute by facilitating such processes, but it should also highlight how political and institutional leadership could be of considerable help.

■ 8. Conclusions

Most learning programmes and education and training (E&T) institutions are currently organised, understandably, according to the characteristics and needs of late industrial societies. Although one of the great merits of modern societies is that education and training is provided, resulting in opportunities for many individuals and families to live a decent life, policymakers and educational stakeholders in Europe acknowledge that there is an urgent need for change. Europe requires new skills and competences to remain competitive in the future knowledge-based society, to guarantee more and better jobs for all, and to realise a sustainable and inclusive society.

Technologies, especially ICTs, have a particular role to play in realising these changes. It is almost impossible to imagine a future learning environment without ICTs. For instance, they could be visibly at the forefront with a learning programme or they could be less visible but equally important in providing access to learning anywhere, anytime and anyhow. Moreover, as ICTs are becoming widespread, it is of fundamental importance for individuals to be able to use them, for many reasons such as employment, education and training, self-development and participation in society.

Technological change is fast and offers many opportunities but also many uncertainties, while pedagogy and learning institutions require some stability and certainty to deliver quality and equity in education. This creates tensions that make it very difficult to manage and implement change in institutionalised learning environments. That is why it is important to acknowledge and take into account the fact that technology, however powerful, cannot bring about the necessary change. The potential of new technologies can

only be realised when they work with, or rather, are embedded in, a social context that is open to innovation, and supported by a favourable policy environment. This explains why it always takes more time to realise technological change than expected. Carlotta Perez shows that it takes about half a century for a new technological paradigm to become established, and then only if the necessary framework conditions are met.⁴¹

This means that the implications for the ICT revolution, and consequently for ICT-enabled learning as one of the key applications for the development of the information society, are promising. According to the Perez analysis, we are now just entering the deployment period for ICTs, meaning that they have still to realise their full potential. This would partly clarify why, up until now, ICT-enabled learning has not lived up to its promise. But it must be repeated that this will not happen by itself. It needs investment, resources, innovation, research, multi-stakeholder involvement, trial-and-error and many more social and institutional changes. And it will probably take longer than expected.

The change that is needed will provide however, many opportunities for more and better learning, education and training in the knowledge-based society. This report has pointed to some of them. It has discussed a number of innovative and potential ICT applications that could make learning better, different, more interesting, pleasant, and relevant. It has also given an account of the role of ICT-enabled learning in addressing some of the challenges Europe faces, now and in the future. For instance, the demographic squeeze, together with the knowledge economy, requires that learning become more flexible and modularised, multi-

41 Perez, C., *Technological revolutions and financial capital. The Dynamics of Bubbles and Golden Ages*, Edward Elgar, Cheltenham, UK, 2002. <http://www.carlotaperez.org/>

cultural and permanent. If it does not, there will not be enough knowledge workers to contribute to economic growth.

This report also presented a vision of learning that embraces both the potential of ICTs and some of the new requirements for learning in the future, called “learning spaces”. The vision places learners at the centre of learning spaces but, at the same time, sees learning as a social process, hence the importance of guidance and interaction. Educational practitioners and peer learners will be connected through learning spaces and will meet in both the physical and the digital world, at the “right time” and the “right place” and in the “right way”. It is this emphasis on the social side of learning, supported by technologies that enable natural synchronous communication; interactivity and community-building that would make this vision different from earlier notions of eLearning (based, for instance, on standalone interactions between learners and learning programmes). This would also require dedicated efforts to train educational staff to play their role in the learning process which will change considerably, rather than disappear.

The vision of learning spaces also confirms the importance of lifelong learning and as a result, the need to have a holistic view on the future of learning. This should not only cut across existing sectors and formal E&T institutions but also across different learning generations and life spheres such as private, public and work; and embrace informal, spontaneous learning.

Such new requirements for learning demand dedicated efforts to “teach the teachers” and “train the trainers”. The new skills and competences teaching and training staff must acquire are thus not only related to ICT literacy, but also to learning to work with learners who are more diverse in terms of age, ethnicity, language, and others. Moreover, teachers and trainers need to learn to teach differently as learning become more

flexible, dynamic and personalised. Learning staff will also face the challenges of demographic ageing.

The concept of learning spaces could contribute to building a pro-active strategy to realise ICT-enabled learning in the future. This report has also observed that although the instrumental concerns with adapting learning and training to competitiveness and the requirements of the knowledge-based society are important, there are also fundamental issues that need to be addressed when thinking about the future of learning in the knowledge-based society: Why do we learn? What do we need to learn? What are the objectives of learning?

These fundamental issues are related to the possible political, emancipatory and empowerment objectives of ICT-enabled learning, and also to the risk that innovative learning via ICT will only be beneficial for the already privileged. This report, however, has also pointed to the inclusive potential of ICT-enabled learning to provide learning opportunities to more people, especially disadvantaged people, families and groups. As repeatedly argued, this will not happen automatically. People will only be motivated to return to learning if it is relevant to their daily lives, their social context and social networks.

Future research could contribute by investigating how such initiatives could be undertaken. Understanding the potential of ICTs for learning requires that we also understand better how to merge pedagogy and technology. This could be done, for instance, by looking at how the younger generation makes use of ICTs. This is the generation that already behaves and thinks digital. Learning from the digital generation should enable us to understand better what lifelong learning (which also involves older people) in the future knowledge-based society will mean. This report has just provided a first glimpse. There is still a lot to learn.

■ Annex 1: Workshop agenda

Day 1 - Thursday, 20 October 2005 (IPTS Room 116)

Session 1: Opening

09:30	Welcome and introduction, Marc Bogdanowicz, IPTS, Action Leader FISTE
09:45	Setting the scene, Maruja Gutierrez Diaz, DG EAC, Head of Unit A/4
10:00	Presentation of participants
10:45	Coffee Break

Session 2: Background paper

11:00	The future of learning in the knowledge society: Disruptive changes for Europe by 2020, Ilkka Tuomi, Oy Meaning Processing Ltd, Helsinki
11:45	Discussion
13:00	Lunch

Session 3: From the Cradle to the Grave: Key priorities for Learning in the EU Knowledge Society by 2020

14:00 – 16:00	Coffee Break
16:20 – 18:20	Dedicated discussions on -ICT and Learning in Education -ICT and Learning at Work -ICT and Adult Learning -ICT and Learning for inclusion
18:20	Close of First Day
21:00	Dinner

Day 2 – Friday, 21 October 2005 (IPTS Room 116)

Session 4: Vision building on ICT and Learning in the Knowledge Society by 2020

09:15	Summary first day discussions, Yves Punie, IPTS
09:40	Discussion and validation

Session 5: Does the vision meet the policy context?

10:20	ICT and innovation in the proposed Integrated Lifelong Learning Programme (ILLP 2007-2013), Brian Holmes, EAC Executive Agency
10:40	Discussion
11:30	Coffee Break

Session 6: Future (FP7) research needs

11:45	Post-it session on identification of future research needs
12:45	Workshop Conclusions
13:15	End of Workshop

■ Annex 2: Background paper by Ilkka Tuomi

The Future of Learning in the Knowledge Society: Disruptive Changes for Europe by 2020

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1. Introduction

In the next fifteen years, European citizens will have access to advanced information and communication technologies that will profoundly change the ways we use, create and learn information, knowledge and skills. We will be able to package material objects in virtual layers of software and information, turn them into extended and informationalized artefacts, and link them to the ubiquitous global net. Our physical spaces will blend material, informational and communicative structures and functionality. Work will become increasingly knowledge-intensive, and productive activities will both concentrate in new geographical regions and, at the same time, become globally distributed. The established institutions of learning will struggle to adapt to the new social and economic order, and new institutional forms of education and learning will emerge.

The transformation towards the knowledge society is driven by complex interactions between technical, social, economic, and human factors. The developments are not deterministic. Instead, the ongoing transformation is being pushed by forces that at each present configuration find their next direction of gradual evolution. At each point of time, the society, embedded in its material past and the world around it, moves towards the possible and the promising, without simple linear causality.

Although this complex process of co-evolution cannot be described using deterministic causal models, it is possible to describe fundamental trends that will generate new possibilities and promising avenues for development. We don't have to guess the future. We can simply look around us and realize that advances in information processing technologies have already changed the world. Even if technical advance in ICTs would end tomorrow, the diffusion of current technologies will fundamentally change the way

we live, work and learn in the 2020. We have created radical technologies but the revolution is still ahead of us. In many ways, we simply have to make current technical opportunities real to change the world.

At the same time, we are creating new technologies that will enable new technical architectures and applications. Due to their important social and economic impact, educational applications of information and communication technologies will be key drivers in this process.

Educational institutions—for reasons described below—have been relatively slow in adopting information and communication technologies. Great expectations about computer-based learning and the rapid growth of educational software markets have in recent years given way to sceptical attitudes concerning the role of technology in learning. To a large extent, this has been because technology has often been used simply to computerize classical learning models. In practice, private firms have often been leaders in experimenting with new learning models and integrating information and communication technologies into their competence development and knowledge creation processes.

As Linné noted in *Philosophia Botanica*, “*natura non facit saltus*.”⁴² Discontinuous and disruptive change is something that, strictly speaking, we invent ourselves. At some point in time, we start to think the world has become different enough that the old reality does not exist anymore. We look at a picture and see a rabbit where we earlier saw a duck, and we look to the sky and see the sun at the centre of the universe instead of being there ourselves. This is the prototypical paradigm shift, made famous by Thomas Kuhn.

Paradigm shifts, however, are not purely mental events. The reality is deeply rooted in social institutions and material constraints. We

42 “Nature makes no leaps.” Also commonly used since the 16th century in the form *Natura non facit saltum*, often translated as “nature does nothing in jumps.”

can see a rabbit and a duck in the same picture partly because they are only two-dimensional drawings on paper. In the picture, the rabbit does not quack like a duck, and the duck does not make jumps. We can relatively freely imagine one or the other, and our imagination does not really matter much in practice.

In real life, our imagination is constrained in many ways. In particular, our imagination is constrained by the imaginations of others and the real practical characteristics of our material environment. Technical and material artefacts have some affordances and functional capabilities and not others. Human imagination is, in turn, constrained by routines that constantly reproduce and regenerate social institutions and stocks of socially shared knowledge. Socially important change, therefore, is slow, and revolutions can often only be described in retrospection.

Disruptive change becomes real when our collective imaginations change and reorganize our world and our interactions with others. When important trends interact, we may have to reorganize our views of the world in fundamental ways. Such “tectonic” disruptions occur in the foundations on which we build our everyday life. They require that we rethink what already was obvious. The rapid and sustained change in information and communication, media, and transport technologies has already created such tectonic tensions and reorganized the world. As a result, our concepts and practices of learning will undergo fundamental change in the coming years.

This paper, therefore, aims at laying out some characteristics of the ongoing socio-economic transformation. It tries to open the discussion on their implications for learning. We have to ask, why do we learn and whether learning will be interesting also in the future. This requires that we revisit and make explicit some assumptions that underlie our educational institutions, theories and practices.⁴³

2. Models of learning

“Protagoras answered: Young man, if you associate with me, on the very first day you will return home a better man than you came, and better on the second day than on the first, and better every day than you were on the day before.”

Learning, in the conventional definition, is the process of acquiring knowledge, skills, attitudes, or values, through study, experience, or teaching. To be counted as learning, it has to lead to long-term changes in behavior potential; in other words, it has to generate new capacity for alternative behaviors of an individual in a given situation in order to achieve a goal. Learning may be viewed as a change in activity, in the structure of behavior, and in a person’s mode of engagement in social practices (Packer, 1993:264). It is change in mind—metanoia, as Senge (1990) calls it—but also change that is reflected in action.

During the last century, learning has been studied in the contexts of behaviourism, cognitivism, constructivism, connectionism, distributed cognition, socio-cultural theory, and organizational studies on innovation and knowledge creation. Behaviourism focused on externally observable change, cognitivism on mental representations and processes, and constructivism on active interpretation and sense making. More recently, studies on distributed cognition have moved the focus from individual human mental processes towards the interactions between human cognition and its social and material environment. This move has partly been influenced by the rediscovery of socio-cultural and cultural-historical theories of learning.

Many variations exist on these research traditions. In general, behaviourism adopted a positivist epistemology, where learners adapt to given external conditions of a learner-independent reality. Cognitivism shared this positivist epistemology, viewing learners as

43 The paper refers to a number of learning theories which are reviewed in a separate Appendix.

processors of external signals and information. Constructivism, in turn, made knowledge and the reality two sides of the same coin, studying, in the words of Jean Piaget, how “the mind organizes the world by organizing itself.”⁴⁴ The cultural-historical and socio-cultural research traditions, inspired by Lev Vygotsky and his students, have put this constructivist epistemology in social and semiotically mediated contexts, effectively starting from the assumption that—although meaningful reality and knowledge about it are actively constructed by learners—accumulated social, cultural and material resources both embed and constrain this process.

3. The objective of learning

In these theoretical traditions, learning has often been viewed as a process of adaptation and generation of problem solving capability. Both Piaget and Vygotsky were centrally focused on the question how advanced forms of thinking and mental operations emerge during individual development. For these authors, the fundamental question was not about acquiring knowledge; instead, the question was how we learn to think. In the Vygotskian tradition, for example, conceptual systems were understood to be important—not because they would accurately reflect the facts of the world—but because theoretically advanced conceptual systems make advanced forms of thinking possible. In this tradition, the ultimate goal of learning mathematics, therefore, would not be viewed as learning to know mathematics. Instead, the capability of using mathematical concepts enables us to efficiently think abstract and complex thoughts. The goal of theoretical learning, therefore, is not to make the learner

able to provide the answer to a given theoretical problem; instead, it is to develop the learner’s capability to think.

These theoretical approaches are descriptive and they typically produce models of how children mature into competent adults. To put it simply, they start from the problem of how children learn that putting a finger in fire hurts. Learning thus becomes seen as a phenomenon of individual development. The normative question of why should we learn, often remains secondary and peripheral.

As a consequence, the objectives of learning are sometimes described as external motives that legitimize learning. For instance, learning is often associated with socio-economic advances. It is frequently pointed out, for example, that education increases economic productivity, which is important for national competitiveness; or that education has substantial private returns for the learners, thus being a rational investment. Such arguments easily lead to discussions about whether it is possible to scientifically prove that education actually has economic impacts, or whether human capital is measured accurately and conceptualized in theoretically sound ways.⁴⁵ On the other hand, such economic arguments can also easily be reversed. Lester Thurow (1975), for example, argued in the 1970s that about half of the educational costs should be counted as defensive costs that people have to pay to avoid economic losses. In Thurow’s job queue model, educational certificates are valuable because they allow individual jobseekers to jump the line and by-pass other jobseekers in the labor market. In this model, it really does not matter much what people have studied, as long as their educational

44 Cf. von Glasersfeld, 1995:57.

45 The social learning models discussed below, as well as a careful analysis on conventional productivity measurement frameworks show that strong or generic statements about the economic impacts of learning are not theoretically very strong or empirically generally valid. Without entering a discussion on the economics of learning, one may note that the current economic models do not well capture socially distributed, context-dependent, historically path-dependent, and innovative characteristics of learning, competence development, or knowledge creation. For a more detailed discussion, see Tuomi, 2004.

certificates put them in the front of the queue.⁴⁶ As job offers are given to people who are in the front of the queue, successful jobseekers have to be better educated than average jobseekers.⁴⁷ The economic function of education may therefore be less about acquisition of knowledge than it is about gaining socially respected educational certificates. Perhaps half of the investment in education, therefore, may generate economically productive competences; the other half is spent because people have to accumulate certificates in an attempt to try and avoid falling back in the queue. This is, of course, just one theory. In economic growth indices that correct GDP by economically positive but socio-economically harmful outcomes such as crime, pollution-induced diseases, and environmental degradation, education, however, is now counted partly as a positive growth and partly as a negative cost.⁴⁸

In practice, the normative aspect is of great importance in education. Education has traditionally been perceived as a means to civilize people and make young people useful and productive members of the society. Much of the current discourse on education centres on the need to produce competent workers for the needs of the economy. At the same time, learning is also understood in the enlightenment context, where individuals become liberated and realize their true potential by acquiring knowledge and by freeing themselves from superstitions.⁴⁹ One way to manage this paradox has been to separate vocational education from enlightenment education, and to understand the former as instrumental and the latter as driven by the quest

for knowledge and wisdom. This demarcation, of course, has now to some extent become outdated, as also non-vocational education is often legitimized through its impact on economic growth and competitiveness.

Debates on the proper objectives of learning, however, will become increasingly visible in the future knowledge society. To an important extent this is because existing educational institutions need to find new ways to justify and legitimize themselves. As workers increasingly need to process up-to-date knowledge and mobilize socially and geographically distributed resources to get their job done, knowing becomes an increasingly dynamic and social phenomenon. Knowledge is reproduced, created, and recombined in fast cycle-times and in problem contexts that are difficult to imitate in educational institutions. Rote learning of facts becomes redundant when everyone has access to ubiquitous networks of information. Learning and knowledge-creation skills become increasingly important for work performance, and educational certificates become increasingly irrelevant. Learning opportunities accumulate fast for some, creating social differences and digital divides, and education institutions and policymakers struggle to combine innovation, creativity and equal opportunities.

A natural reaction to extend the instrumental view on education is to include subject matters such as “social skills,” or “skills for personal priority setting” in the educational curriculum. In the knowledge society, however, we need to go deeper and revisit the traditional debates on

46 In practice, of course, there are multiple queues and a variety of criteria for ranking jobseekers. A Ph.D. in theoretical philosophy may advance in a labour market queue less than a M.A. in computer systems if the queue is for a job on Web portal design. At more advanced skill-levels, however, it often does not matter much whether a job seeker has a Ph.D. in philosophy, linguistics, quantum theory or computer science and they all are, indeed, common in information systems and artificial intelligence research, for example. In the specific case of Web designers, formal educational certificated mattered very little when the profession emerged in the 1990s. For the evolution of professional skills, credential-bestowing institutions and job markets in Web design, see Kotamraju, 2000.

47 In some job categories, jobseekers perhaps now need to be in the top quintile before they are considered to be potential candidates. Below that cut-off educational achievements matter little.

48 See, e.g., Daly & Cobb, Jr., 1989.

49 This paradox of socializing people into existing conventions and beliefs and making them free of these conventions and beliefs becomes particularly visible in adult education (Jarvis, 1992).

education. In Plato's *Meno*, for example, the starting point was the question whether it is possible to teach virtues. At the first sight, this question contrasts with the instrumental views on education and learning. Socrates argues that it is as impossible to teach virtues as it is to put knowledge into someone's head. We cannot give a generic definition of virtue or knowledge, and—as we do not know what they are—we cannot teach them. Learning, therefore, can at best be a process where we recall knowledge that we already knew in some unarticulated form, or where we uncover our pre-existing latent virtuousness.

In the modern world, it is useful to recall Socratic dialogues because they pose essential questions that we now have forgotten. Modern educators rarely ask, for example, whether it is possible to teach virtues. In the emerging global and culturally diversified world, such questions, however, have important practical consequences.

In the Confucian *Daxue*⁵⁰ virtue is described as a style of being that cannot be gained by simply imitating virtuous behaviours. The Confucian concept of learning was originally meant to be an unending process of widening of one's horizon. In practice—and somewhat paradoxically—aspiring civil servants in China had to memorize *Daxue* to pass their public examinations. This, again, illustrates the dual nature of education, as a process that potentially creates revolutionary new knowledge and as a process that socializes the learners as well-educated and well-behaving citizens. In practice, the Confucian widening of horizons has often degenerated into rote book-learning. This is now perceived as the major challenge facing Asian educational systems, and a major competitive advantage of American research universities, which now aim at providing global educational services.

In the modern global context, it is useful to note how the Confucian virtues have their foundation in knowledge and research, and how their ultimate motivation is peace and harmony in the State. The first chapter of *Daxue* clearly states the objective of learning as the illumination “with shining virtue all under heaven.” It explains that this objective can be achieved by first establishing order in the state. This requires order and harmony in the family, which can only be achieved by cultivation of persons, which occurs by rectifying the mind. This, in turn, happens when people verify their opinions, by expanding knowledge through investigation of things. Research leads to knowledge, knowledge leads to right opinions, right opinions lead to harmony in the family, harmony in the family leads to orderly states and orderly states, according to *Daxue*, lead to “peace all under heaven.”

The disciplines of Confucius assumed that there is only one truth. In this—as well as in his quest for the perfect order of the State—Confucius joins his younger contemporary Plato. This basic assumption, however, would have found strong opposition from Heraclitus and Protagoras; first because according to Heraclitus contradiction and crisis is the source of all development, and second, because according to Protagoras, wise men never agree as truths are many, and because wisdom starts when we realize this fundamental fact.

Both Plato and Confucius would also have faced opposition from the sceptics. They pointed out, for example, that the establishment of truth always requires facts, which, in turn, have to be justified by facts. This leads to infinite regression.⁵¹ The project of finding the solid foundation of knowledge that would allow Platonists and Confucian civil servants to build order in their minds, lives, and states, therefore, was futile.

50 The Great Learning, perhaps more accurately translated as “Self-Development of Adults.” This is one of the Confucian classics, written probably in the 3rd century BCE.

51 Infinite regression is one of the Pyrrhonian “modes of scepticism” (cf. Barnes, 1990).

The modern institutions of learning reflect the ideas of Plato and Confucius. In contrast, Heraclitus outlines well the characteristics of modern innovation and knowledge based economy. In the view of Heraclitus, the world is a process of constant change and a stage of creative destruction, where crisis and conflict provide the stable source of true knowledge.

When we use the modern definition of learning as the acquisition of knowledge, skills, attitudes and values that leads to persistent change of behaviour potential, such a definition remains quite unclear or tautological unless we define what we mean by knowledge, skills, attitudes, and values. The definition is easily read as a description of a process that leads to improvement. Today it is often taken for granted that learning leads to progress. The definition, however, also allows for the case where people learn wrong knowledge, dysfunctional skills, bad attitudes and disgraceful values. Although the definition looks universal and value-neutral, the implicit idea is that at least when learning results from teaching, we learn accurate knowledge, useful skills, right attitudes, and proper values. Instead of asking the question that started Menon's dialogue with Socrates: "Can virtue be taught?" the modern discourse often starts from the assumption that learning is a virtue in itself. Thus the question what and why should we learn is often considered to be redundant. This fundamentally ethical and political question is then reduced to an analysis of "skill gaps" that need to be filled to match human capabilities with the demands of industrial production. The pre-industrial question that Socrates posed to us, however, remains highly relevant in the post-industrial age, where productive skill sets are highly transient, socially embedded and networked, and where education cannot function as a means to manufacture pre-defined skills as inputs to the economic machine. Today, children may learn to avoid burning their fingers in fire but they may also download detailed recipes for

chemical weapons from the Internet and learn how to build a transportable nuclear warhead. In this knowledge-based world, ethics of learning is not only a historical curiosity; instead, it has important practical and social consequences.

In the European tradition, philosophy starts by questioning the conceptual nature of common beliefs. In this vein, Socrates might have explained that he does not really understand the view that knowledge is located inside the human brain, and needs to be transported there. Modern educators might help him out by carefully explaining to Socrates that neurophysiology has now revealed that the brain consist of neurons, which store knowledge in the incredibly complex system of axons and synapses, barely visible to the human eye. No wonder Socrates could not understand this, without a microscope. Inspired by science fiction classics such as William Gibson's *Neuromancer*, *Blade Runner* and Fred Hoyle's pioneering *Black Cloud*, they could go on and tell Socrates how information technology soon will make it possible to beam knowledge directly into the human mind, in an ultra fast blast of images that show how the world really is.

Socrates would then have replied with amazement and wonder. What an interesting philosophical view on the nature of knowledge! But shouldn't we also read James Gibson, not only William Gibson? Can knowledge really be represented as irrelevant facts, independent of human action and contexts of knowing? Is knowledge something that can be moved from outside to inside human brains, or conveyed from one brain to another via electric signals and images. Should we ask, as James Gibson argued, "not what is inside our head, but what our head is inside of?"⁵²

The conventional definition of learning becomes inappropriate in the knowledge society for a number of reasons. Strictly speaking, it is broad enough to include almost all human mental

52 Cf. Gibson, 1950, and Mace, 1977. Gibson focused on ecological psychology, asking what are the environmental conditions of human perception.

and physiological processes. The requirement of “long-term change” makes sense only relative to some definite and objective time-scale, and it is easy to see that it is important only to the extent that it makes behaviour predictable to others. The distinction between short-term and long-term change does not have much to do with the processes of learning, per se. It is a social criterion. Also, to be able to make the crucial analytical distinction between change in behaviour and change in “the situation” there has to be an external observer capable of perfectly knowing the world and its situations. In practice, also this criterion is essentially social: we perceive learning in others when from our point of view the situation is unchanged and someone’s behaviour is not. Constructivist theories of learning, for example, may paradoxically describe learning as internal change of mental representations; at the same time as such change could equally well be described as a change in the situation. The distinction between internal and external change was perhaps practical in a world where professions, tools, skills, social institutions and economic relations were relatively stable, and change in the environment was perceived as an exception. In reality, the learner, however, always perceives her situation through what she knows and has learned. Methodologically speaking, therefore, we can never know whether the situation for the learner has in fact changed. The distinction between the unchanging situation and the changing behaviour is therefore methodologically and epistemologically void. What matters are the pragmatic consequences: in learning we attribute change to an acting agent instead of the environment. This has practical consequences for our own action, and for allocation of agency and responsibility, for example. The conventional scientific definition of learning builds on an unarticulated social and ethical foundation, which needs to be made explicit when we try to understand how learning and education will change in the coming years.

The idea that we “acquire” knowledge, represented in the standard definition, at least implicitly carries with it the assumption that

knowledge is already “out there” and can be moved into the brain of the learner. Although some constructivists may interpret knowledge acquisition as the production, generation or creation of knowledge, the term has its roots in classical positivist thinking. As will be seen below, the idea that we internalize knowledge by acquiring it has important consequences for the ways we organize and facilitate learning in the future networked environments.

Indeed, the basic characteristic of the conventional definition becomes explicitly visible if play devil’s advocate and define learning as the process of acquiring errors, incompetence, prejudices, and vices. Although the standard definition claims to describe a process, it, in fact, only describes the outcome: a change in the internal state of the learner. As the process of learning itself remains fully obscure, there is no way to tell, for example, what is the impact of new technological means on learning.

To open the black box of learning, we have to move beyond static definitions of outcomes and characterize the processes that underlie and constitute learning. This will allow us to talk about different pedagogical approaches and the potential roles of technology. A number of such process models are described in the Appendix.

The pedagogic approach of the early Socratic dialogues, including Menon, indeed represents a quite advanced and useful model of learning. The Socratic dialogue fits well with the constructivist conception of learning, where knowledge acquisition is understood as an active and ongoing process towards knowledge. The dialogical model of learning is also well suited for adult learning, where the goal of learning cannot simply be to indoctrinate or inform ignorant students to the true order of reality. The Socratic claim was that we cannot put knowledge into anyone’s head. Instead, the learner has to create the knowledge herself using already available resources and knowledge. Socrates does this by asking questions that make Menon think, and the end result of this thinking is that Menon knows something that he did not know before. Vygotsky

had a similar approach. He moved, however, beyond the Socratic method by showing that we can build scaffolds in thin conceptual air and reach knowledge that no one has known before. Learning, therefore, is not only about revealing pre-existing truths; instead, it can be truly creative, and lead us to new forms of social and individual thinking and action.

Plato, of course, believed that eternal knowledge lurks in the heaven of ideas waiting to be discovered. Pragmatists would say: Forget eternal ideas. Learning, in any case, is based on making mistakes. Get on with the real work.

We start this by sorting the complex institutions of learning, trying to see what they do, what they think they are doing, and what they could be doing in the next fifteen years.

4. Institutions of education in 2020: “ISCED 2020”

The International Standard Classification of Education (ISCED) was designed by UNESCO in the early 1970's to serve as an instrument for assembling, compiling and presenting statistics of education both within individual countries and internationally. The present classification, ISCED 1997, aims to cover all organized and sustained learning opportunities. Within the framework of ISCED, the term education is taken to comprise all deliberate and systematic activities designed to meet learning needs. ISCED includes a variety of programmes and types of education, such as regular education, adult education, formal education, non-formal education, initial education, continuing education, distance education, open-education, life-long education, part-time education, dual systems, apprenticeships, technical-vocational education, training, and special needs education. ISCED does not cover activities that are not specifically aimed at producing learning, and it adopts a clearly institutional—more accurately, programme-based—view of learning. In other words, it focuses on education and not on learning, per se. Learning that is considered to result as a by-product of other activities is excluded.

For example, organizational knowledge creation and learning that occurs in new product development, research, or business intelligence is not covered. Self-organizing and self-organized learning are also excluded. Examples include competence development within open source communities, self-learning among web home page designers and digital photographers, or, for instance, cognitive and motor skill development among computer gamers or garage band players. Some learning-oriented organized and sustained systems, such as public libraries, popular science magazine publishing and television documentary channels are also excluded. Also substitutes for individual learning such as expert services, knowledge networks, or intelligent products are not covered.

Due to its institutional focus, ISCED, however, implicitly categorizes and describes learning institutions where professional teachers work. As ISCED is aimed for international comparisons, it also abstracts these institutions from country and culture specific forms. We can therefore use the ISCED classification as a handle to the current systems of education, and try to see how the structures of education will change from their internal point of view. This is important because the current institutions of learning both structure discussions about the transformation of education and act as major sources of institutional inertia. In principle, the needs of actors within educational institutions are indirectly connected with the learning needs of individual citizens, business firms and the society at large. In practice, the possible routes for change depend on the interests of the people currently working in organized educational settings, as well as the established legal and institutional agreements that regulate working in these settings. In this section I will therefore take the current ISCED definitions of different levels of education, and highlight emerging demands and forms of education that could require reconsideration of the current institutions of education. Basically, we try to see how a revised version of the standard classification, “ISCED 2020,” could look

like in the next fifteen years, given the current practices and emerging opportunities and needs. Due to the complexity of the varied educational structures in different countries, I only highlight some potentially disruptive developments, for further discussion.

The key concepts underlying the ISCED are communication, learning, organized, and sustained. These are defined in the following way:⁵³

- **COMMUNICATION:** a relationship between two or more persons involving the transfer of information (messages, ideas, knowledge, strategies, etc.). Communication may be verbal or non-verbal, direct/face-to-face or indirect/remote, and may involve a wide variety of channels and media.
- **LEARNING:** any improvement in behaviour, information, knowledge, understanding, attitude, values or skills.
- **ORGANIZED:** planned in a pattern or sequence with explicit or implicit aims. It involves a providing agency (person or persons or body) which sets up the learning environment and a method of teaching through which the communication is organized. The method is typically someone who is engaged in communicating or releasing knowledge and skills with a view to bringing about learning, but it can also be indirect/inanimate e.g. a piece of computer software, a film, or tape, etc.
- **SUSTAINED:** intended to mean that the learning experience has the elements of duration and continuity. No minimum duration is stipulated, but appropriate minima will be stated in the operational manual.

The ISCED classification consists of six levels. Several of the levels include subcategories

that separate, for example, vocation-oriented education from education that aims at preparing the learner for the next-level education. Below, I only outline the main characteristics and contrast these with the imagined ISCED 2020.

Level 0 – Pre-primary education

Current

Programmes at level 0, (pre-primary) defined as the initial stage of organized instruction is designed primarily to introduce very young children to a school-type environment, i.e. to provide a bridge between the home and a school-based atmosphere. For a programme to be considered as pre-primary education, it has to be school-based or centre-based. These terms are used to distinguish activities in settings such as primary school, pre-schools and kindergartens from services provided in households or family settings. Such programmes are designed for children aged at least 3 years, as programmes destined for younger children do not normally satisfy the educational criteria in ISCED. This level includes organized instruction for children with special needs education.

2020

ISCED 2020, level 0, will increasingly emphasize basic cognitive capabilities that underlie learning, as well as social collaboration skills. The need to prepare very young children to a traditional school-type “knowledge-transfer” environment will decline. Research on learning disabilities (e.g., dyslexia) will lead to new applications of learning technologies intended for children under 3 years of age. Early-age “cognitive repair” that builds the basic capabilities for learning will be perceived as an important investment in the knowledge society.

53 ISCED 1997. http://www.unesco.org/education/information/nfsunesco/doc/isced_1997.htm

Level 1 – Primary education

Current

Programmes at level 1 are normally designed on a unit or project basis to give students a sound basic education in reading, writing and mathematics along with an elementary understanding of other subjects such as history, geography, natural science, social science, art and music. In some cases religious instruction is featured. The core at this level consists of education provided for children, the customary or legal age of entrance being not younger than five years or older than seven years. This level covers in principle six years of full-time schooling. Throughout this level the programmes are organized in units or projects rather than by subjects.

2020

Immersive computer-based environments will be widely used at ISCED 2020 level 1. They include simulation and game applications for multiple participants that aim for simultaneous development of social and cognitive skills. With ICT support, learners can combine classroom learning with learning at home. As learning will partly move to home, parents will be given the opportunity to become active facilitators and participants in the learning process. This potential of ICTs will be realized particularly in families in the higher socio-economic groups, increasing differences in student performance across socio-economic groups. As technology allows effective remote learning, parents will also increasingly enrol their children to remote schools that provide the best learning services, or where the curriculum is value-based (e.g., religious, individual creativity, ethical, ethnic).

Level 2 – Lower secondary education

Current

The contents of education at this stage are typically designed to complete the provision of basic education which began at ISCED level 1.

In many, if not most countries, the educational aim is to lay the foundation for lifelong learning and human development. The programmes at this level are usually organized on a subject-oriented pattern using specialized teachers. The full implementation of basic skills occurs at this level. The end of this level often coincides with the end of compulsory education where it exists. Level 2 programmes are subdivided into three categories: general education, pre-vocational education, and vocational education. The last one aims directly at providing the learners with practical skills that enable them to access employment.

2020

Computer-supported problem-based learning becomes the dominant learning mode at ISCED 2020 level 2. Learning teams extend across several schools and connect students from different regions and countries. Children are able to interact with students in other countries to get contextualized knowledge on issues such as cultural practices, history, and environment. Teachers act as translators and facilitators, supported by ICTs such as computer-mediated communication and collaboration platforms, VoIP, and Video over IP. Cognitive learning objects, with the capability to support the learning process and guide the learner through the “zone of proximal development,” become important in vocation-oriented education. Classroom learning will be complemented by parent participation at home and—where the possibilities for this are limited—, for example, by virtual grandparents, i.e. elderly people who are willing to remotely support children in their learning process.

Level 3 – Upper secondary education

Current

This level of education typically begins at the end of full-time compulsory education for those countries that have a system of compulsory education (15-16 years). Teachers are typically more specialized and qualified than at ISCED

level 2. The educational programmes included at this level typically require the completion of some 9 years of full-time education since the beginning of level 1 for admission, or a combination of education and vocational or technical experience and the completion of level 2 or demonstrable ability to handle programmes at this level.

2020

ISCED 2020 level 3 will include problem-based assignments with links to the world outside the learning institutions. For example, students may analyze social, economic and environmental problems, develop proposals for their solutions, and introduce the proposals to relevant authorities, policymakers, and business organizations. Pedagogic approaches at level 3 will on one hand focus on building critical and systematic knowledge on subjects such as science and mathematics and, on the other hand, shift from “know-that” to “know-who” and “know-where,” and action-oriented knowledge. Level 3 will move towards the classical trivium (grammar, rhetoric and logic) and quadrivium (arithmetic, music, geometry, astronomy). Grammar studies will include several different languages and genres. Rhetoric will include electronic communication skills, as well as cultural knowledge needed to operate various culturally different linguistic genres. Logic will include reflective learning of theoretical systems of scientific concepts, as well as basic innovation and creativity skills. Arithmetic and geometry is learned using cognitive objects and simulation environments. Music is bundled with visual arts and crafts, for instance, to collectively create audiovisual works in distributed bands and for reconstruction of historical performances.

Level 4 – Post-secondary non-tertiary education

Current

ISCED 4 captures programmes that straddle the boundary between upper-secondary and post-secondary education from an international

point of view, even though they might clearly be considered as upper-secondary or post-secondary programmes in a national context. ISCED 4 programmes can, considering their content, not be regarded as tertiary programmes. They are often not significantly more advanced than programmes at ISCED 3 but they serve to broaden the knowledge of participants who have already completed a programme at level 3. Typical examples are programmes designed to prepare students for studies at level 5 who, although having completed ISCED level 3, did not follow a curriculum which would allow entry to level 5, i.e. pre-degree foundation courses or short vocational programmes. This level includes adult education. For example, technical courses given during an individual's professional life on specific subjects such as computer software can be included in this level.

2020

ISCED 2020 level 4 will grow rapidly and split into two different strands. One will focus on learner-centric self-development in various arts, crafts and conceptual sciences, including philosophy. The other will focus on reintroducing people back to formal education. The majority of ISCED 2020 level 4 activities will be in the former, as middle-aged and aging demographic groups start to improve the quality of their lives by acquiring meaningful skills and knowledge in non-work related areas. In this learner segment, educational certificates will have limited value and learning will be perceived as a value in itself. Information and communication technologies are used in innovative content-specific ways. Level 4 programmes will extend towards level 3 and gain importance in integrating immigrants to formal education and work life.

Level 5 – First stage of tertiary education

Current

Level 5 consists of tertiary programmes having an educational content more advanced

than those offered at levels 3 and 4. Entry to these programmes normally requires the successful completion of ISCED level 3 or a similar qualification at ISCED level 4. Normally these programmes must have a cumulative theoretical duration of at least 2 years from the beginning of level 5. Level 5 programmes do not lead directly to the award of an advanced research qualification (level 6). Level 5 includes “first degree” programmes giving access to professions with high skill requirements, and programmes for specific occupational and technical education. ISCED level 5A programmes are tertiary programmes that are largely theoretically based and are intended to provide sufficient qualifications for gaining entry into advanced research programmes and profession with high skills requirements. They have a minimum cumulative theoretical duration (at tertiary) of three years’ full-time equivalent, although typically they are of 4 or more years. The teaching faculty typically has advanced research credentials. Qualifications in category 5B are typically shorter than those in 5A and focus on occupationally specific skills geared for entry into the labour market, although some theoretical foundations may be covered in the respective programme. Level 5B programme has a minimum of two years’ full-time equivalent duration but generally is of 2 or 3 years or equal credit accumulation. This level includes all the research programmes which are not part of a doctorate, such as any type of Master’s degree. In some countries, students beginning tertiary education enrol directly for an advanced research qualification. In this case, the part of the programme concentrating on advanced research (e.g. the “third cycle”) should be classified as level 6 and the initial years (“first-cycle” and “second-cycle”) as level 5. Adult education programmes equivalent in content with some ISCED 5 programmes can be included at this level.

2020

Learning at ISCED 2020 level 5 programmes move away from purely individualistic “knowledge internalization” models and is

increasingly based on collaborative creation of knowledge. The underlying pedagogic models will be based on experimental (Dewey) and action (Engeström) learning, and on knowledge creation models (e.g., Nonaka cycle) which embed individual knowledge construction with social learning (for a discussion on these different models, see the Appendix). Knowledge construction will increasingly occur within specially designed ICT-enabled environments that support information access, knowledge externalization and modelling, hypothesis testing and simulation-based evaluation. Educational institutions compete for learners internationally at this level, and global educational brands emerge. ICTs will be used to provide mass-customized learning for large student populations. National level 5 programmes will be reorganized to respond to the competitive pressures created by the emergence of multinational educational corporations.

Level 6 – Second stage of tertiary education

Current

This level is reserved for tertiary programmes which lead to the award of an advanced research qualification. The programmes are devoted to advanced study and original research and are not based on course-work only. They typically require the submission of a thesis or dissertation of publishable quality which is the product of original research and represents a significant contribution to knowledge.

2020

ISCED 2020 level 6 is increasingly perceived as an entry qualification for high-status jobs in the knowledge society. Learning paths become multidisciplinary, combining domain specific advanced knowledge with generic research and knowledge acquisition and analysis skills. The explicit goal of building and participating in global knowledge networks becomes integrated in level 6 programmes. Level 6 programmes are also used

to attract global talent. Brand value and access to globally acknowledged thought leaders and future decision-makers becomes an important selection criterion for paying students. Large multinational service providers will be complemented by small personalized programmes that focus on student interaction and high-end ICT learning support. ISCED 6 institutions and large corporations will jointly run new programmes and manage institutional arrangements, including next-generation corporate universities that combine competence development, worker renewal, and certificates that improve worker career paths and employability. Jobseekers will increasingly look for working environments where they can effectively maintain and improve their competences. Policymakers will align social, tax and educational policies so that they facilitate effective learning in these new programmes. Policymakers will also launch initiatives aimed at creating learning partnerships and networks that support learning in small and medium-sized enterprises.

ISCED 2020 Level 7 (Continuous informal learning)

Current:

Excluded from ISCED 1997

2020

Education will increasingly be based on facilitation of informal learning and recognition of accumulated competences and skills. Continuous learning becomes dominant in the knowledge society where work, personal interests, identity construction, consumption and non-economic production will require constant upgrading of skills and acquisition of new skills. Social learning on ICT-enabled communities becomes the dominant source of education in areas where new practical knowledge emerges rapidly and has a short lifetime. Learning on demand is supported at workplace and by product designers, who incorporate learning support in

product functionality. Level 7 pedagogic models, and the capability to integrate them in products and services, becomes an important source of competitive advantage for business firms.

5. The tectonics of educational change

The above outline of the future learning landscape highlights some major macro-level changes in the educational systems. In particular, this change is driven by the ongoing global socio-economic transformation, where information, knowledge, and innovation are emerging as the main sources of economic growth and employment opportunities. Innovation, in turn, is becoming increasingly networked, multidisciplinary, and problem-oriented. Innovators need good social, cultural and communication skills, as well as capabilities to move between conceptual systems and interpretative horizons. Organizations and business managers need new frameworks for managing innovative activities at all organizational levels and across business networks. Societies need to develop new structures, institutions, and policies to facilitate and support innovation and effective knowledge use. National systems of education and knowledge creation become linked to global knowledge networks in real time. As a consequence, educational systems will be redesigned for the production of new skills, utilization of new knowledge technologies, and for cost-efficient delivery of services in the global competitive market of education. Education and learning will be integrated across the full lifetime of individual learners and demographic change will shift its focus to adult education.

Detailed micro-level descriptions and scenarios at the different levels of ISCED 2020 would reveal a large number of innovative uses of advanced ICTs in education. To get the overall picture right, it is, however, important to understand that technical advances do not, in itself, drive social or institutional change. In the first approximation, technology is used to respond to social demand. Changes in demand indirectly reflect emerging technological opportunities;

developmental paths, however, are almost always articulated as practical solutions that release tensions already existing in the present. The increasing pressure to reconsider education is no exception. Education is one of the main social subsystems in the modern societies, and its change is to a large extent driven by other subsystems that already have changed.

Educational systems are extremely difficult to change. As educational researchers often note, it is often easier to move a graveyard than to change the educational system. In both cases, there is resistance from outside and limited support from inside, and in the latter case there is also active dragging of feet. This has little to do with the mythical psychological tendency for “resistance to change,” and it is critically important to understand what, exactly, are the sources of inertia in educational systems. To develop better educational systems we have to understand how educational institutions learn and why learning is difficult in educational organizations.

There are many reasons for institutional inertia in the educational system. Education represents in many countries one of the most important paths for social progress. Independent of the competences and knowledge accumulated in the learning process, education generates valuable certifications, reputations and social capital. Changes in the educational system can often destroy large amounts of such capital. This happens, for example, in countries where educational attainment in specific institutions is used to signal memberships in important social groups. European examples include, for instance, the highly-regarded French *Grandes Ecoles*, which produce some 60 percent of managers in the top 100 French companies and the majority of high-level public administrators and policymakers. Changes in the social position of *Grandes Ecoles* would not only impact their present and future students, but also a large and influential population of alumni of these schools. By default, social elites would find it natural to resist educational change if that would,

for example, make social distinctions based on enrolment in elite schools irrelevant.

In some Asian countries, enrolment to the leading university practically guarantees the access to top-level positions in public administration and private companies. In the U.S., access to Ivy League universities is a major source of social, political and economic capital. Similarly, professions with restricted access, such as lawyers and doctors, tend to react negatively to proposals that would widen and broaden the access to their profession. Educational change, therefore, is not only about optimal engineering of educational practices and about adapting them to the requirements of the emerging knowledge society. Successful change requires that educational institutions, themselves, become learning institutions, where change management is an important objective of management and leadership.

Systemic inhibitors of change in education also include historically accumulated institutional agreements. For example, when the working conditions and performance criteria of teachers are defined using indicators such as chapters of text-books specified in the course requirements, it may be difficult to teach the same content using computer-based methods where books are not used. Teachers sometimes claim that their employment contracts make it extremely difficult to move from traditional lecturing to team-oriented and problem-based learning models, for example. As employment contracts have been negotiated in the context of traditional pedagogic approaches, in practice they make some advanced or innovative learning methods illegal or disconnect them from teacher performance evaluation.

In private business organizations, change in work practices often starts by changing measurement and incentive systems. In public institutions this is often difficult, as their work practices are tightly regulated, standardized, and at least indirectly specified in educational laws.

The increasing pressure to develop creative, innovative and critical skills also implies that the

traditional course-based lecturing model needs to be replaced by student-focused learning models. Psychologically, teacher's job description is, therefore, changing radically. Whereas in many traditional settings the teacher had social authority and his or her views were rarely questioned, in the modern settings teacher's knowledge and competences are continuously questioned. Teachers, who, for example, have chosen their profession based on their own historical perceptions on the nature of teaching and the social position of teachers, may have difficulties in adjusting to the changing educational settings. Anecdotal evidence indicates that some teachers have moved from teaching to research and administration when problem-based learning methods have been introduced. Traditional teacher training has rarely well prepared teachers for the facilitation and support roles that are required in problem-based learning.

Furthermore, teachers who have successfully lectured the same topic over years and accumulated methods and material tailored to their courses easily lose all this accumulated capital when new pedagogic approaches are introduced. Such hidden costs are, economically speaking, a major source of return of investment for teachers. These costs are rarely compensated or considered when, for example, ICT is introduced in classrooms.

Insufficient resources for teacher training are often given as the root cause for the slow and difficult change of educational practices. In many cases, teachers would need time to develop and test new pedagogic materials and methods. The underlying problem, however, is often more about learning and innovation than about inadequate training. Innovation requires slack resources, experimentation and time. The adoption and development of new pedagogic methods requires absorptive capacity that extends beyond individual teachers. If the organizational and institutional context does not support new working methods, no amount of teacher training will be enough to change educational practices.

The dynamics of institutional and organizational change are important. Organizational change is always risky for the agents of change because social change is inherently revolutionary and because it creates conflicts. In private businesses, organizational learning requires organizational culture and management practices that strongly support organizational change agents and which facilitate experimentation and risk taking. Learning organizations, therefore, are qualitatively different from bureaucracies that fundamentally aim at regular implementation or processes and procedures grounded in law. Particularly in institutions of public education, change is therefore often against the deep structures of organizational culture and the modes of operation. This makes typical educational institutions socially conservative and limits the possibilities to introduce new work practices, manage change, and support organizational change agents. In such settings, organizational learning often occurs only through crisis.

One way to improve learning capability in the educational system, manage change and avoid unnecessary crises is to create realistic visions about the future. Such visions can then become the imagined reality where future needs and requirements can be discussed and articulated. Such visions can be used to analyze and discuss the emerging opportunities and challenges, and to develop capabilities and processes that make change possible. In short, scenarios on the future of education will, therefore, be key elements in national and regional knowledge society strategies.

6. New learning technologies: some examples

Experiential learning in immersive environments

In many important learning models, learning starts when the learner experiences practical or cognitive dissonance.⁵⁴ Routine

54 See the Appendix for a discussion on different learning models.

action breaks down, the learner realizes that active sense making is needed, and the world needs to be reconstructed. The reconstruction may require reorganization of meaning and also reconfiguration of the material environment.

In classroom settings, this learning process can be simulated by problem-based learning situations. The student is presented with a specific construction of the world, for example using a textual description, and the dynamics of the world is shown to lead to a contradiction or a problem that needs to be solved. Students may also collaborate in solving the problem, for example, by taking different roles and presenting different interpretations of the situation.

Such problem-based learning settings can be enhanced by immersive information environments where the learner can effectively experience cognitive dissonance and where problem-solving resources are readily available (cf. Dede, 2005). A simple example of such a learning environment is the River City MUVE (Multi-user Virtual Environment) developed at Harvard Graduate School of Education.⁵⁵ In the River City MUVE, student teams use computer-based avatars to explore a historical town, collect notes on their "Lab Notebooks," study virtual water samples of the river, share data with other students, and analyze the reasons for local health and environmental problems. At the end, students write to the mayor of River City describing the health and environmental problems they have encountered, suggesting ways to improve the life of the inhabitants. Learners are engaged in a "participatory historical situation" in which they can apply tools and knowledge from both the past and the present to resolve an authentic problem. In this "back to the future" situation, students'

mastery of 21st century classroom content and skills empowers them in the 19th century virtual world.

Less pedagogically motivated but yet effective learning environments include Massively Multiplayer Online Role Playing Games, such as Lineage⁵⁶ and EVE Online.⁵⁷ The latter is set in an unknown part of the universe, and includes several thousands of solar systems, many of which are settled by the players. The players can inhabit worlds, create organizations and alliances, accumulate wealth and build economies, much as they would operate in a simulated real world. The system provides a persistent and continuously evolving world that runs on servers in London. In October 2005, the system recorded 17,032 simultaneous players. Although MMORPGs are not aimed for learning, they are to a great extent driven by quest for skill development. This is a feature of games and performance-oriented activities, in general. Professional football players learn their skills by playing football, golfers learn by playing golf, and rock guitarists by playing guitar. At present, American football, for example, is taught using 3-dimensional immersive virtual reality environments where the student can engage in the game without actually throwing the ball.⁵⁸ Golf and guitar playing can also be learned using computer support integrated with physical objects and movement. Individual physical sports, such as karate, are now studied using interactive virtual reality simulation.⁵⁹ Immersive simulation systems have also been widely used in flight training and in military training applications. At present, commercial PC-based flight simulators are used to build systems that closely resemble professional multimillion-dollar cockpit simulators.⁶⁰

55 <http://muve.gse.harvard.edu/muvees2003/>

56 <http://www.lineage.com>

57 <http://www.eve-online.com>

58 The University of Michigan Virtual Reality Laboratory has developed the concept for such a "Virtual Football Trainer." It uses the Cave Automatic Virtual Environment where the user is immersed in 3-D computer-simulated world with real-size players (<http://www-vrl.umich.edu/project/football/index.html>).

59 Kick Ass Kun-Fu is an immersive game installation that transforms computer gaming into a visual, physical performance like dance or sports. The gamer can fight and defy gravity like kung-fu movie actors - only there's no wires or post-production needed, thanks to the real-time embodied interaction and virtual set technology (<http://mlab.uiah.fi/animatiokone/kungfu/en/>)

60 Such a PC-based multiplayer simulation environment is used, for example, by Flightline, at Irvine, California, which markets 747 and multiplayer F-16 simulations for corporate events and bachelor parties: <http://www.flightlineusa.com/>.

Experimental learning with simulated worlds

The Deweyan experimental learning model emphasizes the generation and testing of hypothetical problem solutions. This model, therefore, can be supported by computer-based tools that facilitate simulation and “what-if” analyses. Computer-based simulation has been used extensively in organizational settings. In fact, although it has not always been explicitly noted, many historically important uses of computers fall into this category. A prototypical example is the use of computers to design buildings and bridges, where the designer learns whether specific designs are structurally stable. Computations are in this setting used to test alternative designs, and when a working and satisfying solution is found, the structure is implemented in the real world. Another example is the use of executable knowledge representation systems to diagnose the impact of alternative business strategies on competitive positions.⁶¹ Quantitative and qualitative what-if analyses are now commonly supported by management accounting software, and process simulations have been common, for example, in business process design. Software that supports system dynamics modelling and simulation is also frequently used to develop conceptual models and test their implications as a part of real-world learning processes.

Historically, computer-based simulation has been most visible outside classrooms. The reason is simple. Two decades ago, state-of-the-art simulation systems often relied on specialized computer architectures, such as Lisp machines and parallel vector processing. In areas where simulation was important for the actual work—as in structural stability and aerodynamic computations—computer-based simulation tools entered the classroom mainly as the objects of study. The students were taught how to use simulation and modelling tools as competent use of these tools comprised important professional

skills that student would need in their actual work practice. Partly this was, however, because the tools were so complex and expensive that their use could practically only be learned in educational institutions or in special courses provided by the software vendor. Today these simulations can be run on standard PCs.

In the future, simulation tools will provide platforms for the construction and testing of conceptual and dynamic models. This will require modular software, open interfaces, and, for example, message-passing programming architectures. Such environments can be used in learning settings ranging from real-life problem solving to primary education.

Pedagogic veils

I shall call “pedagogic veils” layers of pedagogic knowledge that can be “thrown over” extend material and informational objects. The underlying theoretical concept can be described as an implementation of Vygotskian scaffolding in the object of learning itself. In other words, pedagogic veils are system functionality that provides a novice learner scaffolding that facilitates the learning of competent use of the object.

In the traditional Vygotskian scaffolding, support for learning is provided by a competent adult who skilfully guides a child in the process of competence development. As commercial products become augmented and extended by information technology and bundled with services, pedagogic veils can be implemented in an increasing number of product categories. In a relatively straightforward implementation, products will incorporate their operating manuals and real time communication to expert users and support services. In more advanced implementations, products will be simultaneously designed as material and cognitive artefacts that

61 An example of an AI-based structural simulation environment is Stratex, which was used in multinational corporations to design organizational structures (Paajanen & Tuomi, 1992). The system was also to analyze future skill demands and their match with university-based education in Finland (Tuomi, 1992).

support dynamic scaffolding. Yet another way of implementing pedagogic veils is to use virtual augmented reality to overlay material objects with information and images that help the learner to skilfully operate and use the object. Pedagogic veils have educational implications, for example, as learning becomes integrated with the actual use of products and services. In such a world a hammer can tell the user how to drive a nail, and adaptive pedagogically designed user interfaces can produce competent computer users. This has educational implications, for example, because learning moves out from classrooms and becomes part of the product itself.

Intelligent learning objects

A variation of the idea of pedagogic objects are objects that are specifically designed for learning. Examples of such pedagogic objects include the LeapPad products developed by the LeapFrog.⁶² The LittleTouch LeapPad is an interactive book for children of ages 6 to 36 months with a touch interface and audio feedback. The applications include soundscapes that according to LeapFrog simulate early brain development, and word plays and interactive rhymes that build early language skills. For older kids, the LeapPad system includes, for example, a pen interface that can be used to write on specifically designed interactive books.

The newest LeapFrog product is a “pentop computer,” a pen that has an inbuilt processor, video camera, audio, and plug-in program modules.⁶³ The pen can be used to draw on special micro-dotted paper, which enables the pen to track movements. The user can, for example, draw a calculator or a piano keyboard and drums, which then become active and can be used to make calculations or to play music. The user can also write block-letter words and hear what they have written, or translate written words

into a different language. The users can also download from the net interactive content that they can print on their own printers. For example, the system now interfaces with a database of some 200,000 test questions for commonly used middle school textbooks.

LearningPod

PodCasts and audio books are at present rapidly growing markets, with clear implications for education. Memory storage and audio compression technologies have become so cheap that small iPods and MP3 devices can carry tens of thousands of high-quality music pieces and hundreds of hours of video.⁶⁴ It is now possible to wirelessly download one hour of audio in six minutes using commercial services, such as Audible Air. As the current devices can be easily carried and linked to PCs and networks, their educational use can be expected to expand rapidly. Content such as language courses have traditionally been provided on disks and cassettes, but as the usability and interactivity radically improve with digital devices, learning becomes mobile.

Cognitive repair and support

Some neurological and cognitive problems can become major obstacles for learning. For example, dyslexia is a major handicap for learners throughout their life, as modern educational settings often require understanding of text. Early intervention and special training of pre-school children can sometimes repair such learning deficiencies. In particular, computer-based techniques have been used to cure dyslexia in children at a very early age. It has also been proposed that one of the most important social benefits from interactive digital television could be learning applications aimed at pre-school

62 <http://www.leapfrog.com/>

63 <http://www.flypentop.com/>

64 Apple's 60 gigabyte iPod stores 15,000 songs. It can also store 25,000 photos or 150 hours of video. It weighs 157 grams.

children. As the cumulative effect of cognitive repair and efficient learning strategies is large across the human lifetime, early-age educational applications could become important in the future knowledge society.

Similarly, cognitive support for aging people gains importance as the society becomes increasingly knowledge-based and as the population ages in the European countries. As Vygotsky noted, we use material artefacts and symbol systems as parts of our cognition. The wide availability of digital devices will allow us to offload increasing amounts of cognitive tasks to these devices, effectively redesigning the architecture of our cognition. As the division of cognitive labour changes between humans and their environment, learning needs to be redesigned as well. Education aimed at the oldest demographic groups, in particular, will use cognitive support systems extensively in the future. For example, cognitive technologies will be used to compensate the effects of aging and this will create new learning opportunities for aging people.

7. Conclusion

The ongoing socio-economic transformation towards the knowledge society will have a profound impact on educational institutions and the processes of learning. Information and communication technologies will become increasingly integrated into our everyday life. Individual knowledge workers and learners will use information and communication technologies as natural extensions to their cognition, and the line between material, informational and mental environments will become increasingly difficult to draw. New division of labour will emerge between ambient intelligence technologies and human intelligence. At the same time, it will become commonly understood that the human intelligence always was extended and distributed between material and social actors.

Learning is the key factor that distinguishes the knowledge society from the information

society. Learning, innovation and knowledge creation, therefore, are at the core of the emerging socio-economic order. In this emerging global, multicultural and networked world, it is increasingly difficult to understand the function of education as transfer of pre-existing knowledge and specific cultural systems of knowing. In the future, the adaptive and civilizing role of education needs to be combined in new ways with the developmental, creative, and transformative roles of learning, and we also have to ask what, exactly, we mean by development in this context. Institutional change, however, is difficult. A key to success in the ongoing socio-economic transformation is that educational systems, themselves, become learners, and that policymakers make this possible. This is perhaps the main challenge facing educators in the next fifteen years. To face this challenge, we need to imagine a world where educational institutions are well aligned with the requirements of individual citizens in their different phases of life, as well as with politically debated goals of social and economic development. Information and communication technologies will change both the demand for learning and the processes of learning. Radical new opportunities are emerging. Innovative scenarios and critical reflection are needed to avoid unnecessary crises and to benefit from the emerging opportunities. This paper suggests some first ideas along these lines. Theoretical and conceptual work is important, but for real impact, action and leadership are also required.

8. Appendix: Individual and social learning models

Learning is so obvious that—to paraphrase Augustinus—we only realize how mysterious it is when we have to say what it is. To open the black box of learning in a way that allows us to discuss the impact of technology, it is therefore useful to briefly review a number of influential models of learning. The conventional definition of learning, as acquisition of knowledge, skills and attitudes that lead to long-term change in behavioural

potential, tries to define what learning is. For practical purposes, a more interesting question is how learning happens. We may try to decompose the learning process into its constituent factors and try to see where information and communication technologies might play a role. The following section focuses on individual learning, and presents several variations of well-known process models of learning. The section that follows will then expand the discussion to social learning models. Finally, I will briefly present the 5A model that tries to combine state-of-the-art in both individual and social learning.

In reading this appendix, the reader may be guided by a simple question: If this is how learning happens, where could information and communication technology enter the picture? Due to space limitations, this question is not explicitly discussed in the text. It however, underlies the discussion, which draws on my earlier work (Tuomi, 1999: ch.10-11).

Cycles of learning

The process of learning is often described as a cycle. This is because the modern concept of learning implies adaptation and adjustment of behavior. Most clearly this can be seen in system-theoretic models where learning is explicitly associated with cybernetic feedback.

Bateson, Argyris and Schön: correction of system error

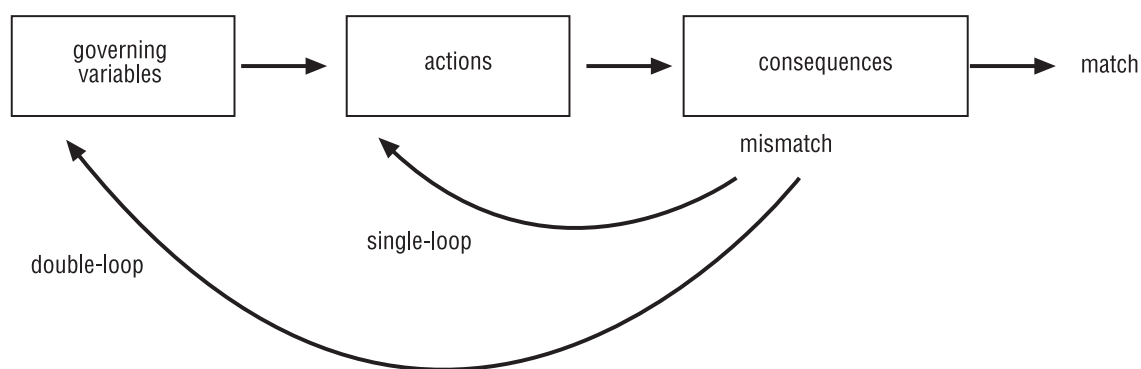
In his “Logical Categories of Learning and Communication,” Bateson (1973:279-308) proposed a system-theoretic model of learning based on classification of different types of error that need to be corrected through learning. According to Bateson, we have to distinguish

four different types of learning. *Zero learning* happens when a specific response occurs that is not subjected to correction. *Learning I*, in turn, is characterized by change in response when a new response is selected from a set of available ones. *Learning II*, which Bateson also called “deutero-learning” and “learning to learn,” occurs when the set of the available alternatives is changed. *Learning III*, in turn, occurs when the process underlying Learning II is changed. According to Bateson, Learning III occurs sometimes in religious conversion, therapy and in other sequences where there is a profound reorganization of character. Modern psychologists could perhaps call Learning III “reframing” and historians of ideas could call it—at a more macro-level—as “paradigm shift.” Finally, *Learning IV* would be change in the process of Learning III. According to Bateson, such learning probably does not occur in any adult living organism.⁶⁵

Bateson’s classification of types of learning may look quite behaviouristic and remote from the common sense view where learning implies internalization of knowledge. It is also epistemologically ambiguous, as it assumes that we can somehow define “errors” that learning then corrects. Such “error-based” learning does not look very innovative or creative. One may compare this model with the Piagetian model where learning consists of accommodation and assimilation. Assimilation is the process of adjusting to the current situation, whereas accommodation happens when the current situation is reinterpreted and when the cognitive model that is used in the interpretation is changed. In the model of Argyris and Schön (1978), direct adaptation is called “single-loop learning” and accommodation is called “double-loop learning.” This model is depicted in Figure 1. Argyris and Schön used this model to describe organizational

65 According to Bateson, the combination of phylogenesis with ontogenesis may, however, achieve Level IV. The idea of Learning IV reflects Bateson’s belief that the human mind is inseparable from its physical and evolutionary context, and that mind can only be understood as a part of ecological relations. The emergence of knowledge-based society (or more accurately, “knowledge-intensive” society) could, however, be understood as Level IV learning. Bateson focused on the relations between individuals and their environment, so that he did not consider this possibility. Bateson’s system-theoretic models of learning have become influential in problem-centric and family therapies, highlighting the close linkage between therapy and learning.

■ Figure 1. Learning as correction of system error.



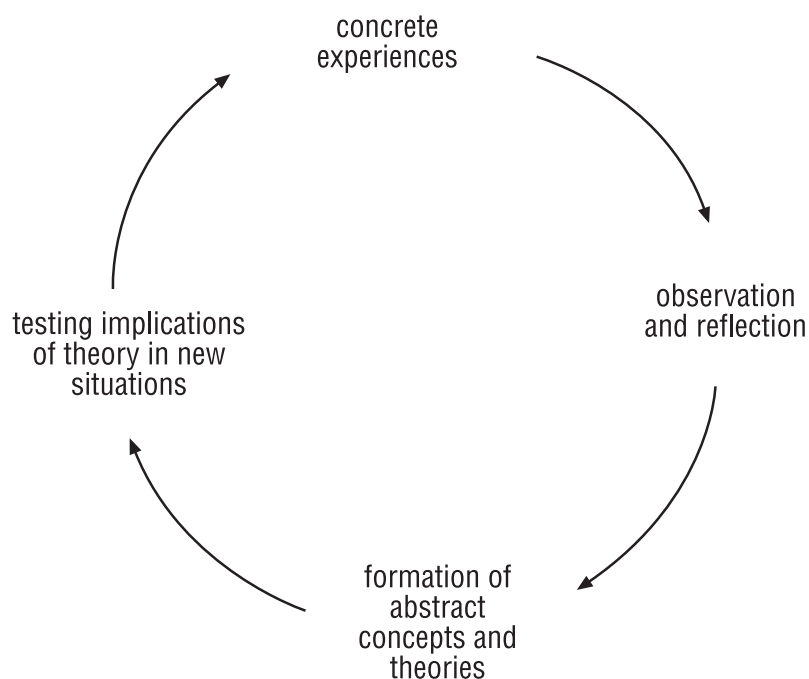
learning, and in particular dysfunctional routines that are harmful for organizational performance. Argyris and Schön, therefore, also pointed out that learning new things requires unlearning of old things.

Kolb: Experiential learning

Although learning, in principle, could also be described as a process of creative destruction of old knowledge, the standard approach is to focus on learning as a process of accumulation.⁶⁶

Learning is therefore often described as an ongoing cycle, where the outcomes of previous learning provide the starting point for further learning. Such an influential and simple model has been proposed by Kolb (1984). Kolb calls this model the “experiential learning model.” In the model, shown in Figure 2, learning occurs through a sequence of phases where concrete experiences generate an opportunity for observation and reflection. This, in turn, leads to the creation of new concepts and models that are then tested in novel situations.

■ Figure 2. Kolb's learning model.



⁶⁶ For practical purposes, the pedagogy of unlearning, indeed, could be very useful. This has been pointed out especially in the context of organizational and social learning, for example, by Hedberg (1981).

According to Kolb, learners need four different types of skills to make the learning cycle effective. They have to be able to engage openly and without prejudgement in new experiences, reflect and observe their experiences from many perspectives, create concepts that integrate observations into logically sound theories, and, finally, use these theories in decision making and problem solving (Kolb, 1984:30).

Dewey: Experimental learning

Kolb has argued that his model is based on the learning theories of Dewey and Lewin, which according to Kolb take experience as their starting point.⁶⁷ In Dewey's model, learning starts when unconscious routine breaks down, and when a problem emerges that needs to be solved. This leads to problem definition and conceptualization, a working hypothesis, a thought experiment where the hypothesis is tested, and experimental action, where the hypothesis is confirmed. In Dewey's pragmatist thinking,

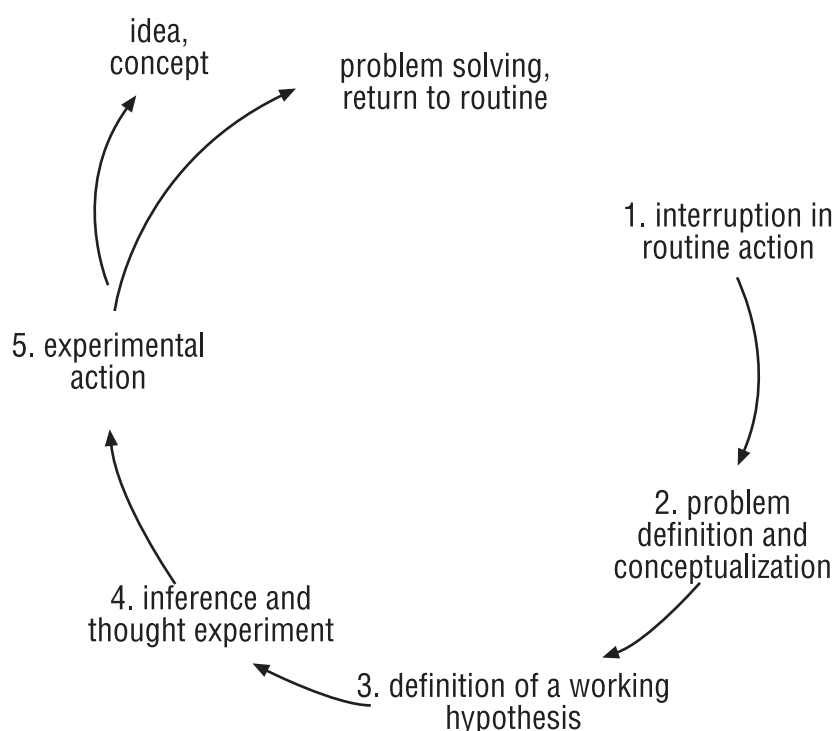
experience is closely related to practical action. Dewey's model, as reconstructed by Miettinen (1998), is shown in Figure 3.

In Dewey's interpretation, concrete practical activity may create "errors" when it does not lead to expected outcomes. Most of the time world works as we expect. Sometimes, however, the reality surprises us and we have to reinterpret the world. Learning consists of this process where a new working reinterpretation is generated. Whereas Bateson outlines a recursive typology of increasingly abstract processes of correcting errors, Dewey describes a sequence of qualitatively different activities that need to be completed for learning to occur. Dewey's model also specifically integrates imagination and creativity as components of the learning cycle.

Engeström: reflective learning activity

Starting from the Vygotskian cultural-historical activity theory, Engeström (1999:383-4)

Figure 3. Learning cycle according to Dewey.



⁶⁷ Strictly speaking, the connection between Kolb's model and Dewey's conception of the learning process is rather loose. Miettinen (1998) has compared these models in detail, and argues that Kolb's model is, in fact, incompatible with Dewey's model, and that Kolb's model is actually an eclectic collection of theoretically unrelated concepts.

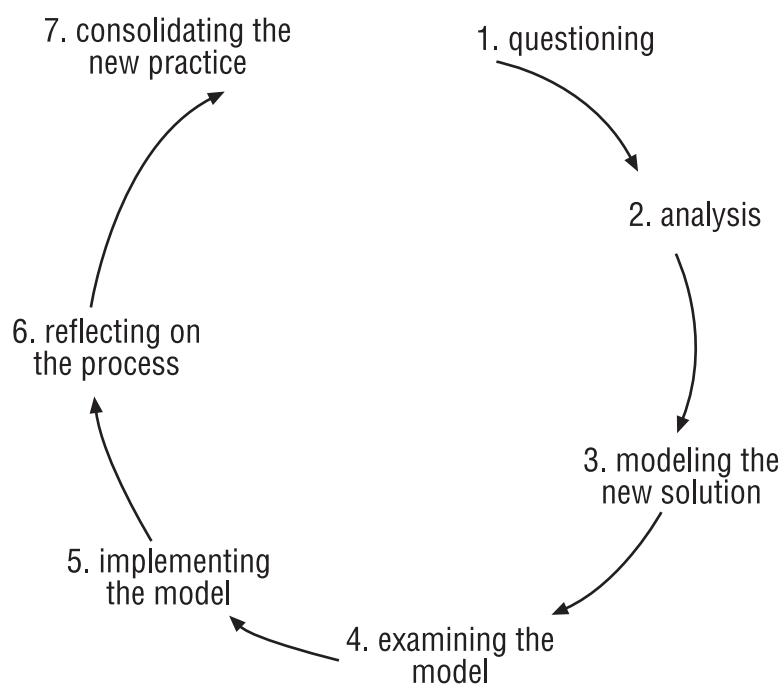
has described a learning cycle that can be related to Dewey's ideas. In Engeström's model, the first step is similar to that in Dewey's model. A problem emerges that requires a solution. In the next step, the problem is analyzed. Based on the created understanding of the problem, a solution model is produced, its characteristics are studied, and a promising solution is implemented. These steps map closely with Dewey's model. However, Engeström adds an intermediate evaluative step of reflection between experimental action and consolidation of the new practice. This, for example, makes it possible for the learners to learn about their successes and failures in learning, and to improve their capability to learn.

Engeström's model also incorporates the idea that learning is not something that occurs only inside an individual mind. It is a social process that develops new forms of social activity and practice. It therefore does not consist of fixing given errors in individual behaviour. Instead, learning becomes in this model a creative and innovative process that changes current practices

and habits, thus also changing the social reality. In Engeström's words: "The expansive cycle begins with individual subjects questioning the accepted practice, and it gradually expands into a collective movement or institution" (1999:383). I will discuss the implications of this social characterization of learning in the next section, which focuses on social learning models. Engeström's learning cycle is depicted in Figure 4.

These cycle-models look rather similar. Their underlying theoretical assumptions are, however, quite different. They also have different units of analysis. The learning subject in Dewey's model is an individual. In Engeström's model learning is understood in the context of the Vygotskian cultural-historical activity theory that puts individual learners within culturally accumulated systems of social practice and division of labour. In comparison, Kolb's model is theoretically a rather straightforward schematic common-sense description of learning. Perhaps for that reason, it has become highly popular in individual, team, and organizational contexts.

Figure 4. Engeström's learning cycle.



Social learning

Traditionally both pedagogical and theoretical learning models have focused on the individual learner. Human activity, however, is inherently social. When we conceptualize learning, we should therefore be careful in defining the subject that learns. In the conventional view, the subject is an individual person who has the capability to acquire knowledge. Social learning models, in contrast, emphasize social interaction as the source of learning and social change as the outcome of learning. This has led to the revival of the Vygotskian cultural-historical research tradition, which starts from the observation that learning is fundamentally an interpersonal and social process, embedded in cultural, historical and material contexts.

Vygotsky: social learning in the zone of proximal development

Vygotsky explained the dynamics of social interaction in the development of child using the concept of *zone of proximal development* (Vygotsky, 1978:84-91). This has several interpretations, which Lave and Wenger classify in three categories (Lave & Wenger, 1991). First, the zone of proximal development may be characterized as the distance between problem-solving abilities exhibited by a learner working alone and when the learner is collaborating with more experienced people. This is the so-called “*scaffolding*” interpretation, where a parent or teacher provides support that is necessary for the learner during the initial learning phase, but which becomes unnecessary and can be removed as soon as this phase is over. The second interpretation is a “*cultural*” interpretation. It construes the zone of proximal development as the distance between the cultural knowledge provided by the socio-historical context and the everyday experience of individuals. In this interpretation the distance between understood knowledge and active knowledge defines the zone of proximal development. The third interpretation views the zone of proximal development in a

“*collectivistic*” perspective. In this context, the zone of proximal development is the distance between everyday actions and new forms of social action that can be collectively generated. The first two interpretations, therefore, focus on an individual learner in a social context, whereas the third focuses on collective learning.

Lave and Wenger argue that learning involves the whole person, not only in relation to specific activities, but also in relation to social communities. In their view, learning only partly implies becoming able to be involved in new activities, to perform new tasks, or to master new understandings:

Activities, tasks, functions, and understandings do not exist in isolation; they are part of broader systems of relations in which they have meaning. These systems of relations arise out of and are reproduced and developed within social communities, which are in part systems of relations among persons. The person is defined by as well as defines these relations...To ignore this aspect of learning is to overlook the fact that learning involves the construction of identities. (Lave & Wenger, 1991:53)

Lave and Wenger: Communities of practice

For Lave and Wenger, development of human knowing happens through participation in an ongoing social world. Learning is not acquisition of knowledge, but increasing participation in a community of practice. Knowledge is not something that can be found in abstract “knowledge domains” of facts and know-how. Instead it is mastership of practice within a community that defines what this mastership means. Learning involves changing membership status in these communities of practice, from entrance as a novice newcomer, to being an expert old-timer, and eventually being replaced by new newcomers. The idea of learning as “internalization” of knowledge is therefore misleading. Knowledge in a community of practice is constantly negotiated in the community, and the identity of a member in the

community, the membership status, and “expert” community practices are mutually constitutive.

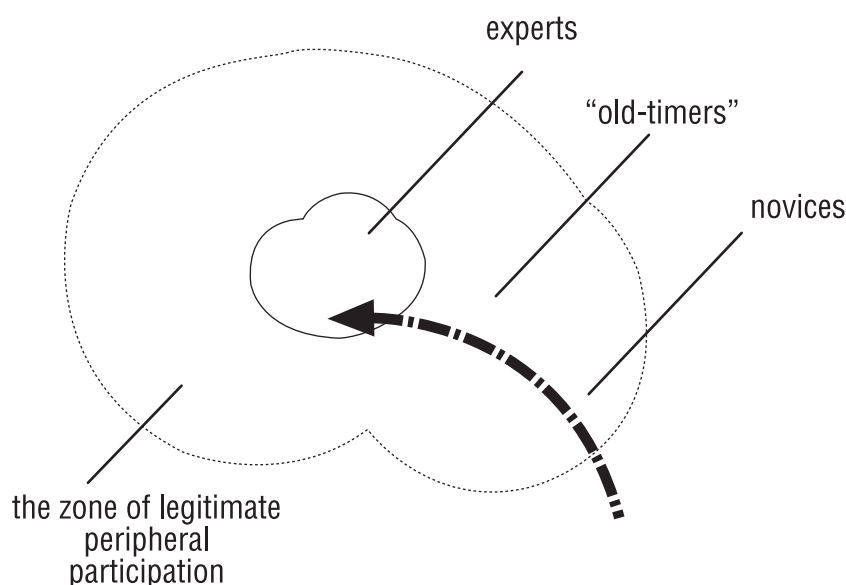
One way to think learning, therefore, is as the historical production, transformation, and change of persons (Lave & Wenger, 1991:51). Lave and Wenger introduced the concept of *legitimate peripheral participation* to explain this process of learning. Legitimate peripheral participators enter the community of practice as newcomers, and through their engagement in community practices learn the skills of masters of this practice. Legitimate peripheral participation refers to both the development of knowledgeable skilled identities and to the reproduction and transformation of communities of practice.

Lave and Wenger introduced the concept of community of practice to describe how apprentices become experts. This process has also been called cognitive apprenticeship (e.g., Collins, Brown, & Newman, 1989; Rogoff, 1990; Orr, 1990; Teles, 1993). Cognitive apprenticeship sees learning as enculturation, and attempts to promote learning within the nexus of activity, tool, and culture that they jointly define. Brown, Collins, Duguid (1989), for example, highlighted the close relationship between technical and cognitive tools with concepts shared by specialized communities:

To explore the idea that concepts are both situated and progressively developed through activity, use should abandon any notion that they are abstract, self-contained entities. Instead, it may be more useful to consider conceptual knowledge as, in some ways, similar to a set of tools...The community and its viewpoint, quite as much as the tool itself, determine how a tool is used. Thus carpenters and cabinet makers use chisels differently. Because tools and the way they are used reflect the particular accumulated insights of communities, it is not possible to use a tool appropriately without understanding the community or culture in which it is used.

The process of becoming a competent expert within a community may be represented as in Figure 5. This simple model has important consequences, for example, when skill development and training is perceived as a process where novices become competent practitioners and experts. Partly because of this, the community of practice model has become extremely popular in recent years. It has been used as a basis for organizational innovation management (Brown & Duguid, 1991), for studies on work practice development (Wenger, 1998), for strategic management of organizational core

■ Figure 5. Trajectory of learning in a community of practice.



competences (Tuomi, 1998), and, for example, to study skill development in open source software communities (Tuomi, 2002).

Davydov: learning through theoretical kernel concepts

In the context of school-learning, Engeström (1996) has compared three approaches to learning that share the focus on practice, culture, activity and tools. One of these is the Davydovian model of learning by formation of theoretical concepts. A child learns, with the teacher's help, to analyze the content of the curricular material and identify a primary general relationship in it. When the child continues the analysis, he or she finds out that this primary relationship is manifested in many different particular relationships in the curricular material, and develops a generalization of the subject under study. As this process goes on, the child eventually is able to develop a "kernel" concept that subsequently serves the child as a general principle that can be used in orienting within the multiplicity of factual curricular material.

Underlying the Davydovian model is the Vygotskian idea that scientific concepts are fundamental in the development of advanced mental functions. Although the Davydovian model may at first look like a method for making children little scientists through acquisition of abstract theories about laws of nature and society, the model actually views teaching as a method to help a child to develop advanced mental functions. In this sense, the Davydovian approach tries to make children more intelligent. In contrast to everyday spontaneous concepts, scientific or theoretical concepts are systems that profoundly change thinking. As Vygotsky notes:

Scientific concepts, with their hierarchical system of interrelation, seem to be the medium within which awareness and mastery first develop, to be transferred later to other concepts and other areas of thought. Reflective consciousness comes to the child through the portals of scientific

concepts. (Vygotsky, 1986:171)

Although Vygotsky used the term "scientific concepts," they can be seen as theoretical concepts that embody systems of cultural development. This contrasts with the view implicitly adopted in much of school learning where, instead of enculturation, the focus typically is on empirical facts, description, and classification of phenomena (Engeström, 1996:160). In the Davydovian model, the goal of learning is the development of thinking.

In the Davydovian model, the goal is not the acquisition or internalization of knowledge embedded in a textbook. Instead, it aims at construction of an open *context of discovery* through practical actions by the students. In contrast, according to Engeström, Lave and Wenger focus on the *context of practical social application*. These interpretations lead to different pedagogical models and school organization:

The Davydov solution to the encapsulation of school learning is to create such powerful intellectual tools in instruction that students can take them into the outside world and grasp its complexities with the help of those tools...The legitimate peripheral participation approach would break the encapsulation the other way around, by creating genuine communities of practice within schools or perhaps by partially replacing school learning with participation in such communities of practice outside school. (Engeström, 1996:168)

Engeström: learning by expanding

According to Engeström, these modes of learning can be integrated in a learning model that is based on *learning by expanding*. This requires that the learners have an opportunity to analyze systematically and critically the learning activity itself. This was the reflective step represented in Figure 4. It provides the *context of criticism*, and generates a meta-level understanding of the subject under study, including its relations

to other communities of practice. The object of learning is the relationships between the context of criticism, the context of discovery, and the context of practical social application (Engeström, 1996:165). In this view, school learning could be integrated in networks of learning that transcend the institutional boundaries of the school in a process of self-organized social transformation.

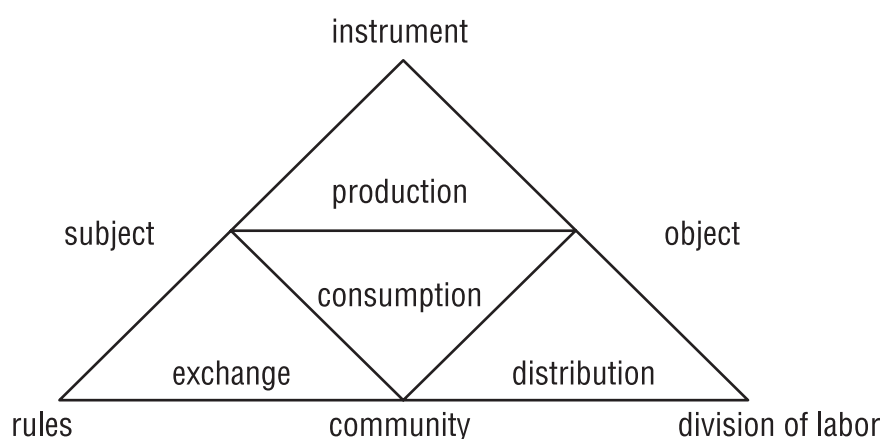
Those researchers who have focused on social practice as the foundation of knowing have conceptualized also individual learning as inherently social, even questioning the nature of identity of individuals. For example, Engeström uses the concept of zone of proximal development in analyzing changing work practice. His interventionist and developmental approach could be characterized as a theory of “generating and negotiating best practices” in a context where these practices are tightly bound to a system of activity and the underlying communities of people. Engeström emphasizes also the role of collective generation of new behavior:

Our concept of zone of proximal development may be provisionally defined as the distance between the present everyday actions for the individuals and the historically new form of the societal activity that can be collectively generated as a solution to the inner contradictions embedded in the everyday actions. (Engeström & Engeström, 1985:214)

In line with Vygotsky, who was inspired by Marx’s theory of cultural and cognitive development, Engeström argues that the original form of human activity is work. In other words, human activity that can properly be called human, and which distinguished humans from other animals, is socially accomplished production. Production requires division of labour and distribution of the results of production. As a driver for production, consumption therefore emerges as the core of human activity. In addition, Engeström—again following Marx—argues that there is a third dominant aspect of human activity, that of exchange, which Engeström also describes as communication and social interaction. Combining the categories proposed by Marx, and the analysis of animal forms of activity by Lewontin, Engeström ends up depicting the structure of human activity as in Figure 6. The core claim of Engeström is that when we talk about human activity, we have to talk about a complex that includes all the elements of the figure. Learning, understood as a change in meaningful and inherently social activity mediated by cognitive and technical tools, requires change in all of them.

Each triangle in the figure can become an activity in itself in a complex society. However, within any such relatively independent activity system, there exists the same internal structure that comprises production, consumption, distribution,

Figure 6. The structure of activity according to Engeström



and exchange. According to Engeström, this has the important implication that there is no activity without the component of production. In the terminology of A.N. Leontev, those components of activity that do not have their own productive aspect can not be called activities; instead, they are actions. There is, however, constant development and reconfiguration of the relationships among activities and between activities and actions. In the course of historical development, actions, therefore, may acquire the characteristics of activity, and new activities may emerge.

According to Engeström, this model of activity is the smallest and most simple unit that still preserves the essential unity and integral quality behind any human activity. Using the model, activity can be analyzed in its inner dynamics and historical change. Activity is in this model also represented as a contextual and ecological phenomenon. Finally, activity is also presented as a mediated phenomenon, where both cognitive and concrete instruments and tools become irreducible elements in the relation between the acting subject and the object of activity.

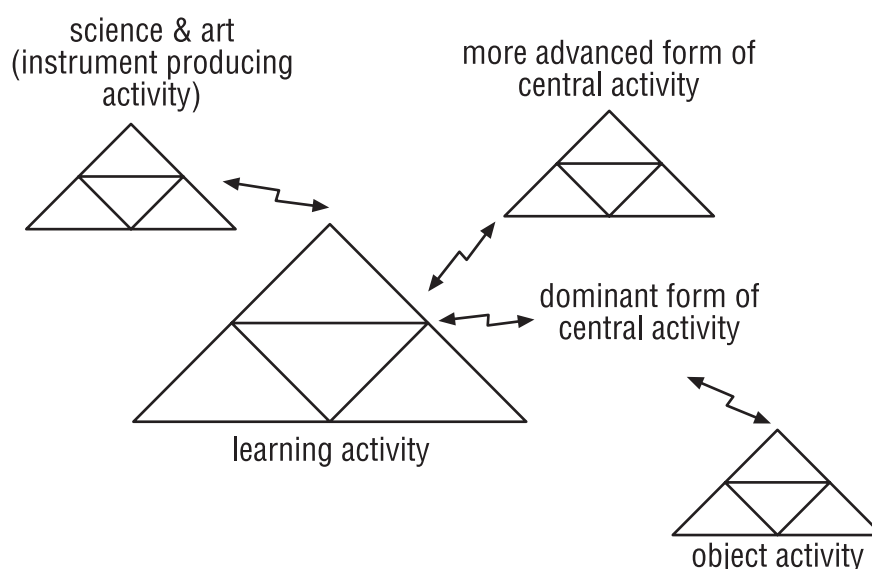
A specific characteristic of Engeström's model is that it can be used to analyze the reasons why learning and change are difficult. The reason, to

put is simply, is that change of activity systems creates both internal and external conflicts. According to Engeström, the primary contradiction in modern capitalist socio-economic formations is the inner conflict between exchange value and use value. Secondary contradictions are those appearing between the elements of the Figure 6. The existing structure of division of labour and the demands of new production instruments is an example here. A tertiary contradiction appears when a culturally more advanced form of activity is introduced that interferes with an existing form of activity. For example, kids may go to school in order to play, but the teacher may try to convert play into study of skills needed in modern society. Or business managers may introduce improved management accounting systems and forget that access rights to the old system were an important source of organizational power and prestige. Finally, there are also quaternary contradictions that emerge as activity systems interact with their "neighbour" activities. For example, change in the focal activity may require change in the activities that produce tools for it.

The structure of learning activity

In analyzing the transformation of learning, Engeström's model is interesting, as he has used

■ *Figure 7. Learning activity in the network of human activities.*



to model to describe the historical evolution of learning activity. According to Engeström, learning can be understood through describing the evolution of three activity systems: the activity of school-going, the activity of work, and the activities of science and art.

Written language is the first truly generic context-free instrument that can be used to reproduce knowledge and skills. Its relative independence of any specific application generates the activity of school-going as a separate socially institutionalized activity. Although written text enables completely new advanced forms of thought, in practice school learning has often remained reproductive. Knowledge acquisition has become understanding of texts written by authorities. Learning becomes “imitatio,” and assimilation of pre-existing canons. Engeström maintains that the general transition to modernity and public schooling has not been a qualitative breakthrough into learning activity, and the seemingly endless stream of literature on the crisis and obsolescence of school learning should be taken as a symptom of this.

Engeström argues that learning should be a developmental activity where the contradictions inherent in the focal activity are overcome. Thus, learning activity needs to become an activity that produces societally new forms of activity. This, however, requires that we have to reconsider the object of school-going. Mastery of given texts needs to be replaced by mastery of advanced forms of thinking. Following Vygotsky, Davydov, and Sylvia Scribner and Michael Cole,⁶⁸ Engeström argues that a key to such advanced forms of thinking is in the development of conceptual systems that are externalized and developed into theoretical systems, for example using written text.

In expansive learning, the object of learning is the societal productive practice, or the social life-world, in its full diversity and complexity. Learning activity makes the interaction between

historically earlier and more advanced forms its object of activity. Thus, in expansive learning, learning is not assimilation and internalization of pre-existing knowledge. Instead, it is creation of new knowledge and its articulation as a new social practice. This makes expansive learning also theoretically relevant for innovative learning, as it occurs in the society and in business organizations.

Nonaka: innovative learning in organizations

As business organizations are becoming increasingly dependent on innovation, also learning has in the recent years been increasingly been studied as a process that creates new knowledge, new concepts, and new technologies and products. This has produced a large body of literature on organizational learning. Much of this literature has framed organizational learning as a problem of effective skill management and human resource development. Others, for example Argyris and Schön, have focused on managing dysfunctional learning that decreases organizational efficiency. One of the most influential organizational learning models is the one introduced by Ikujiro Nonaka. As it adds important conceptual elements to discussions on learning, I will briefly describe it below.

Following Polanyi, Nonaka bases his model on dynamic interaction between two types of knowledge. *Tacit* knowledge, according to Nonaka and his collaborator Takeuchi, is personal, context-specific, and therefore hard to formalize and communicate. *Explicit* knowledge, in contrast, refers to knowledge that is transmittable in formal, systematic language (Nonaka & Takeuchi, 1995:59). According to Nonaka, tacit knowledge includes cognitive and technical elements. The cognitive elements include mental models, such as schemata, paradigms, perspectives, beliefs, and viewpoints, and they help individuals to perceive and define their world. The technical elements,

68 E.g., Cole & Scribner, 1974.

on the other hand, include concrete know-how, crafts, and skills.

The central idea in Nonaka-Takeuchi model is that new knowledge is created in articulation of tacit mental models, in a kind of “mobilization process” (1995:60). In this process, tacit knowledge is converted into explicit form. Although new knowledge is, strictly speaking, created only by individuals according to Nonaka and Takeuchi, knowledge creation does not happen within a single individual:

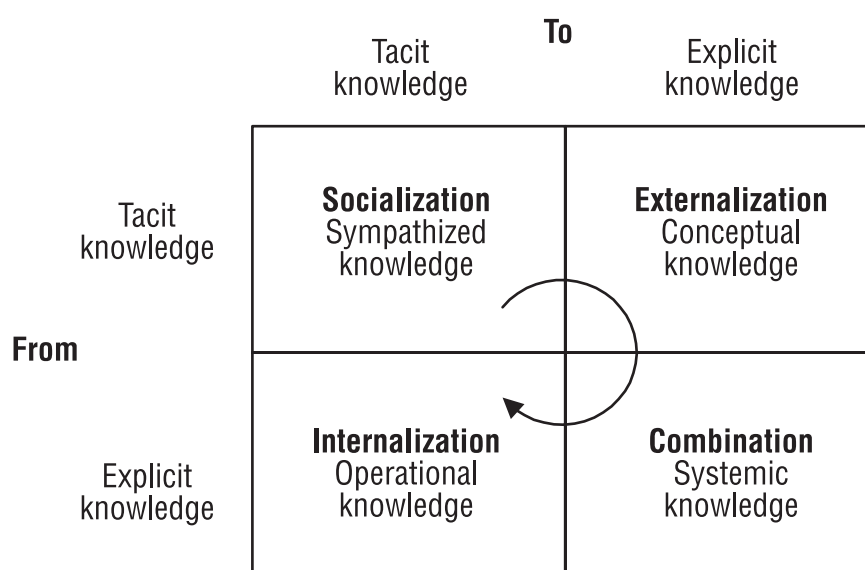
Our dynamic model of knowledge creation is anchored to a critical assumption that human knowledge is created and expanded through social interaction between tacit knowledge and explicit knowledge...It should be noted that this conversion is a “social” process *between* individuals and not confined *within* an individual. (1995:61)

The transformation of knowledge between different forms is a bi-directional process. Tacit knowledge becomes explicit, but explicit knowledge also becomes tacit. Corresponding to the four possible types of knowledge conversion, there are four conversion modes. Tacit knowledge transforms to tacit knowledge through *socialization*; tacit knowledge transforms

to explicit knowledge through *externalization*; explicit knowledge is converted to explicit knowledge through *combination*; and explicit knowledge transforms to tacit knowledge through *internalization*. Nonaka refers to this knowledge creation model as the SECI model (Nonaka & Konno, 1998). Innovative learning and knowledge creation is in this model understood as conversion of tacit knowledge into explicit forms where it can be combined, followed by an internalization process where this new combined knowledge becomes a part of the learner’s knowledge structure. This model is shown in Figure 8.

According to Nonaka and Takeuchi, an individual can acquire tacit knowledge directly from others without using language (1995:62). This socialization process happens through observation, imitation, practice, and shared experience. Externalization, on the other hand, is a process of articulating tacit knowledge into explicit concepts. In that process, tacit knowledge takes the shape of metaphors, analogies, concepts, hypotheses, and models. These we—more or less successfully—try to express using language. Among the various forms of knowledge conversion, “externalization holds the key to knowledge creation, because it creates new, explicit concepts from tacit

■ Figure 8. Nonaka-Takeuchi learning cycle.



knowledge” (1995:66). The third mode of knowledge conversion, combination, is the process of systemizing concepts into a knowledge system, and it integrates different bodies of explicit knowledge. This includes such activities as sorting, adding, and categorizing explicit knowledge. According to Nonaka and Takeuchi, knowledge creation carried out in formal education and training at schools usually takes this form (1995:67). In organizational contexts, one of the main roles of middle management is to create new concepts through combining various sources of knowledge (Nonaka, 1988). Internalization, the fourth conversion mode, is a process of embodying explicit knowledge into tacit knowledge. Experiences through socialization, externalization, and combination are “internalized into individual’s tacit knowledge bases in the form of shared mental models or technical know-how,” and therefore become valuable assets (1995:69).

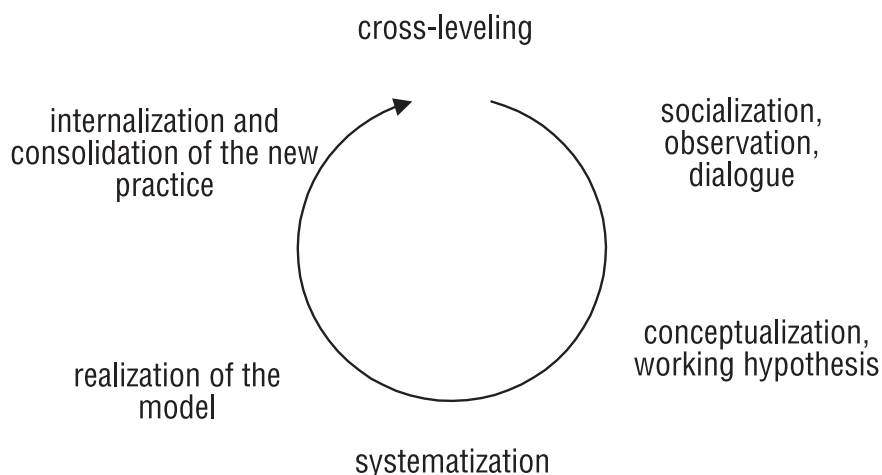
Organizational knowledge creation is a continuous process where the different modes of knowledge conversion interact. Nonaka and Takeuchi describe this dynamic process as a knowledge spiral. In this spiral of knowledge creation, the socialization mode starts with building a “field” or “space” of social interaction (Nonaka & Takeuchi, 1995:70; Nonaka & Konno, 1998). After such a social interaction field

exists, externalization is triggered by meaningful dialogue that sustains collective reflection. As a result, the combination mode is triggered by networking and integrating the newly created knowledge with existing stocks of explicit knowledge. Finally, “learning by doing” triggers internalization. The different phases of knowledge conversion lead to different knowledge contents:

Socialization yields what can be called “sympathized knowledge,” such as shared mental models and technical skills... Externalization outputs “conceptual knowledge”... Combination gives rise to “systemic knowledge”... Internalization produces “operational knowledge”... (1995:71)

Based on these considerations, Nonaka and Takeuchi propose a five-phase model of the organizational knowledge creation process. The first phase consists of *sharing tacit knowledge* within the organizations. The “rich and untapped knowledge that resides in individuals must first be amplified within the organization” (1995:84). In the second phase, tacit knowledge that is shared, for example, by a team within an organization, must be made *explicit*. In the third phase, this explicit knowledge must be *justified*, so that the rest of the organization can determine if the new concept is worthy of pursuit. If the organization gives a “go-ahead” for the new concept, it

Figure 9. A reconstructed Nonaka-Takeuchi model.



then has to be converted into an *archetype*, for example, a prototype or an operating mechanism. The last phase extends the knowledge created across the organization. Such *cross-leveling of knowledge* may involve also outside constituent such as customers, distributors, sub-contractors, and other stakeholders.

The Nonaka-Takeuchi model can be represented as in Figure 9. This representation makes also visible the close similarity between Engeström's and Nonaka and Takeuchi's models. However, as Engeström (1999) has pointed out, in the SECI model the initial problem that starts the cycle is implicit. More generally, one can say that the Nonaka-Takeuchi cycle differs from Dewey's and Engeström's learning cycles as there is no concept of motive, need, or problem integrated in the model (Tuomi, 1999). Therefore, also a criterion for success in learning comes from outside the learning process. In practice, learning in this model has been successful if there is a profitable product out in the market.

The 5A-model

The different models of learning allow us to ask how information technology could be used to support and facilitate different phases of learning processes. Strictly speaking, to answer this question, we have to study learning as an ongoing process and as an element of intelligent human action. This leads to learning models that combine elements of the above models using a non-positivistic, socially constructed, and culturally, socially and historically grounded epistemology. Elements of such a model have been discussed by Tuomi (1999), which proposed the "5-A model of learning" as a practical starting point for managing organizational learning and knowledge management. We briefly point out

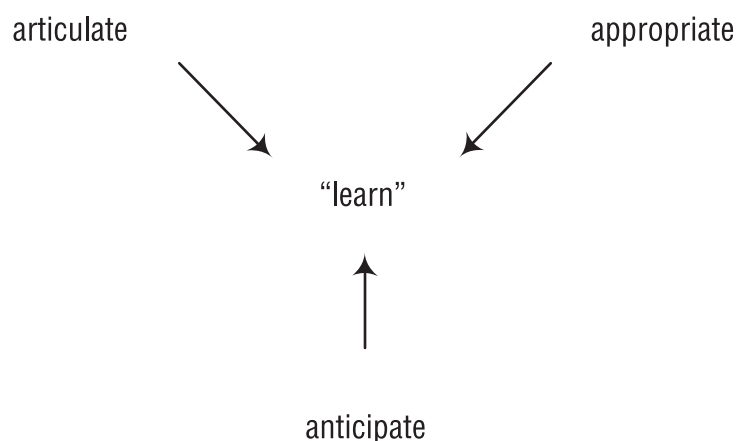
some of the main characteristics of this model, to highlight the potential impact of information and communication technologies.

According to Tuomi (1999) the learning process can be triggered by three different sources: the environment, the society, or the learning unit itself. More specifically, we can distinguish three modes of knowledge generation, which we may call *articulation*, *appropriation* and *anticipation*. We may have a model of a world which suddenly breaks down and surprises us. This tension between our anticipation and observed world may produce new knowledge. We might call this type of learning as "Dewey learning." Learners can also produce knowledge by appropriating knowledge that exists in the society. For example, systems of "scientific concepts" and language can be learned by acquiring them in a joint effort by the learner and a more competent tutor. One might call this "Vygotsky learning." Third, knowledge can also be generated by articulating and reconfiguring meaning relationships within the meaning system available for the learner. This could be called by various names, such as "Polanyi learning," "creative learning," or, more etymologically, "poiesis." These processes are schematically depicted in Figure 10.

These dynamic processes transpire within a context of accumulated meaning structure and knowledge. Learning is always incremental, and possible only if there is memory.⁶⁹ Therefore we need to add to the Figure 10 the process of *accumulation*. Moreover, as intelligence, knowledge and cognition can fundamentally only be described in the context of effective action, we should also add to Figure 10 this process which grounds the rest of our constructs. The resulting model of knowledge processes is shown in Figure 11. I shall call it the "5-A model" of knowledge generation, for short.

⁶⁹ Although learning in itself is necessarily and incremental process as a result of its accumulative character, its manifestations can be radical. When some central nodes in the meaning structure become reorganized, many meaning relations change. This can be seen as accommodative learning in Piaget's terms, double-loop learning in the terms of Argyris and Schön, or Learning III in Bateson's classification.

■ Figure 10. Three sources of ontogenic knowledge.



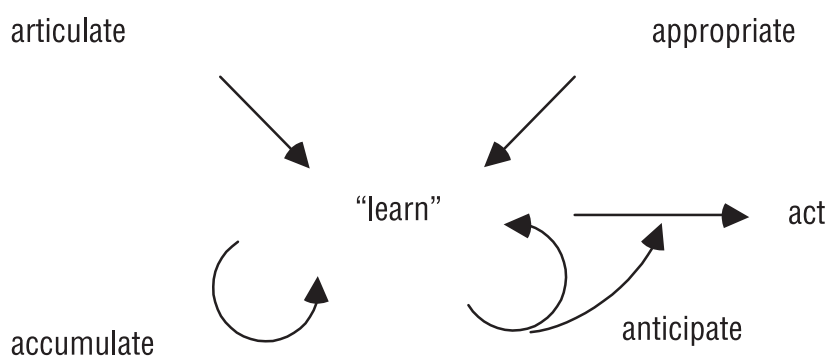
Articulation and anticipation generate knowledge that can be new to the society. Appropriation, in contrast, generates knowledge that is available within the society but which is new for the focal learner. For example, a child learns language by appropriating linguistic knowledge and clusters of meaning packaged into concepts. After becoming a proficient language user, he or she may also articulate new linguistic structures or concepts, thereby creating new language for others to appropriate. In this linguistic domain, the etymological origin of “poietic learning” is clear. One could also note that theoretical science, as a knowledge-creation mode, is a form of poetry. Both express and

articulate something that exists and makes sense, potentially, but which no one said before.⁷⁰

The generic model shown in Figure 11 should be further refined by considering its manifestations within the different units of analysis, including communities, societies and cultures (cf. Tuomi, 1999: Ch. 11). Here it suffices to point out just a couple of examples of the ways in which information and communication technologies enter the learning process.

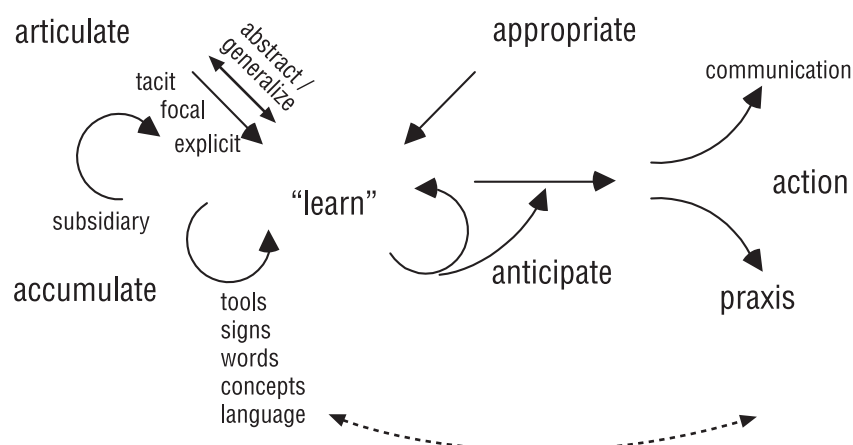
Acts in Figure 11 can mean both internal and external action. “Internal action” corresponds to reflective thought. Information technology can facilitate and support reflective thought,

■ Figure 11. The “5-A model” of knowledge generation.



⁷⁰ Postmodern scholars in literature studies might, of course, find the idea that poetry (or language) can be created through references to non-linguistic realities somewhat problematic. Reference to reality, however, does not necessarily imply naive realism or trivial empiricism. The 5A-model, in particular, rests on a rather elaborate analysis of phenomenological, constructivist and socio-cultural epistemologies.

Figure 12. Detail structure of the 5-A model.



for example, by computational simulation and cognitive augmentation.

External action, in turn, comprises two integrated kinds of behaviour: communication and production. All human action is mediated and symbolic action that has both communicative and productive aspects, in an analytically inseparable package. The communicative dimension of action is related to the meaning of action, and the productive dimension to its transformative function. In other words, whenever we do something, we both produce external effects that become material facts that other's can try to make sense of and which constrain the practical actions of others, and, at the same time, we try to accomplish some meaningful result. To give a concrete example, when I take soup from a kettle, I both take food and leave the kettle less full of soup. Moreover, all action emerges in the context of activity. For example, when I take soup from a kettle, I participate in a complex social and cultural activity of "eating," regulated by norms, historical traditions, available technologies, the temperature of the soup, expectations about food poisoning, beliefs about purity of specific types of meat, and so forth.⁷¹ All these elements spice the soup so that food becomes a profoundly cultural

and communicative phenomenon, independent of the transformative fact that after I take some soup, there is less of it in the kettle. All action, in other words, has meaning within the social context, and action, in itself, always implicitly coordinates social behaviour. All action also produces change as a transformation of some aspects of the world.⁷² Information and communication technologies enter this process when they are used to produce things and also because they provide a medium for social meaning processing.

Accumulation and memory underlie all meaning processing. In some cases, accumulation is based on physiological change in the cognitive system. In some cases such change can be "purely" cognitive, in the sense of being a change in the configuration of self-referential meaning relations. This type of accumulation occurs, for example, when a cluster of meanings is crystallized into a concept. In other cases, accumulation may happen by utilizing external cognitive tools and auxiliaries. In addition to serving as mediated means to augment meaning processing, these external artefacts may also be used to organize social practice. A more detailed picture of the knowledge generation process could then be represented as in Figure 12.

71 "Action" is here used in the activity theoretic sense, as a action directed towards solving a specific goal in a sequence of actions that implement a specific form of social activity or practice. We are therefore here talking about actions that rely on "advanced mental functions" in Vygotsky's sense, i.e., actions that are irreducibly social and knowledge-based. The argument is that, for well developed thinkers and learners, no action remains that would be independent of socio-cultural inheritance. For a young child, the situation may be different.

72 In some cases, of course, production itself may be communication.

Knowledge exists in context and it emerges as plans, anecdotes, language, habits, models, practices, and institutions that guide action. Information and communication technologies can be used to represent all these.

Articulation underlies anticipation as the basis for explorative action and generation of plans. Appropriation of knowledge happens through acquisition of externally generated knowledge that is articulated in communication, tools or action. Most important, accumulation of knowledge requires concept formation, combination of knowledge, and for example, explication of knowledge in language. Although accumulation does not necessarily require representation, when knowledge is represented, meaning processing can use such representations to develop qualitatively new forms of advanced thinking. Representation also enables symbolic communication and collective meaning processing, either through sharing meaning references, or by sharing knowledge artefacts. As a result, knowledge about knowledge becomes possible.

Accumulation of knowledge produces artefacts that can become objects of action. These can be viewed as cognitive tools, in the sense of Vygotsky, by which some meaning processing is off-loaded to the environment. Commonly distinguished articulation processes include abstraction, categorization, combination, explication, refining, visualization, and reflection. Knowledge structures are articulated as concepts, tools, metaphors, images, models, and stories. These in turn, accumulate as practices, languages, designs, integrated histories, and organizational culture, for example. Finally, with written forms of language, some of these accumulated knowledge structures may be represented as documents.

Documents, therefore, can be viewed as attempts to articulate some aspects of underlying accumulated stocks of knowledge in written linguistic form. In most cases, textual representations are only minor parts of the full underlying knowledge structures, and their interpretation always requires knowledge about

culture, practices, and language specific to the focal organization and the community of practice. For this reason, also the common idea that knowledge is created by structuring data into information, which is then interpreted to produce knowledge, is not a very useful starting point for understanding knowledge creation or for designing information systems for knowledge-based activities (Tuomi, 2000). In practice, we have to turn around the conventional data-information-knowledge hierarchy when we design, for instance, collaboration or organizational memory systems.

It is impossible to discuss the implication of the above-presented models in any great depth in this Appendix. Detailed learning models are, however, important when we try to understand the changes in learning activity. They represent learning in a way which is abstract enough that we can see the stable core of learning, and they allow us to describe the historical forms of learning that are now undergoing transformation. For example, the above learning models abstract away specific cultural and technical artefacts, such as textbooks. Using the presented concepts, we may therefore “deconstruct” learning and study how exactly new technologies enter the learning process. They, for example, allow us to avoid the common error of interpreting new information and communication technologies as means to implement traditional institutional forms of organized learning. For example, it is now generally understood that many attempts to use computers in classrooms failed because computer-based learning systems simply tried to replace printed books with electronic textbooks. PC-based educational software market, which was expected to expand rapidly, was last year one-third of what it was in year 2000. At least partly the burst of the computer-based education bubble results from the realization that the conventional mainstream learning models simply are not very useful. When the traditional models are implemented using computer software, the theoretical limitations of these models become explicit, and difficult to hide by competent human teachers. In a way, we learn how our

implicit theories about learning went wrong when we implement our ideas using computers. This also creates the opportunity to rethink what this obvious thing we call learning, actually is.

The proper way to analyze the potential impact of information and communication technologies on learning, therefore, requires that we use theoretical grounded concepts to localize those points in the learning process where technology will create important new opportunities for learning. This work is just beginning. It will lead to new ideas about how to support learning with computers and information technology, and it will produce new insights on how to reorganize education.

One may argue that there can be no discontinuities in learning, as learning, itself, will not change even when educational systems undergo radical change. If we really understand what learning is and how it happens, this implies that our model of learning is accurate in different environments and periods of time. On the other hand, one could also ask whether the emergence of the knowledge society actually means that the social and cognitive processes and the practices of learning are now changing in fundamental ways that will require new models of learning. This, indeed, would be what Bateson called Learning IV. He argued that it could happen, but that it is something that we have rarely seen in the human history.

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Abstract

This report is the result of a workshop jointly organised by IPTS and DG EAC on the future of learning in the knowledge-based society in Europe and on the role and contribution of ICT for realising a new vision of future learning. The report raises social and technological trends and drivers for future learning and looks at the specificities of ICT for learning. It proposes a vision of future learning coined 'learning spaces'. Implementation challenges and possible implications for inclusion are also discussed. The report concludes that ICT can play the role of catalyst for change in education and training in Europe providing ICT change goes hand in hand with institutional and social change.

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