Systemic innovations enabled by information and communication technology in education

Towards an integrative, multi-level research framework for exploring the complex shaping and integration of ICT-based innovations exemplified by the case of e-portfolios

DISSERTATION

zur Erlangung des Doktorgrades an der Kultur- und Gesellschaftswissenschaftlichen Fakultät der Universität Salzburg

Fachgebiet: Kommunikationswissenschaft / Center for Advanced Studies and Research in Information and Communication Technologies & Society

Gutachter/-in:

Univ.-Prof. Dr. Wolfgang Hofkirchner, TU Wien

(ehem. ICT&S Center Universität Salzburg)

Univ.-Prof. Dr[in] Tina Hascher, Erziehungswissenschaft, Universität Salzburg

eingereicht von

Mag. Veronika Hornung-Prähauser, MAS

Salzburg, December 2011

‘E-portfolios are not discrete, they are part of a system.’

(Sue Nicholson, 2007: 7)

‘There is nothing as practical as good theory’

(Kurt Lewin 1952: 169)

Motivation and acknowledgements

My motiviation for writing this thesis has developed during my participation in e-portfolio research and development projects in the field of applied e-learning research at Salzburg Research Forschungsgesellschaft. The emergence of the e-portfolio concept and especially its potential to support individualised, self-organised learning attracted my interest. A more profound understanding about the dynamics of systemic e-learning innovations might lead to more sustainable e-learning projects. This thesis would not have been possible without the theoretical guidance, practical support, and inspiration of many people:

In the first place, I would like to express my sincere appreciation and gratitude to my supervisors, Univ.-Prof. Dr. Wolfgang Hofkirchner, Technical University Vienna, and Univ.-Prof. Dr$^{\text{in}}$ Tina Hascher, University of Salzburg, who both offered their profound expertise and guidance when new orientation was needed. Secondly, it is a great pleasure to thank all my colleagues at Salzburg Research and at the doctoral programme of the Center for Advanced Studies and Research in Information and Communication Technologies & Society, University of Salzburg, and within the lively international e-portfolio community for their stimulating discussions, practical support and encouragement during the years of e-portfolio research and this thesis's work.

Finally, I am heartily thankful to my parents, for their instilling in me great pleasure for learning and scientific curiosity. I am indebted to my beloved husband, my children and sisters, my family and friends, for their unlimited patience and support for me in pursuing this study. A special thank goes to all the invaluable babysitters who enabled focused writing times.

Abstract

The thesis deals with systemic ICT-based innovations, especially e-portfolios, in education, because this type of e-learning innovation is of special character. It can be understood as a techno-pedagogical innovation, and, if integrated on a systemic scale, it is not only adopted by a wide range of actors, but also deeply embedded in the structures of an educational system, and, has boundaries even to other subsystems, such as the economy (job market). Empirical evidence shows that the shaping and integration process of e-portfolios is a very dynamic process taking place in a complex national educational system. The thesis will:

- Provide a systematic, interdisciplinary synopsis of the theoretical approaches on ICT-based innovations relevant for the societal subsystem of education from different disciplines of the social sciences (communication and media science, sociology of technology, education/media pedagogy, economics and organisational studies) and the natural sciences (computer sciences),
- Analyse the theoretical strands as to their aptness for advancing research in the field of e-learning (strengths, limitations, contradictions) and investigate relevant determinants influencing the systemic integration process at the macro-, meso- and micro-levels of an educational system,
- Develop an integrative, multi-level framework encompassing a set of determinants that help to systematically research the interdependencies of a systemic ICT-based innovation in a national educational system, and
- Exemplify the practical and theoretical utility of such an integrative, multi-level framework by the application to the case of e-portfolio integration in European higher education (multiple-case study).

Table of Contents

List of Tables

List of Figures

List of Abbreviations

AT	Austria
CERI	Centre for Educational Research and Innovation at the OECD
Eurostat	European Statistical Office
HE	Higher Education
HEI	Higher Educational Institutions
ICT	Information and communication technology
JISC	Joint Information Systems Committeee
NL	Netherlands
OECD	Organisation for Economic Co-operation and Development
OER	Open educational resources
SCOT	Social constructivism of technology
SDL	Self-directed learning
UK	United Kingdom

1 Chapter 1: Introduction

1.1 Practical and theoretical problem statement

This thesis addresses the practical problem of the low rates of integration of information and communication technologies (ICTs) into the European educational systems and investigates the dynamics and determinants facilitating or hindering the adoption and diffusion of innovative ICT use. In the following section, the practical problem and the related theoretical problem will be introduced.

1.1.1 Practical integration of ICT-enabled innovations into educational systems

Nowadays, ICTs and the Internet are regarded as fundamental technologies affecting the working processes and routines of any system of society. The widespread integration of ICTs in the application field of education is a relatively new phenomenon to be observed in industrialised countries since the late 1970s (Nicholson 2007). Early ICT use in education was predominantly for increasing the efficiency of the administration and management of local and federal educational institutions. Gradually, with the emergence of microcomputers and the Internet, a bundle of innovative Internet-based software applications was developed and designed to enhance the quality of the core function of education: the individual teaching and learning processes.

'E-portfolio', a web-application for collecting, assessing, publishing and sharing information on a student's learning processes and outcomes, can be called such an educational ICT-based innovation[1] (Jafari & Kaufmann 2006). The idea of web-based e-portfolio software emerged as a by-product of the invention of the Internet in the late 1990s. It aimed at supporting the development of a learner's self-organising and self-regulating competences and skills by moving from the traditional form of a "paper-based portfolio" to a "hyperlinked, multimedia e-portfolio" didactic (Barrett 2001). Since then, a wide range of different e-portfolio software has been developed, marketed and implemented, especially in North America and Australia and in different European educational systems (such as in the United Kingdom and the Netherlands), in schools,

[1] "Educational innovation" can be defined as a new approach for learning and teaching, or a new organisation of educational systems related to content and/or methods and learning media or a combination of all these (see Reinmann 2006: 8; translated by author).

universities and adult education training establishments[2]. Notwithstanding some success stories, a huge gap still exists between the early phase of designing and piloting e-portfolios and their system-wide integration into national educational systems. Although the diffusion of ICT hardware and Internet infrastructure into educational institutions has been heavily funded by national governments during the past few years (see OECD Education at a Glance 2005–2010), the potential of techno-pedagogical ICT-based innovations, especially those fostering the development of self-organising and co-operative skills and competences such as e-portfolios or open educational resources (OER), has not been fully reaped yet (JISC Report 2008). Too often, a techno-deterministic view of the complex mechanisms and non-pedagogical interests embedded into ICT design, media competences and educational policy has led to failures and frustrations at all integration levels.

The low level of e-portfolio integration, especially in German speaking countries, may result from different factors: Although e-portfolio software has been rolled out and installed on a large scale in the educational system, the didactical adoption at the classroom level is still lower than expected (e.g. the rates of adoption in the UK; Becta 2006; JISC 2008). Maybe this is due to conceptual differences about the "right design" and the "measurable" impact of e-portfolio: digital CVs, pedagogical instruments, personal knowledge management system or lifelong learning digital learning archive (e.g. discussions in the e-portfolio conferences 2006–2011). Furthermore, the e-portfolio software market can be characterised as a heterogeneous market: large commercial IT suppliers compete with small open source e-portfolio projects and products (see the list of different types of e-portfolio software providers in Hornung-Prähauser et al. 2007). Firms of learning management software of the first generation now enrich their software with e-portfolio functionalities and plug-ins (e.g. the integration of e-portfolio software Mahara into the learning management system Moodle, now called "Mahoodle"[3]). Moreover, dichotomies in national assessment exist: policies at the macro-level of a national educational system exert different influences on ICT to those promoted at the micro-level. On one hand, e-portfolios should be implemented to foster student's individualisation, whereas, on the other hand, macro-policies support central and standardised testing procedures that are identical for all students in the national system.

[2] For case studies on e-portfolio integration in different countries and educational sectors, see the proceedings of the e-portfolio conferences from 2004 to 2010 Available at: http://www.eportfolio.eu/.

[3] For new development on a "Mahoodle", see presentation of Penny Leach at the Moodle conference 2008: [http://www.slideshare.net/maharaproject/20081023-leach-moodlemootbarcelonaen; accessed 2011-03-20].

The process of shaping and integrating ICTs into educational systems is a complex research theme. A better understanding of the interrelationships among all actors, educational and research institutions or regulatory bodies involved in integrating systemic ICT-based innovations would enable the development of sustainable e-learning policies supporting the transfer of e-portfolio pilot experiences into the whole system. The interrelations between actors and the structures, especially in the sector of Higher Education (HE), are depicted in the figure below.

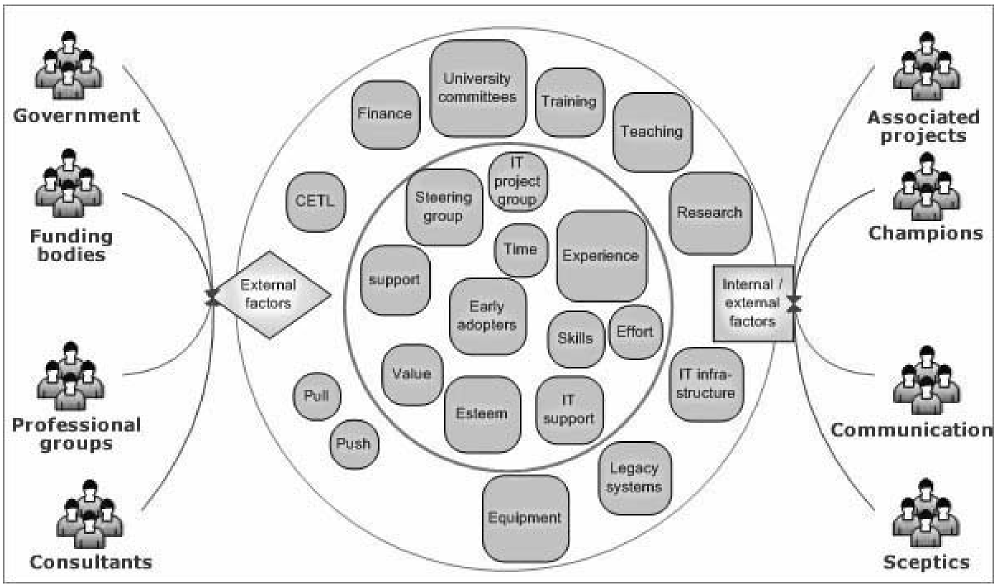


Figure 1: Actors and structures involved in systemic innovation change.

Source: Bates, M., Manuel, S. & Oppenheim, C. (2007).

The institutional framework of a university is bounded by external influences, which in turn influence decisions taken at institutional, faculty, department, and project level. The strength of the boundaries between faculties and departments, or the existence of cross-disciplinary collaborations can affect diffusion of innovations across an institution.Figure 1 illustrates the complexity of the framework within which new innovations are situated. It provides an indication of the task change agents face when attempting to introduce a new service into a university. Having an awareness of early adopter characteristics and the most appropriate methods for targeting these individuals may give projects a head start in achieving institutional adoption for their ICT product or service.

1.1.2 Theoretical tesearch gap in educational technology research

Theoretical research on the process of shaping innovative educational technologies, on its adoption patterns and on ICT diffusion policies in education are complex research issues, because they touch disciplinary boundaries within social sciences and partly beyond, to the natural sciences, e.g. instructional software design. This need for a 'frontier crossing' might be the reason why a theoretical exploration of the relationship between technology, particularly computers and the Internet, and systemic innovation in education has often been a neglected issue in the field of educational technology. As Watson (2006) regrets: "There can be no doubt that the world of ICTs in education is embedded in innovation and change. And yet there is relatively little reference to models or theories of change as an underpinning conceptual framework to understanding what has been happening. How come we have paid it scant attention?" (p. 212).

The field of educational technology research[4] is called a 'multi-vocal' research field (Friesen 2009). The variety of voices originates from different disciplinary cornerstones such as instructional technology and design, educational psychology, media pedagogy and distance education. The research foci in educational technology studies driven by educational scientists have been on e-learning strategies, social contexts, design and/or pedagogies and the impact of computer technology and the Internet on individual learning practices and outcomes (Friesen 2009: 12). Hung (2010) finds that e-learning research has now reached an early maturity stage and that research interests are shifting from issues of the effectiveness of educational technology to teaching and learning practices. Some efforts have lately been made by German educational scientists. Sesink (2008) acknowledges that new media or technologies have been a "side issue" among educational theorists (p. 13). It was not until 2007 that a congress of the German Association for Educational Science, Commission of Media Pedagogy, firstly dealt with the topic of "media, technology and education" and tried to bridge the gap between researchers in the field of educational theory and communication theory.

The field of communication and media science has naturally dealt with the history and emergence of different forms of communication tools. However, this work primarily theorises the research objects of radio, film and movies. Computers and the

[4] Throughout the thesis, the term "e-learning research" will be used as an equivalent for research in educational technology. For more details on definitions and concepts, see chapter 3.

Internet in education play a minor role in the large body of theoretical language and communication approaches (for details on the literature, see next section).

However, the field of the sociology of technology has developed a large bulk of knowledge on social constructivist approaches to explain the shaping of risk technologies, such as nuclear or nano-technology (Schulz-Schäfer 2006; Degele 2003). Moreover, the emphasis of the research lies on the impact of the technologies on the general societal and cultural systems and ignores consequences for the education as a subsector of society.

Summing up, I agree with Reinmann (2006), who argues that the difficulties researching the educational technology in general and the technology and education sector in particular is because of the divergent behaviour of the sciences as a closed community (still ignoring ICT as a determinant) and because of the day-to-day users of technology (e.g. teachers and the educational institutions ignore the theoretical research). She concludes that research in this field has to overcome the internal innovation barriers resulting from the referential system of ”science and practice“. In science, the debate is about what type of research is right (e.g. empirical educational research vs. qualitative research) or what is the aim of research in education. She echoes Berliner (2002), who describes educational sciences and e-learning as “hard-to-do-science“ because of its multi-perspectives (Reinmann 2006). Luppicini (2005) argues in the same accord and cites Winch (1990), who examines how social and natural sciences differ in terms of what is being accounted for. In natural sciences, the experimental results are the focus, whereas social sciences include the social context of the study as well. Winch (1990) states: “So to understand the activities of an individual scientific investigator we must take into account two sets of relations: first, his relation to the phenomenon which he investigates; second, his relation to his fellow-scientists.” (Luppicini 2005: 103-104). It is the aim of this thesis to provide a systematic theoretically based framework, which integrates different theoretical approaches and concepts needed for future multi-faceted research in educational technology. Lately, there have been some attempts to develop a broader theoretical view on the dynamics of ICT in education for example by Kolo & Breiter (2009), who firstly tried to formulate integrative frameworks, by merging a macro-economic view on educational innovation systems (e.g. Kozma) with theoretical approaches on adoption and diffusion processes from organisational management and innovation theories (e.g. E.Rogers;

Aizen/Fishbein). However, a thorough analysis of theoretical foundations in this issue is still lacking. This will be discussed in the next section.

1.2 State-of-the-art of ICT-enabled innovation in education

The following section provides a short state-of-the-art analysis on how computers and the Internet in general, and the issue of systemic ICT-based innovations in education in particular, have been tackled so far in the field of communication and media science, sociology and educational sciences. This review has to stay within some limits, and I will thus point out only the mainstream concepts and approaches that have been well cited in the German speaking e-learning research community.

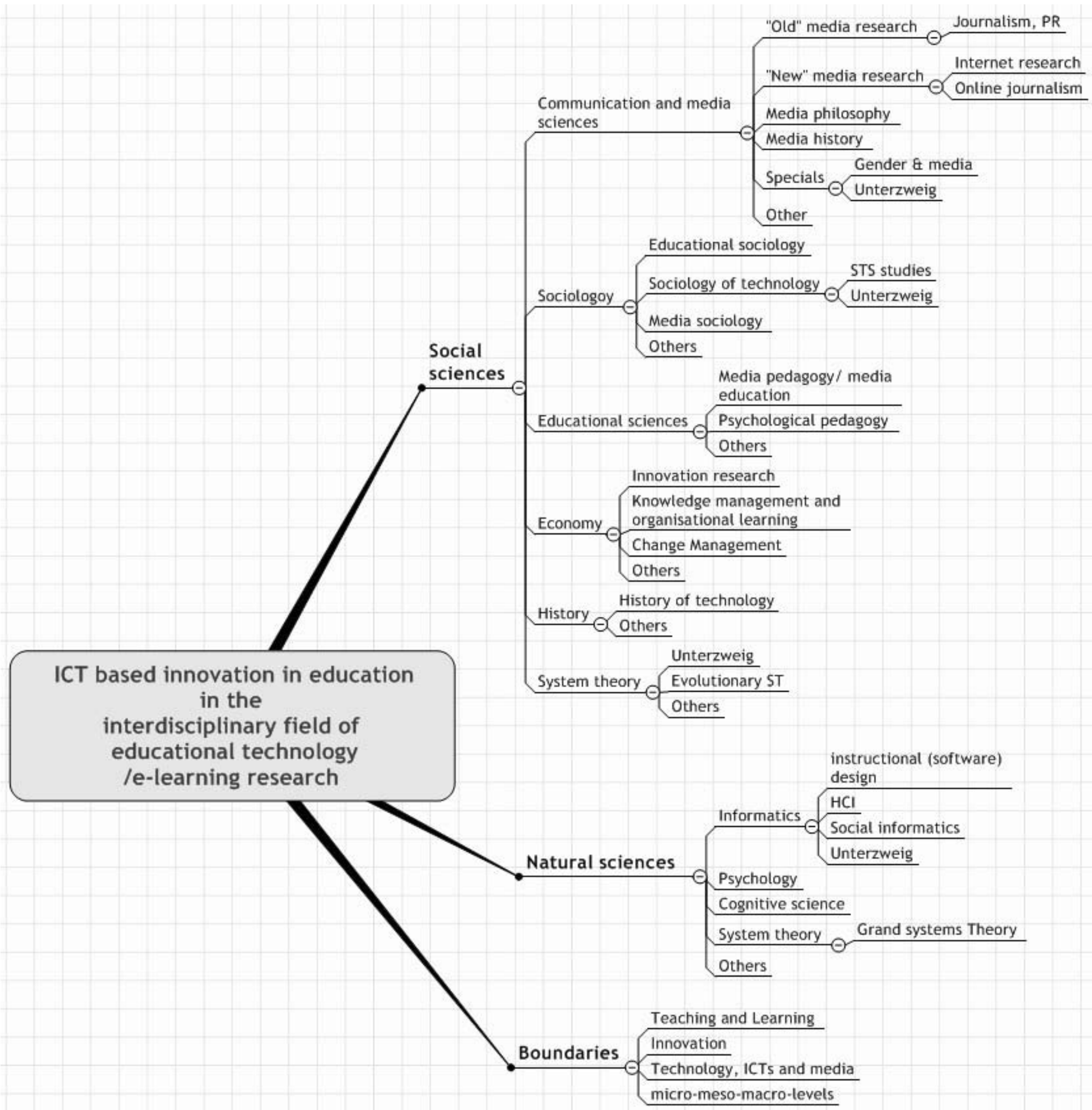


Figure 2: Examples of research fields targeting ICT-based innovation in education

1.2.1 ICT-based educational innovation in communication and media science

The research field of communication and media and sciences can mean different disciplines. The generic term "media sciences" integrates the perspectives from the humanity and cultural disciplines, whereas the term "communication sciences" views itself as an empirical social science, focusing on the psychological, sociological, economic, political and legal aspects of "media" (Batinic & Appel 2008: 79). Research in this field traditionally deals with the natural, linguistic or socio-cultural perspectives of communication and information or knowledge processes of the perception and transmission of media reality, with the meaning and visualisation of "content" and with the formation of an audience (ibid). Computer software programmes (codes) and the production and interpretation of digital content (stories produced with the computer) have played a prominent role in later research work.

In the following section, theoretical concepts connecting traditional media theories and new technological innovations, such as the microcomputer and the Internet, in the field of education will be summarised. The computer is viewed in different ways (Panke 2006: 5pp.), including as a "cultural interface" (Manovich 2001), a "computer theatre" (Murray 1997; Laurels 1993) or a "performance" (Norman 1992; 1997). Theories that originate from the traditional research object of film are being applied to computers to enrich the aspects of "multimedia" and "interactivity" (Manovich 2001). This work deals with the characteristics of digital media and offers another systematic and rigorous theory of digital media placed in the histories of the visual and media cultures of the past few centuries and cinematography (e.g. the rectangular frame, mobile cameras, illusion of reality, viewer represents space). Manovich (2001) worked out new principles for digital media: numerical representation, modularity, automation, variability and transcoding (p. 18). The Internet has also been analysed in terms of aspects such as interactivity, hypertextuality and transversality within media philosophical works (Sandbothe 1996, 2000):

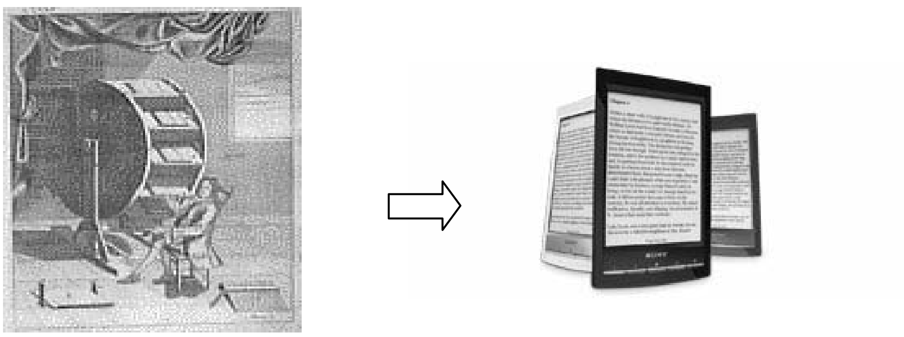
> Given the influence that interactive data networks such as the Internet have on our perception and on our semiotic practice, the intertwined relationships existing between media in the broad, narrow and narrowest sense are becoming obvious. Space, time and identity are being inflected anew in the Internet. The traditional demarcation between image, language and writing is beginning to move in a radical way. With interactive data-networks the digital revolution is becoming the driving force of a comprehensive transformation which is redefining the practices by which we handle signs and, with this, the bedrock of our understanding of reality (Sandbothe 1996, 2000).

The works mentioned above deal with the computer as a technological device, but do not relate their findings to the field of education in general, let alone to the teaching and learning process. Swertz (2009: 24-27) points out three scientists who have tried to bridge this gap and summarises three perspectives of computers and education in communication and media theory.

Meder (1998) views ICT as a cultural technique in our society and states that computer technology can be seen as an automated solution machine, language development machine, simulation machine and/or communication machine (Meder 1998). The adoption of such a machine necessitates the development of a new learner ideal, “the language gambler”. Learners need to be able to cope with contradiction and play with double identities and roles (Swertz 2009: 24).

Baecker (2007) posits the general importance of new media technology and ICTs for the structure of society, especially for universities, and suggests that the changes brought about by computers in today’s education will be as dramatic as the introduction of automated book prints on modern society:

> Wir haben es mit nichts Geringerem zu tun als mit der Vermutung, dass die Einführung des Computers für die Gesellschaft ebenso dramatische Folgen hat wie zuvor nur die Einführung der Sprache, der Schrift und des Buchdrucks. Die Einführung der Sprache konstituierte die Stammesgesellschaft, die Einführung der Schrift die antike Hochkultur, die Einführung des Buchdrucks die moderne Gesellschaft und die Einführung des Computers die nächste Gesellschaft“ (Baecker 2007: 7 cited in Meyer & Schwalbe 2009: 336).



Reading wheel E-book reader

Figure 3: From a reading wheel in the 17th century to a modern e-book reader

Sources: Pictures publicy available from Online Dictionary Wikipedia and Sony Gera http://en.wikipedia.org/wiki/File:Grollier%27s_Reading_Wheel.jpg and http://www.sony.de/hub/reader-ebook [5-12-2011]

Meyer & Schwalbe (2009: 336pp) argues that Baecker is close to the thinking of sociologists M. McLuhan (1994), M. Castells (2001), N. Luhmann (1998) and Debray (2003), who have postulated and assumed that the structures of societies change with the primary transmission media. Each new emerging media goes hand in hand with the new possibilities and forms of communication and knowledge generation. Baecker (2007) stresses that the way of producing, archiving and transmitting knowledge is always in relation to the dominant medium in a society and has consequences to what is defined and valued as knowledge (cited ibid).

Sesink (2004) describes computer technology as a “transclassical machine“ that acts as a toy for programmers in order to find out how to enhance “education“. Sesink stresses that computer simulations lack the context to reality, but argues that the reflection of reality by means of simulation could be a learning process. However, he states that schools have always been a kind of simulation space on the boundaries of reality – even without ICTs.

The most prominent media scientist dealing with technology and media in the field of education is Michael Giesecke (2008), who tries to work out the consequences of e-learning on educational goals and demands ‘triadic thinking’:

> (….) a fundamentally new understanding of communication, knowledge, and information processing. Post-typographic educational ideals relativize the regard for homogeneity and equalization in favour of heterogeneity and the integration of parallel processes. They relativize the importance of mechanizised communication media and of communication with little feedback, and they steer attention towards the bodily media and dialogue forms of communication. Furthermore, they strengthen self-reflexive information processing and enhance triadic thinking (2008: 1).

He suggests that the knowledge production process will change with the use of electronic media and that a new outbalanced approach to using and integrating ICTs and new media will be of utmost importance:

> If the co-evolution idea applies, information that is valued and recognized as ‘knowledge’ by the post-Gutenberg culture will differ from the knowledge of the past five hundred years. The concepts of teaching and learning will be changing as well. The actual discussion about the use of electronic media in teaching and learning misjudges these

> contiguities when it continues to operate with concepts of knowledge and learning that were developed by the culture of the book in order to become aware of its identity. …
> In the future, the 'learning' that is called 'E-Learning' might differ no less sharply from the learning concept of the culture of the book as the latter differed from the pre-modern concept that was condensed, for example, in the Middle High German word "leren". There is not much sense in digitizing the educational programs of the 20th century, to electrify the media or to maintain the criteria for successful learning by national educational institutions. Post-typographical educational policy needs post-typographical concepts of knowledge, ways of generating knowledge and of communication. It will not be possible to justify these concepts exclusively on a scientific basis. In the final consequence they will be based on value judgements. It is necessary to discuss the problem which forms of information, perception, presentation, and dissemination do we intend to approve and authorize. After the general approval and appreciation of craftsmanship and 'craft' in premier times and of 'true knowledge' in the culture of the book and of industry, the question arises how to accept und appreciate alternative forms of information and information processing that use the resources of old and new media in a balanced way (Giesecke 2008: 3–4).

1.2.2 ICT-based educational innovation in sociology

The relation between technology and education is a research issue that also emerges in loosely coupled areas of sociology, such as the sociology of technology studies, educational sociology and media sociology.

The studies in the sociology of technology have dominated in the past 20 years following the initial research programme formulated by Bijker, Hughes and Binch in the late 1990s[5]. The sociology of technology is prominent in explaining the societal and economic factors shaping the emergence of technology, but the authors in the field of technology assessment concentrate their work on empirical studies examining mainly infrastructural technologies for sectors such as transport, energy, health or high risk technologies (gen-/nano-technology or mainframe computers). Such giant systems are characterised in relation to one specific technology, the degree of coupling, the network structures, the huge geographical extension and capital intensity and complexity computers (Degele 2002: 153). In the sociology of technology, ICTs are regarded as an example of both societal dynamics: functional differentiation and reflexive modernisation (Degele 2002: 173). Software programming allows multifunctional usage (ICT = instrument and medium). It increases organisational performance, and the

[5] Bijker, W. E., Hughes, T. P., & Pinch, T. J. (Eds.). (1989; 1987)). The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology. Cambridge, Massachusetts: The MIT Press.

change in software systems (from monolithic systems to distributed systems) has led to a reorganisation of space and time. The potential of rationalisation is valued as the most important motive for using ICTs in an application domain (Degele 2002: 176). In the past 20 years, different technologies have been studied from the point of view of social constructivism, and sociology of technology studies experts have questioned what will come next:

> Maybe, some of the research has put too much weight on demonstrating the obvious, namely that technology is socially constructed (cf. Woolgar 1991: 36; Sismondo 1993: 543). But at the same time we have learned a lot about what is much more interesting: how technology is constructed socially (cf. Joerges 1995) It turned out that the interrelatedness between a technology's context of development and its context of use is of greatest significance for answering this question (Schulz-Schäfer 2006: 3).

At the ICT Center of the University of Salzburg, many studies and theoretical research work has been carried out on the role of techno-social systems. In particular, this work has aimed to further develop the Unified Theory of Information (Hofkirchner 1998; 2010; Hofkirchner& Fuchs 2005) and new models of participation in society (Maier-Rabler 2009). However, the application domain of education has not yet been examined.

Few researchers in educational technology have discovered techno-sociological theories to explain the change enabled by educational technology. Klebl (2007) tries to adopt elements of the SCOT to educational innovations, such as the concept of OER (which is defined as openly accessible software, content and licenses (Geser et al., 2007), and concludes that a systematic consideration of the transformation of the educational system brought by technology is still an open research issue (p. 6). Breiter and Kolo (2008) analyse the cases of ICT in education and electronic gaming for education in Germany and demand that an integrated theoretical research model is needed to analyse the linkages in ICT-based innovations in the educational domain. Lately, some educational researchers have adopted another strand of social constructivist approaches, namely the actor-network theory developed by Latour (1987) and Callon (1998), to e-learning research topics (e.g. the Austrian project evaluation on "net-books in schools" (Gutknecht-Gmeiner 2011). Belliger, Krieger, and Waba (2011) summarises the application of actor-network theory to e-learning ().

Traditional educational sociology aims at explaining the role of institutional structures on inequalities in access to educational programmes and on unequal educational biographies and job profiles. The best-known perspectives are from institution theory, socialisation theory, inequality theory and differentiation theory (Brüsemeister 2008: 20). All try to explain the relation of the individual with society at different levels; however, technology or media play no important role in the major work of educational sociology. Prominent researchers focus on the process of institutionalisation (Esser et al.), on the importance of acquired “social roles” (Parsons; role theory) or on the social (inherited) capital of education (Bordieu 1930–2002; concept of educational habitat) (Brüsemeister 2008: 20). The application of findings from the field of educational sociology to media sociology or to communication and media science in terms of ICT-based innovations are limited

Media sociology, in line with communication and media science, questions the influence of new media on the general socialisation process of young people in their growth into society and the development of a strong identity in their respective communities (Süss 2008: 377). The socialisation of media by young people encompasses diverse aspects in which media plays a role in the psychosocial development of adolescents. Socialisation is the active adaptation of the individual to his or her social environment, which is not a passive process. Media has a role to cope with the challenges of growing up. The acquisition of media competences is necessary to live a constructive and satisfying life within a certain community (Oerter & Dreher 2002: 268). The focus in this research field has long been on the influence of movies, films, photography and youth magazines on adolescents and it is theoretically based on the cultural-pessimistic position (computers and media lead to the brutalisation of youth) and on the critical-optimistic position (media supplements primary experiences; one type of media has different influences on different kids; and the media euphoric position). The theory fundamentals in this research strand are psychological approaches (e.g. developmental psychology), sociology (relation of individual living in “media society” patchwork families; media as an intermediary system of society in contrast to economy, politics) and communication science theories (use and gratification approach) (Süss d. cited in Batinic& Appel, 2008: 370pp) and different concepts of media pedagogy.

Specific work on the impact of computers and media on children and the youth have been undertaken in the German research community by the University of Salzburg in the field of communication science, the University of Hamburg and the Hans Bredow

Institut[6] and the German Jugendforschungsinstitute for Research[7]. Gender-related work and ICT in education has also been assessed by Schachner et al. (University of Klagenfurt). These works question societal dynamics and interrelations. However, the issue of software and the Internet enabling a specific individual learning setting (e.g. e-portfolio) has not been taken up yet.

1.2.3 ICT-based educational innovation in educational science

The issue of "innovation and change in education" in educational science has been well dealt with by all sectors of education. Educational researchers point out the systemic relations and institutional governance in the school system (Fend 2008; Altrichter, Brüsemeister & Wissinger, J. (2007); Altrichter & Maag-Merki (2010); Joseph & Reigeluth 2010) and in the systems of higher education (Boer, Enders & Schimank (2008). However, much of this work does not take technology in general and ICT in particular as a determinant of change or any innovation restructuring. Lately, the impact of social media and web 2.0 technologies and Learning 2.0 approaches were analysed in a study by the European Joint Research Center, which analysed the integration of Web 2.0 as a technological, pedagogical and organisational innovation in formal education and training (Redecker et al. 2009[8]). The strategic aspect of ICT-based innovation at the macro-level was examined by Lundvall (1992[9]) and Kozma (2003[10]), as well as research teams at the OECD Centre for Educational Research and Innovation (CERI)[11], who tried to understand a more global view of the impact of ICT on educational systems. A study trying to compare the emergence of e-learning in higher education in different countries was also worked out by Gyambrah (2007).

Paper-based portfolio work has been dealt with in educational science in many quantitative and qualitative studies, especially also with the view to teacher training (e.g. Häcker 2006a; 2006b; Gläser-Zikuda & Hascher, 2007; Jabornegg 2004; Hascher & Schratz 2001; Johnstone & Hascher, 2001). On the contrary, the research of electronically enhanced portfolio work has been rare in the core disciplines of

[6] More details on: http://www.hans-bredow-institut.de/

[7] See here some examples of the collection of I. Paus-Hasebrink as related to education and ICT or media: Latest work: (2010): Was ist zu tun? Herausforderungen und Aufgaben für die Förderung der Medienkompetenz. In: Fuhs, Burkhard/ Lampert, Claudia/ Rosenstock, Roland (Hrsg.): Mit der Welt vernetzt. Kinder und Jugendlichen in virtuellen Erfahrungsräumen. München: kopaed, S. 223-241 and by Jan Schmidt (2006) In: Forschungsjournal Neue Soziale Bewegungen, Nr 2/2006, S.37 – 46. available at: http://www.uni-salzburg.at/pls/portal/docs/1/1635195.PDF

[8] Online at: http://ftp.jrc.es/EURdoc/JRC55629.pdf; http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=2899.

[9] Lundvall, B-Å. (Ed.) (1992). National innovation systems: Towards a theory of innovation and interactive learning. London: Pinter.

[10] Kozma, R.H. (Ed.) (2003). Technology, innovation, and educational change. A global perspective. Washington, DC: ISTE.

[11] Homepage of Centre for Educational Research and Innovation (CERI): http://www.oecd.org/department/0,3355,en_2649_35845581_1_1_1_1_1,00.html.

educational science. The representatives of e-portfolio research work come from all social science communities and do not follow an unified approach. Indeed, the main focus lies in technological reviews and impact and evaluation studies (Barrett 1999; 2000; Hartnell-Young 2006; Jafari & Kaufmann (2006); Hornung-Prähauser et al. (2007; Schaffert, Hornung-Prähauser, Hilzensauer &Wieden-Bischof 2008, Attwell, G., Chrzaszcz, A. Hilzensauer, W., Hornung-Prähauser, V. & Pallister, J. (2007); Buzzetto-More 2010. Many presentations and reports of e-portfolio pilots and technical research issues are presented at annual international e-portfolio conferences (Collection of Proceedings 2005-2011: available from: <http://www.eife-l.org/publications/allproceedings>).

Summing up, we have seen the gaps in the major scientific fields in which the thesis grounds. In the mindmap provided before, also other fields, such as, the general system theories, organisational theory and management, economic theories and and the history of technology have been mentioned. Their relevance will be analysed in chapter four.

1.2 Research objectives and outline

1.2.1 Research aim

This thesis aims to investigate the process of shaping and integrating ICT-based innovations in the field of education. It will especially deal with the multiple factors influencing the emergence, design and adoption of ICT-based innovations affecting the whole educational system. In order to research on these processes, the thesis will develop a new integrative and multi-level theoretical framework[12]. The thesis will:

- Provide a systematic, interdisciplinary synopsis of the theoretical approaches on ICT-based innovations relevant for the societal subsystem of education from different disciplines of the social sciences (communication and media science, sociology of technology, education/media pedagogy, economics and organisational studies) and the natural sciences (computer sciences),
- Analyse the theoretical strands as to their aptness for advancing research in the field of e-learning (strengths, limitations, contradictions) and investigate relevant determinants influencing the systemic integration process at the macro-, meso- and micro-levels of an educational system,
- Develop an integrative, multi-level framework encompassing a set of determinants that help to systematically research the interdependencies of a systemic ICT-based innovation in a national educational system, and
- Exemplify the practical and theoretical utility of such an integrative, multi-level framework by the application to the case of e-portfolio integration in European higher education (multiple-case study design).

The result of the synopsis is to bridge the gap between "practice aloof theory" and "theory aloof research", which is so characteristic of e-learning research (Reinmann 2006: 7). A sound theoretical model could help avoid the trap of the above described approaches both lacking scientific quality. Empirical evidence without good theoretical assumptions is problematic and a theory without any practical explanatory is of little value. The aim of this thesis is not to gain more insight in rejecting or adopting a theoretical strand or recombining and enhancing complex theoretical approaches. The dimensions of the research problem are depicted in Figure 4.

[12] An innovation is called a systemic innovation in education, if it involves "the change to new learning and workforce structures, to new types of organisations, to new inter-organisational relationships aiming at improving the overall performance of an educational system" (OECD 2009: 66)

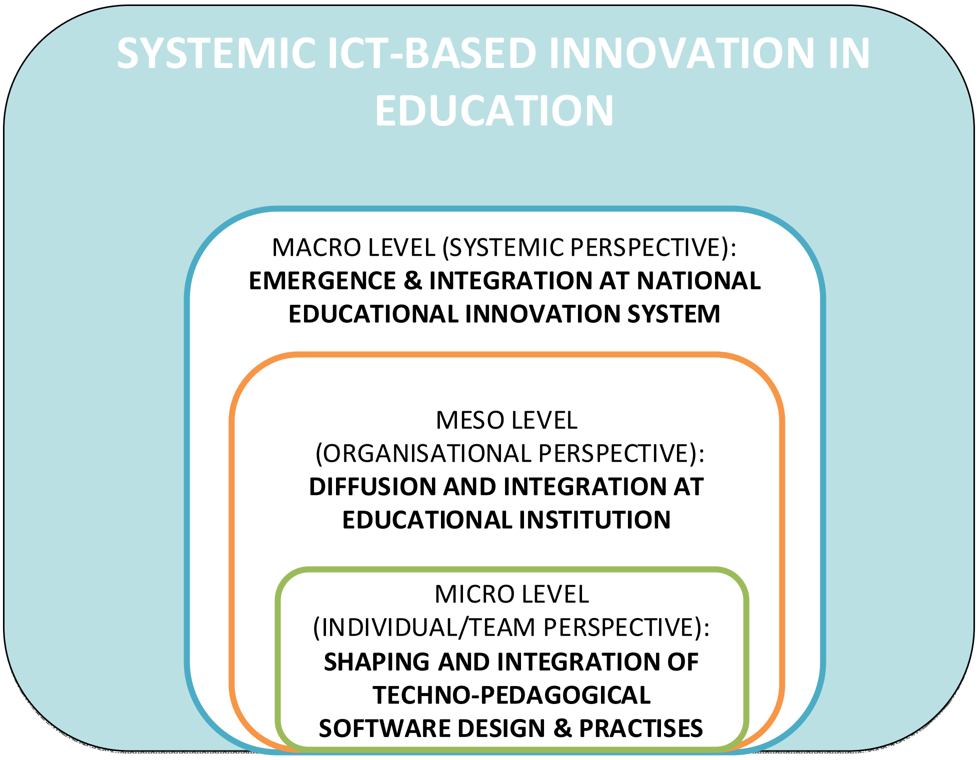


Figure 4: Dimensions of the research problem

An integrative view of the interdependencies between the actors involved at all three levels of an educational system, namely the micro-level (learners, teachers and parents), the meso-level (educational institutions) and the macro-level (national educational systems), will support the development and formulation of sustainable ICT and educational policies and improve further e-learning research work.

1.2.2 A transdisciplinary theoretical study with practical exemplification

As outlined before, the research questions cross scientific boundaries and, therefore, this thesis proposes to follow a transdisciplinary research approach that involves "the integration of theoretical and methodological perspectives drawn from different disciplines, for the purpose of generating novel conceptual and empirical analyses of a particular research topic" (Stokols et al. 2002: 21). It takes account of the view of Friesen (2009), who advances the argument that e-learning research is a "multivocal" enterprise, which is interdisciplinary in so far as it "seeks to combine and explore the interconnections between new and different approaches from different fields and specialisations" and multidisciplinary, in that it "simultaneously tries to respect the multiplicity of differences that can separate one research approach from another" (p. 12). All three approaches above aim at explaining the real situations and practices in e-learning. However, differences between inter- and multidisciplinary methods arise: the former mix their methods, thereby generating new and improved tools that are better adapted to the research topic, whereas the latter simply reunites a range of disciplines independently (ibid).

A transdisciplinary research approach goes beyond these inter- and multidisciplinary approaches and aims to unify knowledge beyond disciplines, while the pursuit of multidisciplinary and interdisciplinary aims always remains within the framework of disciplinary research (Zaman 2010: 7-8). According to Hofkirchner et al. (2007a), "a transdisciplinary approach is expected to bridge several gaps: the gap between the two cultures of (natural) science and social and human sciences as well as the gap between specialists and generalists as well as the gap between applied research and basic research. And it is the result of a process that departs from mono- or multidisciplinarity and transcends interdisciplinarity" (p. 11). The transdisciplinary approach has been chosen because the research problem spans the traditional boundaries of single-level research problems. The process of system-wide integration results in a theoretically so-called "micro-macro problem". This is illustrated in the table below.

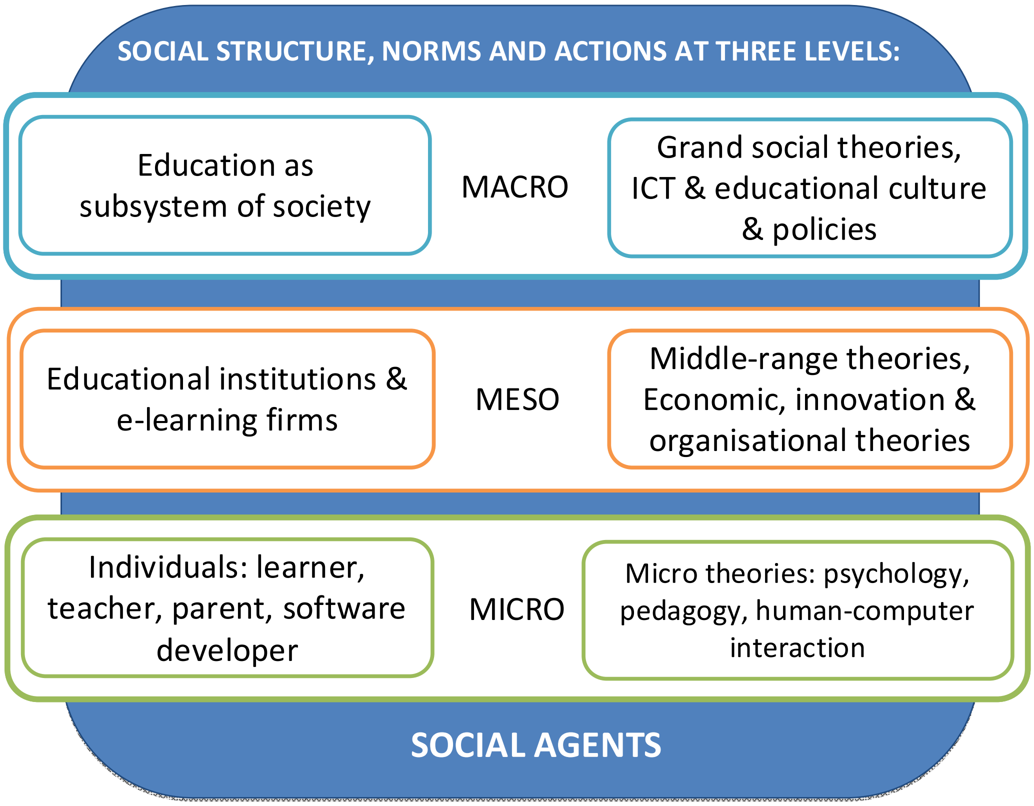


Figure 5: The macro-micro problem in the educational system;
Source: adapted from Hofkirchner (2007: 33)

The table above shows the complex interplay and mutual influences between nested actors on the macro-level (national educational system), meso-level (educational institution; e-learning firms) and micro-level (learner, teacher, learning facilitator) in this multi-level innovation process. The complexity in a national educational system arises from the fact that in an educational system multiple system elements (actors) interact at multiple structural levels with each other. They also relate to each other in a specific way. Moreover, they follow different interests (see Sargut & Mcgrath for the three characteristics of complexity; 2011: 25).

The final step of the work foresees the exploration of the macro-micro problem in educational technology from a practical, real-world example. Since ICTs encompass many technologies and tools, a general study would go well beyond the scope of this work. Therefore, this thesis concentrates on the exemplification of the macro-micro problem using e-portfolios. The reasons for selecting e-portfolios can well be argued.

- Firstly, e-portfolio is a specific type of e-learning software that has emerged in paper-based didactics and in various ICT-enhanced didactics. This ICT enhancement can be traced back approximately 15 years with systems running in different educational systems. E-portfolio pilot implementations took place in different educational sectors (from schools and universities to adult education colleagues and professional trainers) and national educational systems. Research material has been assembled by a living e-portfolio community and is available for research (see http://www.eife-l.org/publications/allproceedings).
- Secondly, e-portfolios are used in all sectors of education and are initiated by private and public policies, even in some countries governed by national regulations (e.g. the United Kingdom; see case 1), and thereby represent a systemic implication. As Nicholson states, “E-portfolios are not discrete, they are part of a system” (2007: 7). Thus, the integration of e-portfolios as a new form of educational technology is not an isolated process in an educational system.
- Thirdly, the development of the e-portfolio software market is a well-documented example of how educational scientists, practitioners and software developers jointly invent such a system. An example is the case of the commercial software system Pebble Pad, which was “born” as a collaborative project at the teaching institute of the University of Wolverhampton, UK and the IT department and is now marketed as a joint venture with a company (http://www.pebblepad.co.uk/uow.asp.). Another example is the open source software Mahara, a government-funded collaboration between different universities in New Zealand (www.mahara.org).

The following screenshot illustrates the open-source e-portfolio software Mahara, developed in New Zealand and adapted by a growing e-portfolio open-source community.

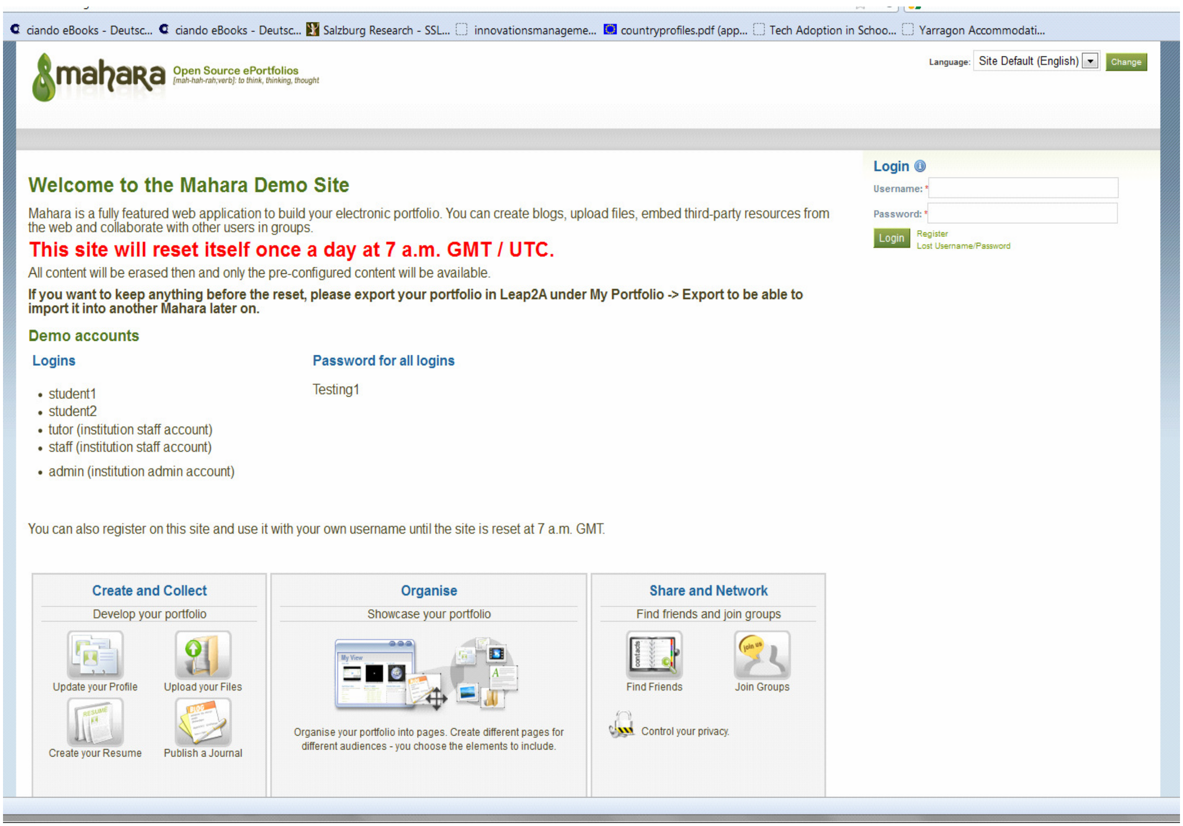


Figure 6: Demo-screenshot of the open-source e-portfolio software Mahara; Source: http://demo.mahara.org/

1.2.3 Research questions and the steps in the research design

The thesis raises the following research questions:

- How do ICT-based innovations in education emerge? What societal conditions shape their techno-pedagogical designs and system-wide integration (adoption and diffusion) in a specific national educational system, such as the sector of higher education?
- What theoretical approaches and concepts can be identified as dealing with the above issues and what are their strengths, limitations and potentials to explain the different structural factors (e.g. economic, political and cultural factors) and influential norms and actions in a multi-level ICT-based innovation system?

• What should a new analytical framework for researching the interdependencies of the different levels (macro-meso-micro) of systemic ICT-based innovations in education look like? What variables and dimensions are of importance and how can they be analytically conceived?

The present work will contribute to a theoretically sound base on which other researchers and disciplines can build further arguments. The thesis will not develop a new theory, but it aims to contribute building blocks that will help further research and the formulation of policy recommendations.. The graphic below indicates the different steps taken in exploring the above questions during the research process of this thesis

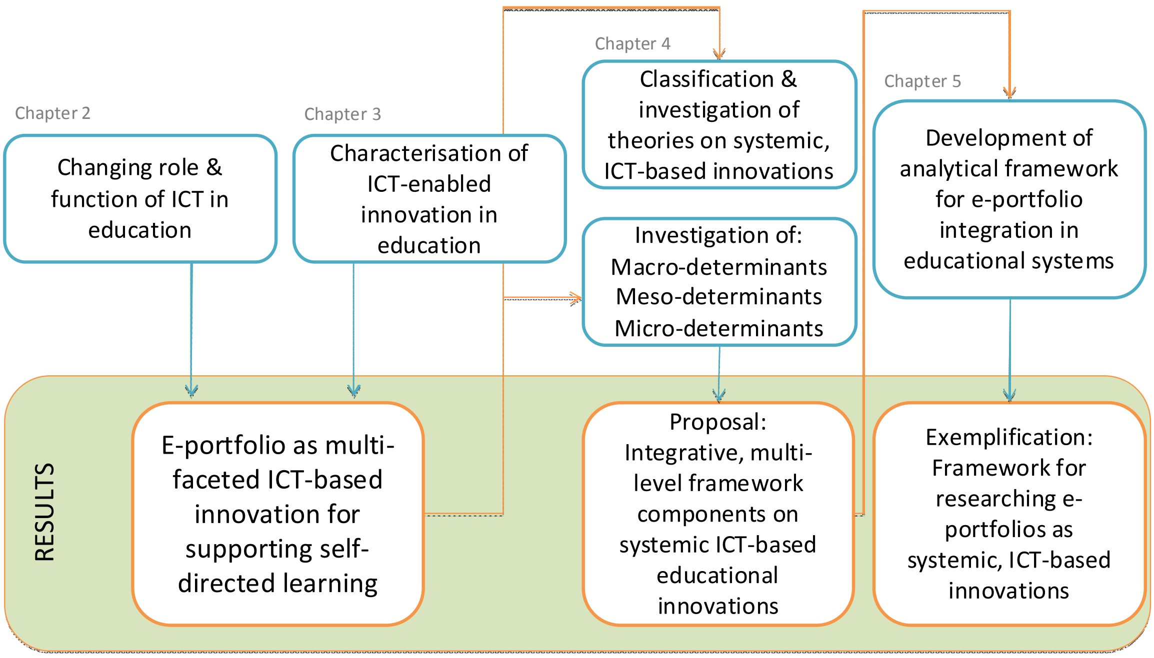


Figure 7: Structure of the research process and outline of the thesis

As a first step, this thesis will investigate the changing perceptions of the roles and functions of ICTs in education over time to provide the background for the coming work. It will sketch four different periods in the history of e-learning and illustrate how the prevailing pedagogical paradigm has exerted influence on technological development and vice versa (see Chapter 2).

The next step is to provide a clear orientation about the definitions and concepts used while researching ICT-based innovations in education. This starts from the notion of education as a subsystem of society, the different conceptions of technology and ICT in an educational subsystem, the different types and roles of digital media in education and the various concepts of understanding ICT-based innovations in education. Finally, we will exemplify how e-portfolios are understood as ICT-based innovations (see Chapter 3).

Because of the lack of an existing theoretical body of knowledge on shaping and integrating ICT-based innovations in education, in the next step different strands of social science theories, which have tried to explain the factors shaping technology in general and in sectors of society other than education, will be analysed to shed light on the characteristics and dimensions of ICT-based innovations in different educational cultures and sectors (see Chapter 4). Here the thesis aims to classify the theories on and approaches to the emergence, design, adoption and governance of techno-educational systems and distil their underlying scientific ways of thinking as well as their limitations and potentials for contributing to the macro-meso-micro problem. This will be attempted firstly by analysing the theories and concepts dealing with techno-pedagogical innovations. The systematic description will include, if possible, the origin, historical setting of theory, research phenomena, problematic research question (representatives), basic solutions and assumptions (core hypothesis), empirical evidence especially in the e-learning research field, the identification of relevant determinants, the epistemological background, structural characteristics and if available, used methods and empirical data sets (see Fischer & Delitz 2005 for guidelines on theoretical comparisons in sociology).

Focus thereby lies on the theoretical approaches and concepts from: the field of social sciences relating to education and technology, e.g. sociology (technology sociology, educational sociology, media sociology), educational science, media pedagogy, critical pedagogy), communication science and media science (incl. media philosophy) and economic innovation research, from natural sciences (psychology, instructional design, human–computer interaction, social informatics), and from newer schools of thought proposing an e-learning theory (Andrews & Haythornthwaite 2007) and a dialectical relationship between technology and societal systems (Hofkirchner 2006).

The classification of the theories will be carried out according to the "four ways of scientific thinking", as coined by Hofkirchner (1999, 2005) to systematically analyse the way of scientific thinking behind an approach:

- Projectivism/Objectivism (object determines subject),
- Reductionism/Subjectivism (subject determines object),
- Dualism (Object and subject exist independently of each other), and
- Dialectic (Object and subject influence each other).

Each section will provide a summary of the determinants influencing the integration processes at the macro-, meso- or micro-levels according to the implicit scientific understanding (see section 4.2.).

In the fourth step, in Chapter 5 the framework will be proposed by deriving the framework components from the systematic review of theoretical approaches on the inonvation shaping and integration process of technology-based innovations (result of Chapter 4). The framework variables will be selected from those theoretical approaches analysed, that offer a dialectic view on the issue and stress specific interrelations between the subset of components and/or the interactions between the three analytical levels e.g. stress on macro-meso relation, macro-micro relation or micro-meso relation. The utility of such a multi-level analytical framework will then be exemplified and discussed by the example of e-portfolio integration in higher education in three European countries.

2 Chapter 2: The changing role of ICTs in education

2.1 Introduction

In the course of time, the emergence of a new technological innovation has always influenced the role and function of educational technology and media in education. In ancient times, the natural media “voice” was used for oral storytelling and theatre-mediated teaching. Paintings on cave walls and Greek or Roman writings on stone tablets were the first attempts to relieve the human memory by means of a technical device. The emergence of mechanically printed books and cheap graphite pencils in the post-Gutenberg era laid the foundation for teaching not only the elite how to read and to write but almost everyone. In the middle of the 20th century, electricity enabled the transmission of lectures and instructions via radio and television. Computer-based training supported standardised mass media teaching. Nowadays, the emergence of the Internet and social software has paved the way for individualised teaching and learning by means of Internet-based personal learning environments. It is this reciprocal relation between technological and the pedagogical aim of educational technology that is of interest here. Therefore, the following section will not only describe the history of new technical devices in education, but it will illustrate that the role and functions of the computer and the Internet in education has changed, from reinforcing the traditional pedagogical paradigm to supporting a changing pedagogical paradigm towards more open learning, especially by means of the collaboratively web 2.0 technologies.[13]

In the literature, the history of educational technology is often grouped arbitrarily. Whereas some authors tell the story in parallel with the evolution of communication and media technologies (e.g. Frick 1991), other authors focus on describing the core products of educational technologies and training companies involved at a specific point in time (e.g. Cross 2004) or on outlining the history of only one specific e-learning type (e.g. distance education; Jeffries, M, n.d,). The following chapter follows Aslan and Reigeluth (2011) to review the history of educational computing and the Internet in light of the primary technology characteristic of each

[13] According to Thomas S. Kuhn, scientific explanations are always embedded in a prevailing scientific paradigm, which can change in the course of time. In: The structure of scientific revolutions. International Encyclopedia of Unified Science II 2. University of Chicago Press 1962; cit. in Poser 2001: 141–156.

period of ICT use in education. It will highlight the forerunners of ICTs in education, the audio-visual environments and automatic teaching machines, the period of using mainframe computers, microcomputers and the Internet in education, and briefly dwell on future technological trends, such as mobile computing and personal collaborative learning environments (cf. Horizon Report 2011). The table below provides an overview of the primary technologies and their adoptions in education.

Time	**Examples of primary technology**	**Function in education**	**Change in pedagogical approach**
Forerunners of the electrical phase			
18th century	1445 Automated book press/Gutenberg 1588 Reading Wheel / Agostino Ramelli (Library)	Books and newspapers as teaching material	Changing teaching paradigm from oral to media-based education; from telling stories to studying books; Change of archiving, publishing and access of knowledge
19th century	1839 Photography / Daguerreotype 1858 First transatlantic cable 1867 Manual typewriter/ Remington 1876 Telephone / Graham Bell 1895 Silent movie / Lumière (first public presentation) 1888 Gramophone and Kodak photo camera 1895 Silent movie / Lumière (first public presentation)	Visual offices: Excursions, pictures, models, maps, charts, motion pictures	
Period of electronic audio-visual environments and automatic testing machines			
Early 1900–1930	1906 First radio technique (silent films together with live piano) 1923 first radio broadcast (Switzerland) 1927 first public television broadcast 1924 Automatic testing machine (Pressey)	Audio visual office: instructional radio, instructional television and movies	Use of technology in education for augmentation of seeing and listening experience
1930–1947	1931: First vacuum tube-based computer (Zuse) 1932: Magnetic type recorder 1940: First colour TV 1940: Two-way-radio/ Motorola; forerunner for mobile telephones	Prototypes of testing machines	

Period of mainframe computers and electrical teaching machines			
1950–1970	1951 first video tape recorder 1953 first electronic typewriter 1954 first transistor radio 1954 Electronic testing machine (Skinner/Holland/ Crowder) 1958 first fully transistorised supercomputer 1960s PLATO (Programmed Logic for Automated Teaching Operations) / University of Illinois, US 1964 PLATO compiler, US (first content authoring system) 1971 TICCIT (Time-shared, Interactive, Computer-Controlled Information Television), US 1960s Team-based teaching machines e.g. Geromat III, Bakkalaureus, Germany 1962-69 ARPANET	Use for educational administrative services Instructional radio Instructional television Distance education Computer-assisted instruction Drill and practice and tutorials	Change of the student assessment procedures Design an educational message and use technology for education
Period of microcomputers and personal computers			
1970 to early 1980s	1970 Havering Computer Managed Learning System, London, England. 1971 Intel's first microprocessor electronic stored computer that used vacuum tubes, 1971: E-mail 1973 National Development Program in Computer Assisted Learning, UK	IT training for software programmers (database management) Advanced drill and practice and	Change of role of teacher as faciltiator Design of an instructional (multimedia) computer-based system in order to educate Applying of psychology and cognitive science on educational (instructional) problems
Late 1980 to early 1990	1980-82: Word Processing Machine 1981: Cyclops: shared screen-teleconference system, UK; video and radio text systems (Open University, UK) 1987: Hypercard : Apple (1987) actually hypermedia (nonsequential links to documents) includes authoring system -tool for building interactive hypermedia documents (Authorware Model, Linkway)	Mailing lists Drawing tools Multimedia (Texts animated with sound, picture and graphics (short videos) stored on CD ROM; DVD;	
Internet and social software			
Early 1990s to early 2000s	1990/1992: Wide Web Tim Berners-Lee, development of HTML (HyperText Markup Language) *Hypertext system * Authoring tools 1994: first digital camera (electronic image sensor) 1996: First Internet Browser (Microsoft Internet Explorer); Netscape Browser 1997 Blackboard Inc. founded 1997: Learning Management Systems 1997 – java script for simulation education 2000: Short Message Service (SMS)	Homepages of Educational Institutions School/University administration and data management Delivery of online courses Content archives of learning objects Computer Supported	Change of archiving, publishing and access of knowledge again Design an instructional (multimedia) Internet base system in order to educate

	2000 Claroline, Belgium, BE 2000: LMS Ilias, Cologne, GER; IBM Class server; US 2000 onwards: E-portfolio Systems	Cooperative Learning Multimedia e-Portfolios	*E-Learning 1.0.:* Traditional teaching was only re-inforeced by ICTs
Middle of 2000 to late 2007	2001: Burst of Internet Bubble 2002 IBM Class server 2002 Moodle 2004 SAKAI project 2006 Mahara-e-portfolio 2005: Web 2.0, coined by Tim O'Reilly Social Software (Linkage Platforms, individual knowledge management services e.g. Bookmarks,) Content management systems (Drupal, Confluence) • Notebook classes • W-Lan areas in all educational institutions (except primary school) 2007 Share point learning kids (MS) MIT – 100 Dollar computer	Upgrading of school homepages with social software (Wikis, Blogs, networking platforms) Learning Management Systems Information retrieval (Online Search Engines and Encyclopaedia) E-assessment E-portfolios Online universities / camps Personalised, individual learning environments	E-Learning 2.0.: Traditional teaching is being challenged; the teacher as coach and facilitator and not the universal knowledge transmitter
Early 2008 to today	• Social software • Mobile computing • Converging Technologies (Internet, smartphones; RFID) • Augmented reality • Collaborative filtering • Learning analytics	Personal broadcasting Personal Publishing Peer information production Collaboration – Peer Learning E-portfolios with Web 2.0	*E-Learning 3.0.:* Individual and informal learning forms; design a self-organised personalised, individualised learning activity and collaborate Co-evolution of knowledge; increasing importance of online peer learning

Table 1: Changing role and function of ICT in education and interactions to pedagogical changes.
Source: based on sources of media history and pedagogical history by Aslan & Reigeluth 2010; Steinmaurer 2007; and Simsek 2005; Schulmeister 2002; 2005

2.2 Audio-visual environment, testing and teaching machines (early 1900s to 1950s)

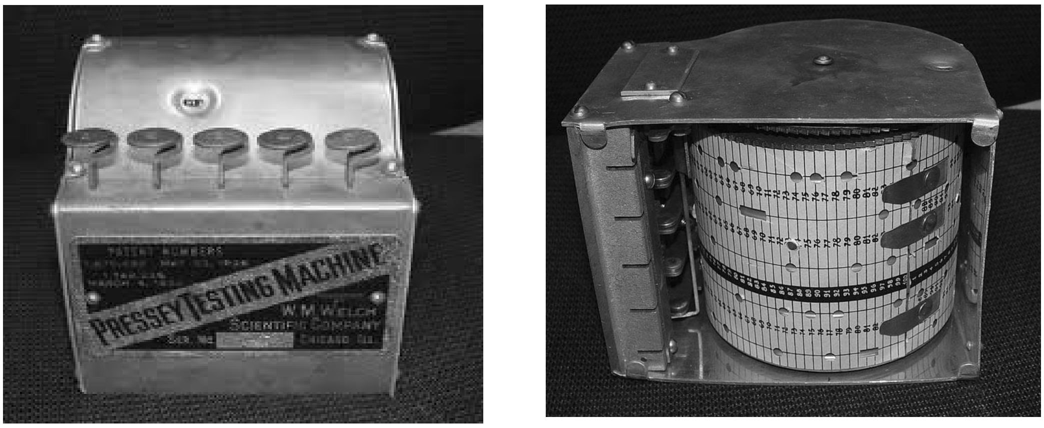
The emergence of electricity opened a new chapter for educational technology and influenced the theorists and reformist educators who opposed formalism and verbalism in educational practice that was valid until the early 20th century. As the historian of technology, Cortez (2007), describes, educational reformists put "more and more emphasis on the role of the senses in learning and re-position education in general (and instruction in particular) away from the then-current methods that were dominated exclusively by words, repetition, and oratory" (ibid).The increasing use of multimedia technologies built on the perception that "visual media brought reality and concreteness—breathing visual reality into the spoken and printed word, stirring emotions and interest, and requiring far less time than traditional instructional methods of the time." (ibid). It was also the phase in which silent movies were produced and presented in schools for achieving specific educational goals, and when the school museums and visual education offices were newly established in the Anglo-Saxon and European school systems (Simsek 2005). Simsek describes that the use of films in the early days of films and movie production in education was intrigued by the pedagogical idea of the "seeing experience", which has also involved the use of other types of visual aids such as the excursion, flat pictures, models, exhibits, charts, maps, graphs, stereographs, stereopticon slides, and motion pictures (Simsek 2005: 175).

As technological developments advanced, radio and other audio recording technologies turned the concept of visual education into "audio-visual education". The best days of the instructional radio was in the 1920s, and a similar attempt in education began with the use of instructional television in the 1950s in North America[14]. The expectations of instructional radio and television were purely economic: offering more education and training for a skilled workforce after the Second World War needed fewer teachers (see Aslan & Reigeluth 2011: 3). The interest in these forms of educational technologies faded somewhat in the second half of the 20th century, with

[14] By the early 1960s, 53 TV stations were affiliated with the national Educational Television Network in the US with the primary goal of sharing films and coordinating schedules. For more details on instructional television and the history of distance education, the Midwest Program on Airborne Television Instruction launched "flying classrooms" to broadcast instructional programmes to about 2,000 public schools and universities, 400,000 students and 6,500 classrooms. See Jeffries, M. (n.d.): The History of Distance Education.

some critics blaming the low quality of the instructional programming that often entailed only a teacher delivering a lecture (see Jeffries, n.d.)

Parallel to these audio-visual environments, researchers worked on the first prototypes and practical pilots of mechanical and later on electronic testing machines, now regarded as the forerunners for today's e-assessment systems and commercial online testing software (e.g. the software Questionmark Perception[15]). Sidney Pressey, an educational psychology professor at Ohio State University, developed a mechanical machine in order to provide drill and practice items to students in his introductory courses in 1924. Pressey's opinion about the use of such a teaching method became known as "the procedure in mastery of drill and informational material were in many instances simple and definite enough to permit handling of much routine teaching by mechanical means[16]". The device looked a bit like a typewriter with a window that displayed a question with four answers (Flindt 2005).



Pressey's testing machine: external and internal view

Figure 8: Automatic teaching machine (Pressey 1924–25). Source: Picture publixly available from:<http://www.leerbeleving.nl/wbts/1/history_of_elearning.html>[03 March 2011]

The questions for the Skinner machine looked like:

"To help the poor debtors of England, James Oglethorpe founded the colony of (1) Connecticut, (2) Delaware, (3) Maryland, (4) Georgia." (Pressey 1926: 36 cited in Flindt 2005: 14).

The user needed to press the key that corresponded with the correct answer. When the user pressed a key, the machine recorded the answer on a counter at the back of the

[15] http://www.questionmark.com/.

[16] Pressey cited in web-training module: "The e-learning fundaments", chapter: "The history of e-learning"(n.d): available at: http://www.leerbeleving.nl/wbts/1/history_of_elearning.html.

machine and revealed the next question. After the user finalised the step, the person scoring the test slipped the test sheet back into the device and noted the score on the counter[17].

In the late 1950s, Skinner and colleagues (Holland, Crowden), the best-known representative of behaviourism, developed a teaching machine built on behaviouristic conditioning principles called programmed instruction[18].

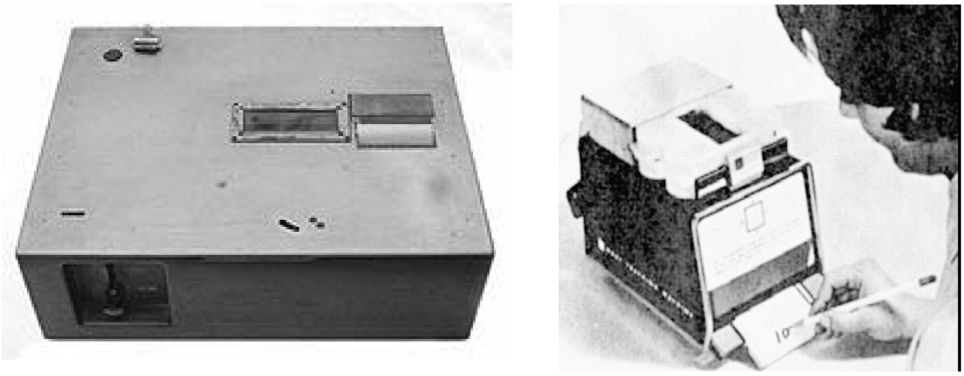


Figure 9 : Teaching machines

Source: see Skinner (1958): Teaching Machines. From the experimental study of learning devices that arranged optimal conditions for self-instruction; pictures publicy available from Online Encyclopedia Wikipedia: Pictures freely available from: http://en.wikipedia.org/wiki/B._F._Skinner [4 May 2011]

It was in this period, that the pedagogical approach towards the use of a technology for efficiency purpose (e.g. Skinner wanted to increase the efficiency of teaching for getting better learning results). However, the hope that automatisation would support an individual psychological preference for a learning process has already been there.

[17] For a detailed of Pressey's machine, see the description at: http://www.leerbeleving.nl/wbts/1/history_of_elearning.html [2011-03-29].

[18] [18] For details on the principles of conditioning, see Skinner (1958): Teaching Machines. From the experimental study of learning devices that arranged optimal conditions for self-instruction. Also: Klausmeir & Lambert 1961. Teaching Machines and the Learning Process. Educational Leadership.

2.3 Mainframe computer in education (late 1950s to 1970s)

The disadvantage of film and radio is they are one-way communication tools. By contrast, the period of emerging mainframe computers in education was characterised by attempts to develop computer-based applications to meet the requirement of "interaction", an approach to support a deep learning process (Aslan & Reigeluth 2011: 3). Grounded on the psychological understanding of Skinner's programmed instruction (1954), the company IBM built one of the first mainframe computers for teaching maths (IBM 650 computer) and software programming (e.g. the MIT Artificial Intelligence Laboratory developed the programming tool LOGO, see Aslan & Reigeluth 2011: 4).

US governmental- and military-funded software projects (e.g. SOCRATES: System for Organising content to Review and Teach Educational subjects; and CLASS: Computer-based Laboratory for Automation of School Systems) worked on developing software applications for supporting engineering subjects such as maths, software programming and flight simulations. Two remarkable software applications paved the way for further research and development into learning software in other research labs:

- PLATO (Programmed Logic for Automatic Teaching Operation) was developed by the Computer-Based Education Research Laboratory University of Illinois. It ran a single central computer and independent computer terminals for students. Each of these terminals could interact with the central computer using a touch-sensitive screen and a keyboard. Aslan and Reigeluth regarded the PLATO system as a system that used computers as tutors and simultaneously delivered individualised computer-managed instruction (2011: 4). Owing to the expense of a mainframe computer system, in 1980 micro-PLATO was developed for use on microcomputers (Merrill et al. 1996 cited in Aslan & Reigeluth, 2011: 3).
- TICCIT (Timeshared, Interactive, Computer Controlled Television) was developed by Brigham Young University, USA (mid-1975). It was built to run on mini-computers in combination with colour television technology (ibid).

The difference between the two systems was the improved attention of TICCIT for a learner to control functionality, the possibility to select the learning material and the paths of learning (see Aslan & Reigeluth 2011: 4–5). In contrast to PLATO, for which teachers needed to learn software programming, each teacher could run the TICCIT system easily. IT used the same frames and the in-built instructional system.

PLATO system

TICCIT– system

Figure 10: First computer-assisted instruction systems. Source: Flindt (2007: 18-19)

The disadvantage of mainframe computers was the high costs of such a learning system. At that time, PLATO mainframes cost approximately USD 3 million and transmission amounted to USD 2,500 per month. However, between 1961 and 1967, more than 300 learning programmes were produced for PLATO and this demonstrated its application potential (Schulmeister 2002: 98; Aslan & Reigeluth 2011: 4–5).

In this period of piloting mainframe computers in education, computer-assisted instruction gained much popularity in the USA, and attempts were made by many different organisations to produce more efficient and effective systems. The Minnesota Educational Computing Corporation was founded in 1973 to support mainframe computer time-sharing services in Minnesota schools. After a while, it designed the first software membership program to obtain high quality software at cheap prices. Similarly, the World Institute for Computer-Assisted Teaching was organised in 1977 to develop software for English, mathematics and reading. Many other consortia began in the early 1970s to improve the quality of computer-assisted courseware. All these efforts were made to apply computer technologies in educational settings, almost exclusively in the role of computer as tutor (see Aslan & Reigeluth 2011: 5).

According to Feenberg (2002), a representative of the critical theory of technology, technological artefacts are "programmed" or "encoded" with a specific ideology and thus they cannot be regarded as neutral or following only a rational technical logic (Friesen 2009: 204). The period of governmental and military funding of research into mainframe computers for training and learning can be better understood against the background of the Cold War and the necessity to train a very large amount of military staff around the world. Sociological and historical research, which was undertaken to trace the "military values" embedded into technical codes and common technologies of Cold War technologies, showed the influence of the technological priorities and paradigms from cognitive psychology, network science and computing science prevailing at that time in computer applications (Friesen 2009: 206–207).

2.4 Micro (personal) computer (late 1970s to early 1990s)

The next period was the result of the emergence of smaller and less cost-intensive microcomputers in the late 1970s. At first, the microcomputers were introduced in a do-it-yourself assembly or preassembled form (Commodore Pet, Apple and TRS-80). Furthermore, the young Apple II microcomputers became very popular and were used in schools or departments of universities (Aslan & Reigeluth 2011: 5). In 1981, when the IBM Personal Computer was released, there was an increase in demand for microcomputers in business and industry. However, because of having an early lead, reasonable cost, courseware availability, better graphics and other advantages, Apple II dominated educational settings. By contrast, the IBM PC started to be widely used in higher education and corporate settings. In 1984, Apple's Macintosh computer was released, which changed the field of microcomputing a lot because of its unique feature of mouse input and better graphical and text support (Aslan & Reigeluth 2011: 5). These small and cheaper computers paved the way for the development of: word processing applications, electronic spreadsheets, database management systems (used for critical thinking skills), and for new drawing tools (Aslan & Reigeluth 2011: 8). Moreover, visualisation and multimedia became very important. In this era, the pedagogical thinking was that technology could be used as an efficient means to solve cognitive training and instruction and that drill and practice exercises would work better if they contained multimedia elements (Mayer 2005). It was assumed that students would learn better if they could watch animations in colour or small video clips and then do the exercises. Leinonen (2007) calls this the "golden era of CD-ROMs and multimedia computing[19]".

In this period, the use of ICTs for special education became an issue, since "computers could be operated by just touching a button, they were very effective for disabled students" (Golden 1985) cited in Aslan & Reigeluth 2011: 8). Another less common use of technology in education during the microcomputer period was "Intelligent Tutoring Systems" (Jonassen 1996: 6), which were developed in the 1980s

[19] See Blog of the e-learning expert Leinonen: available at: http://flosse.blogging.fi/

and 1990s by researchers working on Artificial Intelligence to teach procedural knowledge and problem solving skills. There were many criticisms of these systems. Jonassen (1996) emphasises that giving simple textual feedback in Intelligent Tutoring Systems could not replace sensitive feedback by a human tutor. Moreover, these systems were generally implemented in universities, with no significant implementation in the public schools of North America (Aslan & Reigeluth 2011:8).

Summing up, in general drill and practice teaching scenarios were a common type of computer use in education until the 1980s. The software applications presented a stimulus with video or animations for students to enter a correct response. The computer and software applications for education were designed to then give feedback through text or eye-catching graphics. Interaction and communication of the teaching content or goal with another person was not yet foreseen.

2.5 Internet and social software (mid-1990s until today)

Before the Internet was used in the field of education, it fulfilled the function of a strategic computer-based communication network for military purposes and for commercial interests[20]. In 1962, the beginnings of the Advanced Research Projects Agency was funded by the US Department of Defense with the primary focus on developing IT that could survive a nuclear attack and thus laid the foundation for what became the ARPANET and, much later, the Internet. In 1971/72, Ray Tomlinson, an ARPANET contractor, invented the first killer application of the Internet, e-mail. Thanks to Internet pioneers Vinton Cerf und Bob Khan, who invented the Transmission Control Protocol (TCP) und Internet Protocol (IP) in 1983, the Internet enabled the connection of many government, academic and private computers with each other. While at the beginning the ARPANET connected only four academic institutions (the University of California at Los Angeles, the University of California at Santa Barbara, Stanford Research Institute and the University of Utah), it now amounts to more than 2 billion internet users in the world (March 2011: http://www.internetworldstats.com/stats.htm) In 1989, at CERN in Switzerland, Tim Berners-Lee addressed the issue of the constant change in the currency of information and the turnover of people on projects. Instead of a hierarchical or keyword

[20] For the history on the Internet, see the following homepages and historical summaries: The Internet Society http://www.isoc.org/internet/history/; http://www.computerhistory.org/internet_history/; http://www.innovativelearning.com/online_learning/timeline.html

organisation, Berners-Lee proposed a hypertext system that ran across the Internet on different operating systems, which is now known as the “World Wide Web”. Search engines such as “Gopher” and web browsers such as “Mosaic”, “Netscape”, “Firefox” etc. were invented rapidly (Griffin, n.d.).

Pedagogical ideas using the Internet for teaching and learning purposes were already being developed in 1971 (Illich 1971). Illich envisaged a reference service to educational objects facilitating access to things or processes used for formal learning, skill exchanges, peer matching and reference services for educators (e.g. a directory of teachers giving their addresses and professional skills[21]). A Computer Supported Intentional Learning Environment (CSILE), an educational knowledge media system, was developed by Scardamalia and Bereiter at the Ontario Institute for Studies in Education in 1984. It was based on Zimmerman's (1989) self-regulated learning approach and constructivists' views of learning (see also Chapter 4). It emphasised building a classroom culture supportive of active knowledge construction that could extend individual learning to the group level. The purpose was to make students think about and reflect on their thought processes in order to provoke question asking and answering in a public forum. The ultimate goal was to get students involved in knowledge itself rather than improve one's mind, which shifts from individual mastery learning to improving the quality of public collective knowledge (Scardamalia et al. 1994). Then, in the late 1990s, the development of Internet-based learning environments followed, such as the CourseInfo Release’s Interactive Learning Network (later to be known as Blackboard) (1997[22]), the release of the commercial environment WebCT, the Belgium academic project Claroline (2000[23]), the open source LMS Moodle (2001; 2006 release 1.6.) and the Sakai Project (2004[24]).

E-portfolio software systems were also developed in this period: Folio-web[25], Pebble Ped[26] and others (see Barrett on evaluation of early e-portfolio software, cited in Hornung-Prähauser et al. 2007). The latest e-portfolio system reaching out to the educational market is the Australian open source project “Mahara”. This was first

[21] cf. http://en.wikipedia.org/wiki/History_of_virtual_learning_environments.
[22] This learning application, originally called the "Interactive Learning Network" (ILN), was developed at Cornell University by the CourseInfo team. The product was installed at several academic institutions including Cornell University, Yale Medical School and University of Pittsburgh. The ILN was the first e-learning system of its kind to leverage and install on top of a relational database MySqL. http://www.cquest.utoronto.ca/env/aera/aera-lists/aera-c/97-11/0123.html [11] CourseInfo would later merge with Blackboard, Inc. and ILN would be subsequently released as Blackboard CourseInfo.
[23] The Claroline project was initiated in 2000 at the Catholic University of Louvain (Belgium) by Thomas De Praetere and was financially supported by the Louvain Foundation. www.claroline.net.
[24] http://www.serensoft.com/eportfolios/osportfolio.
[25] www.folioweb.org
[26] http://www.pebblepad.co.uk/

established in mid-2006 and started as a collaborative venture funded by New Zealand's Tertiary Education Commission's e-learning Collaborative Development Fund, involving Massey University, Auckland University of Technology, the Open Polytechnic of New Zealand and the Victoria University of Wellington.[27] Mahara’s architecture was inspired by the modular, extendable architecture of Moodle. The Mahara team were also heavily involved in the Moodle community, with recent work mostly focused on Moodle Networks. Similarly, Mahara systems can be networked together by having a single sign-on from Moodle 1.9 upwards. Mahara will continue to evolve as a ‘pluggable’ modular e-portfolio system designed to leverage Web 2.0 web services and built with interoperability in mind.

The development of social software did not happen overnight. Chapman (2009) summarised the most important stages of the development. In 1997, usernets were first designed by Tom Truscott and Jim Ellis. Usernets let users post articles or posts (referred to as “news”) to newsgroups. Bulletin board systems and mailing lists went online in the late 1970s (the forerunners for RSS feeds), followed by chat applications, such as Internet Relay Chat, which was developed in 1988 and used for file sharing, link sharing and otherwise keeping in touch. ICQ was developed in the mid-1990s and was the first instant messaging program for PCs. Then, dating sites and gaming sites appeared and built communities, such as the massive multiplayer online role-playing games, which have become social networks in their own right. The most famous of these games is “World of Warcraft”, where players interact both in the game world and on related forums and community sites. The early 2000s brought some huge developments in social networking and social media. Examples were networks for sharing personal contacts such as Friendster, Facebook, Ning, Hi5, LinkedIn and XING. Platforms for sharing other multimedia content include Flickr (photos), YouTube, Revver and Vimeo (films) and search results (bookmarks, references etc), such as DIGG, Delicious, scientific resources and contacts (Mendeley), Twitter, Posterous and so on. Friendster (bought by Facebook in 2007) is a service that generates more of the applications on the desktop[28]. The newest development brought about by the Apple iPhone are real-time update applications, such as “iRovr”, a social networking app specifically for the iPhone/iPod Touch. Lifestreaming and life casting is possible at Ustream.tv, Justin.tv and many other sites including social network functions. The evolution of social media applications has brought about debates in education about

[27] www.mahara.org.
[28] http://www.webdesignerdepot.com/2009/10/the-history-and-evolution-of-social-media/.

privacy, multiple identities and media competences. The concentration of data in a few (mainly American) companies is of concern to Internet critics (see Fuchs, 2003; 2008). The table below shows the variety of e-learning tools and how they can be integrated in learning processes.

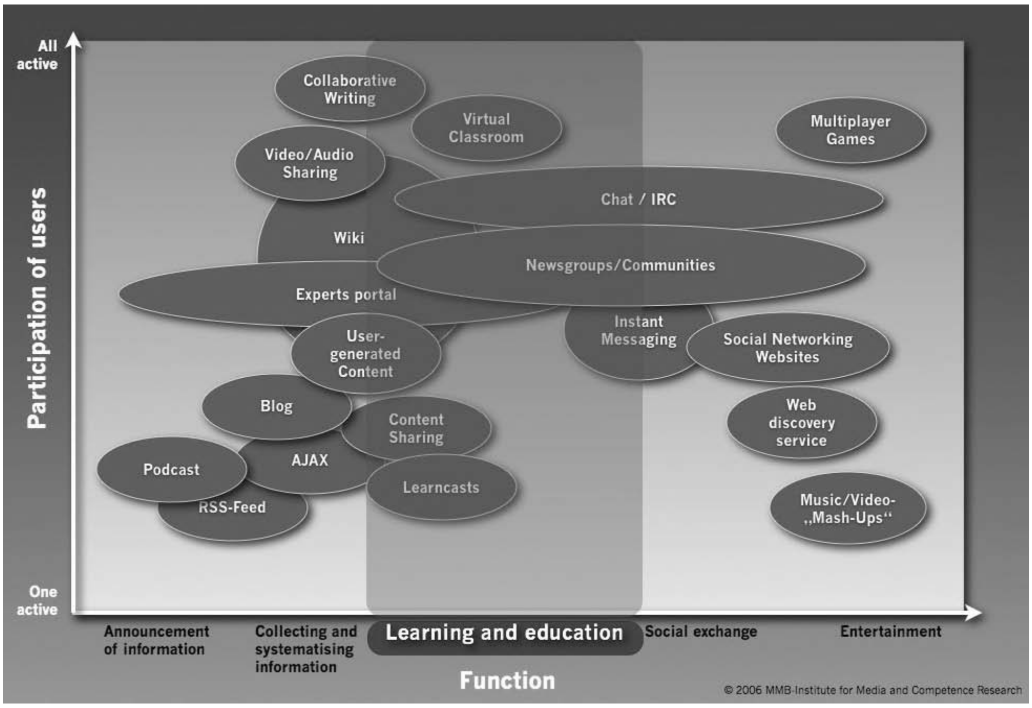


Figure 11: Use of social software in learning and education

Source: Goertz and Hedergott (2006). Institute for Media Competence Essen, Germany

The increasing availability of the Internet in this period has affected the way stakeholders use technology in schools. The primary use of the Internet has been as a source of information, professional development and data management). At the beginning, it was not used for the delivery of instructions but rather for administrative issues such as grading and recordkeeping (Aslan & Reigeluth 2011: 8). The Internet has been helpful for these functions because of the need for communication. However, since most technologies – including wireless, portable computers, Web 2.0 technologies and Personal Broadcasting – are relatively new, their use in education is just beginning. However, they are likely to play an important role in the future since they can all facilitate the personalisation and customisation of learning. Now the growing participation and interaction of Internet users is modifying this. The rise of user-created content is becoming a central element of the World Wide Web. Individual Internet users are increasingly making their own personal contributions instead of merely surfing the web. User-created content takes many forms, ranging from sharing short movies (YouTube) or pictures (Flickr) to the creation of an online encyclopaedia (Wikipedia) or the creation of a personal blog and wiki (Tapscott 2007). Karrer (2007) describes the changes that brought about the development of the web. The pedagogical thinking behind using the Internet in education has changed as it has technologically developed and enriched the functionality from a read-only web to a read and write web.

	E-Learning 1.0	***E-Learning 1.3***	***E-Learning 2.0***
Main Components	Courseware, LMSs Authoring tools	Reference hybrids LCMSs Rapid authoring tools	Wikis, Social net-working and book-marking tools Blogs, Add-ins, Mash-ups
Ownership	Top-down, one-way	Top-down, collaborative	Bottom-up, learner-driven, peer learning
Development Time	Long	Rapid	None
Content Size	60 minutes	15 minutes	1 minute
Access Time	Prior to work	In between work	During work
Virtual Meetings	Class	Intro, Office hours	Peers, Experts
Content Access	Learning Mg. System	Email, Intranet	Search, RSS feeds
Delivery	At one time	In many pieces	When you need it
Driver	ID	Learner	Worker
Content creator	ID	SME	User

Table 2: Understanding E-Learning 2.0. Source: Tony Karrer (2007)

Leinonen (2007) argues that the educational ideas behind Internet-based training were not pedagogical at all:

> The purpose and reason to promote it was the belief that it is cost-efficient as there were no more travelling to training or absence from workplace. Finally it was not that cost-efficient at all. In the end of the day there was very little under the bottom line – people didn’t learn much. The Internet-based training got mature in late 1990’s and early 2000 in a form of e-learning. The hype around e-learning is a kind of classical example of creating needs. Thousands of websites, articles and companies made it clear for all somehow related to education that this is something you must be involved it. The IT managers of thousands of educational institutions and organisations were asked by the

> educational experts to come up with e-learning solutions and companies were happy to help the IT managers. The e-learning industry was built, even though it was not proven that anyone (except the IT managers) needed these products. The markets for e-learning courses and especially for Learning Management Systems (LMS) were created. The pedagogical thinking around the e-learning is closely related to the computer-based training. The point is to deliver courses for students. Later on the learning platform developers has become more aware that learning requires social activities among the learners themselves and the learner and the teacher(s). Still the user interfaces of the LMS systems are at least implicitly telling you that you should first read the content and if there is something you do not understand you may ask your peers or your teacher.

Steve Wheeler (2009) argues that the disadvantages of the early Internet period will be outweighed by new social software features.

> If Web 1.0 was the 'Write Web' and Web 2.0 is the 'Read/Write Web', then Web 3.0 will be the 'Read/Write/Collaborate Web'. But it will not only promote learning that is more richly collaborative, it will also enable learners to come closer to 'anytime anyplace' learning and will provide intelligent solutions to web searching, document management and organisation of content… (..) Through predictive filtering and massively multi-user participative features, e-Learning 3.0 will make collaborating across distance much easier. With the best will in the world, very little collaborative learning occurs through the use of wikis and blogs, whilst social networks generally connect people but often superficially, and can also isolate. In a recent post entitled Is Twitter the semantic web?, I speculated on Twitter's functionality and suggested that through its primitive filtering tools such as RT, DM, @ and #tagging, we are witnessing some of the early semantic features that enable users to work smarter and more collaboratively. Intelligent agents will take this a lot farther. (see Blog Wheeler 2009)[29]

2.6 Summary

This brief outline of the history of educational technology based on primary technologies shows that psychological experts and software developers jointly developed teaching machines and software that understood the concept of individualised and self-organised learning as "being independent" from teachers and thus developed computer-assisted training programme. However, the technological

[29]Available: http://steve-wheeler.blogspot.com/2009/04/learning-30.html.[13-april-2009].

possibilities were not there at the “right” time and it was not until the emergence of the second generation of Internet technologies that pedagogical experts and technological developers pointed out the same role and function of technology. Now, the expectation is that social software enables collaborative, individualised teaching and learning, which, according to Reigeluth (2010), should be the premise for the next generation of educational technology usage:

> In our current educational system, student progress to a new topic is based on time, not on learning. If it is Monday, we move on to the next topic, in spite of some students not having attained the standards just taught. This system is sorting-focused (which was appropriate for the Industrial Age when manual labor was predominant), not learning-focused (which is needed for the Information Age when knowledge work is predominant. A learning-focused system would not allow a student to move on until she or he succeeded in attaining the current standard. And it would require each student to move on as soon as he or she succeeded in attaining the current standard. This requires a completely different paradigm of education, one that is customized to meet each student’s needs and potential. This requires a different role for teachers, students, and, yes, technology.

However, as will be argued more often in this study, it is not the technology per se that would automatically lead to these expectectations. The next chapter deals with the definitional foundations on which the framework will be based.

3 Chapter 3: Characterisation of ICT-enabled innovations in education

3.1 Introduction

This chapter aims at characterising the research issue ‘ICT-enabled innovation in education’. It will clarify how the terms and concepts underlying this research object have and still are being dealt differently within social science. A systematic view of the implicit assumptions behind the terms and concepts, commonalities and differences will help explain the disciplinary boundaries and provide the grounds for bridging them. The following sections will deal with:

- The function of education as a subsystem of society (3.2),
- Technology, ICT and digital media in education (3.3), and
- Innovation in education (3.4).

Finally, based on these clarifications, the concept of e-portfolios and the definitional approach used for the purpose of this work will be discussed (3.5.). This will guide the further work on analysing the theoretical approaches (Chapter 4) aand help developing the integrative, multi-level framework (Chapter 5).

3.2 Role of education in society

This section examines the different ideas about the role of education in society and explains what a systems orientation in educational research implies.

3.2.1 Etymological origin of term education

The term education is known to us already from ancient times. The Greek word “paedeia or paideia” means “child-rearing and/or education” (Jaeger 1989: 38pp). The Latin origin of the verb “educo” means “to guide, to conduct or to educate” (Stowasser 1980: 183). Originally it meant the “education in social codes and manners” and only from the 1610s onwards was it referred to as the "systematic schooling and training for work"[30]. The educational ideal was that tradition was the teaching of cultural heritage

[30] Online Etymology Dictionary: available from: <http://www.etymonline.com>.[2011-03-10].

and cultural values for the next generation (subjects included rhetoric, grammar, mathematics, music, philosophy, geography, natural history and gymnastics), rather than learning as a “trade or an art”, which the Greeks called banausos, and which were considered mechanical tasks unworthy of a learned citizen (ibid). Researchers of educational technology in German-speaking regions should be well aware of the fact that the English term education also entails the "act of rearing a young person" (English Dictionary: www.dictionary.com), whereas in the German language the word education falls apart in two terms, namely “Bildung” and “Erziehung”, which are close to the two terms “upbringing” and “education”. The background for this is that “Erziehungsfunktionen” were functionally differentiated in the 18th and 19th centuries respectively into upbringing and public education (cf. Qvortrup 2005).

3.2.2 Education as a subsystem of society

As has become clear from the different views of the purpose of education and pedagogical science, many different actors and contexts are involved in the activities. Whereas in the 18th century a mechanical and naturalistic view of education was predominant, nowadays it has become clear among educational philosophers and scientists that systemic relations characterise a national educational system and its subsystems. Morrison (2006) describes this as follows:

> Educational systems, institutions and practices exhibit many features of complex adaptive systems, being dynamical and emergent, sometimes unpredictable, non-linear organizations operating in unpredictable and changing external environments. These systems, institutions and practices shape and adapt to macro- and micro-societal change, and, through self-organization, respond to, and shape the environments of which they are a part. As Stewart (1991) remarks, there is co-evolution between the organism and its environments. This process occurs through learning, adaptation and development (p. 3).

As Markham (2008) outlines, “one of the keys to understanding the power of systems orientation in education is the idea that any system is embedded in other systems; that systems do not operate insolation and interfaces between system components have to be understood” (p. 14). The figure below indicates these relationships.

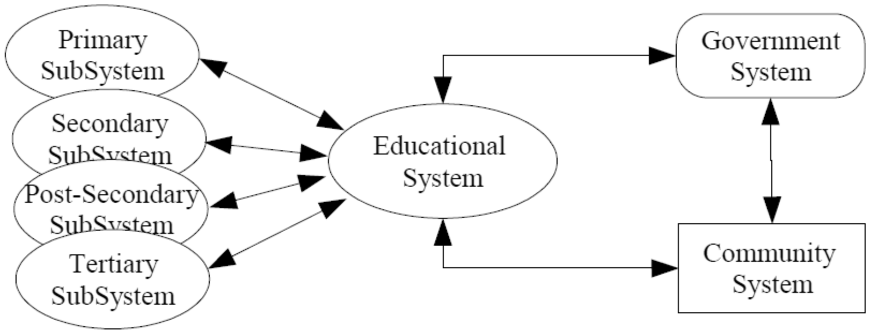


Figure 12: General model of the subsystem. Source: Markham 2008: 16

Educational systems can be viewed either as subsystems of society in line with culture, mass media, science, technology or policy (see Hofkirchner 2006; Fuchs & Hofkirchner 2005) or as functional systems[31]. The first approach is based on the Unified Theory of Information, which argues that information is a threefold dynamic process of cognition, communication and co-operation and that information-producing systems are self-organising systems. Applying this idea to society and its subsystems can best be done by conceiving the interactions and dynamics of social systems as mutual production processes of social structures and social practice (Fuchs & Hofkirchner 2005). It is further argued that each subsystem of society is based on information and self-organisation processes with knowledge as the social manifestation of information (Fuchs & Hofkirchner 2005: 2): "We live in a knowledge society insofar as all social systems are knowledge-generating systems. Modern society today has become knowledge-based because our social systems are increasingly based on technological and scientific knowledge and on mental labour".

Luhmann (2002) distinguishes between two functions of an educational system: "making human beings persons" and "career selection" (translated by Qvortrup 2005). "According to Luhmann, the fundamental function of an educational system is not to impart knowledge, to discipline, etc., but to minimize the improbability of social communication. An educational system achieves this through the function of making human beings persons, that is, by creating that distinction, for which the labeled side is the person and the unlabeled side is the human being. He considers the "transformation

[31] See Qvortrup 2005: "In 1982, 1986, 1990, 1992 and 1996, Luhmann, together with Karl Eberhard Schorr, published a series of collections of articles about upbringing and education: *Zwischen Technologie und Selbstreferenz* (Between technology and self-reference), *Zwischen Intransparenz und Verstehen* (Between intransparency and understanding), *Zwischen Anfang und Ende* (Between beginning and end), *Zwischen Absicht und Person* (Between purpose and person) and *Zwischen System und Umwelt* (Between system and environment). In addition, after the death of Schorr, in 1997, he published a book together with Dieter Lenzen entitled *Bildung und Weiterbildung* im Erziehungssystem (Education and further education in the educational system)".

of human beings into persons: persons for themselves and for others. “Human beings are born. Persons develop through socialization and upbringing/education. Keeping this difference in mind, it is natural to set the education function into relation with the fact that human beings become persons. Especially in complex societies, this cannot be left only to socialization. This does not function specifically enough and is too connected to the environment where this occurs. In both instances we are dealing with the process of becoming a personality. It is here that leeway exists that education can use in order, on the one hand, to correct the results of socialization, and on the other hand to amend them. But that interaction develops at all between socialization and education depends on whether both processes are related to becoming a person” (Qvortrup 2005: 38).

The secondary function of supporting the selection of a career is based on the idea that not everyone fulfils the same function in society and that this selection process is taken care of by the education system. “Ergo, the education system includes, no matter how much the participants protest, two functions: on the one hand, it functions to create and (to an increased degree in the form of lifelong education) to maintain the preconditions for human beings to function in society as persons. On the other hand, it functions to execute evaluations in order to realize career selection. Naturally, both functions have to be fulfilled by the education system with the help of communications” (Luhmann 2002 translated by Qvortrup 2005).

Heil (1999) examines the origins and applications of theoretical systems approaches and conceptions of self-organisation to pedagogical thinking and considers that it is difficult to draw normative consequences from Luhmann’s systemic approach. She includes the systemic-constructivist didactical ideas of the educational scientist Kersten Reich (1999: 67; Reich, Sehnbruch & Wild 2005). For the purpose of developing a framework which analyses the context of a national educational system, it is important to consider diffferent views on the function and role of the education in a society or a cultural region (e.g. Europe, Anglo-Saxon academic tradition) exist. Moreover, the educational actors and structures are interrelated, schools and universiteis are influenced to some degree by their external community and/ or the governmental policies and have also feed-back loops to them. In e-learning the interrelations have become more evident, due to the need of a permanent national and institutional technical infrastructure (e.g. internet access in classrooms; server hosting for data archiving, which cannot be done in one school).

3.3 Technology, ICTs and electronic media in education

This section examines the different characteristics of technology in general and ICTs and electronic media[32] for e-learning[33] as essential preconditions for modelling the integrative framework for analysing systemic ICT-based innovations beyond different disciplinary boundaries.

Technology	ICTs	ICTs as educational technology	Educational hardware: e.g. network technologies, electronic devices (e.g. overhead), computer, digital television, radio, I-Phone, camera, USB, smart boards sticks etc.
			Educational software: e.g. CDs, DVDs, Learning management systems, e-portfolio systems
			Internet as teaching material archive; search & collaboration tool
		ICTs as business technologies	Financial and auditing systems Knowledge management systems Production and logistics technology etc.
		ICTs as public communication technologies	Digital media (television, online news, Internet)
	Other technologies	Energy technology	e.g. Solar enegery
		Nano-technology	In deveopment

Table 3: View on the hierarchy of terms in technology, ICTs and media.

3.3.1 Etymological origin of technology

The etymological origin of the term “technology” can be traced back to the Greek words “tekhnologia” and “technikos”, which mean the "systematic treatment of an art,

[32] Electronic (or digital) media have often been called the “new” media, in delineation of the “old” media mass TV, radio and cinema.

[33] Here, all types of “electronically” enhanced learning and teaching are called e-learning. The term has emerged with the advent of the Internet, indicating a permanent online connection to the computer infrastructure and learning software and material (Flindt 2005; Neubauer 2002).

craft or technique"[34]. Rammert (1999) states that since the times of Aristotle, technology has been made up of four related elements: the stuff or material out of which a techno-fact is made, the given form or shape, the end or use for which it is determined, and the efficient action exercised by humans (p. 23). Bijker (2006) distinguishes between three of the most common meanings of the word "technology": a set of *physical objects or artefacts* (e.g. computers, mobile telephones or whiteboards), *human activities* (designing, making and handling of such objects or machines) and *knowledge* (what do people know and do with machines and related production processes) (p. 2).

3.3.2 Different conceptions of technology

The views of the characteristics of technology have changed in the course of time. As Bijker (2006) stresses, "it is important to recognize that—within these common meanings of technology—different conceptions of technology can be used. These concepts differ in the (often implicit) underlying assumptions about technology's development and about technology's relation to other societal domains" (p. 2). Rammert (1999) argues that technology has historically been defined by a "difference in relation to something changing from a substance to functional view" (p. 23). Technology was characterised by the difference between: nature and technology, life and technology, culture and technology, and society and technology (ibid).

The oldest tradition is the understanding that *nature and technology* are two separate worlds and that "technology needs competent human intervention to come into being, Aristotle being the classical source for this view" (Rammert 1999: 24). However, the more natural science has found out that nature is also constituted by experimental intervention, this conception has lost explanatory power (ibid). The distinction between *life and technology* stresses a difference between vibrantly living and dead, crystallised. However, according to Rammert (1999), this difference is diminishing if one looks at the processes of biotechnology and the fabrication of organic life:

> In the computer sciences, mechanical models of knowledge engineering are followed up by various approaches to create Artificial Life, and to cultivate an evolutionary selection

[34] Online Etymology Dictionary: http://www.etymonline.com/index.php?search=technology&searchmode=none (2011-03-24); the German word "Technik" has been introduced from the French language "technique". It is assumed that the term was firstly related to the building of a house or the craft of a carpenter, because one finds similar words in ancient Indian, Iran and Indo-Germanic languages for this activity. In the course of time, the material term was enriched by self-conscious human activity. See for definition of "Technik" also the Studienbuch Informatik und Gesellschaft, Fuchs and Hofkirchner (2003: 186).

> among a variety of growing programs. Machines and programs are moving beyond the purely mechanistic. Physical materiality or mechanical artificiality may be significant markers of technological objects. But they are not sufficient to encompass contemporary technology and to define its core characteristics (p. 24).

The third conception of technology focuses on the difference between a cultural world of sense-making and a technological world of rules and forms. However, Rammert reasons that this view has not proven sufficient, since logic research postulates that "even the most rigourous symbolic technique is based upon language games" (Wittgenstein 1953 cited in Rammert 1996: 24). The three views outlined above are examples of a rather classical understanding of technology as material tools, machines and mechanisms (Rammert 1999: 24). The fourth way of characterising technology corresponds to the difference between *society and technology* in which "technological efficiency is often contrasted to the inefficiency of social institutions". This view warrants that there is a difference between the social world and the technological order:

> The social way of doing something recognizes the double contingency of interaction between subjects; it requires communication, and it admits negotiation. The technical mode of making something is associated with a simple regularity of operations between objects, with programmable control and with reliable performance. In a certain way, the analytical differences between technique and praxis, work and interaction, system and life-world reproduce this division of the technological order from the social world (Habermas 1987 cited in Rammert 1996: 25).

Summing up these different views, Rammert (1999) argues that all four have insufficient expressive power for exploring the distinctive character of technology and the emergence of "techno-structures" in society. He claims that it is the relation between "technicisation and technical practice to the world" that constitutes the practice of technology in daily life, and he identifies three types of relations: Causal relations (consist of agents and objects that are "mangled" in tightly coupled effective systems), hHermeneutic relations (emerge with use and determine the very meaning of a technology by the way it is really practiced and not how it was originally projected), and eEvaluative relations (connect different technical practices and artefacts with one another and regulate how they are included in the social collection of legitimate technologies and how this techno-structure gains influence) (pp. 28–30).

In line with Rammert (1999), Fuchs and Hofkirchner (2003) argue that no unique definition of what is to be understood by technology exists and that the role and function of technology depends on scientific thinking (for a description in detail, see section 4.1). Engineers, technologists and technicians are more inclined to view technology as the process of material construction based on a systematic engineering knowledge of how to design artefacts and they associate technology very closely with machines or physical systems. A social science researcher typically views technology in broader terms, exploring what is understood by material construction to take social significance into consideration. Dialectical thinking relates technology both to material construction uses as well as to intellectual and social contexts (Luppicini 2005: 104). The different conceptions on technology are summarised below:

Type of approach	***Technology is….***	***Example, representative***
Objectivism	Related to the material structure of technology technology = material object	Machines using natural power for human purposes (Hüber 1973–74: 1475); “Technology is the material substratum of relations internal to the labour process which make collective labour-power a single force producing surplus-value” (Aglietta 1979) Technology understood in the narrow sense: material artefacts
Subjectivism	Related to the human subject using the technology technology = art, knowledge, work, activity, procedure, process	Technology understood in the wider sense: procedural instructions; activity and thinking; methodological rules for operations and aimed at a strategic goal
Dualism	Either a material or a social activity	
Dialectics	Both a material and social activity	Technology should consider both material and social aspect of a socio-technical system (Weyer 2008: 37)

Table 4: Classification of approaches about the conception of technology

Source: by author; based on Weyer 2008; Fuchs & Hofkirchner 2003; Rammert 1993.

Weyer (2008: 37) criticises the distinction of technology in a narrow and wide sense as problematic, because almost any methodological and strategic human action, e.g. the greetings of a neighbour, would be a “technology”. Such a wide concept is not helpful for a techno-sociological perspective. According to Weyer, the historian and philosopher of technology Thomas P. Hughes (1979, 1986, 1987) dissolved the dualism of material and/or social view by focusing on the relation and linkages with other components to a functional or socio-technical system (2008: 37). The work of Rammert is further developed by Geels (2002), who defines technological transitions as evolutionary reconfiguration processes and establishes a dialectic relationship between technology and society:

> Technology, of itself, has no power, does nothing. Only in association with human agency and social structures and organisations does technology fulfil functions. It is the combination of 'the social' and 'the technical' that is the appropriate unit of analysis. In this respect Hughes (1986, 1987) coined the useful metaphor of a 'seamless web' in which physical artefacts, organisations (e.g. manufacturing firms, investment banks, research and development laboratories), natural resources, scientific elements (e.g. books, articles), legislative artefacts (e.g. laws) are combined and work together. Building on the tradition of sociology of technology, Fleck (1993) analyses technological systems as configurations of technological and nontechnological components (pp. 1257–1274)

Raffl et al. (2008) argues that there is a linguistic subtleness to whether the term socio-technical systems (coined by the Tavistock Institute) and techno-social system means the same. Raffl et al. plead that the "notion socio-technological systems is misleading in that sense that it insinuates that there are technological systems, that form a category, and that there are socio-technological ones, that form a subcategory of the former. In our understanding it is more likely the other way round: Technological systems are subsystems of social systems. Hence we employ the term techno-social.)"

Summing up, the concept of educational technology is continuously evolving and has to be understood in the mindset of the present time. Following the views of technology, educational technologies may refer to material objects used by humans (= learners of any age), such as machines or hardware, but it can be associated with a broader concept, including systems, methods of organisation and techniques. In the following section, we examine ICTs. Although the world of education at first does not look like a very "technical" sector (in contrast to industrial sectors), the current way of knowledge generation has become "technicised" and needs more and more sophisticated technical skills (e.g. ICT skills and media competence). In the daily practice of e-learning, these different relations are of utmost importance.

3.3.3 Different conceptions of ICTs and e-learning in education

The previous discussion can be applied to ICTs and their absence of education, which is also addressed as e-learning in the course of this thesis. The following table provides an overview of how to perceive ICTs in different ways of thinking and e-learning in the educational application domain. I have tried to systematically distinguish the different views on e-learning. Relevant for the framework development is especially the understanding that e-learning covers both the technical infrastructure AND the underlying process of teaching and learning (dialectic approach).

Type of approach	***ICTs are…***	***Examples***
Objectivism	ICTS are a channel and media that the acquiring, storage, processing, transmission, dissemination, management, control, transformation, retrieval and use of information is typically in a digital format.	-Information of the sender can be decoded by the receiver in the same (syntactical) (Shannon-Weaver-Wiener Model). -ICTs are defined as a "diverse set of technological tools and resources to communicate, and to create, disseminate, store, and manage information" (Blurton 2002) -ICTs can be understood as extension of individual and collective cognitive skills in time and space (Kincezei 2008: 57). -E-learning = the use of ICTs to facilitate and enhance learning and teaching (Koper 2007) -E-learning = "learning conducted via electronic media [especially], on the Internet" (OECD 2007)
Subjectivism	Information cannot be transmitted, but exists already in the (cognitive) system. It is not determined that the code can be decoded by the receiver as expected	Mead; Bateson, Forester, Luhmann; Constructivistic media theory (Luhmann 1984): E-learning = e.g. distance education, is also interaction, that is, communication between those present (Luhmann 2002)
Dualismus	ICTS and media are transmitters and relieve the communication process	Theorie kommunikativen Handelns (Habermas 1981)
Dialectics	CTS and media are producers and mediators of	Semiotic information model (1915/1938); evolutionary approach to information Fuchs-Kittowsky, K.; information and self-organisation (Hofkirchner & Fuchs 2007, 2010) E-Learning = a term covering a wide set of applications and processes, such as web-based

		learning, computer-based learning, virtual classrooms and digital collaboration. It includes the delivery of content via the Internet, intranet/extranet (LAN/WAN), audio and videotape, satellite broadcast, interactive TV, CD-ROM, and more (American Society for Training (2003)

Table 5 Classification of approaches on what is ICT and e-learning.

Source: based on Flindt(2007:25) and Fuchs & Hofkirchner (2003: 195–226.)

Following an objectivistic or instrumental approach, ICTs are defined as a "diverse set of technological tools and resources to communicate, and to create, disseminate, store, and manage information" (Blurton 2002: 1). Often, the use of ICTs in education is described extensively (Flindt 2007: 25) with a heterogeneous list of electrical machines or networks such as computers, Internet, broadcasting technologies (radio and television) and telephony. In the context of education, this list could be enriched with other electrical tools that are specifically designed for use in teaching, lecturing and training scenarios such as overhead projectors, beamers, whiteboards and different kinds of software such as digital information (e-content) on DVDs, CD-ROMs and learning management systems or e-portfolio software. One problem of delivering an objectivistic, clear-cut classification of how ICTs are used in education lies in the fact that modern technological components merge and thus different technologies are used in combination rather than as sole delivery mechanisms, for example the computer or iPhone can be used in many different teaching and learning settings. The instrumental approach to explaining e-learning is represented by the definition of e-learning by the Buffalo State University, which characterises educational technology as "all components of informational technology used in the delivery of educational materials" (see Glossary of Buffalo State University[35]).

The most recent national survey on technology uptake in Australia (the E-learning Benchmarking Project 2005) uses a broad definition of e-learning as "access to, downloading and use of web, CD-ROM or computer-based learning resources in the classroom, workplace or home" (I & J Management Services 2005: 5). Also the OECD follows a rahter objectivist approach and defines e-learning as "learning conducted via electronic media [especially], on the Internet" (OECD 2007).

[35] Glossary of Buffalo State University http://www.buffalostate.edu/disabilityservices/glossary.xml.

The *subjectivistic* approach views ICTs and e-learning as process-oriented activities as opposed to single tools. ICTs are viewed as a “universal technological system, which is interwoven with and permeates older technological systems, creating new technological systems at the same time. The network of its human and non-human components may surmount any previous systems in complexity and heterogeneity. Some flagship technologies of ICT are microprocessors, telecommunication infrastructures, or – belonging to the world of non-physical artefacts – e-mail and SMS applications, and of course, the world wide web (www), which can be considered a technological system in itself“ (Kincezei 2008: 57). Koper (2007) defines e-learning “as the use of ICTs to facilitate and enhance learning and teaching” (p. 356). This pays special emphasis to the technologies and practices associated specifically with the Internet and the web.

A *dialectical view of* ICT use for e-learning is expressed by Andrews (2009):

> The term ‘e-learning’ is helpful because it is a hybrid, compound term. It suggests that there is something distinctive about e-learning, and that it is different from ‘learning’. In the Handbook of E-learning Research, we proposed a conception of the relationship between new technologies and learning that saw them as reciprocally co-evolutionary. That is to say, they each develop independently and alongside each other; but they are also related, and contribute to each other’s development. As one changes, so does the other. This is not the same as a symbiotic relationship because symbiosis exists to maintain a status quo. E-learning, on the other hand, is dynamic, changing and adapting itself to new social situations, new politics, new technologies, new forms of learning (p. 1).

For the purpose of developing an integrative and multi-level framework, I will suggest to use a combination of the objectivist and subjectivist approach. As we will later further discuss, e-portfolios are both a technological instrument, but support an underlying pedagogical objective. It will be further discussed, how the software programming of an e-portfolio software (design) influences the actual,intended pedagogical practise.

In the following section, we will look at the concept of media, which in common and pedagogical writing are often intermingled. Whereas the use of ICTs in e-learning communities is used rather often in an objective, instrumental way, the use of the term media, although also having an “instrumental face”, also carries other implications.

3.3.4 Etymological origin of term media

Nowadays, the words “medium” and “media” (in its plural form) are buzzwords that are used in many different societal and educational contexts. However, the history of this term is rather “young”. The media historian Hartmann notes that the word “mèdium” was previously used in French and then introduced into the German language[36] (Hartmann 2008: 19). The media theorist Faulstich found the “oldest” origin of the German word “media” in a conversation encyclopaedia in 1888[37].

The Latin origin of the word “*medium*” bears different meanings: “*in the middle*” (in medium in medio), *to publish publicly* (de medio removere; in medium procedure) and/or in the *public way* (omnia in meio). The substantive “medius” relates to “space – in the middle” and to “time oriented”, whereas the predicative form (met) is interpreted as “mediated, disturbing” (see Stowasser 1980: 278). The adjective form of “medius” or “medial” is found earlier and means "intermediate agency, channel of communication" (from 1605 onwards), and in the artistic sense the term relates to technical tools used for painting (e.g. oil, watercolours, etc.) and has been found from 1854 onwards. The use of the term medium as a "person who conveys spiritual messages" was firstly recorded in 1853, and it relates to the idea of "substance through which something is conveyed" (see Online Etymology Dictionary).

More familiar today is the plural “media”, which since 1927 has referred to "newspapers, radio, TV, etc.", often in connection with “mass media” (a technical term in marketing; 1923 Online Etymology Dictionary [38]). In educational technology, the term is often used in combination with other syllabi, e.g. “multimedia”, a word commonly used in education, mainly in the context of assessing the quality of digital education material (e.g. amount of animated text, audio, images, animation, video and other interactive content forms). Very often used in the field of e-learning is the “twin” word media pedagogy, treated as a subfield of pedagogy that deals with the role of "old" and "new" media in teaching, education, socialisation and literary. “Instructional media” are media designed to improve and support learning and teaching. “Media education” is a field contributing to improving the media literacy of children, adolescents, adults and seniors (see Batinic & Appel 2008).

[36] cf. Joachim Campe: Wörterbuch zur Erklärung und Verdeutschung der unserer Sprache aufgedrungenen fremden Ausdrücke 1813 cited in Hartmann 2008: 19.
[37] Werner Faulstich: Medientheorien. Einführung und Überblick. Göttingen: Vandenhoeck und Ruprecht 1991: 8. cit in Hartmann 2008.
38 http://www.etymonline.com/index.php?term=Media [2010-07-25].

3.3.5 Different typologies of media

As discussed before, the term media can also be conceived in an objectivistic or instrumental way by focusing on the "materiality" of the media (Hartmann 2003). The instrumental approach distinguishes three basic types of media (Batinic & Appel 2008: 97):

- Primary media: media connected/embodied in a body (e.g. voice); advantage is that the modulation of the voice can support the spoken text (direct mediation),
- Secondary media: media need technical support in order to produce signs (printing books); the reader does not need a technical means (maybe glasses) to read handwritten or printed texts (indirect mediation: use of technology/technique for interpretation on the side of the sender to produce information), and
- Tertiary media: media that needs technical devices/support to broadcast/transfer and receive information.

The media used in techno-pedagogical innovative scenarios are mainly tertiary media (radio, TV, DVD, film, audio). Faulstich (2004) differentiates the three types of media further and characterises "digital media" as "quartiary media" because of its digital character. Digitalisation has given rise to the use of the term "new media", differentiating traditional "analogue" media until the early 20th century from digital, computerised media. Nowadays, this distinction is blurred by the fact that the Internet has become a "mass" publishing media system in which films and radio information can be broadcasted and downloaded. Weidemann (2002) points out the types of information encoded in media technology. In e-learning, a lot of digitised teaching material is perceived as "mono-medial" (e.g. available only on DVD) and "multi-codal" information (encompassing audio, video, text and images) (cited in Osterwalder 2009: 171).

The communication and media theorist Marshall McLuhan (1964; 1992) distinguishes between types of media by the way they exert influence on society, not so much on their technological characteristics. On the one hand, warm or hot media mean that the user only enhances only "one single sense", the visual eye and the person does not need to engage indepth while watchin a movie. On the other hand, cool media, such as the television, requires more engagement by the user to understand the meaning (1964: 22-25pp). He was contrasted by Kittler (1995, who stresses the autonomy of technology and disagrees with McLuhan's opinion of the media as "extensions of man". He points to the technological function of archiving data and information and that nowadays the digitalisation and the computer merge the previous different technologies of archiving (book, movie, photograph, telephone) into one archiving-system ("Aufschreibesystem" in German) (see also discussion in Fuchs & Hofkirchner, 2003: 228–229).

Another prominent media and system theoretist Luhmann discusses the role of media on formal (school) education and classifies three types or aspects of communications media that he considers relevant for e-learning[39]:

- *"[D]istribution media:* the teacher does not whisper but raises his/her voice. In order for the students to hear and see better, the teacher stands higher up and writes important words on the blackboard, uses an over-head project slides, PowerPoint presentations or computer-based communication. In order to reach parents, letters and notices are sent home to the family.
- *comprehension media*: Language and a conceptual vocabulary and reference system is one of the fundamental comprehension media. Curriculum work and instruction planning consists of creating a purposeful development of comprehension media in the classroom.
- *effect media:* The function of this media is to achieve the intended effect. This is achieved with rhetorical resources, with the creation of togetherness in the classroom, with the teacher acting "authentically", and fundamentally with having the students acquire the specialized communications media of the educational system, that is, the comprehension that the aim of education is the acquisition of knowledge, and that this knowledge will be tested with the help of tests and examinations."

Based on the above difference, for an analysis of e-portfolio emergence and integration it is important to realise that each modern e-portfolio software encourages the user not only to submit textual reflections or learning results, but to submit videos or images. Since nowadays the digital photography and video has become ease, even with mobile cameras, this technologies are used also for e-portfolio processes. For example, the e-portfolio forerunner Helen Barrett, promotes to use the mode of "digital storytelling" as e-portfolio approach (see Homepage for digital storytelling: https://sites.google.com/site/digitalstorysite/). It becomes obvious that by such an approach, the traditional questions of media research, such as choice of media, image analyses, gender-bias in using digital media for expressing competences etc.).

[39] Luhmann's work on education deals only with classroom learning; translated by Qvorstupp (2005). Available from: http://www.seminar.net/files/LarsQvortrup-SocietysEdSystem.pdf [2009-8-23]; see also: Baecker Dirk:Title: Niklas Luhmann in the Society of the Computer. aus: Cybernetics And Human Knowing. Vol. 13, no. 2.

3.3.6 Function of electronic media in education

Friesen and Hug (2009) describe two aspects of new media in education in Germany and Anglo-Saxon educational science discourse and practice in a publication emphasising a “mediatic turn”. They point out the double nature of media in education, as a *cultural element* outside of the institution, and as a *technical element* instrumentalised within educational contexts (ibid). The research on the effect of multimedia on learning and cognitive structures is depicted in the figure below (Hede & Hede 2002).

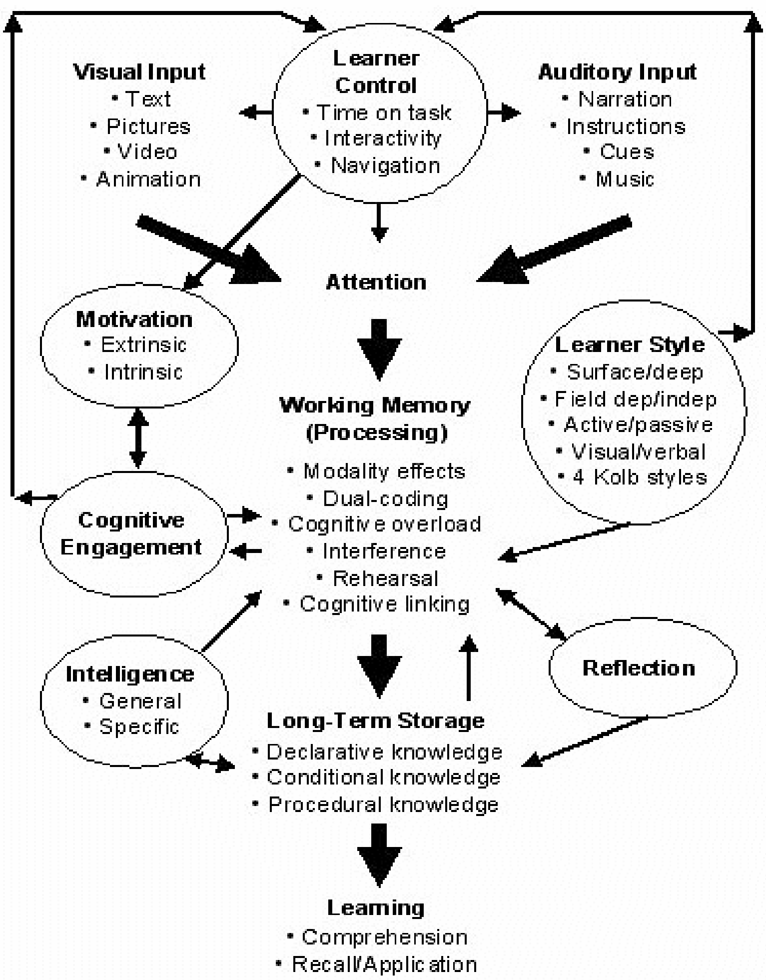


Figure 13: Integrated model of multimedia effects on learning. Source: Hede & Hede (2002).

It is the task of instruction designers to design ICTs and media in order to enable tools for “meaningful” and illustrative learning (Mayer 2005; 1998). The issue driving research and practice in this subdiscipline is the efficient use of media for instructional ends. Efficiency, moreover, tends to be defined in terms of the fixed, physical and logical characteristics of media and their correlation with curricular content and individualised cognitive functions (Mayer 2005 cited in Friesen & Hug 2009). The media theorist Michael Giesecke (2008) argues that the use of ICTs and media influences our culture of knowledge generation in society:

"Teaching and learning are phases in the cycle of information processing, a module of knowledge management. Only such information can be taught that was perceived with one or more of the senses and stored adequately. All learners take their information from information media that are more or less technologically based. If the ways in which they are perceived change, we will gather different types of information, and sooner or later the manner of presenting media and the ways in which information is passed on will change as well. Irrespective of the change of the information processing cycle that we enter, no phase of the whole information cycle remains unaffected: New media provoke backlashes to the manners of perception, new manners of perception provoke alternative forms of presentation, etc." (2008; n.p.). The table below summarises the influence of the ICTS and media on knowledge generation.

Typographical scientific ideal	Counter movement during the last decades
Social organization: hierarchic institution, linear organisation	Project groups, interdisciplinary networks
Homogeneous discipline, regulated by axioms, relying on scientific principles, public educational programmes	Plurality of theories and methods, description of the singular, specific phenomenon
Quality criteria: true:false. Falsification	Knowlege that is successful in a given project, adequate, pragmatic, functional, tolerant of faults
New knowledge emerges as sum of individual processing of perceptions and of informational performances	New knowledge emerges as result of net-based projects (from individual learning to learning organisation, and group)
Progress is the result of accumulation, technization, standardization	Progress is the result of synergy, networking, globalization
Preference for visual data, visual forms of presentation as well as for linguistic codes (professional jargon) and standardized symbolic presentation	Multi-sensory surveys, multi-media presentation of knowledge, avoiding exclusively semantic classification
Linear presentation and coherence	Hypertexts (in print media as well), multidimensional data banks
Thinking in binary oppositions (either-or), classical bivalent logic (tertium no datur)	Fragmented thinking (as well as), introduction of intuition, emotional intelligence
Learning ahead, accumulation of knowledge; teaching as instruction (requires knowledge of results in advance)	Learning during and after practice, learning as unlearning of principal assumptions, of dogma
Lecturers and teachers as experts in scientific disciplines (lawgiver and teacher)	Approximation to (self-reflexive) counselling, teachers as moderators, at least in graduate studies

Table 6: Influence of ICTs and media on knowledge generation.

Source: Giesecke (2008: 8)

Secondarily, media are also defined in education specifically in terms of instructional media, instructional multimedia (and also as “multimedia learning,” “instructional materials,” or “message design,” all of which are generally classified as subdomains of instructional design and development). These terms refer to the intentional and systematic use of computer, broadcast, and other technologies for instructional purposes, and generally in instructional settings.

“Multimedia learning,” for example, is described as

> …focus[ing]…on how people learn from words and pictures in computer-based environmens. [These] environments include online instructional presentations, interactive lessons, e-courses, simulation games, virtual reality and computer-supported in-class presentations. (Mayer 2005, p. ix)
>
> The issue driving research and practice in this subdiscipline is the efficient use of media for instructional ends. Efficiency, moreover, tends to be defined in terms of fixed, physical and logical characteristics of media and their correlation with curricular content and individualized cognitive functions (e.g. Mayer 2005).

Summing up this section on technology, ICTs and e-learning, it has become clear, that, first of all different approaches exist and by researching e-portfolios it may be helpful to make clear the underlying mindset. For the purpose of developing the integrative, multi-level framework, I propose to use the understanding, that any e-portfolio shaping and integration takes place in a dynamic educational system, that has to fulfill both societal functions (e.g. education as means to develop society) and personal functions (the education of young students to follow a career/ job). Moreover, the modern digital information and technologies influence the way of communication and knowldege acquistion and archiving in a radical way. The type of media used in e-portfolio processes is of utmost importance for societal and individual development. This is not only important for communication processes underlying any traditional teaching and learning process, it will be of utmost important for new processes emerging. However, before turning to innovative e-portfolio processes, we will take a thorough look how we conceive "innovation" in a national educational system.

3.4 Innovation in education

This section examines the meaning of the term innovation and the different typologies of innovation worked with in social science research. It further analyses the type of innovation that can or cannot be enabled by ICTs in the field of education.

3.4.1 Etymological origin

The Online Etymology Dictionary points out that the Latin terms "innovationem" (= noun) or "innovare" (=infinitive) are a combination of the Latin syllabus "in-" (into) and "novus" (new), which together carry the meaning of "to renew" or "to change"[40] (cf. Stowasser 1980: 302). Change is an important element related to innovation and the intensity and impact of change are important aspects to deal with in a shaping and emergence process of an ICT-based innovation.

3.4.2 The characteristics of change in innovation processes

In the social science literature, innovation is connected with the notion of creating something "new" and research is occupied with the question of "how to bring newness into the world" (see Peschl 2009). Most literature echo Rogers' (2003) view of innovation as a synonym for new ideas, for new knowledge or for new practices. In common thinking, innovation is connotated as something "being better than before"; however, it is by definition possible to worsen. The assessment of "newness" is difficult in practice, since it is not always immediately clear whether a new idea leads ultimately to a better situation. Sometimes this can be judged only over a longer period. This is a problem that is particularly relevant in education. According to Blumenfeld et al. (2000), "innovations can be successful relative to their objectives, but detrimental to other objectives, or the might simply create new problems, such as additional costs (e.g. through new training needed), exceed the benefit of the innovative practice" (cited in OECD 2009: 65). This is also a problem in the e-learning field and needs more empirical attention.

In economics, an innovation is regarded as "new" only, if 50% of the industrial sector have taken it up (cf Fuller 1981 cited in OECD 2009: 65). According to the statistical standards definition of the OECD and Eurostat, an innovation is:

> An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational

[40] See search results at: Online Etymology Dictionary: available from: http://www.etymonline.com/index.php?search=innovation&searchmode=none. [2010-10-5]

> method inbusiness practices, workplace organisation or external relations.
>
> …..Innovation activities are all scientific, technological, organisational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations. Some innovation activities are themselves innovative, others are not novel activities but are necessary for the implementation of innovations. Innovation activities also include R&D that is not directly related to the development of a specific innovation. (OECD 1997,2005a: 46-47).

This view represents a techno-economical conception because it refers predominantly to technological product and process innovations and thus it is commonly used to measure economic productivity at a regional, political or firm level[41]. In the innovation literature, the problem of how to assess what means "new" has led to the distinction of the types of innovation according to the intensity of change they induce in a relevant application field. Studies differentiate intensity as follows (Braun-Thürmann 2005: 42, Christensen & Laergreid 2010 cited in OECD 2009: 66, 69): Incremental innovation products and processes or radical innovation products and processes. Whereas the first type of innovation results only in minor changes to existing services or products, the second one will lead to the introduction of *new* services or ways of "doing things" in relation to a process or service delivery. Moreover, Christensen and Laergreid (2010) further distinguish this view and characterise the impact of innovations as either: sustaining *innovation*, or *disruptive innovati*on. The impact of sustaining innovations lies in improved performances to existing services introduced in a traditional way or method. The impact of disruptive innovations is defined as a new performance trajectory by introducing new dimensions of performance, either creating new markets or offering more convenience or lower prices to customers at the lower end of an existing market (cited in OECD 2009: 69). Clayton (2008) describes examples of disruptive innovations in business and discusses strategies and principles for educational innovations.

3.4.3 Different typologies of innovation

In general, the European Union and the OECD statistical departments distinguish between the following types of innovations can be distinguished (for all see source: OSLO Manual, 2005): A *product innovation* is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics.

41 For more details on standard definitions, see revised indicators (OECD 1997; 2005): Available from: http://www.oecd.org/dataoecd/35/61/2367580.pdf.

Product innovations can utilise new knowledge or technologies, or they can be based on new uses or combinations of existing knowledge or technologies.

A *process innovation* is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. Process innovations can be intended to decrease unit costs of production or delivery, to increase quality or to produce or deliver new or significantly improved products.

A *marketing innovation* is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. Marketing innovations are aimed at better addressing customer needs, opening up new markets or newly positioning a firm's product on the market, with the objective of increasing its sales.

An *organisational innovation* is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations. Organisational innovations aim to increase a firm's performance by reducing administrative costs or transaction costs, improving workplace satisfaction (and thus labour productivity), gaining access to non-tradable assets (such as non-codified external knowledge) or reducing costs of supplies (see OECD, Oslo Manual 2005 Chapter 3, p. 47pp.).

A *social innovation* is generally regarded as new a societal structure or idea aiming at social change, e.g. the introduction of the legal voting right for women (see Howaldt &Michael Schwarz 2010). The theory of social change was advanced by Ogburn (1923), who distinguished between material and non-material culture (see Braun-Thürmann 2005: 19). Andrea Bassi (n.d.) identifies three different approaches to social innovation: the systematic, pragmatic and managerial.[42] Westley and Antadzes (2010) propose a comprehensive definition of social innovation: "Social innovation is a complex process of introducing new products, processes or programs that profoundly change the basic routines, resource and authority flows, or beliefs of the social system in which the innovation occurs. Such successful social innovations have durability and broad impact" (cited in Bassi, 2011: 1).

If one approaches e-learning innovations from an objectivist point of view, th above definitions might fit for a research approach. However, in a dialectiv view and for the purpose of the framework development those approaches to innovation are not

[42] http://www.esse.unibo.it/paper.pdf.

heplpful, because they do not refer to any interrelations both of the shaping and integration process of an innovation . Thus, in this thesis, we will introduce the concept *of systemic innovation*, which draws attention away from a single innovation product or innovation process to a more holistic view.

3.4.4 Systemic innovation and change in educational systems enabled by ICT

A systemic perspective on innovation focuses on the related systems, very often this view is laid on "national innovation systems" with research, development, production and marketing being simultaneously optimized in an interactive process (see Howaldt and Schwarz 2010). Taylor and Levitt (2004) view an innovation as systemic innovation, if it reinforces the existing product, but necessitates a change in the process that requires multiple firms to change their practice. In economic terms, systemic innovations typically lead to increases in overall productivity over the long term. However, they also cause additional costs (e.g. switching or start-up costs) for some participants, and reduce or eliminate the role of others. Taylor and Levitt (2004) point to new virtual design and construction, supply chain integration, and prefabricated subcomponent wall systems in homebuilding as example.

		Core Concept	
		Reinforced	**Overturned**
Linkage between Core Concepts & Components	**Unchanged**	**Incremental Innovation** *Example: Lumber Wall Truss Frame Replacing Conventional Stick-Built Lumber Wall Frame*	**Modular Innovation** *Example: Extruded Metal Truss Frame Replacing Conventional Stick-Built Lumber Wall Frame*
	Changed	**Architectural ("Systemic") Innovation** *Example: Prefabricated Wall Frame with HVAC, Plumbing & Electrical Components Replacing Conventional Stick-Built Lumber Wall Frame*	**Radical Innovation** *Example: Geodesic Dome Frame Replacing Conventional Stick-Built Lumber Wall Frame*

Figure 14: Types of innovation depending on intensity of change.

Source: Taylor and Levitt (2004)

Being aware that this view stems from a rather objectivist view on innovation and technology, it might be interesting to adopt it to the field of e-learning. In the example of e-learning and e-portfolio, one has to ask what is the core concept of e-portfolio and what are the components? What is the impact of e-learning, does it lead to new results in education? Does it only re-inforce the traditional way of teaching? Several frameworks have been developed by researchers and practitioners that aim to characterise the ways ICT can support and promote educational innovation. Kozma

(2000) characterises ICT-based innovations in four main dimensions: curriculum content and goals, student practices (activities, products, roles and collaborations), teacher practices (methods, roles and collaborations) and the ways of ICT use in schools. For the purpose of this thesis, we will follow another approach, based on Crosta et al. (2009), which characterise ICT-based innovation in education The e-learning research group at the EU research centre understand ICT-enabled innovations as a threefold concept "which should amalgamate both technological novelties (tools, programs, hardware, etc.) and sociological novelties (target audience, social integration, social interaction) and also the improvements in the quality of the service (educational improvement, learning support, teaching support, etc.)" (Crosta et al. 2009).

Therefore, in the following section, ICT-enabled innovations in education will be systematically divided into three sets of innovation levels and combined with the impact and change.

Techno-pedagogical innovation	***Organisational innovation***	***Systemic innovation***
Unchanged core-concept of teaching	Changed core-concept	Changed core-concept
Roles of actors change	New roles of actors emerge and become routine	Re-design of roles of actors and of structures necessary
High change of actors; low structural change	High change of actors; high change within insittutional structures	High change with all actors; high change of structures at all levels of a national education system

Table 7: Levels of change of an ICT-based innovation in education.

In the following, I will characterise these three forms of innovations in the field of e-elearning:

- *Techno-pedagogical innovation in education*

ICTs and electronic media in education can be regarded as techno-pedagocial innovations, if the basic technology and/or media used changes and a new tool or software is developed for use in educational organisations and teaching and learning processes (= radical innovation). Very often new releases and mergers of existing tools and software occur (= incremental innovation). Tools and services developed for another purpose are thus integrated and adapted to a current learning setting. The use of ICTs can potentially make a difference in teaching and learning, but this alone does not necessarily lead to a new pedagogical setting. Some authors provide studies that "learner-centred guidance, group work and inquiry projects result in better skills and competencies and that interactive forms of e-learning can lead to a more reflective, deeper and participative learning, learning by doing, inquiry learning, problem solving, creativity, etc all play a role as competencies for innovation and can be enriched and improved by using e-learning"[43]. Other authors characterise pedagogical ICT-supported innovations if they foster "learner-centered and constructivist processes, and the acquisition of lifelong learning skills. Such skills include the planning of one's own learning, self-assessment of learning processes and outcomes, making decisions as to whether and when to act as an active or passive learner, adapting to changes in learning settings, applying collaborative skills, or integrating knowledge from different disciplines using different learning strategies for different situations (Knapper & Cropley 2000)" (Forkosh-Baruch & Nachmias 2005). Kozma and Anderson (2002) study new pedagogical practices for formal classroom education enabled by ICT in different countries. For this study, only schools and pedagogical practices qualify as a "innovative pedagogical use of technology":

(i) In which technology plays a substantial role,
(ii) With evidence that indicates significant changes in the roles of teachers and students, the goals of the curriculum, assessment practices and/or the educational materials or infrastructure,
(iii) With evidence of measurable positive student outcomes, and
(iv) The innovative practice shows sustainability and transferability (SITES n.d.).

The researchers provide a list of examples drawn from literature: Promote active and independent learning in which students take responsibility for their own learning, set their own learning goals, create their own learning activities and/or assess their own progress and/or the progress of other students; provide students with competencies and technological skills that allow them to search for, organise, and analyse information and communicate and express their ideas in a variety of media forms; engage students in collaborative, project-based learning in which students work with others on complex,

43 http://ec.europa.eu/education/lifelong-learning-programme/doc/sec2629.pdf.

extended, real-world-like problems or projects; provide students with individualised instruction, customised to meet the needs of students with different entry levels, interests or conceptual difficulties; address issues of equity for students of different genders or ethnic or social groups and/or provide access to instruction or information for students who would not have access otherwise because of geographic or socio-economic reasons; 'Break down the walls' of the classroom—for example, by extending the school day, changing the organisation of the class, or involving other people (such as parents, scientists, or business professionals) in the education process; improve social cohesiveness and understanding by having students interact with groups and cultures that they would not interact with otherwise (Kozma & Anderson 2002).

- *Organisational innovation in education*

Changes in pedagogy and organisation will come with growing e-maturity of the actors involved and the enabling organisational structures. Organisational change increases the impact of a techno-pedagogical innovation, as schools evolve for example towards open learning centres, universities towards "blended" learning service providers, companies towards learning organisations and cities and regions towards learning support environments. This implies for example, the development of new curricula, new course guidance systems, e-assessment systems, new network relations etc.(see table 8) that may change due to the use of ICT in learning and teaching in the whole institution. E-portfolios could be used to provide a digital record of learning achievements in formal, non-formal and informal learning settings and offer a showcase for students' work for his/her educational biography not only at one institution. However, in order to reap benefits from such a new techno-pedagogical innovation, the concept needs to be used not only in one lecture, but at the whole organisation (for reasons orfcomparativitiy) and/or in other organisations to which a student moves on (e.g.from school to university to adult training programmes). Universities need a special knowledge base required for the successful implementation of organisational innovation in education and training, including and intelligent and innovative use of ICT for lifelong learning. In order to develop such organisational knowhow, the European Commission supports the development of training and standards needed for points of transitions from one school/university to another (see the variety European funding programmes for e-e-learning[44]).

[44] http://ec.europa.eu/education/lifelong-learning-programme/doc/sec2629.pdf

- *Systemic innovation in education*

According to the OECD-CERI, a systemic innovation can be defined as "*any kind of dynamic system-wide change that is intended to add value to the educational processes and outcomes. Systemic innovations are aimed at the improvement of the operation of the systems, their overall performance, the perceived satisfaction of the main stakeholders with the system as a whole, or all of the above. The term "systemic" should not be interpreted as if the whole educational system needs to be involved"* (see citation from online document of the CERI Institute[45]. Systemic innovations are aimed at the improvement of the operation of the educational systems, their overall performance, the perceived satisfaction of the main stakeholders with the system as a whole, or all of the above (OECD 2009b).

Type of innovation	Area of innovation	Characteristics
Organisational innovation	Access to education	New target groups to education (e.g. illiterate learners); OER
	Assessment	Assessment with students and for them
	Financing	Efficient means for adimintration
	Services	Use of ICT for enrolments, assessment, library changes, personalised services
	Curriculum, Programme, Certificates	New certificates for e-learning competences; Development of online-curricula
	External relations	New partnerships with other educational institutions (merger); foundation of new institutions (online universities)
Techno-pedagogical practice	Pedagogy/ Teaching and learning methods	deviation from traditional didactics Individual learning needs
	Innovative pedagogue	New role of teacher – facilitator
Technological innovation	Digital learning material	New topics to be taught (e.g. environment) End of one textbook for all…
	Web-based learning environment (e.g. Moodle, e-portfolio software	Time and space independent
Systemic innovation	Changing parts of national education system	Central assessments; E-portfolio integration; transfer systems

Table 8: Areas of ICT-based innovation in education;

based on Seufert & Euler 2003; 2004; Kozma & Anderson (2002) ; Nuissel 2011;

[45] http://www.oecd.org/document/1/0,3746,en_2649_35845581_38777345_1_1_1_1,00.html

Summing up, it has become clear from this chapter that also the term “innovation” carries different implications. In the case of e-portfolio the dimension of change will become an important element, which should be considered in the integrative, multi-level framework.

3.5 Characterisation of e-portfolios as ICT-based innovations

During the past few years, e-portfolios have gained widespread attention in e-learning research and practice with the first reported pilots undertaken in Anglo-Saxon educational systems (US, Canadian and UK) in the late 1990s. This section will develop a systematic understanding of the underlying technical, pedagogical, organisational and systemic aspects about the role and function of e-portfolios as an e-learning instrument. It will characterise e-portfolios based on the previously outlined theoretical concepts of ICT-based innovation and discuss their techno-pedagogical, organisational and systemic role and function in a national education system.

3.5.1 Etymological origin

The term e-portfolio is a combination of the letter “e”, which stands for electronic (in contrast to paper-based), and “portfolio”, which by origin is traced back to the Italian language around the end of the 19th century. According to the Online Etymology Dictionary[46], at that time a portfolio meant “a case for carrying loose papers," (see porta, imperative of portare "to carry" and “foglio" (sheet, leaf see from Latin. folium/folio).

3.5.2 Different conceptual views of role and function of e-portfolios

As Barrett outlines, paper-based portfolios as practical containers of skilful work are not a new thing. “Artists have maintained portfolios for years, often using their artefacts and collection for seeking further work, or for simply demonstrating their art; an artist’s portfolio usually includes only their best work. Financial portfolios contain a comprehensive record of fiscal transactions and investment holdings that represent a person’s monetary worth. By contrast, an educational portfolio contains work that a learner has selected and collected to show growth and change over time; a critical

[46] Online Etymology Dictionary: available from: <http://www.etymonline.com>.[2011-03-10].

component of an educational portfolio is the learner's reflection on the individual pieces of work (often called 'artifacts') as well as an overall reflection on the story that the portfolio should tell" (Educational Encyclopaedia forthcoming[47]). However, discussions at international e-portfolio conferences and the collections of proceedings make evident that there is still much confusion and discussion about the "right" concept of an e-portfolio.The table below classifies the different views of the role and function of e-portfolios from the perspective of how e-learning is taught.

View	Focus	Definition and purpose of e-portfolio
Objectivism	Product - Technology and media as an instrument for documenting learning results for assessment.	E-portfolio is a *software* (digital educational media) that allows to integrate lifelong data and multimedia material ((video, audio) of a learning biography. Allows standardisation if skills and competences. = educational technology (multimedia software)
Subjectivism	Process - Role on personal learning process and social/pedagogical interaction with teachers and tutors	E-portfolio is an electronically enhanced *pedagogical method* for individual learning and reflection. = pedagogical method
Dualism	Product or Process	E-portfolios are seen either as a product (e.g. digital CV) or a process of learning (learning journey) = software product or pedagogical method
Dialectics	Product and Process	E-portfolios combine the product and process of personal learning and development planning useful for institutional and individual assessment/ reflection = techno-pedagogical learn setting

Table 9: Classification of the conceptions of e-portfolios.

Authors considering e-portfolio in the instrumental or objectivistic way put the aspect of the technological software product in the centre of the definition, such as e-portfolios are "software that allow to integrate lifelong data and multimedia material (video, audio) of a learning biography". Similarly, Wilson (2005) notes: "An e-portfolio is a repository of information about a particular learner provided by the learner and by other people and organisations, including products in a range of media that the learner has created or helped to create alongside formal documents from authoritative sources, such as transcripts of assessed achievement, which the learner has chosen to retain" (cited in

[47] http://electronicportfolios.com/portfolios/encyclopediaentry.htm available from: <http://www.etymonline.com>.[2011-06-10].

MOSEP 2007: 28–29). The e-portfolio association of California defines an e-portfolio as follows: “At its basic core, an ePortfolio is a digitized collection of artifacts including demonstrations, resources, and accomplishments that represent an individual, group, or institution. This collection can be comprised of text-based, graphic, or multimedia elements archived on a Website or on other electronic media such as a CD-ROM or DVD” (http://eportfolioca.org; [accessed 2011-06-03]). The figure below illustrates the different functions of e-portfolio tools.

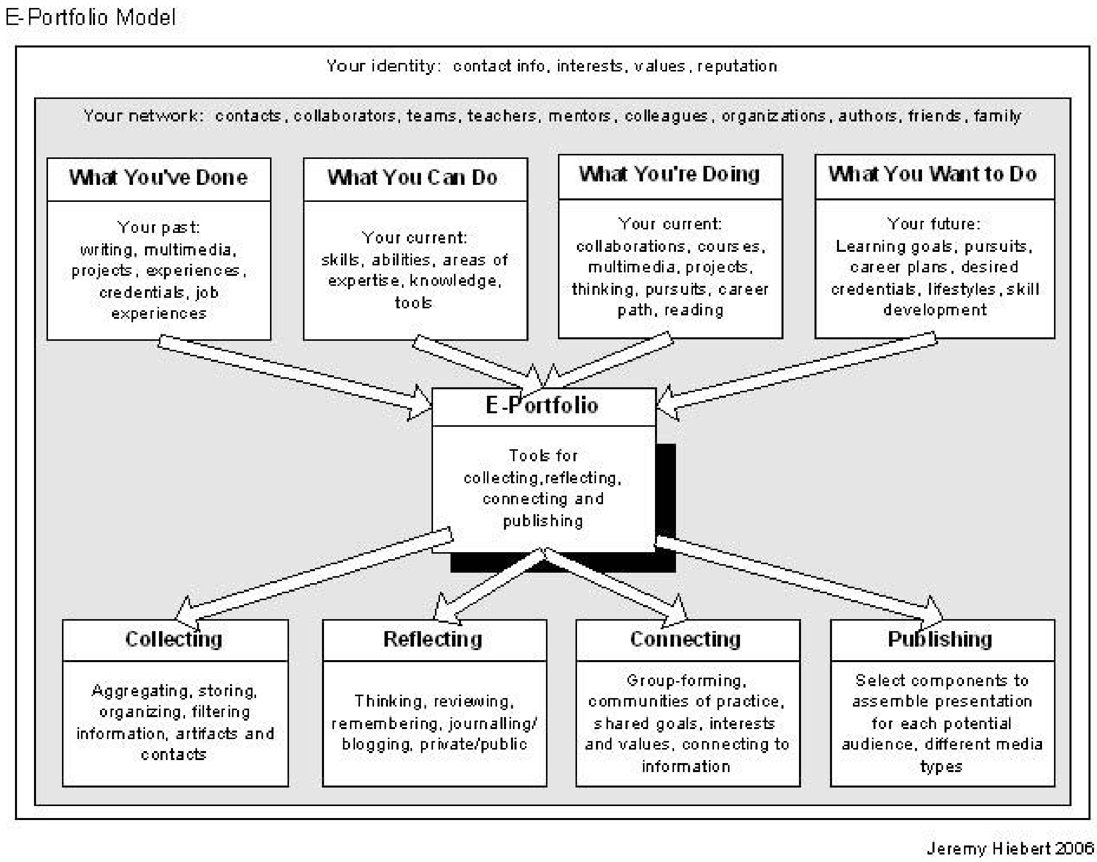


Figure 15: A generic e-portfolio model

Source: Hiebert (2006)

Writing about the low integration uptake, Batson (2009) argues: “The problem is that portfolio is a learning approach not a technology … the essential nature of an ePortfolio for learning is not as a repository but as a place for reflection” (2009 n.d.). Gray & Joyes (2010a) interviewed the following persons: The subjective-orientated researcher would point out the societal and communicative aspect of the pedagogical method of e-portfolios: “It is a reflection of the student as a person undergoing continuous personal development, not just a store of evidence (Rebbeck 2009). Darren Cambridge (2008), based on a technical e-portfolio background and longstanding teaching and e-portfolio research experience, would put the pedagogical practices in the centre:."E-portfolios are a genre, a set of practices supported by a set of technologies" (2010).

The educational theory guiding this thinking is rooted in the constructivistic learning approaches of "self-directed learning (SDL)", based on works of Deci and Ryan (1985, 2000, namely Self-Determination Theory (SDT), and others (e.g. Assor 2008; Vallerand 1997). SDT is a motivation theory developed by Deci and Ryan at the University of Rochester that has its foundations in the idea of the innate needs of human mankind (competences, relatedness and autonomy) and the concepts of balancing extrinsic and intrinsic motivation[48]. Related to SDT is the concept of SDL, which was explored by Hiemstra (1994). This includes the concepts of the "proactive assumption of responsibility" and "self-determination" to act as the primary causal agent in one's life and make choices and decisions regarding one's quality of life free from undue external influence or interference (Wehmeyer 1992). It also includes "metacognitive learning", which implies a competence in planning, monitoring, self-questioning and self-directing personal learning (Hiemstra 1994). The scheme below summarises the meta-learning strategies taking place during a learning and knowledge process.

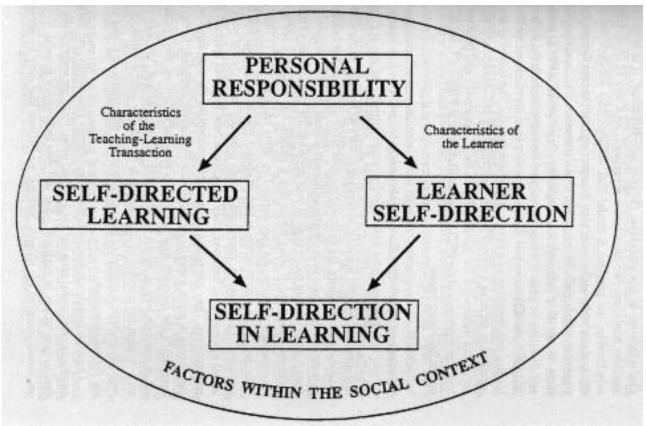


Figure 16: The Personal Responsibility Orientation Model

Source: Hiemstra 1994.

The Joint Information Systems Committeee (JISC) bases its work on the understanding that the term encompasses both product and process. "An e-portfolio is the product, created by the learner, a collection of digital artefacts articulating experiences, achievements and learning. Behind any product, or presentation, lie rich and complex

[48] http://www.psych.rochester.edu/SDT/.

processes of planning, synthesising, sharing, discussing, reflecting, giving, receiving and responding to feedback. These processes – referred to here as 'e-portfolio-based learning' – are the focus of increasing attention, since the process of learning can be as important as the end product" (JISC 2008b). The following table provides an overview about the e-portfolio processes used for different purposes (Joyes & Hartnell-Young 2009).

Purpose/ Context	e-portfolio Process	Information capture	Information retrieval	Planning	Reflection	Feedback	Collaboration	Presentation	Technical requirements
Personal Development Planning / Continuing Professional Development									
Transition/ Application									
Work Based Learning/ Employment									
Assessment									
Life-long learning									
Technical progress									

Table 10: The e-portfolio purpose-process matrix. Source: Joyes & Hartnell-Young 2009.

Barrett has worked out the dualistic problem of conceptualising e-portfolios as either a product or a process, which can be depicted in her diagram about the two faces of e-portfolios.

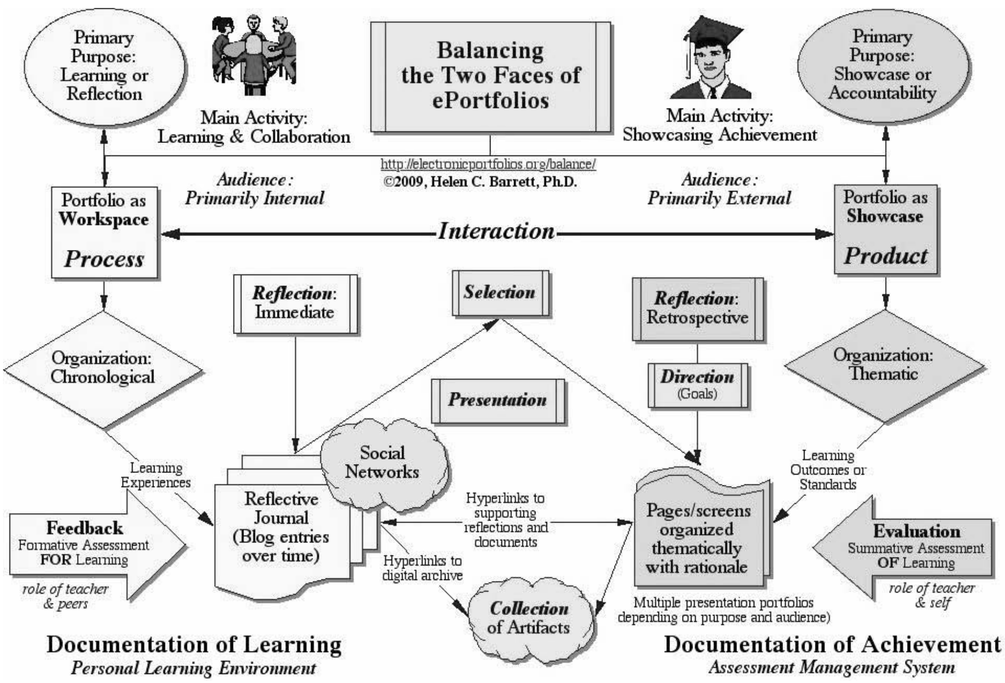


Figure 17 :The dualistic view of e-portfolios. Balancing the Two Faces of e-portfolios. Source: Helen Barrett, Ph.D[49].

[49] http://electronicportfolios.org/balance/index.html

"A portfolio is often defined as a purposeful collection of student (or teacher) work that illustrates efforts, progress, and achievement in one or more areas over time. An electronic portfolio uses digital technologies, allowing the portfolio developer to collect and organize portfolio artifacts in many media types (audio, video, graphics, text). A standards-based portfolio uses a database or hypertext links to clearly show the relationship between standards or goals, artifacts, and reflections. The learner's reflections are the rationale that specific artifacts are evidence of achieving the stated standards or goals. An electronic portfolio is a reflective tool that demonstrates growth over time." (Barrett 2000, 2005). An attempt to provide a taxonomy on e-portfolio was put forward by the e-portfolio team of the Danube University (Baumgartner 2008).

Proposing a dialectical view of e-portfolio, in this thesis I consider e-portfolios as a "techno-pedagogical" innovation with both the technical product and the pedagogical underlying process characteristics that shape each other. Since the learning and teaching process is mediated through e-portfolio software and/or Web 2.0 tools, the pedagogical process is different to a paper-based-led portfolio process with boxes and drawing papers.

3.5.3 E-portfolio as a technological innovation

An e-portfolio system is made up of a space for storing digital artefacts and resources. Then, different e-learning tools support the typical pedagogical e-portfolio processes of e-portfolio work, such as authoring, publishing, communicating, sharing and collaborating (see Barrett 2000; Hornung-Prähauser et al. 2007; Häcker 2006b). As outlined in Chapter 2, the change that ICTs have brought to an e-portfolio process implies different tools and methods for authoring, storing and publishing digital artefacts. E-portfolio work involves three technical aspects: publishing environments, authoring environments and infrastructural environments. In the course of time, publishing environments have changed from optical media (CD-ROM, DVD-ROM) to the Internet, authoring environments have altered from single common software tools (e.g. HyperCard, HyperStudio, MS Office & Adobe Tools, HTML editors and content management systems) to central customised systems (either commercial or open source e.g. online databases, work flow and assessment management systems) and infrastructure for storage and data management has varied from personal computer storage, networked solutions to future mobile devices and cloud services.

Batson (2009) states that in the North American e-learning market "more vendors of e-portfolios software then of learning management exist" (p. 1). In the past few years, many studies have been carried out by evaluating the functions and abilities of e-portfolio software (e.g. Richardson & Ward 2005). One of the first attempts was a survey by an American educational technologist working with Edutools, ePac and the Western Cooperative Educational Technology (WCET) co-operation[50]. Based on the catalogue of the WCET (66 functionalities), Salzburg Research extracted six core groups of functions and evaluated a sample of commercial and open source e-portfolio software tools. The focus of the evaluation was the availability of the functions and their usability for different competency levels of e-portfolio users (see Attwell et al. (2007: 67; grafik and tool evaluation done by W. Hilzemsauer, Salzburg Research)

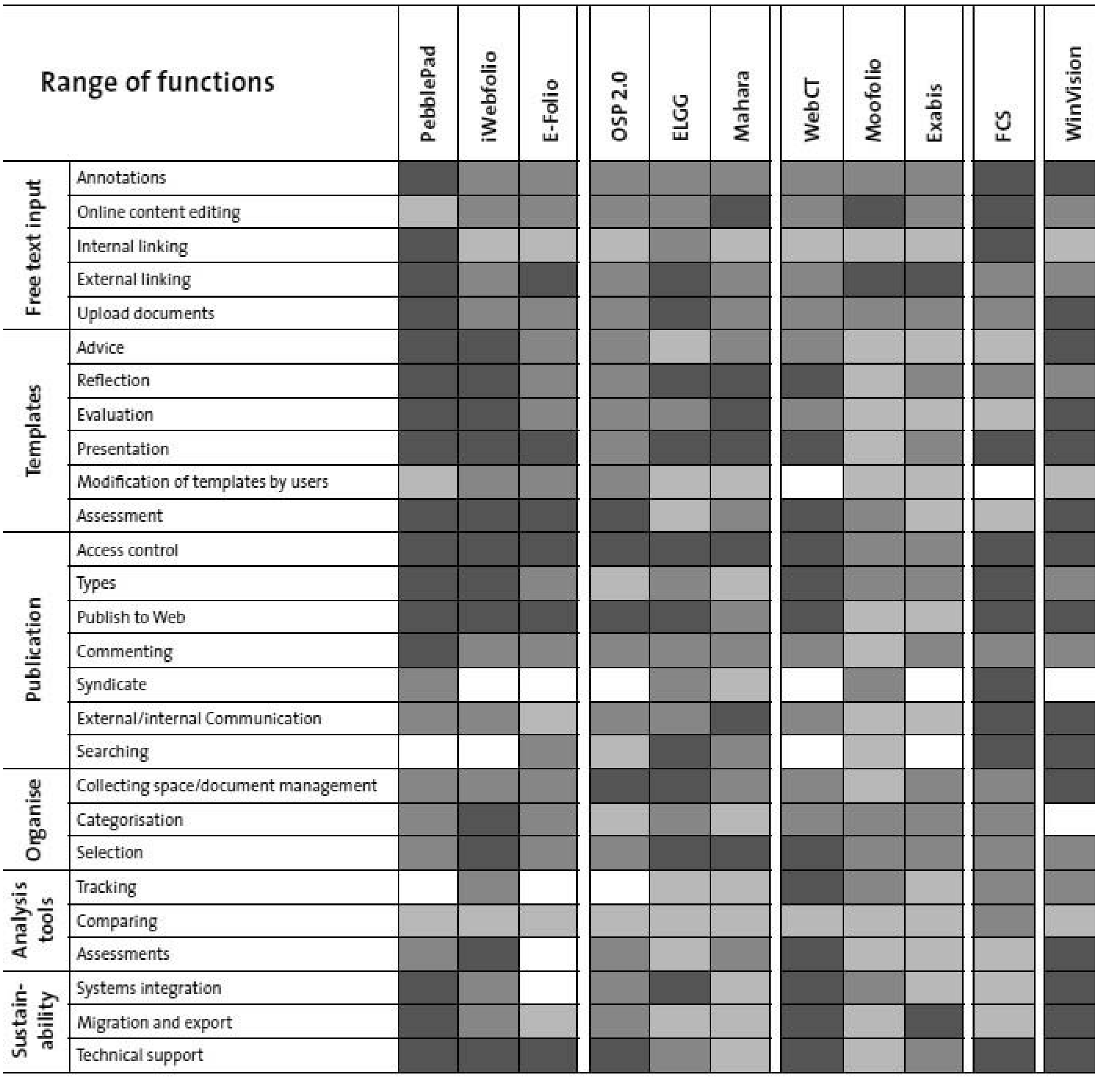


Table 11 : The range of electronically enhanced functions in an e-portfolio process.

Source: Attwell et al. (2007: 67).

50 EduTools. (2011). ELP: Area List. Available at: <eportfolio.edutools.info>.[5-July-2011]

The technical issues in the work with e-portfolios in education are still manifold. Technical interoperability and the privacy of data are two of the most important initiatives for overcoming some of the following problems (see BECTA Report 2006):

- Consistency of provision must not be at the expense of suitability to specific contexts – one standard, multiple implementations,
- Web-services will not be suitable for all institutions – need to learn lessons from institutions following the off-the-peg route as well,
- Open standards will lead to real diversity of products – benefits and risks for institutions e.g. choice and flexibility vs. multiplication of SLAs, support and maintenance requirements, responsibilities, and
- Open standards should advance the ease of use and not make additional demands on ICT or administrative staff (BECTA Report 2006).

The development of the Internet has also influenced the future of the e-portfolio software market. Interdisciplinary e-portfolios keep discussing the use of social software and web 2.0 applications. The possibilities of bridging institutional boundaries with the current state of the Internet 2.0 influence the discussion on a new concept for e-portfolios in education. The vision is to (technically) merge the social and assessment components to enable a new e-portfolio process (Lopez 2010). The following graphic provides a scheme of the components of another idea for technological e-portfolio software innovation.

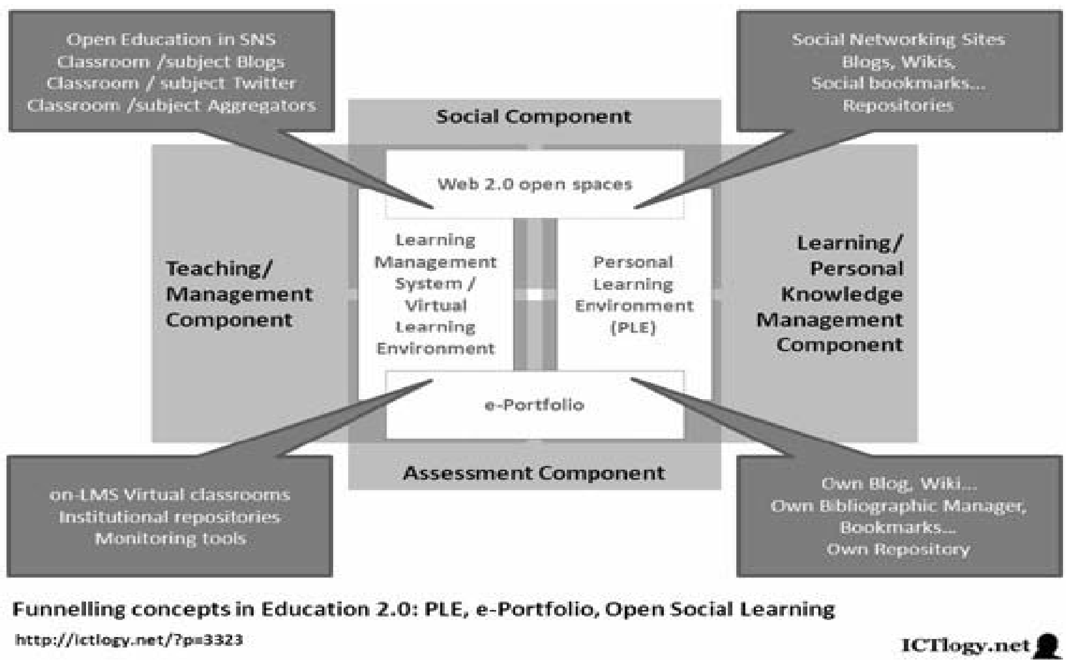


Figure 18: Future trends in Education 2.0 (Lopez 2010)

Source:http://ictlogy.net/20100311-centralisation-vs-decentralitacion-in-government-and-education/

Future scenarios will also investigate the use and adoption of mobile phones in e-portfolio processes (Barrett 2011). Below Barrett has tried to consider a mobile e-portfolio concept.

e-portfolio process to support	Mobile phones (not smartphones)	iOS/Android/Microsoft devices (smartphones)
Capturing & storing evidence	Camera can capture still images, audio and video, transmit to a website or upload to a computer.	Devices with cameras can capture images. audio and video, which can be uploaded to a website or uploaded to a computer.
Reflecting	SMS reflections to a website (depending on the capability of software) - Needs to be similar to Facebook updates	There are mobile apps for several web-based e-portfolio tools as well as generic tools such as blogs
Giving and receiving feedback	No (Can mobile phones read websites to be able to provide feedback/comments?)	Mobile web browsers should allow reading posts and online documents, and providing comments or co-authoring
Planning and setting goals	A form of reflecting (above)	A form of reflecting (above)
Collaborating	One-to-one using SMS Post directly to web-based accounts	One-to-many using online communities and services, such as GoogleDocs or wikis
Presenting to an audience	No (presentations require more powerful tools)	Some apps are available to create presentations and projects with the appropriate hardware connections to projectors

Table 12: Is the Future of E-Portfolios in Your Pocket? Source: Helen Barrett (2011)

The next graphic below shows another attemot to used the fast changing technological ideas on shaping and designing an e-portfolio by Arne Horst (2011), a Dutch e-learning expert at the applied university of INHOLLAND, NL which is a very experienced e-portfolio piloting university (see case Netherlands in chapter 5).

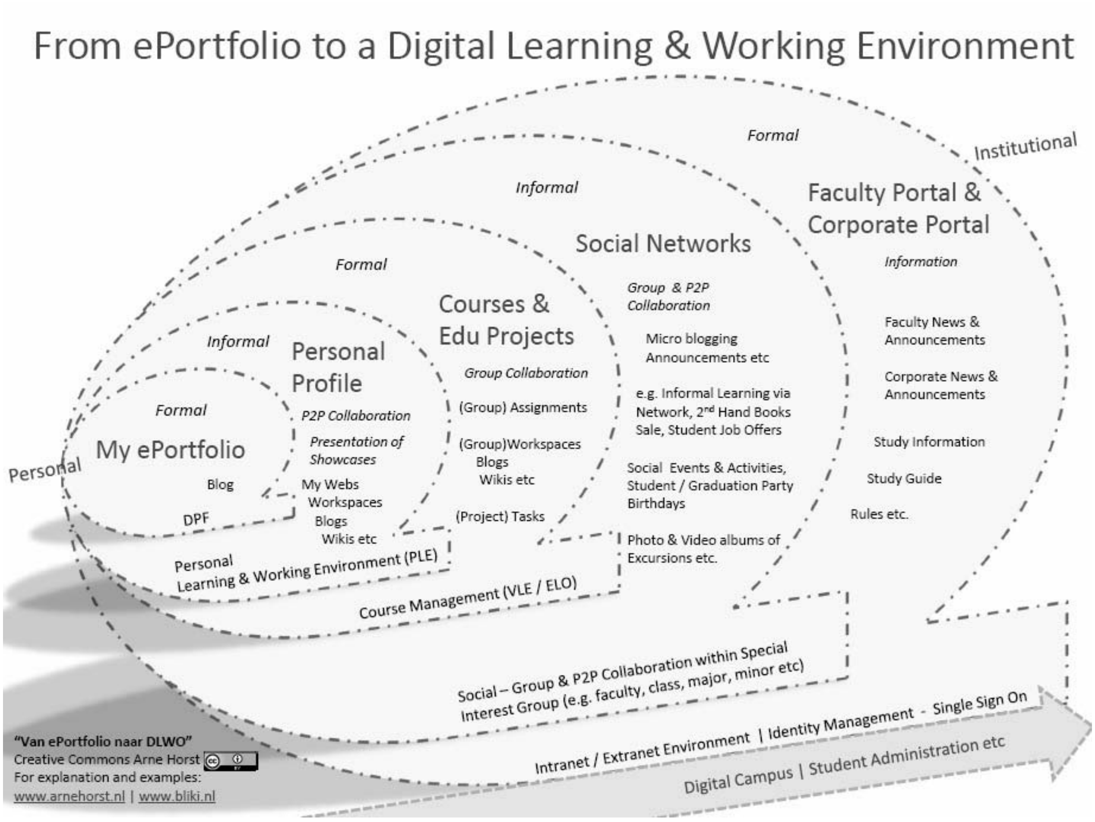


Figure 19: Vision of a new e-portfolio approach. Source: Arne, H. (2010)[51]

Although those visionary models entail a lot of pedagogical thinking, the following section will provide an insight into how to perceive an e-portfolio in a dialect view, both as technical product enabling a new and very different pedagogical e-portfolio process.

3.5.4 E-portfolio as a techno-pedagogical innovation

The idea of portfolio-based learning is not new; it has been mainstreamed in art education in most countries for a considerable period of time. Furthermore, in many vocational and practical subjects, there is a long tradition of producing and demonstrating artefacts developed through participation in a learning programme (see Gläser-Zikuda & Hascher 2007). Those artefacts may contribute to reflecting the learning process. A paper-based portfolio didactic flourished in the times of reform pedagogy, and it was mainly further developed and used by pedagogical scientists with constructivistic pedagogical backgrounds such as Maria Montessori and John Dewey (see Hornung-Prähauser et al. 2007). The pedagogical aim of portfolio work is to support individual strategies to solve subject-related problems, to develop strategies to

[51] See Blog, Arne, H. Available from: <https://www.surfgroepen.nl/personal/arne_horst/Blog/Lists/Posts/Post.aspx?List=e164a2a3-aa4e-4931-b5f3-2728f497e2f7&ID=57>.[2011-08-03]

plan and pursue learning goals by reflection, to document and record learning results and to discuss them at a meta-cognitive level. It can also be an instrument for alternative assessment. All in all, it offers the potential for designing real learning time, a concept advanced by Hascher (2007: 296). Paper- and e-portfolio-based learning has the potential to benefit learners because of its support for the following pedagogical processes (Beetham 2005: 5; Jafari & Kaufman 2006):

• "Summative assessment: demonstrating competence according to criteria set out within a programme of study or by an accrediting body,

• Learning and 'learning to learn': enabling the learner to identify and reflect on their strengths and weaknesses, making use of formative feedback, and enabling professionals to support learners in ways appropriate to their achievements and preferences, by drawing on information in the profile,

• Presentation: showcasing the learner's best or most relevant achievements in the context of a specific learning or career opportunity, for example on application to a school, university or during a professional development review,

• Personal and professional development planning: supporting the general pro-cess of reflection, self-evaluation and action planning for lifelong learning, including guidance on educational and/or career pathways." Beetham 2005: 5; Jafari & Kaufman 2006).

The idea behind the pedagogical process is described in the MOSEP study as follows:

"The e-portfolio process informs and supports the planning process. The learner uses their reflections to plan what it is that they must do to move forward, to learn something, to achieve something, to produce something etc. It simply adds the Record stage to the Plan, Do, Review cycle. The Record stage is very important in that it can make the reflection more 'explicit' which in turn enables and encourages the learner to share their reflections with others. The sharing process might help the learner to take more from the learning experience, but more importantly if a learner has to spend time preparing their thinking so that they can share it with others they might engage in 'deeper' thinking as they try to make sense out of their experiences and fit it into their existing thinking, memories, structures etc, hopefully enabling them to take more out of the learning experience. The different stages of the learning process (derived from Kolb's learning cycle) can be combined with the e-portfolio processes" (see Attwell et al. 2007; MOSEP project study). How does the use of ICTs affect the didactical e-portfolio processes and exert change? The portfolio process, supported by digital technologies, offers the advantage of archiving different e-portfolio artefacts (e.g. assignments, courses, certificates, grades, project results, research papers), publishing them with web technologies and sharing them with others by means of collaboration tools or other social software e.g. Wiki and Weblog. The following section summarises some benefits of using IT by developing electronic portfolios (see Hornung-Prähauser & Luckmann 2009; Hornung-Prähauser et al. 2008, Butler 2006, Challis 2005).

	Traditional paper-based portfolio work	Electronically enhanced e-portfolio work
Product view		
Artefacts	Analogue media: homework, assessment reports	Digitised learning results and media
Carrier	Box (paper), ring files	CDs, DVD; Digital file forms
Process view		
Collecting	Paper, photo collection by hand	Collection of ny digitised object by means of ICT-skills
Storing	Paper box	Digital archives
Reflecting	One-to-one feedback	One to many feedback
Publishing	Print	Prin and web publishing

Table 13 Differences in using ICTs for handling an e-portfolio processes.

• Support of different skills and media competences:

The use of IT has a motivational aspect, since the use of “cool tools” makes learning activities more attractive. Digital e-portfolio work supports the development of media competences more than using only scissors, glue and paper. Electronic portfolios can integrate a huge amount of digital artefacts by means of using different media formats (e.g. text, pictures, sound, video, animation). Learners with different skills and learning styles (text, writing, reading, audio) can thus be addressed more easily.

• Enhancement of the learning process:

E-portfolio users can document their learning results in more than one linear way. The easy-to-use e-portfolio software (often a content management system in technical terms) can link formal and informal learning processes. This enables direct communication and review besides the contact between the learner and tutor as well as to peers. The assessment of an e-portfolio is documented and archived, and thus always transparent.

• Chronological documentation and administration:
The electronic archiving and administration of artefacts and the various steps in development provide automatic documentation (e.g. history function). Moreover, e-portfolio systems based on social software and Web 2.0 tools allow for a description of artefacts and tagging without having to arrange the artefacts as new. The digital organisation has a simple structure, with search functions that allow the administration of many artefacts (not only linear and hierarchical order). Software allows the integration of more and different learning results, which by use of hyperlinks can be referenced in many different ways.

• Flexible access to information by different audiences:
An e-portfolio saved on a web server can be accessed by different viewers and feedback is possible without time restrictions. Using social software, the circle of people reading the e-portfolio can be – with the control of the e-portfolio owner –enlarged. Parents can accompany their kids in difficult times more closely and share their ideas and views. More intensive feedback and reflections loops are also possible.

• Easier e-portfolio transfer, distribution and presentation

Disadvantages of digital portfolios is the insecurity of data, as is the case with almost all ICT services involvong personal data (see Behrendt, W., Hornung-Prähauser, V. & Hilzensauer, W. (2006).E-portfolios are also discussed as one form of electronic assessment (Becta 2006), as summarized by the table below:

(E)-assessment	(E)-portfolios
The (electronic) process by which learners progress and understanding is assessed. This can be: • diagnostic (to assess the current levels of knowledge and understanding in order to target future learning appropriately), • formative (to support and feed back into current learning), • summative (to assess knowledge and understanding at the end of an episode of learning, usually equated with a formal award). Outcomes of assessment of all types may feed into a learner's e-portfolio.	The (electronic) process and services through which outcomes of learning and assessment are recorded. • The process and services through which the outcomes and evidence of learning are used to support transitions between phases of learning and career development across a lifetime. • A process of presenting digital evidence of progress and achievement to one's self and others. • A process to support reflection on learning.

Table 14: Relation between e-assessment and e-portfolio.

Sources: Becta (2006) and Hornung-Prähauser et al. (2007)

3.5.5 E-portfolio as organisational innovation

As described before, an *organisational innovation* is regarded as the implementation of a new organisational method in a firm's business practices, workplace organisations or external relations. Organisational innovations aim to increase a firm's performance by reducing administrative costs or transaction costs, improving workplace satisfaction (and thus labour productivity), gaining access to non-tradable assets (such as non-codified external knowledge) or reducing costs of supplies (see section 3.4.3). Following this definition, it can be questioned what methods and processes in the realm of an educational institution change because of e-portfolio implementation at the institutional level. In the literature, the common understanding is that e-portfolios are used as:

- Competence-based, alternative assessment methods (curriculum-based),
- Study guidance tools,
- Recruitment instruments,
- A means for student transfers between different departments, and
- Career guidance tools (see Baumgartner, P., Himpsl, K. & Zauchner, S. (2009).

The San Francisco State University describes the purpose of the institutional use of e-portfolios as addressing "a current and emerging need for students to have an environment in which they can collect, select, reflect upon, build, and publish a digital archive of their academic work. These ePortfolios can serve multiple purposes within the SF State academic setting. Students can use them to showcase achievements and/or receive feedback and assessment from faculty, peers, potential employers or graduate programs. Universities can use them to collect student work and assessment data for accreditation purposes or recruitment of future students. Since e-portfolios are becoming more commonplace in the K-12 and Community College systems, they can also be used by feeder institutions in California to assist with student transfer to SF State" (Cox et al. 2008: 4).

The difference between e-portfolios as techno-pedagogical innovations and organisational innovations lies in the greater number of people and processes affected. For examples, Kemper and Boer (2006) describe the introduction of e-portfolios in the university system of the Netherlands as the "realignment of the organisation", which is connected with the other management areas and processes of an educational institution. Kemper and Boer (2006) describe the introduction of e-portfolios within their university system in 2003 (INHOLLAND University). This university was the result of a merger of four major Dutch universities in 2002, and it is one of the largest institutes for higher education in the Netherlands with more than 38,000 students and over 3,500 employees. INHOLLAND comprises 16 campuses and learning centres throughout the western part of the Netherlands. The university offers a wide range of bachelor and master programmes such as finance, IT, business management, communication, economics, education, social work and health care. Its e-portfolios have affected not only the pedagogical and didactical strategy at the micro-level, the lecturers and students, but also the management between the different educational departments and the university as a whole. They affected the business strategy, the ICT strategy, the organisational structures and processes and the ICT infrastructure and processes.

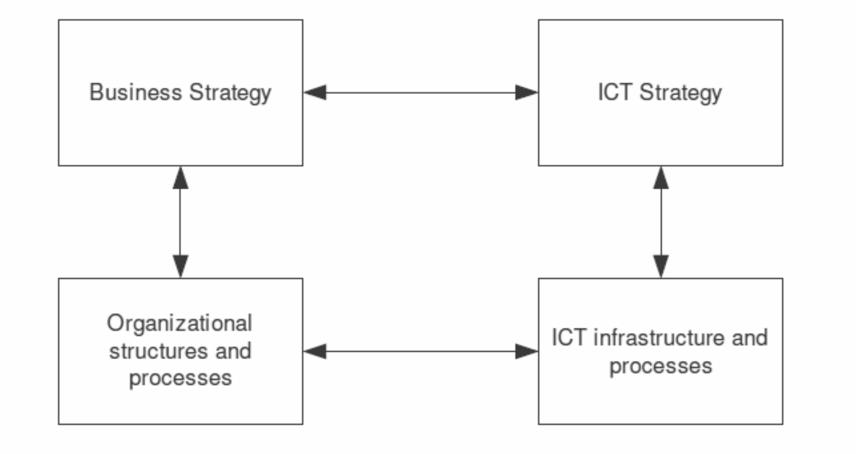


Figure 20 : Concept of organisational integration of e-portfolios at INHOLLAND University, the Netherlands. Source: Kemper & de Boer 2006.

The implementation at an organisational level of a school, university or adult education requires change and resources at three intersecting areas (Cox et al. 2008: 4–5):

- Educational best practices: Demonstrates best teaching and learning practices from an educational planning and assessment perspective. Integrates universal design for learning principles to ensure accessibility for all.
- Student and faculty support systems (training, hotlines): Offers comprehensive and tailored pedagogical and technical support for faculty and students in order for them to develop the technical and cognitive skills associated with assigning, creating or evaluating (rubrics, guidelines).
- Technology infrastructure: Provides a reliable, scalable and robust technological solution for creating, hosting and archiving e-portfolios. The system integrates with, and extends, the current campus technological environment. Beetham (2005) summarises the many challenges for e-portfolio implementations at the organisational level:

- "Portability: credibility and recognition of information by different parties
- Flexibility: different kinds and degrees of access while retaining learner control of information
- Interoperability and open standards for learner records
- Interoperability of business processes across organisations and sectors
- Motivating learners: learner control over look and feel; the potential to include multimedia files as evidence; professional and appealing outcomes
- Developing learner skills in self-evaluation, reflection and personal development plan
- Understanding and enhancing learner motivation, particularly once they move out of a

structured personal development plan context

• Developing practitioner skills in supporting reflection and personal development plan

• Further development of electronic tools to support reflection and personal development plan

• Integration with advice and guidance services

• Integration with electronic services such as CV building, job search, access and social inclusion services, and services provided by professional bodies

• Focus on best practice in the process of personal development plan rather than the enabling systems".

The issues relating to the use of e-portfolios to support the learning process include:

• "Developing effective and credible diagnostic tools,

• Integrating diagnostics, learner tracking and e-portfolio functions,

• More research into adaptive/personalised learning, including work on accessibility,

• Cost/benefit analysis of personalised provision,

• Staff training in the use of learner profiles to recognise the needs of learners,

• Integration of systems storing Learner Profiles with CMS/VLEs, Student Record systems and Learning Design systems,

• Prioritising learner experiences e.g. through personalisation, recognition of individual needs and preferences, effective choices and pathways." (ibid).

Rubens and Kemps (2007) address the implementation of e-portfolios in the academic sector of the Netherlands. They argue that e-portfolio implementations in an educational system can reach the following different routes of adoption and they characterise these different stages in the matrix below (p. 18).

Phases:					
5 Redefinition and innovative use			HR		
4 Network redesign and embedding	HAN INHOLLAND	Avans Fontys HAN HR INHOLLAND UU UvA VU WUR	Avans Fontys HAN INHOLLAND UvA VU WUR	HAN HR	HAN HR UU
3 Process redesign	Avans Fontys HAN Hanze HR UU UvA VU	HU	HAN UU UvA	Avans Fontys HAN INHOLLAND VU	Avans Fontys Hanze HU INHOLLAND UU UvA VU
2 Internal coordination	HU UvA	Hanze	Hanze HU UU	HAN Hanze HU INHOLLAND UU UvA WUR	INHOLLAND UU UvA
1 Local use	WUR				WUR
	Consistency policy/practice	ICT infrastructure	Freedom of choice: portfolio	Freedom of choice: educational programme	Curriculum embedding

HAN: Arnhem-Nijmegen University of Applied Science, Hanze: Hanzehogeschool, HR: Rotterdam University of Applied Science, HU: Utrecht University of Applied Science; TUE: Eindhoven University of Technology, UU: Utrecht University, UvA: University of Amsterdam, VU: Vrije Universiteit; WUR: Wageningen University and Research Centre

Table 15: Types of organisational e-portfolio integration in a national educational system**.** Source: Rubens and Kemps (2007: 19)

The e-portfolio maturity model aims at highlighting the empirical observation that not all institutions follow the same route in organisational integration of e-portfolios. Whereas some of the Dutch institutions decided to use e-portfolios only locally (course level), others integrate the concept as internal coordination mechanism (e.g. the INHOLLAND universities has five locations and use their technological system and pedagogical approach for their administrative university-wide internal co-ordination, e.g, of study programmes and entry requirements (complex access solutions are needed). Moreover, a number of Dutch universities had moved on in using e-portfolio to redesign their university-wide teaching approach towards a more competence oriented one. This route was taken especially by those institutions which have emerged as “new” universities (for more details in this ser later also the case-study Netherlands in chapter

5). Rubens and Kemps (2007) identified then in an empirical survey the position of the various institutional changes to the national educational system .

Summing up, Beetham (2005) points to many open issues given an organisational e-portfolio integration: “Integration of policies on e-portfolios with policies on learner records; learning, teaching and assessment; skills and employment; and workforce development; policy implications of data sharing across organisational and sector boundaries – e.g. need for policy on data protection, security and authentication; credibility and recognition of information across sector boundaries (may involve further rationalisation of credit); resources for the creation, management and long-term maintenance of learner records; human resource implications of e-portfolios, especially staff development and changes in administrative roles and responsibilities; flexibility of policy mandate and promotion of innovation” (Beetham 2005).

3.6 Conclusions: Modelling e-portfolios as a systemic ICT-based innovation

Based on the findings of chapter 3, this section sums up my view on e-portfolios as multi-faceted ICT-based innovation, which should make clear why it needs a very systematic and clear research approach in dealing with impact and policy research on it. E-portfolios are an interesting research phenomenon, because in my view the concept can include all three characteristics of an ICT-based innovation, discussed before: e-portfolios can be conceptualised both as a techno-pedagogical innovation, as an organisational innovation or as a systemic innovation. The distinction between one and the other is the intensity of change brought by the integration to the actors and structures involved at the micro-, meso- and/or macro-level of a national educational system. The figure below illustrates the case of e-portfolio as a techno-pedagogical innovation[52].

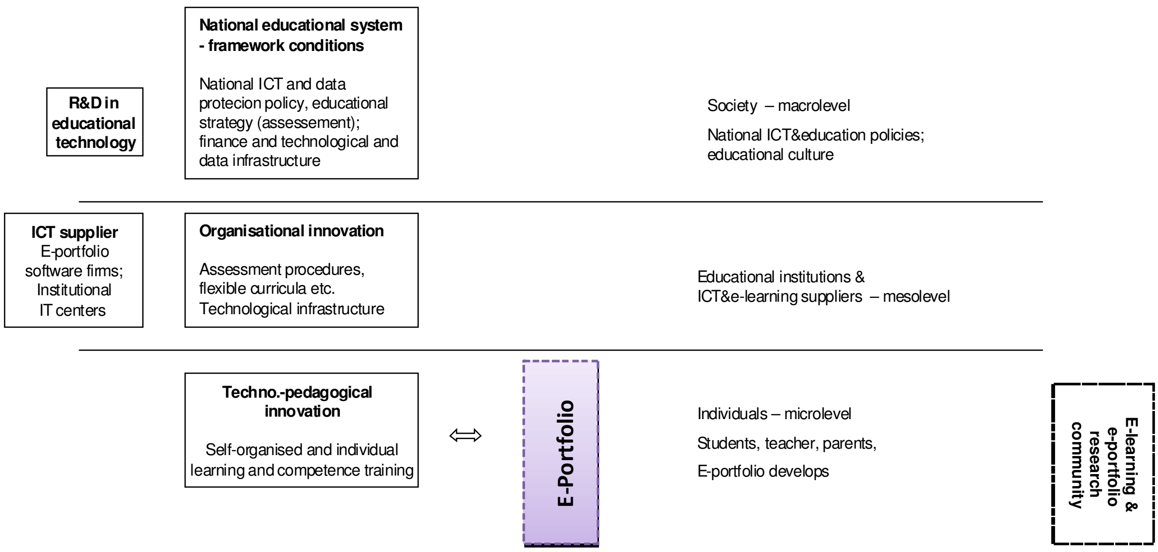


Figure 21: E-portfolio as techno-pedagogical innovation – Change level 1

Hereby, the pedagogical practise changes, both because of a change of the pedagogical process towards more self-directed and self-organised, individualised teaching and learning and because also the ICTs change the process. The use of ICTs and media does not simply enhance the paper-based portfolio method. Due to the potential of for example the Internet, the process of collecting (e.g. more portfolio artefacts can be collected; in different forms of media) and publishing (e.g. the publishing of the

[52] The way of systematizing the interactions of ICT-based innovations in a national educational sytem is based on first attempts of Kolo & Breiter (2009) to conceptualised the dynamics of ICT-based innovations. However they follow an objectivist view on the role of ICT in education.

portfolio contents via the internet allows more persons to view the process and results of an e-portfolio and enlarge the amount of feedbacks). Whether the way of reflection really changes, is still disputed, however, new competences of e-portfolio facilitators and teacher trainers change the underlying process (see Attwell et al. 2007). Although the relation between the actors on the micro-level changes when using e-portfolio in a course, it does not necessarily imply a change of the organisation of the educational institution issuing this e-portfolio. This is the case at the next change level, e-portfolios as organisational innovation, as depicted in the figure below.

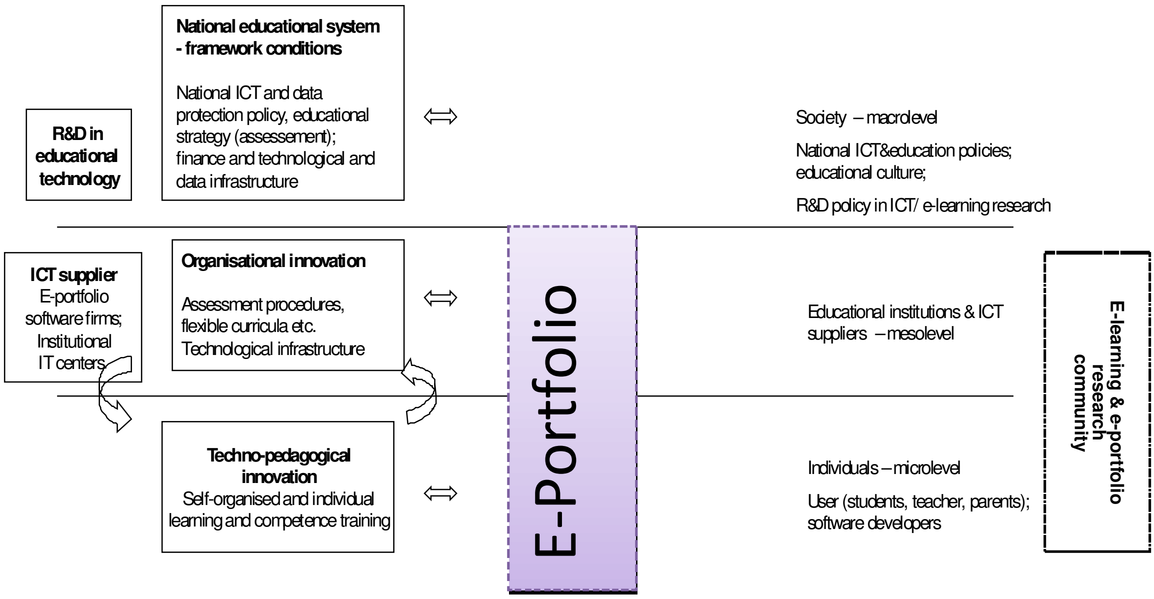


Figure 22: E-portfolio as techno-pedagogical innovation – Change level 2

In the case of e-portfolio as organisational ICT-based innovation, the integration of an e-portfolio concept involves more actors and stretches beyound the borders of a classroom or a course. The expectation is to develop a different learning and assessment culture for the whole insititution. Moreover, the roll-out of one ICT system for an organisation implies changes that target for example the ICT service center of an university (access rights, server space), the curricula bodies (validation of e-portfolio results via traditional assessment forms), the human resource planning (training of new competences) and even the labour unions (need for more time for extra e-portfolio work.

If the expectation of e-porfolio integration spans the use across the individual organisation, for example as instrument for transparency and transfer of skills and competences (e.g. mix of formal and informal competences) , then the e-portfolio concept gets a systemic dimension. This is illustrated in the next figure:

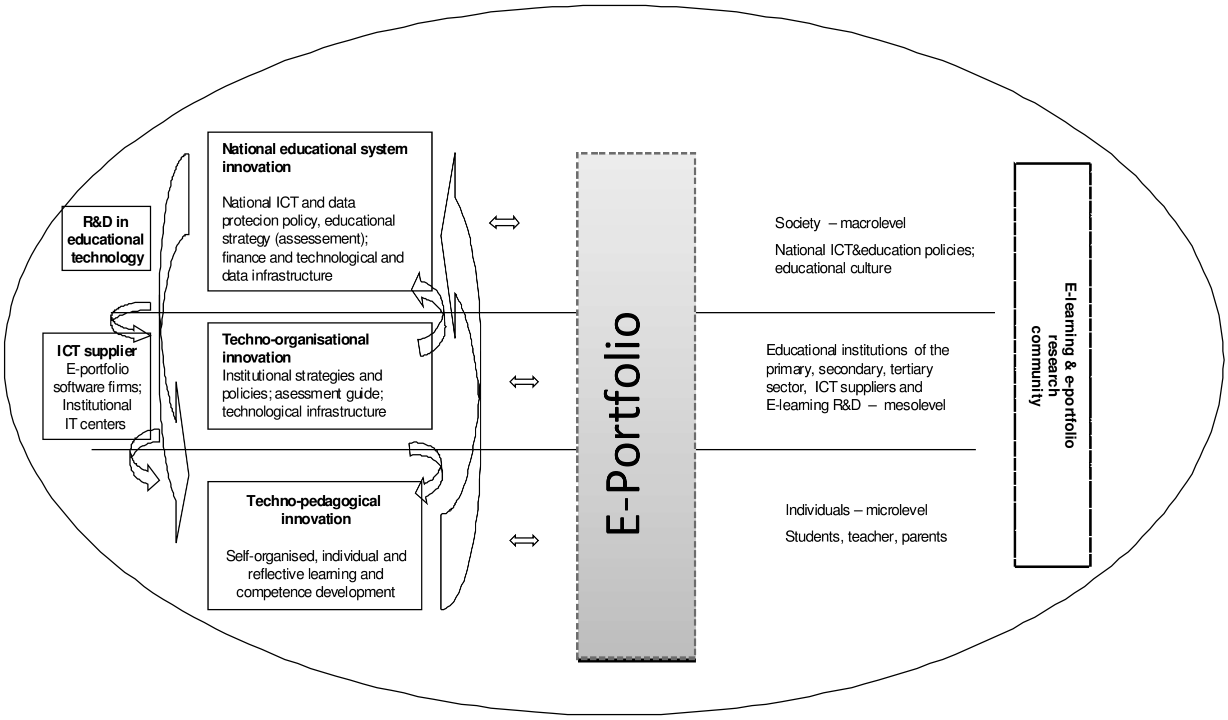


Figure 23: E-portfolio as techno-pedagogical innovation – Change level 3

In that case, a change takes place at all three levels of a national educational system. A systemic integration implies that all three innovation types interact with each other. How this dynamic can be theoretically explored and empirically observce is the taks of the next two chapters.

4 Chapter 4: Theoretical background to the shaping and integration of systemic ICT-enabled innovations in education

4.1 Introduction

The objective of chapter four is to provide the theoretical background to the formulation of a new theoretically grounded multi-level framework needed for analysing the dynamics of systemic ICT-based innovations. As was outlined in the previous chapter, e-portfolios are regarded as a multi-dimensional type of innovation, which, depending on the intensity of change, can affect three different levels of an educational system and society (see the macro-meso-micro research problem in chapter 1). In order to understand how such a multi-dimensional innovation is systemically shaped and integrated, we need to firstly analyse the determinants exerting an influence on each single level. Then, secondly, the overlaps and boundaries of the determinants affecting other levels are scrutinized. Therefore, the chapter will deal with theories on and approaches to

- the socio-economic emergence and evolution of ICT-based innovations on the macro-level of an educational system (section 4.2),
- the institutional diffusion and integration of ICT-based innovations on the meso-level of an educational system (section 4.3), and
- the individual shaping of the techno-pedagogical design and practices of ICT-based (section 4.4).

The identification and integration of an interlinked set of theoretically grounded determinants influencing the shaping and systemic integration of ICT-based innovations on the macro-level will contribute to the research questions of how macro-level determinants can be part of the to be developed integrative, multi-level framework exploring systemic ICT-based innovation.

4.1.1 Selection and scope of interdisciplinary theoretical approaches

Selection of a scientific grounding in humanities and social science is always a problem of subjectivity and the personal attitudes and research stance. Here the selection of the theories and the approaches dealing with the above issues is derived from the application of the criteria; what is the *primary content* of the theory (ICTs and Internet as technology; relevance of education), what is the *analytical scope* (minimum target is one societal level) and is it a scientifically mainstream or outsider approach (scientific awareness):

As regards the content of the theories, each approach has to target the concept of technology, and in particular, the ICTs as infrastructural technology in society and education. The theories selected should provide explanatory ideas to answer these questions: How does a new technology emerge and change in the course of history? What determinants are influencing the rate and direction of technological change? What determinants are used to analyse the interdependencies and mutual effects between individual actors (micro-level), social structures (meso-level) and society (macro-level) in the phase of the emergence and evolution of techno-societal systems? What factors shape the techno-pedagogical design and practical implementation of an innovation in a concrete micro-level learning environment with new technologies?

As regards the scope of the selected theory, each approach should deal with the shaping and integration of ICT-based innovations in at least one integration level (macro-,meso-, or micro-level). However, the focus is on those theoretical approaches and frameworks that are already trying to explain overlaps.

As regards the relevance of the theoretical approach in the scientific community, the aim was to select theoretical mainstream work and a well-rehearsed framework within the English and German e-learning research community (assessed, for example, on peer-reviewed papers, conference contributions and/or recitations in e-learning study books or readers). The selected theoretical approaches and concepts meet the above criteria and stem from the different fields of:

- Social sciences relating to economic innovation research (economic theory, organisational theory, management and marketing approaches, systems theory)
- Natural sciences (psychology, instructional design, human–computer interaction, social informatics, systems theory), and

- Newer schools of thought proposing a new e-learning theory (Siemens, 2004; Andrews & Haythornthwaite, 2007) and/or a dialectical relationship between technology and societal systems (Hofkirchner, 2006; Geels, 2002).

The following mind map provides an overview of the relevant disciplines and approaches to be analysed in the following sections (macro-theories section 4.2.; meso-theories 4.3., and micro-theories 4.4.).

Each theoretical sub-section includes the origin of the theory, the epistemological background, the representatives, the research question and basic solutions and assumptions (core hypothesis, empirical evidence, normative messages if applicable for education), structural characteristics and, if available, methods used and empirical data sets (see Fischer & Delitz, 2005 for guidelines on theoretical comparisons in sociology). Each section will provide a summary of the different theoretical approaches and the relevant determinants influencing the integration processes at the macro-, meso- or micro-levels according to the implicit scientific understanding. The systematic description of each of the theories follows the same structure: Theoretical approach, research question and representatives; basic assumption, core hypothesis and empirical evidence; relevant determinants for ICT-enabled innovations and relevance to research on systemic ICT-enabled innovations in education and view on interconnections.

4.1.2 Four ways of thinking as a method of classification

Throughout the history of science, four different points of view of phenomena can be differentiated: the analytical, the constructivist, the hermeneutic and the dialectic point of view (see Poser, 2001: p. 24). Given the fact that the selected theoretical explanations of the dynamics of ICT-enabled innovations depend on a specific school of thought and/or traditional principles, the description and analysis of the theoretical approaches need to rest on certain categories or, in other words, a classification system. “Classification can be defined as the process of ordering entities into groups (i.e., types in the case of typologies or "taxa" in the case of taxonomies) following the similarity principle in such a way as to: a) minimize within-group variance and maximise between-group variance; b) exhaustively catch all the possible instances.” (Abadie et al.,, 2011, p.).

The classification of the theories is accomplished according to the “four ways of scientific thinking” coined by Hofkirchner and developed in different works (1999, 2005, and 2008). He distinguishes four ideal types of ways of thinking, all of which differ in their way of viewing "identity and difference and their relation of a subject and the relation to each other" (e.g., technology and society) (Hofkirchner, 2008: p. 2):

- Objectivism:

This way of thinking views the establishment of identity by eliminating the difference for the benefit of the less complex side of the difference and at the cost of the more complex side. ("Higher complexity is reduced to lower complexity").This approach is considered to be typical for the deterministic thinking of natural sciences and technology (object determines subject) (ibid.).

- Subjectivism:

In this point of view, identity is based on eliminating the difference, "albeit for the benefit of the more complex side of the difference and at the cost of the less complex side. It takes the "higher" level of complexity as its point of departure and extrapolates or projects from there to the "lower" level of complexity and overestimates the role of the whole and belittles the role of the parts" (ibid.). This approach is commonly used in theoretical thinking in the field of social constructivism and is of little relevance to natural scientific views (subject determines object).

- Dualism:

The dualistic way of thinking "eliminates identity by establishing the difference for the sake of each manifestation of complexity in its own right. It cuts all relationships between all of them by treating them as disjunctive. It dissociates one from the other. It dichotomises and yields dualism (or pluralism) in the sense of diversity without unity" (ibid.). In the context of the thesis, this would mean that there is no direct relation between technology and pedagogy and that each develops independently from each other (object and subject exist independently of each other).

- Dialectical:

A dialectical way of scientific thinking aims to integrate the two sides of a phenomenon. It "addresses the difference (yielding unity) and it differentiates identity (yielding diversity). It is a way of thinking that is based upon integration and differentiation. It is opposed to both dissociation and unification and yields unity and diversity in one" (Hofkirchner, 2008). Dialectical thinking integrates "lower" and "higher complexity" by establishing a dialectical relationship between them" (ibid.) (object and subject influence each other).

I will use this differentiated view on the theoretical approaches on innovation and technology research, because the explification of the scientific thinking behind a theoretical approach helps to better find an orientation, if formulating a new theoretical framework. The dialectic view implies that a researcher knows the crucial point of view and context in which the theory has emerged, and by contrasting or merging it, something new can emerge.

4.2 Macro-Level: The socio-economic emergence and evolution of ICT-based innovations in national educational systems

The emergence of educational technologies per se and the interrelated integration of a systemic innovation, such as e-portfolios in a national educational system, can be explained through the lenses of theoretical approaches which have been developed especially in three disciplines of social science- distinct from the general field of e-learning research- since the 1970s (Weyer, 2008). As explained in chapter one (State of the Art), these are strands of

- economic innovation research (e.g., macro-economic research, marketing and organisation research),
- sociological research (e.g., sociology of science and sociology of technology) and
- historical research (e.g., history of technology and media).

These strands favour either a linear model of innovation or a non-linear and evolutionary model of innovation (see Bauer-Thürmann, 2005). The linear understanding of (mainly technical) innovation is grounded in the works of the highly distinguished national economist Schumpeter (1934)[53], often called the 'father' of innovation research. He and his followers (e.g., Schmookler, Solow) researched technological product innovation as a driver for economic growth. The economic field of innovation research has also had a great impact on national and European research and funding policies until today (see, for example, the European Research Framework, the Lisbon strategy and the Digital innovation agenda launched lately[54]). In the field of education, a European Year of Innovation and Creativity was launched in 2009 and ICTs are regarded as a major driver for both economic and educational innovation (see Hornung-Prähauser & Luckmann, 2010).

The aim of the major research works on technological and ICT-based innovation in the above fields has been to understand and explore how technology emerges in the course of history: What can be learned for modern times (historical view), what factors are influencing the rate and direction of technological change and how can (technical

[53] Schumpeter, J.A. (1934): The Theory of Economic Development, 13th Printing 2007, New Jersey: Transaction Publishers.
[54] For more details on the European Innovation Union: http://ec.europa.eu/research/innovation-union/index_en.cfm

and scientific) knowledge, as a crucial resource for the knowledge society, be produced most efficiently in order to gain relative competitive advantage (the macro-economic view) or to create and design technologies in a societally desired way (the sociological view) (see Weyer, 2008: p. 146). However, no sub-discipline in social science has yet developed a "unified theory on technology and innovation". Degele (2002) argues that the techno-sociological research in technology genesis and technology assessment faces boundaries because it lacks a coherent theory of technical development, which would synchronise a theory of technological change with a theory on social change (2002: p. 57). That there is a need to go beyond disciplinary boundaries arises from the thinking of Willams and Edge (1996), who argue that the "influences of the social and of the economic have often been counterposed – an unhelpful and surprising dichotomy, since the economic is also, surely, social. Indeed, economic shaping is one of the most salient features of the social shaping of technology" (1996: pp. 856pp-). In the following section, the main macro-theoretical approaches to technology-based innovations will be briefly characterised and analysed as to their relevance to contributing to a better understanding of ICT-based innovations in the societal sub-sector of education. The table below provides an overview of approaches, grouped according to their scientific thinking.

4.2.1 Objectivistic approaches

Characteristic of this way of thinking is the notion that the emergence, shaping and integration is influenced predominantly by technical factory (core technology, type of technical innovation) or economic (price ratio, market supply-demand, etc.) factors.

4.2.1.1 Theory of long waves

Basic assumption

The theory of long waves is described here because it views ICTs as core technology of production and society. It was developed by the Russian researcher Nikolai Kondratiev, revised by Schumpeter (1939), and later adapted by Perez (2002) and Smihula (2009[55]). The basic assumption is that a market-oriented economy undergoes regular cycles of economic growth and downward spirals. Kondratiev based his view on observing economic data and historic events (invention of base technologies such as steam engines, railroads, etc.) of the 19th century and calls the periods in the cycle: expansion, stagnation and recession. Nowadays researchers have added a fourth period, a turning point (collapse) and assume that the long-run macro-economic and price cycles last approximately fifty years, as depicted in the scheme below.

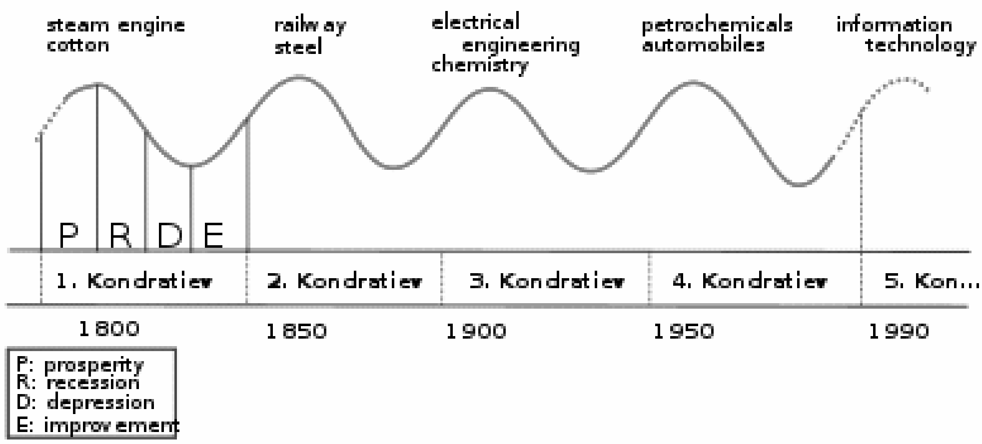


Figure 24 Information and communication technology as core drivers for economic change. Source: Graphic was drawn on data tables from Kondratiev published in Korotayev (2010); publicly available via Online Encyclopedia Wikipeadia.[56.]

[55] See Šmihula, Daniel (2009): The waves of the technological innovations of the modern age and the present crisis as the end of the wave of the informational technological revolution, Studia politica Slovaca, 1/2009, Bratislava, ISSN-1337-8163, pp. 32-47

[56] Korotayev, Andrey V., & Tsirel, Sergey V.(2010). A Spectral Analysis of World GDP Dynamics: Kondratiev Waves, Kuznets Swings, Juglar and Kitchin Cycles in Global Economic Development, and the 2008–2009 Economic Crisis. Structure and Dynamics. Vol.4. #1. P.3-57.

Smihula hypothesized that the period of information and telecommunications revolution will last from the years 1985-2015 and will come to an end and be replaced by another post-informational technological revolution, e.g., nano- and biotechnology.

Determinant for technological change:

It is assumed that the change of the different phases depends on the relation between financial capital and production capital (price/profit-ratio). Market saturation leads to a stagnation in the economy. If there is a lack of further investment, low interest rates lead to a stage in which speculations and high debt levels occur and ultimately lead to a financial crisis. Perez (2002) analysed such a pattern for the IT crisis in the Internet dot.com crisis in the early 2000s.

Empirical evidence

The changes were empirically analysed in the context of technological inventions such as the steam engine, railways, electronic engineering and the petrochemical industry. Information technology is supposed to be the fifth Kondratiev cycle (see Figure 24 above).

Relevance for ICT-based innovation research in education

Without ICT as base technology, the e-learning market would not have emerged. The emergence of the ICTs led to a global e-learning market, consisting of a market for ICT infrastructure, e-learning software and IT-services, digital training materials (e-content) and new virtual university services. Although the approach stresses the evolutionary character of technology, it focuses only on the economic determinants that explain the emergence of technological innovation (e.g., the level of profit on new innovation in the lead sector in comparison to old technology) and it focuses solely on production technology (TV and media are not regarded as technology). This approach is limited for e-portfolio research, because it only focuses on data explaining past emergences and cannot say much about future emerging technologies within the domain of ICTs, or explain the emergence of new educational services such as virtual university campuses.

4.2.1.2 Science and technology-push approach

In the first half of the 20th century, the prevailing (macro-economic) notions of technological change and emergence of innovations were the science and technology-push model and the demand pull model, often called "linear-sequential innovation models" (Weyer, 2008: p. 150). These two techno-deterministic models were developed at a time when the decisive role of technology in economic growth and early empirical innovation research results (Solow, 1956; Schumpeter, 1947; Usher, 1954 cited in Nemet, 2009: p. 700) were acknowledged. The question arising was whether the rate and direction of technological change was more heavily influenced by

- changes in market demand or
- the advances in science and technology that were being discussed.

Basic assumptions

Representatives of the science and technology-push approach assumed that the transfer of knowledge from one phase to another is a more or less an autonomously evolving process kicked off by fundamental research and development. In the beginning there is no clear vision of a product, which gives impetus for applied R&D leading to diffusion of innovation resulting in a market success (see Weyrer, 2008). Nemet (2009) summarizes the central critique of the assumptions of the technology-push model: "it ignores prices and other changes in economic conditions that affect the profitability of innovations. It views the emergence process as a unidirectional progression within the stages of the innovation process and neglects feedbacks, interactions, and networks" (2009: p. 701).

Determinant

The funding and amount of research and development effort of companies and regions are regarded as most influential factor in the science and technology-push approach.

Empirical evidence

Degele (2002) classifies the invention of the Xerox copy machine by Chester Carlsons and the telephone by Bell as good examples of technological innovations in the computer sector, which were being developed without a clear vision of a product. Bell`s telephone was envisioned as transmitting classical operas into private houses, but there was no idea of communicating from individual to individual person at the beginning. Studies tell us that the technology-induced developments analysed were less likely to be widely diffused (e.g. laser technology) than demand-driven technology (Degele, 2002:. 66).

Relevance for ICT-based innovation research in education

The approach is interesting for analysing the development of the emergence of the educational technologies which, in the beginning (see chapter 2), followed a technology-push model. ICTs were first introduced in sectors other than education for efficiency gains in administration and were also pushed for that reason into educational institutions. The implementations were top-down approaches and were orientated towards the need of the organisation (meso-level). The strength of the approach lies in pointing to the role of public funding of R&D in e-learning for the teaching and learning processes. Nowadays interdisciplinary e-learning research and further technological development are taking place, for example, within the European Framework Programme, ICT for learning. The focus of this programme has changed over time and it nowadays stresses the development of multi-lingual content and teaching processes with social software. The limits are that the model is a linear-sequencing model, ignores prices and economic conditions and does not take feedback loops, interactions and networks into account. Although there are many empirical examples of science/technology push developments for technological and organisational innovations in education (e.g., learning management systems), the rates of pedagogical innovation adoptions (e.g., e-portfolios) are not high .

4.2.1.3 Demand pull approach

Critics of the science and technology push approach point to the reverse process, the ‘demand pull’, whereby the technology or innovation is thought to emerge because the market or society has developed a certain demand for a new product or service. The pull model is based on empirical studies in the 1950s and 1960s and argues that changes in market conditions create significantly more opportunities for firms to invest in innovation to satisfy unmet needs or “latent demand” (Schmookler, 1962; 1966). The studies were criticized in later years, e.g., by Nemet (2009), who challenges the methodology: “the definition of demand in empirical studies had been inconsistent and overall, was considered too broad a concept to be useful …demand explains incremental technological change far better than it does discontinuous change, so it fails to account for the most important innovations” (p. 701).

Basic assumptions

A specific technology emerges because a market or society has developed a demand for a new product or services.

Determinant

The representatives of the market pull approach view changes in market conditions as a decisive influence on the emergence of ICT-based innovations, because they create opportunities for firms to invest in innovations to satisfy unmet or latent demands.

Empirical evidence

Relevance for ICT-based innovation in education

Given the idea that the demand for a specific product or services enables the emergence of an ICT-based innovation, this approach seems relevant for explaining only small-step pedagogical innovations in e-learning. Reinmann (2006) argues that ICTs in the classroom are not yet changing the structure and process of education (techno-pedagogical innovation). The strength of the approach is the focus on the educational demand of the user (micro level) and not only induced by the existence of a technology or new tool for learning. The limitation of the market demand approach is that the concept of demand is too broad to help define and identify 'educational demand' (what is an educational demand?). While the approach does contribute much to explain the variety of needs at different levels of demand (societal / cultural demand, educational institution. Which demand on which levels is decisive?), it does not give explanations of how the future demands of students and teachers are taken into account.

4.2.1.4 Classical evolutionary economics

Basic assumption

Classical evolutionary economics is a theoretical approach combining evolutionary concepts and microeconomics to explain technological change, the emergence of new technological inventions and economic growth. The theory was originated by Richard Nelson and Sidney G. Winter with their influential standard works in 1977 and 1985 (An Evolutionary Theory of Economic Change) and Giovanni Dosi et al. (1994), who further adapted their approach using the concepts of "technological paradigms" and "technological trajectories".

Determinant

Weyer (2008) describes the findings of the researchers and highlights that Nelson and Winter no longer argue only on the rationale of decision making and consensus on the allocation of R&D, but stress the need to take the “institutional structures” into account (2008: p. 162). They demand to analyse the “micro-process” of the decision about how innovations come into being. Most of all, the development of a technical innovation is a decision “under uncertainty” e.g., about the future market development or technologies for which no known rules are yet available (Nelson & Winter, 1977: pp. 47-52 in Weyer, 2008: p. 162). This uncertainty arises at two points of the innovation process, before and after the market deployment phases. According to Nelson and Winter a two step process (“two acts of innovation” (Nelson &Winter, 62/48 in Weyer, 2008: p. 163) is necessary, first to produce more different types of innovation, secondly to deploy at least one of them successfully. The success of an innovation is the result of its environment selecting the technology and using it. Weyer (2008: p. 164) points to the fact that if a specific way of thinking about technology is in the head of developers, a “technological trajectory” can become a very influential technological regime and influence (hinder) new invention processes.

Empirical evidence

In the field of computer technology, authors cite the invention of the “QWERTY” keyboard (Weyer, 2008). Other innovation researchers have examined other industry technologies, such as the chemical industry (see Belt & Rip, 1987).

Relevance for ICT-based innovation research in education

This approach may be useful in the field of e-learning to explain how “cognitive mind maps” from software developers and R&D communities on pedagogical function and use of technologies influence the emergence of a new technology. It allows a description of the past path that has led to the current status of an educational technology. It is an interesting concept because it is one of the earlier efforts to bridge the macro-micro-level problem.

4.2.1.5 The concept of national innovation system in education

Basic assumption

The basic assumption of the theoretical approach of a national innovation system stems from works of innovation researchers who were unsatisfied with the traditional technology based bias of input and output relation of innovation factors, such as the relation between expenditure on research, and number of patents (OECD 1991: 3). In the late 1980s the attention was directed to explore the interactions among the actors involved in technology development and to acknowledge their decisive role. This approach was originally worked out with the view on technological innovation in economic systems (representatives are Lundvall 1992, Nelson 1993 and Freeman 1995) or within interorganisational networks (Sydow (1992). The approach was adapted by Kozma (2002; 2003) and some OECD CERI study groups to the question of educational technology in the international and national educational system (2009a and 2009b).

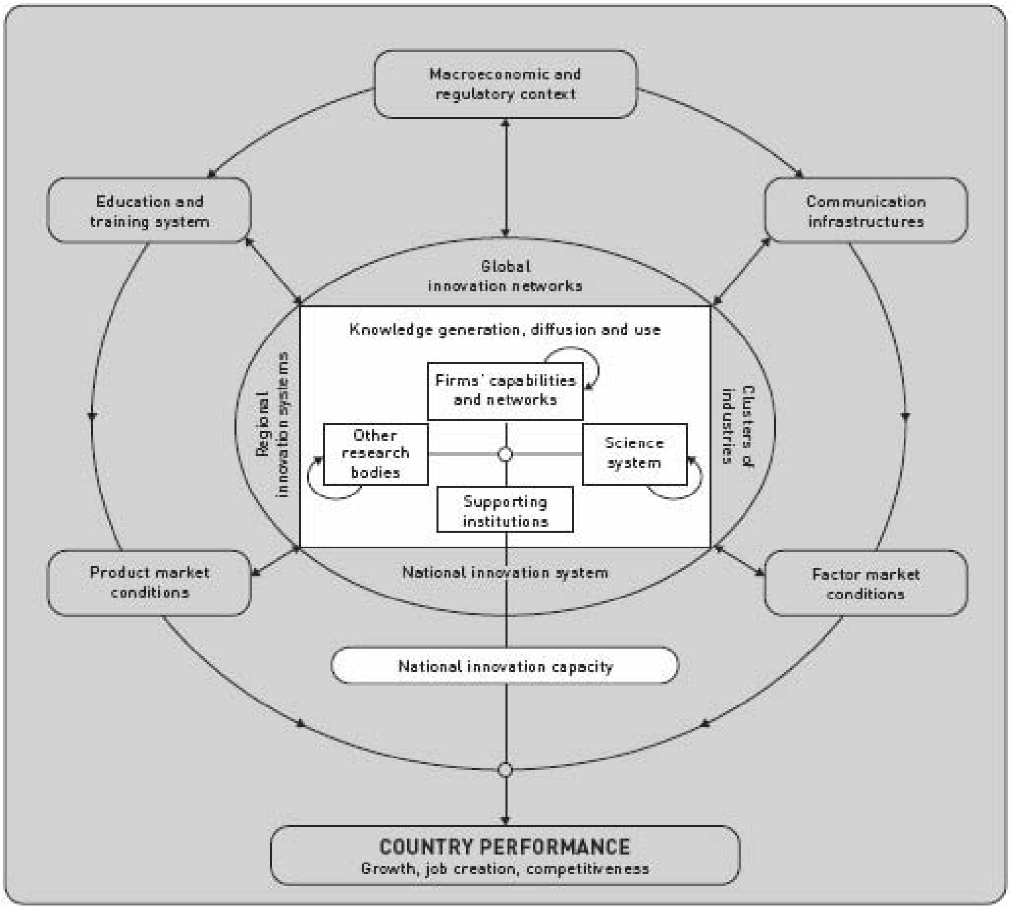


Figure 25: Scheme of a national innovation system

Source: Managing National Innovation Systems (OECD, 1999)

Determinant

The intensity and type of relations within the various actors in a national innovation system, including companies, universities, school and government research and strategy development institutes. Policies influence the networking activities of these actors and organisations and would like to stir the innovation capacity in integrating ICT-based innovations in all educational sectors (Kolo&Breiter 2009).

Empirical Evidence

The concept was transferred also to explain regional innovation capacity, for example Freeman examined the Japanese economy on their innovation potential[57]. Sydow has worked out many industrial case studies, consumer industries and public services such as the health service[58]. All of them confirmed the importance of the interplay between the diverse stakeholders in the system, however, still unclear are the exact impact and governance of these relationships.

Relevance for ICT-based innovation

This approach is highly relevant to the field of e-learning research, because it stresses the relations between the different actors and systems in an educational sector. In many works Kozma applied this approach to ICT use in a global view and specifically to developing countries (2002; 2003a; 2003b). In my view the approach has been dominated by a techno-deterministic view on the (economic) relation between the actors and structures in an educational system. However, the observation of the interlinkages has become prominent and by applying a more outbalanced view on how technologies emerge and effect innovative techno-pedagogical practice (see chapter 3) can make an important contribution to the development of the framework.

---

[57] Freeman, C. (1988) 'Japan: A new national innovation system?', in G. Dosi, C. Freeman, R. R. Nelson, G. Silverberg and L. Soete (eds.) Technology and economy theory, London: Pinter.

[58] See publication list by Sydow J. available from: http://www.wiwiss.fu-berlin.de/institute/management/sydow/media/publist/Veroeff-Sydow_04-2011.pdf[8-8-2011].

4.2.2 Subjectivist approaches

The subjectivist approaches understand the emergence and evolution of technology not as an economic or technically driven process, but rather as one driven by human actors, a way of thinking close to constructivist thinking (see Weyer, 2008: p. 183). This section includes approaches from the so-called science and technology studies (STS) and historical evolution of media (Brian Winston). The major point of interest is the interrelation of the context of societal development and the context of the use of technology. In the German e-learning community, there is limited awareness of the use of some of the explanatory STS concepts for exploring systemic innovations (see the attempt by Klebl, 2007: Open educational resources and STS studies).

4.2.2.1 Social construction of technology studies

Basic assumption

In contrast to the objectivistic approaches, in the second half of the 20th century another school of thinking influenced the discussion about technical change and the role of technology. A series of research approaches focused on the "social shaping of technology" (this expression was coined by MacKenzie & Wajcmann, 1985 cited in Williams & Edge, 1996), which analysed the "social factor" as a decisive influence on the design and implementation of technology and scientific knowledge. The aim was to provide an alternative approach, other than a deterministic understanding of technology, to examine the content of technology and the processes involved in innovation. The social shaping approach has developed as a critique of pure technological deterministic perspectives on the role and impact of technology. Williams and Edge (1996) point out that not only industrialists and politicians thought that particular paths of technological change were inevitable; also, social scientists acknowledged technology as "given" and tried to examine its social impacts in their simplistic way. However, the research field of social shaping of technology explores the ways in which social, institutional, economic and cultural factors have shaped

- the direction as well as the rate of innovation
- the form of technology: the content of technological artefacts and practices
- the outcomes of technological change for different groups in society (see Williams & Edge, 1996).

The idea of scholars in the social construction of technology was to identify opportunities to influence technological change and its social consequences already in an early phase in which control might be exerted. Some representatives in Europe developed guiding models, such as Pinch and Bijker (1984). They claim that technological products or artefacts are socially constructed by social groups and that the criteria for whether such products are considered successful or a failure are perceived and judged differently by 'relevant social groups' with differing and sometimes entirely contrasting objectives, goals and intentions. Kincsei (2008) discusses the two main concepts of the social construction of technology approach, the notion of *interpretative flexibility* and the *closure concept*:

"Interpretative flexibility means that each technological artefact or scientific artefact is shaped by different meanings and interpretations assigned to the technology by relevant social groups (..) The different meanings and conflicting interpretations between the socially relevant groups are the "true" determinant of the functionality and design of a technology" (2008, p. 51).

Relevant social groups means users, producers and non-users of the technology, who often have different (even competing) opinions and interpretations about the design, purpose and use of a given technology and its implementation. "A design is only a single point in the large field of technical possibilities, reflecting the interpretations of certain relevant groups. The different interpretations often give rise to conflicts between criteria that are hard to resolve technologically (in the case of the bicycle, one such problem was: how can women ride the bicycle decently in a skirt?), or conflicts between the relevant groups (the 'Anti-cyclists' lobbied for the banning of bicycles)" (ibid.). In the field of digital educational technologies, the group of non-users and sceptics are a very influential group with strong ideas on the design and use of ICTs.

The closure concept relates to the idea that "over time, as technologies are developed, the interpretative and design flexibility collapse through closure mechanisms. Any technology stabilises when the conflicts and discussions are settled and the phase of *closure and stabilisation* begins" (Kincsei, 2008, p. 51). In this phase two mechanisms can be observed. First of all, "rhetorical closure" may arise: the social groups involved regard the problem as being solved, and the need for alternative designs diminishes, often due to the result of massive advertising. Secondly, the problem may be redefined: a design standing in the focus of conflicts can be stabilised by inventing a new problem, which is solved by this very design. The aesthetic and technical problems of the air tyre diminished, as the technology advanced to the stage where air tyre bikes started to win bike races. Tyres were still considered cumbersome and ugly, but they provided a solution to the 'speed problem', and this overrode previous concerns. The basic assumption of the SCOT approach is that 'closure' underlies an evolutionary process and is not permanent. New social groups may form and reintroduce interpretative flexibility, causing a new round of debate or conflict about a technology.

Determinants

Social, institutional, economic and cultural factors influence the development of technology, particularly, the direction and rate, the form (content of artefact or practice) and the outcome of technology. The context of development and the context of use are important for the direction, form and output of technological innovation.

Empirical evidence

In their early studies, Bijker and Pinch (1984) and Bijker (1987; 2006) applied their approach to analyse the historical invention and evolution of the air tyre of bicycles and the diverse consequences of this invention. On the one hand, tyres are perceived by one user-group as a more convenient mode of transportation, on the other hand another group feels disturbed by the "technical nuisances, traction problems and ugly aesthetics to others" (the problem of trade-off between traction and speed). As discussed in chapter one (State of the art), the STS studies have concentrated their case studies on nuclear power and other high-tech risk technologies (see also Degele 2000).

Relevance for ICT-based innovation research in education

The approach may provide insight into the emergence of different types of e-portfolio software and funding. The closure of a technological innovation depends on a stakeholder group - in e-learning that would be the different lead-users in different sectors - and the use of the e-portfolio for different purposes (see chapter 3 on the different concepts and approaches towards the use of e-portfolios, e.g., for professional training, standardised career management vs. individual career). Educational technology is permanently assessed by e-learning lead-users, but the finalisation of a closure phase in e-portfolio development has not been achieved, as can be seen by the various attempts to build new e-portfolio concepts with Web 2.0 tools (see chapter 3) on the e-portfolio as technological innovation). The strengths of the approach are the critique of linear-sequencing approaches on technology innovation and the inclusion of social factors other than the economic or purely technical. The view of social constructivism is limited because it focuses only on social factors. That explains the societal emergence, but does not highlight the consequences or impacts of using the concrete technology. Moreover, difficulties arise in the delineation of what is the ‘relevant’ social group and how to perceive the dynamics and interlinkages of the different social groups Weyer criticizes the social constructivist researchers’ concentration on identifying the determinants of emergence and integration on the early phase of technology development (see Weyer, 2008: p. 186).

4.2.2.2 Network theoretical approach in sociology of technology

Basic assumptions

Inspired by Hughes, Rosenkopf and Rammert, a phase model of technology genesis was developed by a German research group at Bielefeld (Weyer, 1997; 2008). They assumed that the emergence of a technology is a self-organised process of interacting actors enabled to take strategic action for the construction of social networks. The genesis of technology takes place in a step-wise process of social construction of technology and each phase is characterised by different and changing actors. The social dynamic of technology is divided into three phases: emergence (origin), stabilisation and implementation (successful diffusion). The development of technology is finalised with the market success and adoption by the users. Weyer (2008) characterises the different phases, as summarised in the table below (2008: p. 189):

Phase	*Constellation of actors*	*Social mechanism*	*Result*
Emergence	Unstructured; outsider	Informal communication	Socio-technical core
Stabilisation	Tight social networks	Social closure	Prototype
Implementation/Diffusion	Wide social networks	Social closure	Decontextualisation

Table 16: Phase model of technology genesis.(translated by author).Source: Weyer, 2008: p. 190.

The *emergence phase* is characterised by a loosely structured network of outsiders, in many cases rather at the edge of a community. The participants in the community are changing and the level of commitment and responsibility is low. An informal communication (open exchange of ideas) supports the development of radical innovations, where radical means it has the potential to induce a change to or eliminate an existing system (e.g., Homebrew Computer Club, 1970, California). In the phase of emergence, the core of the socio-technical system is being developed, and it will then remain unchanged during the different following phases and constitute somewhat an identity. The core is made up of a general construction principle and a social configuration (Weyer, 2008: p. 190). As examples, the development process of the open architecture of personal computers has been examined. However, the technical product in its emergence phase is not a fast selling product, and unexpected developments are pre-programmed.

In the *stabilisation phase* a small network of actors has to cope with the low demand for the prototypes. In order to achieve a wider level of diffusion, the socio-technical core of the technology, which until now has remained the same, will undergo a revision and develop different versions so as to meet the demands of a larger network (in many cases it is not the market but the policies that demand a new technological development). One of the options which the technology offers will be selected and realised. As an example, Weyer describes the case of the “Transrapid” train or the “Airbus”in 1977 (2008: p. 191).

Determinant

The success of alternative technologies depends on the social closure of an alternative actor-network other than in the emergence phase. The network and the translation between heterogeneous groups is decisive (Weyer, 1997: pp. 53-99).

Empirical evidence

In the realm of information and communication technologies, Weyer cites the example of the computer pioneers producing the first personal computer IMSAI-8080 and the Altair 8800 from Micro Instrumentation Telemetry Systems in the 1970s,, which were replaced by Apple and later on IBM (Weyer, 2008: 192).

Relevance for ICT-based innovation in education

The techno-social network approach is relevant for systemic ICT-innovation research because e-learning lead-users are organised in many different lead-user networks, such as mobile learning networks, micro-learning, personal learning network or subject specific networks (e.g., ICT for natural science or creativity). Also, for the innovative practice of e-portfolios, specific national and international networks have been developed (see http://www.europortfolio.org/). The strength of this approach lies in the focus on changing social actor-networks and interests in different phases and the need for reconfiguration of small networks, if the innovation aims at market success. Networks involve public and private actors, but governance is possible not only on one system-level, but both actors are equal and mutually shape each other (Weyer, 2008: p. 194). In Austria, for example, the educational ICT policy pushed the development of one specific e-portfolio software (Exabis) to be implemented into a learning management system used system-wide in all educational sectors. The approach is of limited importance for research into multi-level systemic consequences, because it views only the individual actors and not the network structure and power balances. Unlike the ‘closure concept’ of the SCOT, this view acknowledges that a successful innovation needs more cycles of social construction. However, further research on the question of the symmetry or asymmetry of power of network structures and the role of the network society, enabled by the internet, is needed (see Castells,1996; 2006; Dolatal, 2004).

4.2.2.3 A historical model for change of communication technology

Basic assumption

The media theorist Brian Winston (1998) postulates that it is not possible to explain technological emergence and directions of future change without referring to the past, especially to the history of science, and in the case of ICT and media, the history of electricity. He claims that the historical development of media is based on recurring rules of the structure of innovations and that it is the social sphere that is the environment in which innovation activities and processes are primarily taking place. As the figure below shows, communication media emerge and develop in three transformation stages within a social sphere:

- Ideation stage: from technology to a technical prototype
- Stage of supervening social necessity leads to an invention
- The law of "suppression of radical potential" can hinder/ enable a system-wide diffusion of a new technology.

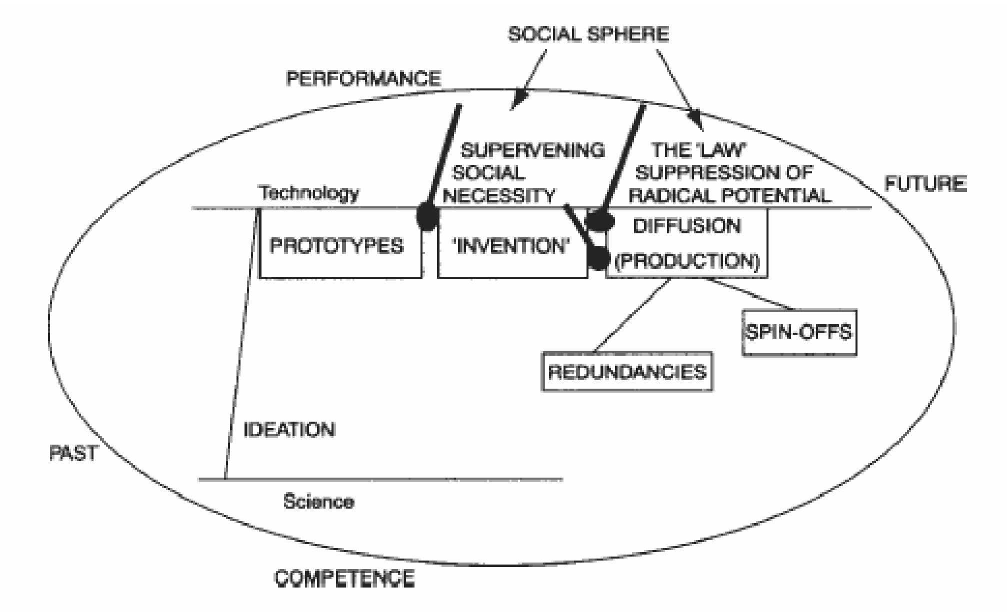


Figure 26: Model of structure of innovation through history: The influence of social needs and acceptance on the emergence and diffusion of communication media. Source: Winston, 1998: p. 14.

In the first transformation stage - the ideation process (based on scientific technical understanding) - the scientist develops the vision of the technological artefact based on his/her scientific competence and knowledge and only builds the technical artefact to test the technological performance. Winston illustrates his hypothesis with the invention of the telephone, which was theoretically conceptualised (e.g., various telegraph devices 1816; 1854) many years before Graham Bell (1860s) filed a patent for a telephone apparatus. In the second transformation stage – the supervening social necessity- a new societal demand decides whether the tested devices, termed prototypes, are a candidate for system-wide diffusion, and it is not always the technological effectiveness that decides. As Nygen states, in the thinking of Winston, "the decisive forces to move a prototype out of the lab into the society are termed supervening social necessities and might be created by either (1) other technological innovations (such as the railway stimulating the need for telegraphic devices); or (2) a concentration of social forces (such as the rise of corporations and modern offices accelerating the use of telephones and typewriters); or (3) commercial needs for new products" (Nygen, 2007). The third stage of transformation - the law of the suppression of radical potential – depends on the "new device's potential damage to existing values". "An invention, however needed it is, might not be accepted if it does not operate in a way consistent with established social norms. Indeed, the second and third stages are overlapped – i.e., they could happen at the same time" (ibid).

Determinants

The determinants are threefold: scientific knowledge and competence of scientists, supervening social needs and the law of "suppression of the radical potential". Media and ICTs emerge within a social sphere in three transformation stages: the ideation process, invention (supervening social necessity) and diffusion (law of suppression of radical potential).

Empirical evidence

Winston demonstrated his model with the evolution of electronic communication technology and the Internet (1998). Although he has not address the history of educational media explicitly, it seems a highly relevant approach to explain the emergence of them in the same way as the general media emergence would imply.

Relevance for ICT-based innovation research in education

See above in empirical evidence

4.2.3 Dualistic approaches

A dualistic way of thinking would consider the emergence of new technologies *independently* of the influences of society and social contexts of actors and structures.

4.2.4 Dialectical approaches

The dialectical thinking about the emergence and evolution of technology is characterised by the notion of mutual shaping of technology, social and cultural environment.

4.2.4.1 Unified theory of information and critical evolutionary social systems theory

Basic assumption

The dialectic thinking about the complex and changing role of technology, particularly of ICTs in society, has been advanced by many works of W. Hofkirchner (2010a; 2002; 2004; 1999; 1998) and is influenced by two main theoretical cornerstones: an integrated concept of the different manifestations of "information" (Unified Theory of Information, see www.uti.at) and the concept of evolutionary self-organisation of social systems (critical evolutionary social systems theory[59]). Both concepts are connected, if it is assumed that on the one hand, self-organisation is informed (in order to generate differences making a difference) and information-producing systems are self-organised (see Hofkirchner, 1998: p. 78). "A Unified Theory of Information looks upon information generating systems as self-organising systems and considers society and even more information society as just another information-generating and, hence, self-organising system" (Hofkirchner & Fuchs, 2005: 2). Therefore, in the following these two aspects are summarised. According to Hofkirchner (1998) and Fuchs (2008), information is understood as a dynamic process in which three sub-processes - cognition, communication, and co-operation – are interacting:

> A single individual (cognitive level) connects itself by using certain mediating systems to another individual and a feedback is established (communication). From communication processes a system of shared or jointly produced resources can emerge (cooperation). Networked computer technology enables cognition, communication and cooperation

[59] The concept of the Evolutionary Systems Theory was first developed by Ervin Laszlo (987), Vilmos Csanyi (1989) and Susantha Goonatilake (1991). The theory deals with evolving systems and a merger of systems theory and evolutionary theory. The origins lie in the biotic and human or social systems, but is also relevant to physical systems. It is the most recent elaboration of General System Theory as founded by Ludwig von Bertalanffy" (Hofkirchner, 2005 cited in Raffl et al. 2008].

> processes that are spatially disembedded and either temporally synchronized or not. The level of information (cognition, communication, cooperation) and the type of temporality characterize network technologies. Synchronous temporality means that users are active at the same time ("in real time"), asynchronous temporality that the users are temporarilly disembedded. In both cases, technology enables a spatial disembedding of users. (Fuchs, 2008: p. 128)

In other words, "cognition" addresses the individual dimension of a social system, "communication" relates to the interaction of a minimum of two individuals of a social system and "co-operation" integrates the social system itself that is constituted by the interaction of its elements (see Fuchs & Hofkirchner, 2005: p. 247).

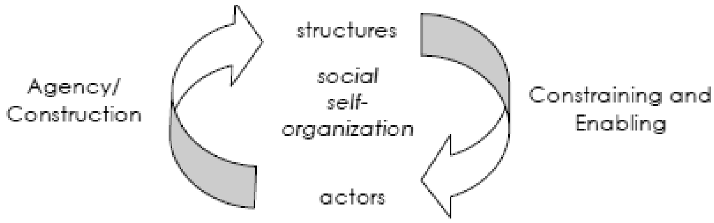


Figure 27: Self-organisation in social systems. Source: Fuchs & Hofkirchner, 2005: 247

The so-called Triple C-approach[60] was used to explain the three evolutionary stages of web development and hence defines Web 1.0 as a tool for cognition, Web 2.0 as a medium for human communication, and Web 3.0 as networked digital technologies that support human co-operation (see the section on empirical evidence below). The figure below shows the stage model visualising the dynamic of the Internet's emergence and evolution throughout the last thirty years.

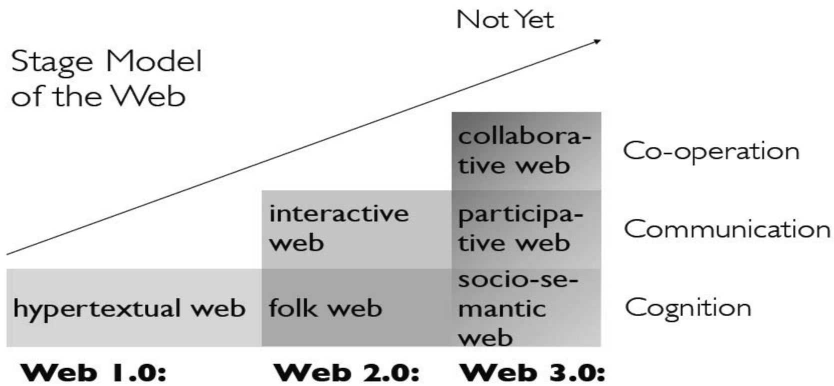


Figure 28 The dynamic of the techno-social self-organisation of the web.

Source: Raffl et al. (2008)

[60] See Journal Triple C: *www.**triple**-c.at/*

The basic assumption of information-producing systems as self-organising systems has been further applied to describe and explain the interactions and dynamics of social systems as mutual production processes of social structures and social practices. It is not the material aspect of how ICTs or the Internet technologies have changed over time which is of interest here, but the aspect of the change and evolution of the whole techno-social system, and the incorporation of evolutionary thinking: "the critical evolutionary social system theory argues that the development of the Internet proceeds in stages (a stage model consists of different phases and layers; the principle of emergentism is that an emergent next phase is new and not the same as before"(Raffl et al., n.d.).

Hofkirchner describes the architecture of the society as built in a "matryosha-like" style, consisting of different spheres each encapsulated in the other and characterised by the "basic cycle of agency and structure". The different levels of a social system are described as the system of the techno-sphere, the system of the ecosphere and the system of the socio-sphere which, in turn, is made up of the system of the economy, the system of politics and the system of culture, as depicted in the figure below.

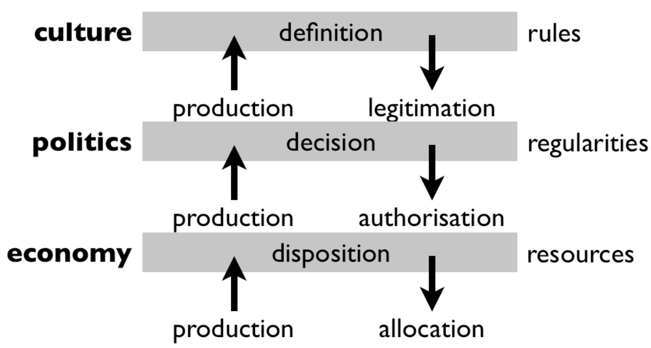


Figure. 6: Social subsystem levels II
Source: Hofkirchner, Society as a self-organising system, (2006)

Hofkirchner points out that the:

> "Internet belongs to the technological infrastructure of a society (techno-sphere = social system with individuals at the micro-level and technology at the macro-level). Individuals produce and use technology. The techno-sphere is a sphere in which means are produced,

humans are active in innovating and applying scientific-technological tools. Technology augments the actors that take the role of productive forces in that they produce or create something (instrumental activities). Technology is a subsystem of society – a nested hierarchy of systems."(Hofkirchner, 2006)

In the same way as the economy, politics and culture can be seen as subsystem of society, so is education. The table below exempliefies the relevant actors and structures, as the relate to the concept of triple c – cognition, communication and co-operatoin.

System	Actors	Structures	Cognition	Communication	Co-operation
Ecology	Human Individuals and Groups	Natural Resources	Mental construction of the transformation of nature	Appropriation of natural resources	Ecological sustainable appropriation and usage of natural resources
Technology	Human Individuals and Groups	Tools	Mental construction of tools	Production and usage of tools	User-friendly production and usage of tools
Economy	Producers, Workers, Managers, Capitalists	Property, Use Values	Mental construction of use values	Production, labour process, consumption, distribution of use values, management	Self-management
Polity	Individuals, Political Groups	Decision power	Production of political ideas, identities and values	Political processes: political discourse, lobbying, voting, campaigning, protest, devising and passing laws	Grassroots democracy, political participation
Culture	Individuals, Value-based Communities	Definitions (norms, values, meanings, traditions)	Production of meanings and values	Normative discourses and struggles	Unity in Diversity
Science	Researchers, Research groups	Theories	Production of scientific ideas	Scientific discourse, publishing of articles/journals/ monographs, giving lectures and talks, organizing conferences, criticism	Participatory science, scientific discourse and critique as general social phenomena
Art	Artists, recipients	Artworks	Production of artworks, interpretation of artworks	Discourses on artworks, social interpretation processes of artworks, asynchronous communication of the artist and the recipients	Participatory art, common production of artworks, recipients as artists (as e.g. in happenings, performance art, Web art, virtual art)
Education	Students, teachers	Skills	Acquiring and testing theoretical and practical ideas (e.g. reading a book, listening to lectures)	Lectures as communicative encounters of teachers and students, discussions, criticism	Participatory education (teachers as students and students as teachers)

Table 17 : Actors, Structures, and Knowledge Processes in the Subsystems of Society

Source: Fuchs (2005)

Determinant

- Information emerges in three processes: cognition, communication and co-operation.
- Information-producing systems are self-organising systems;
- ICTs and the Internet belong to the technological infrastructure of a society (techno-sphere= social system with individuals at the micro-level and technology at the macro-level);
- Techno-social systems are mutually shaped by technology and the social context in which it emerges in different (emergent) stages;
- Social structure and actors are mutually changing.

Empirical evidence

The so-called “triple-C” concept, perceiving information as cognition, communication and co-operation, has been explored in the context of characterising the evolution of Internet technologies and tools and working out a typology of Internet technologies (see Fuchs, 2008: p. 129). However, there have been no case studies etc. on the subsystems of society.

Relevance for ICT-based innovation research in education

The Unified Theory of Information is higly relevant for the field of e-learning research. Below I have tried exemplatory to apply the triple-C approach to e-portfolios. As was maintained before, the evolution of the internet has moved from support of coginitive processes of knowledge generation to support of communicative and co-operative behavior. This evolution reflects als in the case of e-portfolio shaping. Whereas the first generation of e-portfolio tools and practises was oriented towards collection, selection and reflection on “cognitive artifacts” and learning results (well supported by the first generation of stand-alone e-portfolio tools). Nowadays, as pedagogy has evolved, the e-portfolio design and practises has been enriched by the co-operative functions and practises of Web2.0. This development is visualised in the figure below.

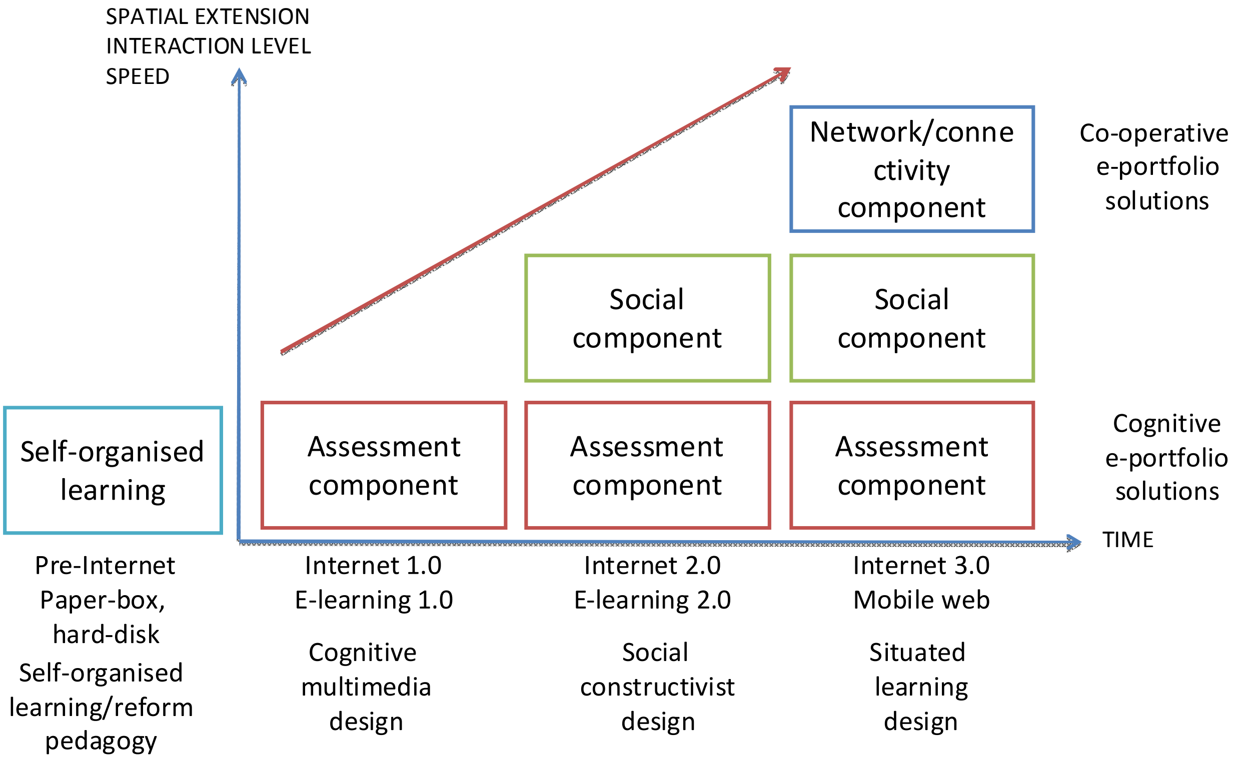


Figure 29; Emergence and evolution of e-portfolios. Based on Triple-C approach.

4.2.4.2 Multi-level framework for explaining dynamics of socio-technical transition

The following approach is placed within the macro-level theoretical approaches, although it also targets other levels. However, the use of the term “macro-meso-micro” by Geels (2002) is slightly different then the one used here in this work. Whereas the concept of “landscapes” resembles the macro-level of an educational system, the meso-level, the other two levels have not completely the same meaning. However, since the approach is dominated by explaining the macro-level it is dealt with in this section.

Basic assumptions

The theoretical approach, represented by Rip and Kemp (1998) and Frank Geels (2008), regards itself as an analytical and heuristical framework to understand the multi-dimensional complexity of changes in socio-technical systems[61], particularly the phases of technological transitions and systems innovations. The authors understand technological transitions as major technological change in the way social functions are fulfilled (change of user practice, regulation, industrial networks, infrastructure and symbolic meaning and culture). The approach draws on different strands of theories (classical evolutionary economics represented by Nelson, Winter and Dosi - see section 4.2.1.4) and aims to cross disciplinary boundaries between the philosophy of technology, science and technology studies and evolutionary economics and technology innovation management. The multi-level perspective is a framework for understanding sustainability transitions of socio-technical systems. Geels (2002; 2005; 2004; 2007; 2008;) conceptualises socio-technical systems at three levels:

- Micro-level: In technological niches radical innovations emerge (“protected spaces”)
- Meso-level: At this level a multi-actor network in a socio-technical regime which is locked in and stabilised on several dimensions (technology, symbolic meaning of technology, user practices, application domains/markets, industry, structure, policy and techno-scientific knowledge), and
- Macro-Level: At this level, an exogenous socio-technical landscape (culture, context, infrastructure, policy) influences the development.

Technological change (transitions, regime shifts) comes about through interacting processes within and between these three levels, as depicted in the figure below.

[61] These system changes are labelled ‘socio-technical’ because they entail not only new technologies, but also changes in markets, user practices, policy and cultural meanings (Geels, 2004).

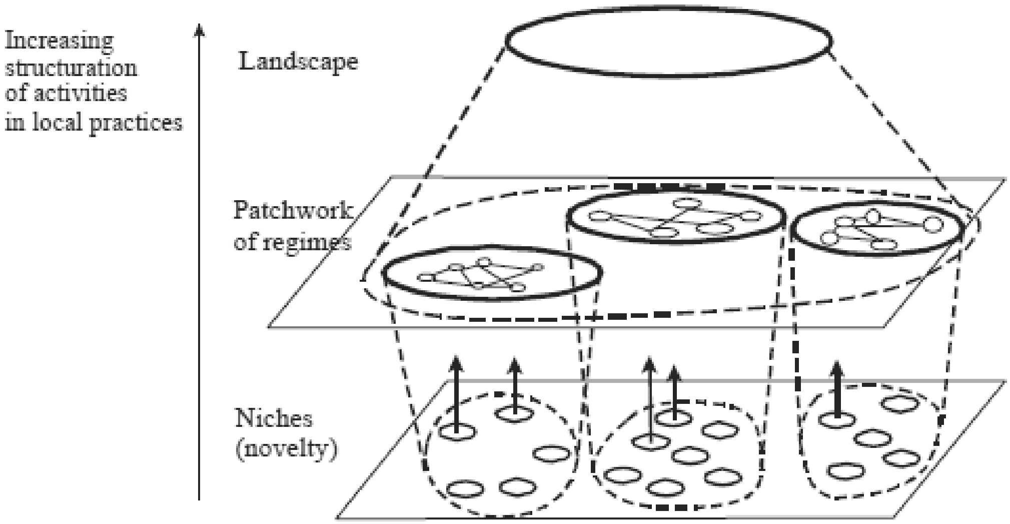


Figure 30: The levels of the multi-perspective framework on technological transitions.
Source: Geels (2004: p. 684)

This multi-level approach tries to integrate the dynamic of the actors of these three different levels and takes into account the evolutionary aspect of innovation systems. The approach suggests "that transitions, which are defined as regime shifts, come about through interacting processes within and between these levels. Transitions do not come about easily, because existing regimes are characterised by lock-in and path dependence, and oriented towards incremental innovation along predictable trajectories. "(Geels, 2004: 685)

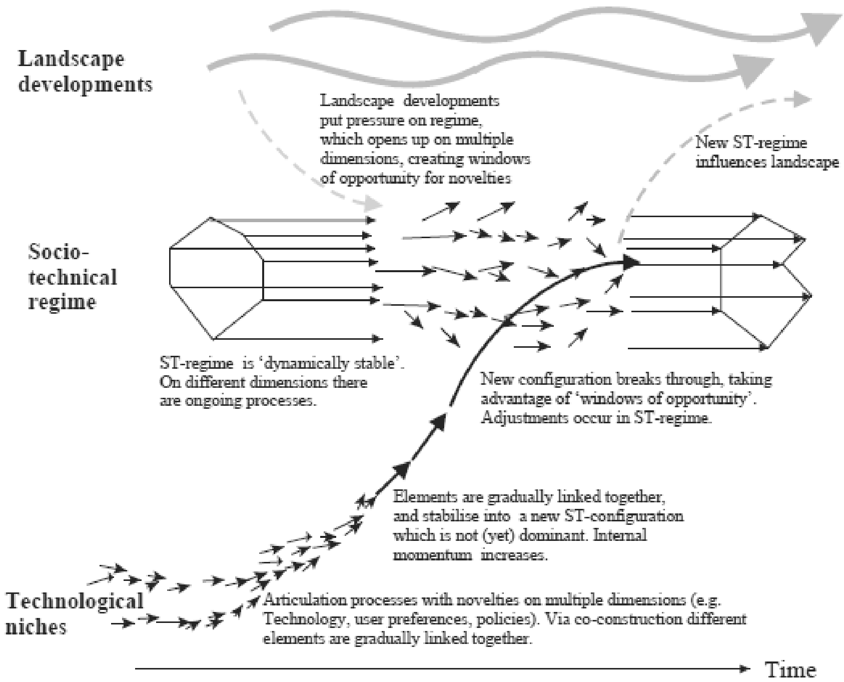


Figure 31: A dynamic multi-level perspective on system innovations. Source: Geels (2004, p. 685)

In this model the meso-level is understood as “socio-technical regime”, which are responsible for keeping the present status quo of an exisiting technological development and the possible ways of innovation stable. The macro-level is understood as the external environment “providing gradients for the trajectories”. At the micro-level, there is the potential to generate something radically new. This innovation emerges with a strong orientation towards the existing or future needs socio-technological regimes. However, the change from one technology to the other is not automatism, more a struggle between “lock-in and path dependenc”, it depends on the “fit” between socio-technical regimes as context and the landsape (as selection environment) (see Geels 2002; 2004)

Determinant

Technological transitions occur as the outcome of linkages between developments at all three levels: niches, a multi-actor network of a socio-technical regime (technology, user practices, markets, R&D policies and legal regulations) and exogenous socio-technical landscape (culture, context, infrastructure, policy). Transitions occur as an outcome of linkages between all three levels.

Empirical evidence

The approach has been explored in diverse case studies taken from agricultural and infrastructural sector technologies (e.g., Geels on transition periods of steel, water supply, bio gas, rock and roll, horticulture, sewer systems[62]).

Relevance for ICT-based innovation research in education

This framework is among the rare examples of dialectic approaches which view the emergence of innovation and ICT as a multi-dimensional issue, and it assesses the need for an interdisciplinary research approach. The transitions occurring on three levels would be useful to explore in the realm of educational technologies, because many ICT tools were developed in protected niches. The approach also takes account of the economic drivers for e-learning, since the e-learning industry regime is focused on cost-efficiency, and educational and ICT policy relevance. The strength of the framework is its combination of evolutionary economics, STS, technology innovation management, neo-institutional theories and cultural studies. It combines issues of technology sociology with general sociological questions and looks for patterns and mechanisms in

[62] For a complete overview of case studies see the homepage of F.W. Geels at the University of Sussex: http://www.sussex.ac.uk/profiles/228052

transition processes. Its limitations lies in the concentration on case studies so far only in the economic sector. In my view the approach implies an interdisciplinary thinking, however, this has not yet let to a truly transdiciplinary (something new out of the many disciplines involved) outcome.

4.2.5 Macro-level determinants of emergence and evolution of systemic integration of ICT-based innovation

The table below summarises the interdisciplinary view on the proposed factors influencing the emergence and evolution of innovations, which have been analysed as relevant for the field of e-learning research. Whereas in the beginning of innovation research the focus of determinants have been put on technologically and economc driven factors alone, the recent approaches acknowledge increasingly the role of interlinkages of actors and structures also at other system-levels (e.g. Geels). This insight will be deepened with those fields and

View	Theoretical approach	Determinants
Objectivism	Macro-economic innovation research (Kondratiev, 1926; Perez, 2002; Schumpeter, 1947; Solow, 1950; Smookler, 1962) Classical evolutionary economics (Nelson & Winter, 1977; Dosi, 1985) Sydow, 1992; Kozma, 2003a; 2003b OECD, 1997; 1999; 2010)	• A marketed-oriented economy encounters a regular fifty year cycle of economic growth and downward spiral influenced by the relation between financial capital and production capital (investment in core production technologies as economic driver). • Information and communication technologies are considered as fifth Kondratiev cycle starting from 1985. • Innovative technological products are emerging in a linear pattern and without clear vision as a consequence of basic natural science research and applied technology research being transferred into a market (science and technology-push approach). • Innovative technological products are emerging because consumer needs and market demand drive new technology development (demand pull approach). • Technological change depends on the predominant technological paradigm and trajectories (path dependency). • National innovation systems are drivers for development and implementation of ICT-based innovation.

Subjectivism	Science and technology studies; sociology of technology (MacKenzie & Wajcman, 1985; Pinch & Bijker, 1984; Rammert, 1993; 1999; Weyrer, 1993) History of communication technology and media (Winston, 1998)	• Human actors drive development of technological innovation. • Technological artefacts emerge as social constructs. • Social needs and acceptance of technology, institutional, economic and cultural context determine direction and rate of innovation, the form of artefact and the outcome. • The relations in a (self-organised) social network with different and changing actors determine the phases of emergence, stabilisation and diffusion of technological innovations. • Media and ICTs emerge within a social sphere in three transformation stages: ideation process (scientific expertise), invention (supervening social necessity) and diffusion (law of suppression of radical potential).
Dualism		• Innovations emerge as technology and/or as material artefact independently from social and cultural context as individual activity
Dialectics	Unified Theory of Information (in progress); critical evolutionary social systems theory; (Hofkirchner, 1999-2010; Fuchs, 2003) Multi-level framework for technological transitions: Evolutionary economics; STS and technology innovation management (Rip & Kemp, 1998; Geels, 2002; 2004; 2005; 2008)	• Information emerges in three processes: cognition, communication and co-operation. • Information-producing systems are self-organising systems. • ICTs and the Internet belong to the technological infrastructure of a society (techno-sphere= social system with individuals at the micro-level and technology at the macro-level). • Techno-social systems are mutually shaped by technology and the social context in which they emerge. • Social structure and actors are mutually changing. • Technology occurs as outcome of linkages of three levels: niches, a multi-actor network of a socio-technical regime (technology, user practices, markets, R&D policies and legal regulations) and exogenous socio-technical landscape (culture, context, infrastructure, policy). Transitions occur as outcome of linkages between all three levels.

Table 18 Macro-level determinants of emergence and evolution of systemic integration of ICT-based innovation. Source: author

4.3 Meso-Level: The institutional diffusion and integration of ICT-based innovations

This chapter discusses the relevance of theoretical approaches that deal with the adoption and integration of ICT-based innovations at the organisational level of educational institutions. Some of the theoretical frameworks point to interrelations with the macro-level (e.g., as the environment of educational institution) or to the micro-level (e.g., techno-pedagogical design and practices encompassing students, teachers and parents). The core research questions of the meso-level approaches are how, why, and at what rate are new technologies, services or techno-pedagogical practises spreading through different organisational cultures? What factors determine the rate of organisational adoption and pattern of diffusion and what hinders or enables the institutional integration of ICT-based innovations?

The integration or adoption of technology can be viewed from different perspectives: consumer behaviour (market research theories, economic and innovation research theories), information diffusion and rational choice theories (cognitive psychology), assimilation of cultural tools and practices (cultural studies, activity theory, etc.) (see Baltaci, 2006). Generally speaking, the main organisational theories[63] and traditional innovation research approaches focus on characteristics of profit-oriented organisations, firms and enterprises and do not specifically address non-profit organisations. However, in my view we have to pay special attention to the fact that educational institutions have other characteristics that enable or hinder the organisational integration of ICTs. Organisational sociology has identified the following main characteristics of educational institutions (see Brüsemeister, 2008: pp. 179-191):

- Educational institutions are considered as "expert-organisations" and problems arise from the double role of teachers and professionals. On the one hand, they are members of a profession with their specific professional codes and conduct. On the other hand, they are also members of their administrative organisation, which pays their salary and establishes the administrative framework (Brüsemeister, 2008: 183). Problems arising from this double role and membership are incongruous goals of the two types of memberships (e.g., the rule to use a written language for official memos in an environment of permanent oral communication; ibid.: 181).

---

[63] For an overview see: http://statpac.org/walonick/organizational-theory.htm

- Educational institutions, especially schools, are constituted on specific (bureaucratic) structures and processes.
- Educational institutions are regarded as organisations which are in a permanent exchange of personal interaction and society (system-theoretical model of educational institutions, see Brüsemeister, 2008:189). Therefore a strong disparity between the institutional logic of the organisation and its interaction systems can occur.
- Organisations act in a double way, as is analysed by the theory on sociological neo-institutionalism: educational organisations not only follow 'rational' choices and measure success in efficiency, but operate on the notion of 'legitimacy'. Such an understanding leads to a divided culture. On the one hand, the organisation formally changes its structures, but the internal structure remains unchanged as before (Meyer & Rowen, 1997 cited in Brüsemeister, 2008: p. 190).

Being aware of the special organisational characteristics of educational institutions, in the following, the mainstream theoretical approaches from the field of innovation research, organisation theory, technology management and critical theory on technology and pedagogy will be discussed. They will be assessed as to their contribution and relevance for explaining the adoption and integration of ICT-based innovations on the organisational level and to explaining the interlinkages of ICT-based innovations to the two other two levels, the macro- and micro- levels. This will be needed for deriving the set of components of the framework for the meso-level of a national innovation system in education.

4.3.1 Objectivistic approaches

4.3.1.1 Disruptive innovation theory for organisations

Basic assumptions

The disruptive innovation theory is a business management model, developed by Clayton Christensen (1997; 2008), in which he aims to explain the success of companies and organisations developing and marketing successful product or service innovations. Based on the concept of technological change, he developed the notion of "disruptive (technology or service) innovation" which in its emergence phase underperforms in comparison to traditional products or services, already at the market (low performance). However, eventually, in the long run of the diffusion process, they (=entrant firms) will outperfom and displace the established technologies or services providers (=incumbents) (Christensen 1997; Danneels, 2004). The basic elements of the disruptive innovation theory are depicted in the figure below.

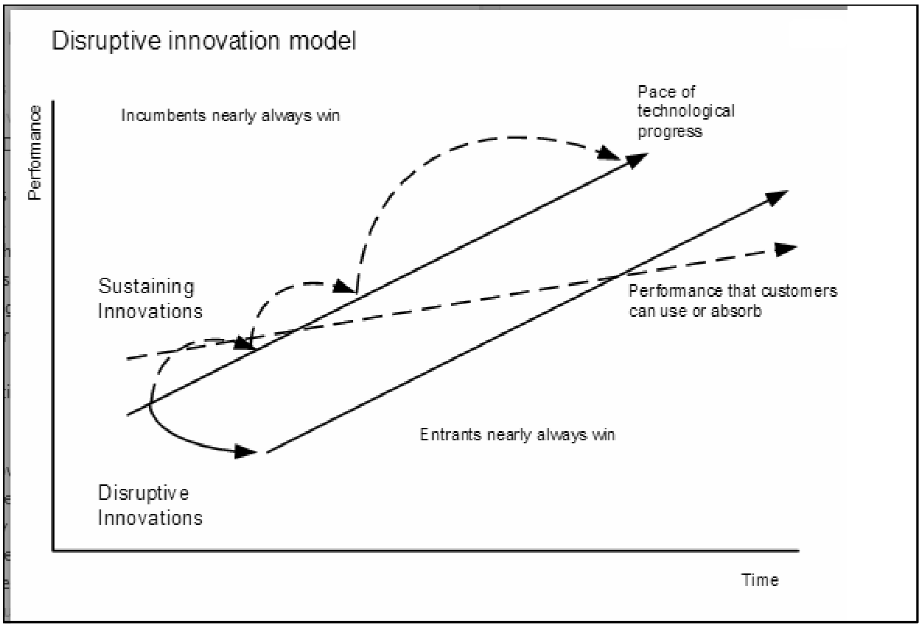


Figure 32: Model of disruptive innovation. Source: by A. Scott et al. (2008); based on Christensen et al. (2008: 46).

Christensens et al. (2008) argue, that, disruputive innovations differ from sustaining innovation by its simplicity, lower price and new product qualities demanded by another (mass) customer segment. Because sustaining innovations usually are getting more expensive, but do not bring any significant value to the traditional product anymore (=added value of performance to customers decreases; e.g., cars have potentially more

PS, but nobody can drive faster due to legal regulations), there will be always a different customer segment who would be interested in cheaper products, satisfying their specific core-needs (Christensen et al., 2008: pp. 46-47). "An innovation that is disruptive allows a whole new population of consumers access to a product or service that was historically only accessible to consumers with a lot of money or a lot of skill. Characteristics of disruptive businesses, at least in their initial stages, can include: lower gross margins, smaller target markets, and simpler products and services that may not appear as attractive as existing solutions when compared against traditional performance metrics" (Christensen ert al., 2008: p. 46). Christensen argues that, "because companies tend to innovate faster than their customers' lives change, most organizations eventually end up producing products or services that are too good, too expensive, and too inconvenient for many customers. By only pursuing "sustaining innovations" that perpetuate what has historically helped them succeed, companies unwittingly open the door to "disruptive innovations"." As examples of disruptive innovation, he points to cellular phones, community colleges, and discount retailers as disruptors, and to fixed line telephony, four-year colleges, full-service department stores or traditional doctors' offices as disruptees.

Determinant

Disruptive innovations are successfully developed and integrated, if they are simple and cheaply designed for a mass of clients, that can afford them, compared with expensive product improvements meeting only the demand for a small group of lead-users.

Empirical evidence

Christensen et al. (2008) applied their theoretical model to the North American school system and examined how schools can change to student-centred learning with computers. He characterised the external demands on schools affecting innovation integration since the 1960s. In the aftermath of the Second World War, he argues that the educational institutional policies were adapted to include teaching for democratic values. Then the change to provide equal access to minorities and women was enforced. In the second half of the 20th century, the educational institutions had to introduce more science-based teaching, because the USA aimed at becoming more competitive. Nowadays the 'No Child Left Behind Act' has an important influence on changing education so as to provide equal opportunities and fight poverty.

Relevance for ICT-based innovation research in education

The disruptive innovation approach is based on economic thinking and as Danneels (2004[64]) argues, the theoretical foundation leaves some open questions (e.g. how to know when a technology is becoming disruptive? Can you predict that ex-ante? Etc.). However, in my view it is a relevant approach to be aware while discussing the issue of emergence and integration of ICT-based innovations, since the e-learning market functions in the same way. Many evaluation studies of e-portfolio implementation complain about that the currently available e-portfolio tools at the market are too difficult to use and do not really serve the pedagogical intention. Those e-portfolio products which were merged with learning management system enhances their function only slightly, but does not bring any additional value to the potential mass of e-portfolio users (see Strivens, 2010; Zwiauer&Kopp,2008).The development of new services, which were easy to use and meet the need of the actual users at the micro-level (e.g. by meeting the current pedagogical approach; individual benefit, usability) could influence the shaping of future e-learning, resp. more easier to use e-portfolio technologies.

[64] For a critique and description of the core concept of disruptive versus sustaining technology change see: Danneels E. 2004 Disruptive Technology Reconsidered: A Critique and Research Agenda.

4.3.1.2 Stages of growth model on institutional adoption of ICTs

Basic assumptions

The innovation research literature worked on so-called stage models to explain the different phases in which organisations are integrating ICTs into their work routines and processes. The basic assumption of the ICT adoption model, developed by Richard Nolan (1973) is, that the innovation adoption processes in organisations are similar to individual adoption processes (s-shape) and occur in five stages: initialization phase; contagion phase, control phase, integration phase and maturity phase. The figure below summarises the stages and the different organisational processes.

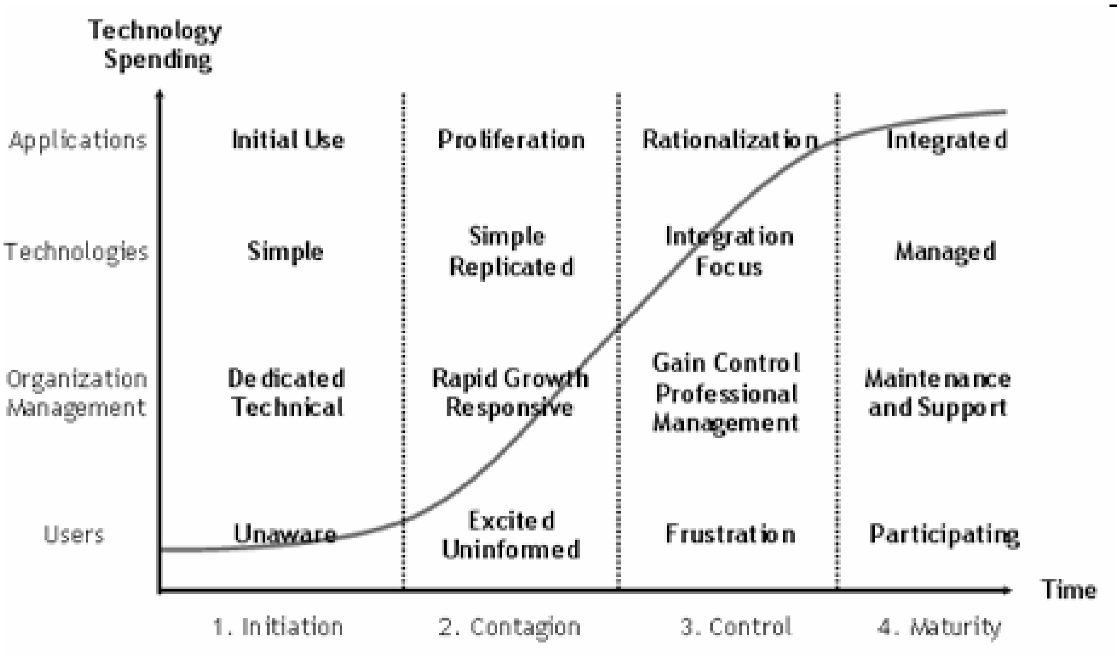


Figure 33: Stages of organisational integration of ICT-based innovation based on Nolan.
Source: by Cyrus F. Gibson and Richard L. Nolan (1974).
Managing the Four Stages of EDP Growth. Harvard Business Review

Nolan has observed that the integration of technological innovations in an organisation is a gradual process. In stage one (initialisation), very often a small unit or team starts the initiative of introducing a new ICT system, mainly to provide the management or the IT department with simpler and cheap software. The most commonly used argument for the introduction of a new IT system is the need for cost reduction, typically for a situation where organisations have grown in size. Looking at the integration of IT in the educational sector, many studies confirm that the IT integrations has played a more prominent role in thoses schools and universities which have grown in size. The more the users apply the IT system, the more the organisation learns from problems which may arise, and the organisation starts to learn to avoid mistakes or to customise the system to the organisation's particular needs (stage of contagion). Before reaching the stage of 'control', the IT department and users work relatively freely and the members of the IT department are the specialists for giving support. In the practical integration of ICTs in educational institutions, this stage is reflected in the development of new specific e-learning service centres, especially in universities, which control the IT-based e-learning infrastructure (e.g., the course management system), and train lectures in the development of media competence and the required ICT skills. In schools, the situation is slightly different: one or two computer specialists, often called 'e-learning coordinators', run the learning management system, but have little extra capacity to train their colleagues. This happens nowadays in emerging innovative networks of e-learning professionals. In the stage of contagion, there are still a considerable number of sceptical members of the organisation, who need to be convinced of the need for and value of computers. On the management level, it becomes apparent that a budget and planning for the new and growing ICT infrastructure needs to be implemented (see Kolo & Breiter, 2009: 95).

Determinant

Institutional integration of IT is a gradual process that occurs in four specific phases: initialisation, contagion, control, integration, maturity. Technological integration is viewed as a "subject of control and motivation" and only a matter of enough "machine training".

Empirical evidence

The maturity model of Nolan has often been used for empirical studies on identifying successfactors for integrating ICTs in a company or an organisation. Lately, this has been done increasingly in the non-profit-sectors, such as e-government and e-learning and also for e-portfolio (e.g. e-portfolio threshold model by Gray J.,2010; e-portfolio maturity model by Rubens & Kemps, 2008). As Hartnell-Young points out the relationship with e-learning and e-portfolio maturity modelling: "A maturity model is a profile based on a set of text descriptors that can be used to provide a snapshot of an organisation's progress towards an increasingly optimised point of development" (Hartnell-Young et al., 2007: p. 29). Marshall and Mitchell (2002), from the University

Victoria, Wellington, Australia, proposed one and provide a full set of indicators and assessment working material[65].

Relevance for ICT-based innovation research in education

The strength of the organisational IT-adoption stage growth model lies in its observation of changing organisational demands and needs and involved stakeholders while introducing ICTs into an organisation. At the beginning of the introduction of the personal computer in an organisation, the motives are the need or demand for productivity and efficiency (statistic systems, financing, accounting, etc.). The need for efficiency is a management need and is driven by an IT department and management. Other users have to be trained and convinced to introduce and accept its use. However, in the era of the Internet, the motives have changed completely and thus the stage growth models do not fit any more in the classical sences. Other motives for introducing ICTs, for example, for supporting techno-pedagogical practises, for marketing of the educational courses and institution (via homepages) and/or for providing open access to new clients, come into play. The limitation of this approach is the linear thinking of a stage growth model and the techno-deterministic thinking about the organisational "efficiency goals" that are to be determined through technological change. This may be interesting for consulting and practical advice on how ICTs implementation could be done stepwise and/ or to assess the current position and strategise future positions of an organisation (see Rubens, W. & Kemps, A. (2007) for the e-portfolioa maturity model for Dutch universities). However, for using the model in the integrated, multi-level framework approach it provides little insights in the determinants modelling the organisational maturity and the mutual interrelations with other influencing levels (micro and macro) systems.

[65] E-learning maturity assessment material: University Victoria, Wellington, Australia: Available from: http://www.utdc.vuw.ac.nz/research/emm/.[6 May 2011]

4.3.2 Subjectivist approaches

4.3.2.1 Innovation diffusion theory

Basic assumptions

The most influential and well-cited model of innovation diffusion is the work of the innovation diffusion researcher Everett M. Rogers (2003) who explored and conceptualised rules and patterns of individual and organisational innovation diffusion by drawing on insights of empirical case studies (especially from the agricultural industry). He viewed diffusion as “the process by which an innovation is communicated through certain channels over time among the members of a social system” (2003, chapter 1-38). Analysing a vast volume of adoption studies, he claimed that the performance of adoptions over time looked like a “normal, bell-shaped (frequency) curve, where the first segment (2.5%) represents innovators, the second segment (13.5%) represents early adopters, followed by the early majority (34%), located between the mean date of adoption and the mean minus one standard deviation, and late majority (34%), the segment between the mean date of adoption and the mean plus one standard deviation. The last 16% are described by Rogers as laggards, and include “those who resist change” (as cited by Elgort, 2005: p. 182). The development of a diffusion process in the case of social software, nowadays used in e-learning 2.0 scenarios, is depicted in the figure below.

Figure 34: The categories of adopters of social media in business.

Source: Tertel J. (2010)

According to Rogers' model, adopters within each category have particular dominant characteristics and values. Elgort notes that, "innovators are usually intrinsically motivated to use new technologies and tolerate ambiguity and setbacks well. Early adopters are opinion leaders or role models, and have extrinsic reasons to adopt innovations. The early majority are well respected by their peers, but not leaders, while the late majority group includes followers and sceptics. This group may adopt an innovation as a result of the peer pressure" (2005:182). The strategies (especially marketing) to bridge the gap between the early adopters and the early majority are called 'chasms', as promoted by Geoffrey A. Moore (1991; 2002 edt.). Rogers' innovation diffusion research is based on the different types of innovation leading to a different decision behaviour (optional/individual, collective, authoritative), on the observation of different stages of a diffusion process (knowledge, decision, implementation, confirmation) and the involvement of different actors (early adopters, early majority, late majority, laggards).

Askarany (2003) has enhanced Rogers model of diffusion phases and developed a "general diffusion model", which takes into account the charactersistics of the innovation (i.e., complexity), the social system (framing the innovation decision process) and of the institutional adopters (organisational structure, culture and strategy). These determinants are depicted in the scheme of a general model of diffusion of innovation below.

Determinant

Rogers (2003) identified multiple dimensions as influential on the intensity and success of diffusing and integrating a new product or service, however it is especially the more holistic approach by Askarany (2003) which might serve for analysing the meso-level. The set of influential determinants are: the type of innovation (optional/individual, collective, authoritative; public/private consequences); the type of communication channels; the phases of diffusion (knowledge, decision, implementation, confirmation) and type of actors involved (early adopters, early majority, late majority, and laggards); the organisational strategy and structure and the organisational culture and learning (change agents acting as catalysts of change). In the context of the to be developed framework, the aspecto of organisational structure and culture (see box on the right top corner of the figure) is of interest to the issue of theoretically explain the institutional integration of ICT-based innovations.

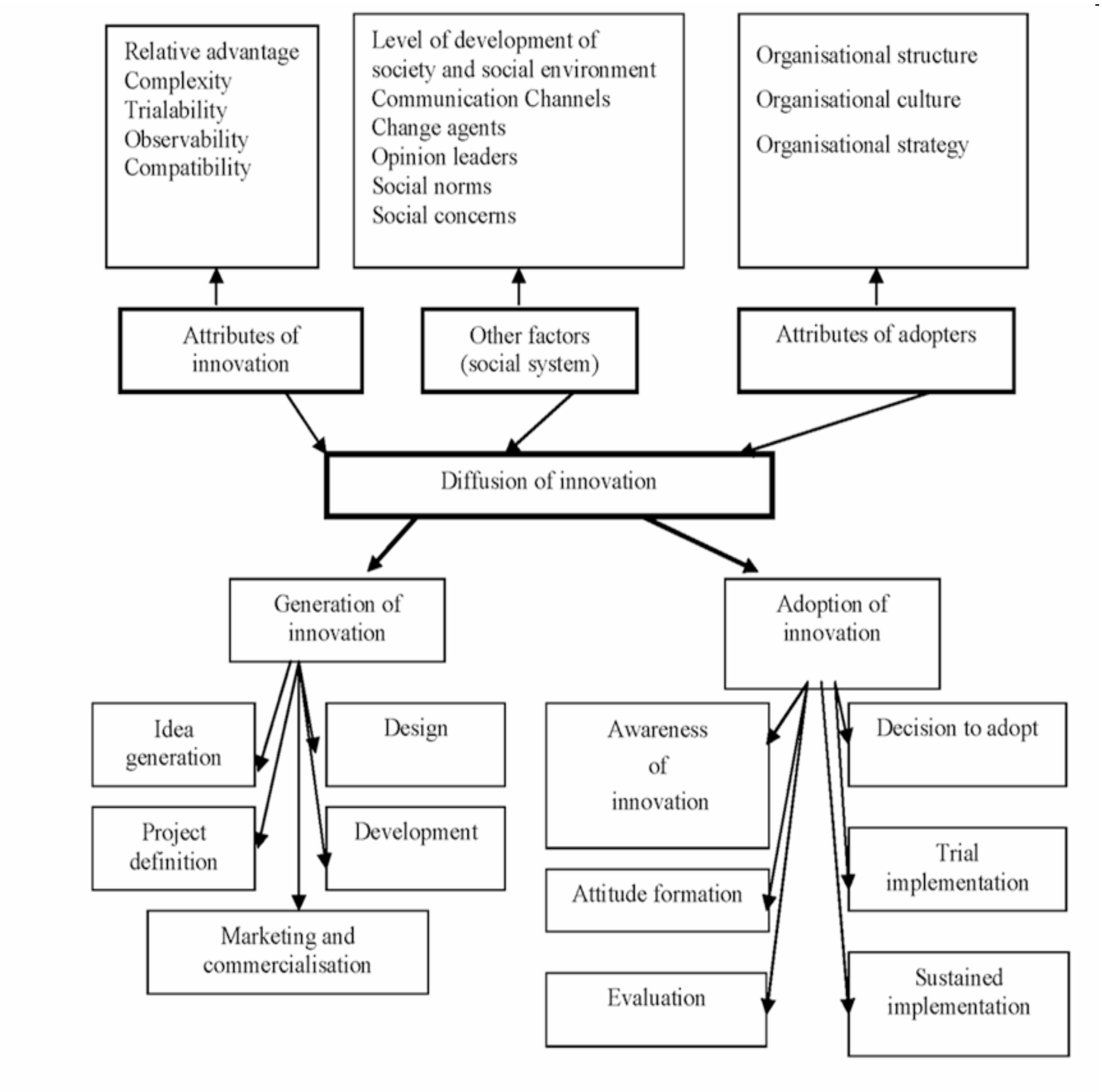


Figure 35: General diffusion model of innovation. Source: Askarany, 2005, (based on Rogers 1995)

Empirical evidence

The innovation diffusion model of Rogers is very well known and has often been applied also in the field of e-learning research. Zemsky and Thwart (2004) have found out that the e-learning integration patterns follows the proposed S-shape curve, however, the problem with e-learning in universities seem, that many different overlapping innovation adoption cycles occur and a very complex integration situation has arisen in the case of e-learning integration at the University of Pennsylvania, US (project report). They found out four adoption cycles, each necessitating another level of change. Firstly, enhancements to traditional course configurations; secondly, the introduction of new course management tools; thirdly, import of digital content ("learning objects") and finally, the configuration of new courses (2004: 11).

The cycles include:

- "Enhancements to traditional course/program configurations, which inject new materials into teaching and learning processes without changing the basic mode of instruction. Examples include e-mail, student access to information on the Internet, and the use of multimedia (e.g. PowerPoint) and simple simulations;
- Use of course management systems, which enable faculty and students to interact more efficiently (e.g. Blackboard or WebCT). They provide better communication with and among students, quick access to course materials, and support for administrating and grading examinations;
- Imported course objects, which enable the faculty to embed a richer variety of materials into their courses than is possible with traditional "do it yourself" learning devices. Examples range from compressed video presentations to complex interactive simulations including the increased use of "learning objects" ;
- New course/program configurations, which result when faculty and their institutions reengineer teaching and learning activities to take full advantage of new ICTs. The new configurations focus on active learning and combine face-to-face, virtual, synchronous, and asynchronous interaction and learning in novel ways. They also require faculty and students to adopt new roles – with each other and with the technology and support staff" (see Zemsky and Massy, 2004: 10pp.).

Zellweger (2007) used the adoption model to develop a „faculty adoption" cycle, which argues that the teacher and staff at faculty level undergo the same adoption cycle as sketched out for technological innovations and that they need special technical support depending on the phase of e-learning integration. Bates et al. (2007) provide a model of early adoption of ICT innovations in the Higher Education sector by considering specifically the role of change-agents attempting the introduction of an innovative new ICT-service into Higher Education institutions.

Relevance for ICT-based innovation research in education

The general diffusion model of innovation does integrate interrelated meso- and micro-level factors and focuses both on the shaping and the integration process of innovation. Hence it is a powerful model to be used in e-learning. However, in my view, it is specific valuable for investigating the impact of organisational structure, organisational culture and organisational strategy on the intensity and integration patterns of a changing techno-pedagogical practise and not only the administational and efficiency role of ICTs in education.

4.3.2.2 Theories on organisational culture and innovation

Basic assumption

During the 1980s, organisation and management theorists have explored the influence of the organisational culture, strategy and structure on the organisation's ability to adopt and integrate technological innovations. The most cited representatives of this research strand are Edgar Schein (focus: organisational culture, 1989; 1996), Argyris and Schön (organisational learning, 2008) and Peter Senge (organisational strategy; 1990).

Edgar Schein (1996; 1989) defines organisational culture as "a pattern of shared basic assumptions that the group learned as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way you perceive, think, and feel in relation to those problems"[66]. According to Schein (1989), three dimensions of organisational culture influence the culture and an integration process of something new, as all the e-learning innovations have been, in an organisation:

- "Artefacts: that is, organisational attributes that can be seen, felt and heard by the uninitiated observer, such as the facilities, offices, furnishings, visible awards and recognition, the way that its members dress, and how each person visibly interacts with each other and with organisational outsiders.
- Espoused values: professed culture of an organisation's members. At this level, company slogans, mission statements and other operational creeds are often expressed, and local and personal values are widely expressed within the organisation.
- Basic organisational assumptions: tacit assumptions are found. These elements of a culture are unseen and not cognitively identified in everyday interactions between organisational members. Additionally, these are the elements of culture, which are often taboo to discuss inside the organisation. Many of these 'unspoken rules' exist without the conscious knowledge of the membership. Schein argues that "the deeper level of basic assumptions and beliefs that are: learned responses to the group's problems of survival in its external environment and its problems of internal integration are shared by members of an organisation; that

[66] Source: Management Lexika: at http://5starinnovation.com/organization-culture-and-innovation/ [retrieved 2011-07-23]

operate unconsciously; and that define in a basic taken-for-granted fashion in an organisation's view of itself and its environment“ (Schein, 1989).

Schein aims to explore paradox situations in organisations, for example, when introducing an innovation, underlying tacit cultural norms often hinder the organisation-wide integration. While trying to implement new solutions, change agents have to understand both the culture at its deepest level and the dynamics of interpersonal relationships.

Argyris and Schön (1978) explored the relation of the individual person and the organisational structure and developed methods to make the interpretations and reflections of the individuals explicit and enrich the organisational learning needed to cope with change and innovation integration (organisational maps, reflexive inquiry). They differentiated between three models of organisational learning, namely: Single Loop, Double Loop and Deutero Learning. Single-loop learning is the type of learning that has been effective in the past days and tradition of an organisation (e.g., the organisation uses the same process of information acquisition and distribution) and is used to keep existing objectives and keep the organisation's performance, considering existing rules. In practise, they have observed that any organisation respects existing principles, norms and values, but adapts itself constantly to the environment. Therefore, if an organisation only focuses on traditional single-loop learning, then it misses reflection of existing behaviour and decisions, because that would clash with established mental models (Senge, 1990). In order to bcome a learning organisation, able to integrate new processes such as e-learinng, a double-loop learning process ensures a collective analysis of the system's basic principles and opens up ways for an organisation to revise structures, develop a new paradigm and share its mental model (e.g. by critical review of the theory in use by questioning current principles and rules, which are properly altered (Argyris & Schön, 1978)). Senge (1990) specifically considers a need for double-loop learning if an organisation wants to support the development of creativity or innovation. In his book on the Fifth Discipline for Change, he highlights five competences that enable organisational learning and change: mastery of a personality, understanding mental models of an organisation, the building of a shared vision, team learning and systems thinking. The most important one is the last of the five competences, integrating the other four.

In a broad range of works, Michael Fullan (1993, 1999 and 2010) transferred the findings of organisational theory to the context of organisational learning of educational institutions. He argues that it is important to realise that the educational change process is very complex. To deal with such complexity is not to control the change, but to guide it. Fullan thereby focuses on the roles and strategies of various types of change agents. Fullan emphasises that educational change is based on creating the conditions to develop the 'capacity' of both organisations and individuals to learn. The focus moves away from an emphasis on structural change towards changing the culture of classrooms and schools, an emphasis on relationships and values (see Fullan 1999, 2010) proposed that there are four broad phases in the change process: initiation, implementation, continuation, and outcome.

Determinants

The inter-relationship between multiple levels of human activity co-constructs change on different levels of culture within one organisation (tacit assumptions, espoused values, artefacts). Double learning loops are important to revise established mental models and allow for the generation of changed behaviours and actions of teams.

Empirical evidence

The models for organisational learning became prominent in many industrial case studies (e.g. influence of organisational learning on innovation in the case of Brazil's Electro-Electronic industry by Sampaio &Gattermann), but also in the field of e-learning. As soon as the difficulties with e-learning integration into daily practises in schools and universities have become evident, the hypotheses of the organisational learning theories were applied.

Relevance for ICT-based innovation research in education

In my view, the value of the organisational learning theories is their view of innovation integration as dynamic process. The focus on the enabling or hindering role of the many interrelations between team-culture, department-culture and hidden, almost behaviour patterns of organisational learning, can help to develop effective organisational policy interventions. Moreover, they allow to relate the educational culture of a macro-system of with the cultural aspects of the meso-level system. The learning strategies of the individual actor to cope with change are not element of these approaches. All these three approaches had been developed during the 1980s, a time in which the roll-out of e-learning was only at its beginning. Unfortunately little attempts have been made so far to advance those organisational learning theories by questioning the role of ICTs and Internet as techno-sphere of the organisation.

4.3.2.3 Actor network theory

Basic assumptions

A systematic description of the relation between an individual person, the used technological device and his/her environment, is given by the *actor-network theory* (ANT) which is regarded as a framework and systematic way to consider the infrastructure surrounding technological achievements ("No one acts alone"). Michel Callon (1987; 1991) originally developed the approach, later enhanced by Bruno Latour (1992) and John Law (1987), to have a better understanding of the processes of technological innovation and scientific knowledge-creation. It does not aim to explain why a network exists, it aims to describe the infrastructure, and thus also the structures of actor-networks within educational institutions, how they are formed, how they can fall apart, etc. (Learning Theories Knowledgebase, 2011).

The actor-network theory is based on the *principle of generalized symmetry*, which means that human and non-human (e.g., artefacts, organisation structures) should be integrated into the same conceptual framework and assigned equal amounts of agency. By such a method, it may be possible to precisely describe the concrete mechanisms at work holding a network together, while allowing an impartial treatment of the actors (ibid.). The following key-concepts of the actor-network theory: translation (problematisation; interessement, enrolment, mobilisation of allies) and building networks; intermediaries and mediators (principle of symmetry) and actants are important. Social meaning, and also power can be inscribed into technological objects. "Non-human artefacts can be used as delegates for particular human interests as well as to hide decision processes from.

Determinants

The actor-network theory considers all surrounding factors of an environment as influential determinant on the use of technology.

Empirical evidence

Lately, there has been some attempts apply the actor-network theory to education, see for example by Erich Herber & Stephan Waba (2011[67]). They have evaluated the use of net-books in schools by the approach of the actor-network theory.

Relevance for ICT-based innovation in education

Summing up, the actor-network theory can be used to understand the role and power of the e-portfolio as "artefact" in educational context besides human actors and actions. It does sharpen the view for the "hidden, embedded" power into ICTs by distinguising human and non-human actors. In any case, the technology does not empower autonomously. Therefore, in my view the descriptive approach is limited in exploring concrete determinants influencing the intensity of the interactions with actors at other levels of the organisation.

4.3.3 Dualistic approach

A dualistic way of thinking would consider the adoption of an ICT-based innovation either as a technological or a social integration problem. Adoption and integration of ICT-based innovation occurs independently of social practices. To my knowledge no major theoretical work has been prominantely put forward.

4.3.4 Dialectical approach

The dialectical approaches regard the institutional adoption of an ICT-based innovation as a mutual change process between the structure and actors of the meso-level with both the macro- and the micro-level actors..

4.3.4.1 Framework for technological innovation and sectoral change

Basic assumptions

Although the framework for technological innovation and sector change seem to better classify as a macro-economic model, I discuss it in the "meso-section", because two of the major arguments of this approach relate to institutional characteristics and organisational behaviour. This approach focuses more or less on "technological change"

[67] The example was descriped in a joint article on "Die Akteur-Netzwerk-Theorie
Eine Techniktheorie für das Lernen und Lehren mit Technologien" by Andréa Belliger, David Krieger, Erich Herbert and Stephan Waba (2011) in the L3T study book.

(the interplay of technology and social shaping). An additional question is how specific sectors (e.g. sectoral patterns) and thereby socio-economic structures, institutions and actors are changing under the influence of new technologies (Dolata, 2009: 1066). The framework proposes that technological change (gradual transformation) does not take place at the same pace and rate in different economic sectors. Modes of sectoral transformation are between three poles: reactive/crisis ridden, anticipative, and proactive. The transformative capacity of a new technology is not an autonomous category, but a relational one, between the characteristics of a technology and the structural and institutional constitution of a sector on which the technology has an impact. New technological opportunities challenge the existing match between technology, structures and institutions in the course of their formation and adoption. The Internet as a multi-purpose technology opens up specific sectoral opportunities for use, application and transformation. The question is how the new technology alters the technological profile of the sectors, affects existing patterns of R&D, distribution, products and market relations, enforces new co-operation patterns and competitive interaction, and opens up or widens existing borders of sectors. Sectoral change is, as a rule, the result of a multitude of actor-based and gradual transformations successively modifying the organisations, structures, and institutions of a sector—either through endogenous processes, primarily promoted by the actors of the system themselves, or through new, that is to say, system-external actors thronging to the system with strategies of their own (ibid). The framework depends on two interrelated influencing factors: Firstly, the “sectoral-specific transformative capacity of new technologies” and, secondly, to the “socioeconomic adaptability of the established sectoral structures, institutions, and actors confronted with the challenges presented by new technologies” (Dolata, 2000:1067). The first aspect questions whether a technology (in an instrumental sense) has the potential to change the guiding business concept and rules of the economic sector. The second aspect deals with the already known determinants of organisational change, as discussed in section 4.3.2.2. (theories on organisational culture and innovation). New, respectively different from the previous attempts is the interrelation between technology impact from macro-to meso (sectoral level) and the combination of the organisational innovation capacity. These mechanisms are illustrated below.

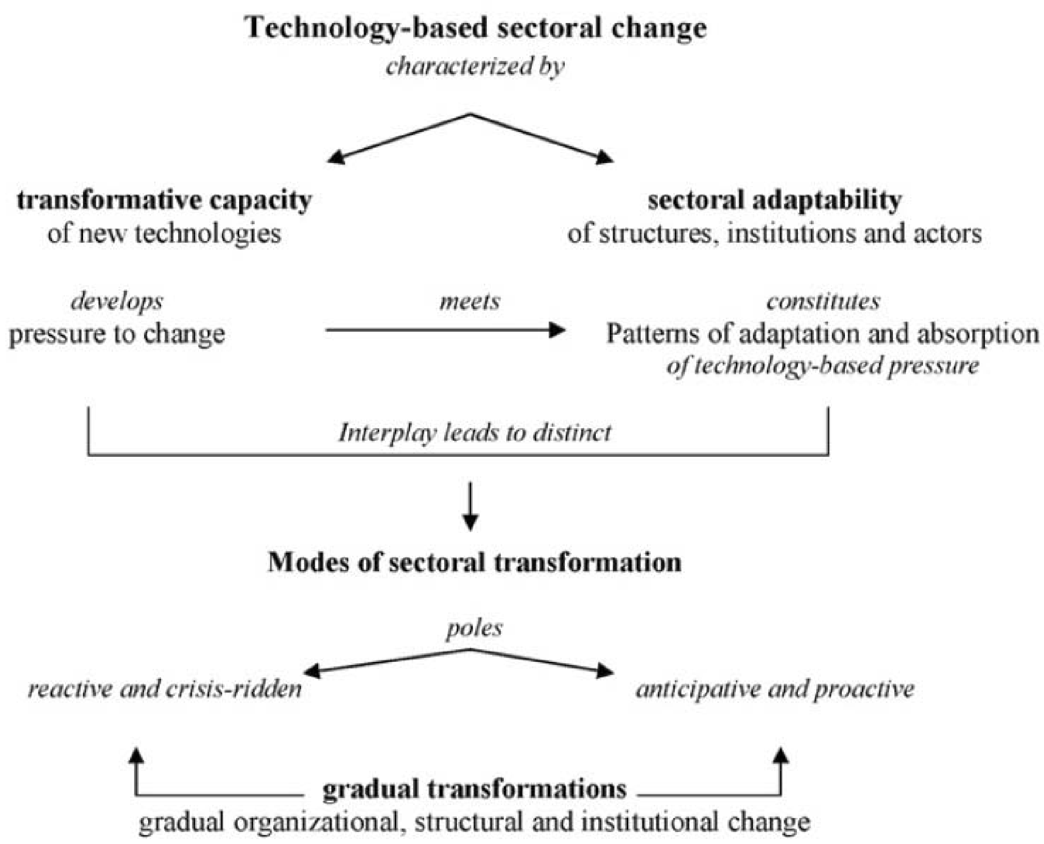


Figure 36: Basic categories of analytical framework on technology-based sectoral change. Source: Dolata (2009: 1067)

Therefore, Dolata (2000: 1070-1072) identifies further different levels of sectoral adaptability:

• "on the organisational level the ability to identify, communicate, and adopt the challenges of new technologies in a timely manner and to renew established routines and strategies;

• on the institutional level the openness and flexibility to change and readjust the overall "rules of the game" i.e., the regulations, norms and shared beliefs guiding and structuring the activities of the actors involved;

• on the structural level the permeability of research, production, market, and demand conditions in supporting discontinuous innovations, developing new products, constituting new markets, and facilitating the entry of new actors".

Therefore, Dolata suggest that sectoral change is, as a rule, the result of a multitude of actor-based and gradual transformations successively modifying the organisations, structures, and institutions of a sector—either through endogenous processes, primarily promoted by the actors of the system themselves, or through new, that is to say, system-external actors thronging to the system with strategies of their own (Dolata, 2000: 1066–1076).

Determinants

(Sectoral) technology-based change depends on the interplay of transformative capacity of new technology (the more it affects the existing patterns, the less it is able to be implemented, used within the existing institutional and organisational framework) in this specific sector AND the socio-economic adaptability of the established sectoral structures, institutions, and actors confronted with the challenges by new technologies.

Empirical evidence

There are works of Dolata (2008) dealing with the transformation of the music-industry by the Internet. However, no application of this framework to the role of ICTs in the sector of education could be found.

Relevance for ICT-based innovation research in education

The value of this approach lies in the relation of a macro-view, which takes respect of technology as techno-sphere of the organiation, and, the institutional capacity to develop and cope with innovation. As mentioned before, this approach differs from m the previous theoretical approaches in focusing at the interrelations between the role of technology at the macro-level and the organisational innovation capacity.

4.3.4.2 Critical theory on integration of ICTs in educational institutions

Basic assumptions

In literature “critical theory” is a term describing the dialectical social criticism, a strand of theories developed by the Frankfurt School (Institute for Social Research), which is connected with authors such as Adorno, Horkheimer, Benjamin, and Marcuse (Ryder, 2006) between 1930 and the 1960s. With minor exceptions (Friesen, 2009: pp. 173-201), the fundamental thinking of critical theory (“ideology critique”) or critical pedagogy (the concept of “conscientization” by Paulo Freire, 1921-1997; critical media pedagogy by Henry A. Giroux, 1948 to the present) is not well recited in the e-learning community.

The basic assumption of critical authors is that the development and organisational integration of educational technology are not guided so much by empirical and theoretical knowledge about learning as as by neo-liberal and commercial interests (Nicholls & Allen-Brown, 1996 cited in Coverdale 2009). Feenberg views the role of ICTs and the Internet in education as between two poles: automation (reduction of the personal teacher and tutor by computer) and flexibility (ICTs enable flexibility and individuality of skilled workforce). Moreover, ICTS are used as a “centralizing, managerial and delivery tool” (2002). Feenberg (2002) argues that the role of ICTs and the Internet in education in the future will not be determined by the technology itself, but by the politics within the educational community and national political trends. He proposes a dialectical thinking so that the use and integration of educational technology of an advanced society should be shaped by educational dialogue rather than the production-oriented logic of automation (Coverdale 2009).

Feenberg (2009) and Norm Friesen (2009) criticise that the deterministic view of technology leads to false myths about the impacts. He argues that, for example, the so-called “knowledge economy (coined by Daniel Bell)” sector is far smaller than other dominant sectors of the service industries, such as tourism, health care and retail business. Moreover, the myth of unlimited time and space restrictions (“anyone, anywhere, anytime learning”) is only partly empirically grounded and digital divides in media competencies and skills, race and gender still prevail, because a diverse range of socio-economic factors influence the uptake of a new techno-pedagogical practice. Finally, Friesen contends that the current use of ICTs and the Internet in the educational institutions reinforces traditional pedagogical practice rather than motivating the uptake of innovative forms of tuition made possible by the advent of new Internet technologies and Web 2.0 (e.g., Open educational resources) (Friesen 2009: pp. 182-198)

Determinants

Use and integration of ICTs depends on the dialectical thinking of educational and economic (production-oriented) national and institutional policies.

Empirical evidence

Friesen (2009: p. 197) shows that learning management systems such as Web CT and Moodle were technically developed and designed as course management systems with direct interest and funding from university management. They primarily support the central administration, and are centrally serviced and supported by a university technical network.

Relevance for ICT-based innovation in education

The value of the critical theory on ICT-based innovations lies in my view in the critical assessment of economic interests and mindsets guiding also the sector of education. Especially the field of e-learning is coupled with the IT-market, in the meantime a very important national sector of economy. Such a close look on external influences on the meso-level can help to avoid the trap of making only individual users, especially teachers or less IT-affin learners, responsible for low adoption rates of ICT-based innovations in education.

4.3.5 Meso-level determinants of institutional integration and diffusion of ICT-based innovation

The table below summarises the interdisciplinary view on the proposed factors influencing the instituttional integration and diffusion of ICT-absed innovations, which have been analysed as relevant for the field of e-learning research:

View	Theoretical approach	Determinants
Objectivism	Disruptive innovation theory for organisation(Christensen, 2008)	Disruptive innovations are successfully integrated if simple and cheaper for mass of clients in contrast to expensive gadgets for a small group of lead-users.
	Stage model on IT-adoption (Nolan, 1973; Zemsky & Massy, 2004)	Institutional integration of IT is a gradual process following specific stages (initialisation, contagion, control, integration, maturity). Adoption of ICTs depends on the individual social psychological/behavioural factors and mindset for making innovation decisions (person's attitude and beliefs about the behaviour and subjective norms). The (techno-pedagogical) innovation diffusion process follows four phases involving change at each level: initiation, implementation, continuation, and outcome.
Subjectivism	Technology innovation and diffusion theory (Rogers, 1962; 2003)	The diffusion of the technological innovation depends on • The type of innovation (optional/individual, collective, authoritative; public/private consequences). • The type of communication channels. • The phases of diffusion (knowledge, decision, implementation, confirmation) and type of actors involved (early adopters, early majority, late majority, and laggards.
	Systems-oriented organisation and management theory (Schein 1998; Argyris & Schön 2008, Senge 1990; Fullan, 1993; 2010)	• Organisational strategy and structure. • Organisational culture and learning (change agents acting as catalysts of change; learning loops) and • The inter-relationship between multiple levels of human activity co-construct change.

Dualism		The institutional integration of ICT-based innovation occurs either as technical orsocial practice.
Dialectics	Framework technological innovation and sectoral change (Dolata, 2009)	The integration of ICT-based innovations depends on both organisational and technological characteristics and needs: ability of technology to change institutional routines (transformative capacity) and ability of institutions to change to external and internal demand (socio-economic adaptability)
	Critical theory of technology and pedagogy (Feenberg, 2002; Friesen, 2009)	The integration of ICT-based innovations is influenced by the economic drivers behind the e-learning market; a full integration depends on the balance between the role of ICTs for automation of organisational processes and support of techno-pedagogical practise.

Table 19: Meso-level determinants of institutional diffusion and integration of ICT-based innovation.

4.4 Micro-level: The individual shaping and use of techno-pedagogical design and practices of ICT-based innovations

This chapter deals with the shaping and integration of innovative techno-pedagogical design and practice involving ICTs and Internet applications by individual persons or groups on the micro-level, for example, by students, teachers or parents, software developers, R&D researchers, e.g., in virtual class room teaching, online academic lectures, asynchronous training, virtual universities, etc. Reinmann (2010) defines didactical design as concepts, models and theories which support educators to decide how to plan learning products and services, conceptualise teaching and learning scenarios and the arrangement of learning environments (Reinmann, 2010: p. 7). Given the focus of the thesis on technology-enhanced learning and the understanding that both technology and pedagogical thinking are influential forces, I will slightly adapt the term to "techno-pedagogical" design and practice.

As was already outlined in chapter three (Characterisation of an ICT-based innovation, section 3.3.: Technology, ICT and electronic media), an instrumental approach focusing on the material aspect of a new technology alone does not explain the use and integration of an innovative educational technology in a specific pedagogical learning setting on the micro-level. Krantzberg's first law of technology tells us, "Technology is neither good nor bad; nor is it neutral" (1985: p. 50). This means that techno-pedagogical design and practices have embedded principles of different pedagogical philosophies and learning theories, which influence both the software design and the actual decision to use it or not in a concrete learning environment. In the course of time, the pedagogical paradigms have changed from behaviourist and cognitivist learning theory to constructivist and socio-cultural learning theories. The latter school has been extended by a new theoretical approach, which explicitly targets the technology-enhanced learning in a digital network, called connectivism by George Siemens (2006; 2008). This chapter aims to review the principles of how to shape a techno-pedagogical design and practice depending on the pedagogical school of thought.

The thinking about the interrelation between learning theory and educational practice has a longstanding tradition in the domain of psychology (sub-discipline psychology of learning and/or instructional psychology) and in the beginning was influenced primarily by American scholars such as E. L. Thorndyke, William James, and John Dewey (in Reigeluth, 1993: p. 5) [68]. The diverse theories on instructional design have a major impact on how educational technologies are designed not only from a technological point of view, but also for achieving specific educational goals and pedagogical support. Molenda et al. (2003) define instructional design as "a construct referring to the principles and procedures by which instructional materials, lessons, and whole systems can be developed in a consistent and reliable fashion. The principles and procedures can be applied to guide designers to work more efficiently while producing more effective and appealing instruction suitable for a wide range of learning environments" (2003: p. 2).

Therefore this chapter will, firstly, review the major learning theories (behaviourist, cognitivist, constructivist and socio-cultural), and single learning models specifically aiming to achieve the objective of self-organised learning and reflection (e.g., self-regulated and self-determined learning, experiential learning) . Secondly, it will assess their relevance to determine the shaping and integration of techno-pedagogical practice. It is important to state that a specific techno-pedagogical design does not automatically lead to an integration of ICT-based innovations, but it makes the pursuit of a specific learning goal, such as self-organised learning, either easier or harder to achieve. Therefore, finally, a short summary of the identified determinants will be given.

[68] For more details of the history of instructional design see: Reigeluth, C. M. (1983). Instructional design: What is it and why is it? In C. M. Reigeluth (Ed.), Instructional-design theories and models: An Overview of their current status (vol.1, pp. 3-36). Hillsdale, NJ. Erlbaum.

4.4.1 Objectivistic approaches

4.4.1.1 Behaviourist instructional design and practice

Basic assumptions

The roots of behaviourist instructional design lie in the works of American psychological researchers such as Watson (1913), Thorndyke (1913), Skinner (1950) and Bandura (1963) and their various theories on "conditioning" (e.g. Pavlov's Theory on Classical Conditioning, Skinner's Theory on Operant Conditioning) and the "stimulus-response" principle (see Learning Theories Knowledgebase, 2011)[69]. The main characteristic of the behaviourist learning theory is the notion that "learning happens when a correct response is demonstrated following the presentation of a specific environmental stimulus" and the learner is a black box: "what happens inside is unknown" (Dabbagh, 2011).

Educational technology based on behaviouristic learning theories treats the information process like a computer-machine through association and reinforcement with passive learners and knowledge creators. Important elements are the functions of trial and error and that digital teaching material (e-content) includes factual information. The units of a course curriculum are designed step-wise, starting from simple units to more advanced ones. The learner is regarded as unknown personality and the stress is on observable and measurable results and behaviours. The control of the learning process takes place via e-assessment tools (e.g. multiple choice) (ibid.). A modification of a specific behaviour is due to a response to a targeted stimulus and learning takes place either through trial and learning or through association and reinforcement. The role of a teacher or tutor is to control the stimuli, to adapt the needed resources (learning material) and observe the outcome (see Conole et al., 2004: p. 19).

Determinants

Techno-pedagogical design, based on the behaviourist school of pedagogical thinking, perceives that learning takes place like a "computer-machine like information process" through association and reinforcement. Learners are viewed as passive receivers and knowledge creators at learning tasks are simple tasks, which need the learner only to recall facts and pre-defined answers. Therefore standardised e-assessment procedures are likely to be used in such a scenario.

[69] Learning Theories Knowledgebase (2011, August). Paradigms and Perspectives at Learning-Theories.com. Retrieved August 23rd, 2011 from http://www.learning-theories.com/design-based-research-methods.html

Empirical evidence

Behaviourist instruction has been used for designing computer-assisted instruction systems (such as the "PLATO-System: Programmed Logic for Automatic Teaching Operation" and the "TICCIT CAI System: Time-shared Interactive Computer Controlled Information Tele-vision" which were described in detail in chapter 2) and learning management systems in their first versions (first designs in 1990s; used for simple online learning tasks).

Relevance for ICT-based innovation research in education

The influence of behaviourist instructional design and practice goes back to the interest of the American military in the 1960s in achieving a rapid transfer of learning outcomes and a skilled work force. The approach lost its importance in the middle of the last century, due to the limitation that the principles only work well for simple and unquestionable learning tasks. Reinmann (2011) points to the fact that the diffusion of behaviourist psychological learning theories and instruction designs was not evenly taken up in the world of educational science. In the first half of the last century, the American psychologists were forerunners in experimenting with using computers for educational goals. In the German-speaking science world, the pedagogical psychology aimed at empirical findings; however, the didactical perspective remained in the realm of the humanities until the end of the 1960s (2011: 108) and for example, the German educational discourse and research was more targeted to macro-oriented questions on the conditions, aims and initiatives of a new educational policy (ibid.: 110). Conole et al. (2004) make the criticism that although behaviourist design does not match current educational objectives and the skills needed for a complex information society, even in the 21st century many e-learning applications are still designed according to a "webpage turning mentality" which would imply a stimulus – response learning objective.

4.4.1.2 Cognitivist instructional design and practices

Basic assumptions

Cognitive instructional design has extended the behaviourist learning theories and focuses on the importance of internal cognitive processes for learning. The principles of cognitivist design are that learning is regarded as a process in which the state of the acquired factual changes and knowledge acquisition is perceived as a direct consequence of a mental activity (Dabbagh, 2011). Learning takes place as "transformations in these cognitive structures" (Conole et al., 2004: 19). Cognitive instructional design and practices focus on the ability of learners to remember, retrieve, and store information in their mind memory. However, the process of learning is regarded as an active process that occurs within the learner, and which can be influenced by the learner and the outcome of learning is dependent not only on what the teacher provides, but also on what the learner does to process this information individually (Dabbagh, 2011).

A range of well known representatives of cognitivist instructional design are the early works from Piaget (Stage Theory of Cognitive Development 1951; 1973), Gagnè (Conditions of Learning; Nine events of instruction, 1965/1985), Merill (Components Display Theory, 1983), Reigeluth and Stein (Elaboration Theory for sequencing curricula and tasks, 1983), Sweller (Cognitive Load Theory, 1988), Richard Mayer (Multimedia Cognitive Load Theory, 1997; 2001) and Hutchinson and Salomon (Distributed cognition; social aspects of cognition 1980; 1997).

In the context of multimedia and virtual ICTs and the Internet, the cognitive load theory is important. By the late 1990s, John Sweller and his team had discovered several learning effects related to cognitive load and the design of instructional materials (e.g., the split-attention effect, the redundancy effect, and the worked-example effect[70]), all of which were extended by Mayer (1997; 2001). Mayer's work is based on his rationale for the multimedia principle, which holds that "[t]here is reason to believe that – under certain circumstances – people learn more deeply from words and pictures than words alone" (Mayer, 2005: 3) and builds his theory on three assumptions: a learner has two separate channels (auditory and visual) for processing information; each channel has a limited (finite) capacity and learning is an active process of filtering, selecting, organising, and integrating information based upon prior knowledge (Mayer, 2005). Dabbagh summarizes the pedagogical implications of the goals of a practical cognitivist learning setting:

- "Communicate or transfer knowledge in the most efficient, effective manner (mind-independent, can be mapped onto learners)

[70] "The theory is derived from the work of cognitive psychologist George A. Miller and his research on the capacity of working memory. His influential paper, "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information", stated that average working memory can only hold between five to nine objects at a time. John Sweller further developed this research into Cognitive Load Theory. He said that the design of instruction should work to reduce the amount of load on working memory to help the learner".
Source: Encyclopedia of Educational Technology http://eet.sdsu.edu/eetwiki/index.php/Cognitive_load_theory

- Focus of instruction is to create learning or change by encouraging the learner to use appropriate learning strategies
- Learning results when information is stored in memory in an organized, meaningful way.
- Educators are responsible for assisting learners in organizing the information in an optimal way so that it can be readily assimilated "(Dabbagh, 2011).

Determinants

Techno-pedagogical design based on the cognitivist school of pedagogical thinking stresses that educational software and digital learning material should be designed so as to carry intense factual information and be organised in several units, from simpler units of knowledge or skill to more advanced ones. The control of such an ICT-enhanced learning process should take place via e-assessment tools, which now allow a testing on individual pre-requisites and processes.

Empirical evidence

Cognitivist design principles were popular in the second half of the 20th century, when they were dominated by American developers and pedagogical psychologists who wanted to improve the micro setting of educational objectives with ICT-based innovations. The work was guided by the perception of ICTs as an instrument for automation and individual flexibility. Therefore, software developers, very often in collaboration with pedagogical psychologists, were looking for instantiations of this approach, embedded, for example, in intelligent tutoring systems. As already outlined in chapter 2, those systems are used particularly for the teaching goals of mathematical reasoning, problem-solving in scientific fields, learning a second language, and learning to read. The idea was to use technical systems (including personalised tutors) in combination with human actors to teach also less well-defined skills and complex problem-solving. The cognitivist view on learning was lately explored also in the context of e-portfolios (see the article by Bradford, Hess and Regan, 2008). The author-team developed three software prototypes based on three different instructional design theories namely, Mayer's Designing Instruction for Constructivist Learning, Schwarz, Lin, Brophy, & Bransford's Flexibly Adaptive Instructional Designs, and Reigeluth's Elaboration Theory (2008:1).

Relevance for ICT-based innovation in education

The strength of the cognitivist approach is the guidance to design sequences of teaching material, which build on existing information structures. Conole et al. stress further the possibility to use the notion of distributed cognition (Hutchinson & Salomon) for designing a shared knowledge structure between individual learners and their information-rich environment of resources and contacts (Conole et al., 2004: 19). However, the limitation of cognitivist instructional design and the role of media in it is that ICTs and media are understood as an instrumental, technical approach to reach educational objectives. Most of the strands still ignored the influence of the social context (e.g., media skills and competences as a prerequisite for handling educational technologies) to achieve a specific educational goal. Reinmann sees the potential of the cognitivist strands in the realisation that it is not one solitary design and practice approach that is needed in education, but that it depends on the type of knowledge (factual, declarative and procedural knowledge) (2011: 111).

4.4.1.3. Excursus: Theories on the individual adoption process of innovations

Following Altrichter et al. (2007) and Kolo & Breiter (2009) in their view, that the actual adoption and integration of an ICT-based innovation is deeply rooted by the individual person, I will insert at that point two familiar psychological theories that aim at explaining behavioural factors influencing the individual adoption process. Since the theory of planned behaviour (Ajzen 1985) and the theory of planned behaviour (Fishbein & Ajzen 1975) are no learning theories, but could be classified as following an objectivistic approach, I will insert a short excurs here.

Basic assumption

The theory of reasoned action assumes that individuals assess the consequences of their behaviour before they perform a particular action or behaviour; intention as determinant for behaviour and behaviour change: The “intentions develop from an individual's perception of a behaviour as positive or negative together with the individual's impression of the way their society perceives the same behaviour. Thus, personal attitude and social pressure shape intention, which is essential to performance of a behaviour and consequently behavioural change (Ajzen 1985). The Theory of Planned Behaviour emphasises the role of intention in behaviour performance but is intended to cover cases in which a person is not in control of all factors affecting the actual performance of a behaviour. As a result, the new theory states that the incidence of actual behaviour performance is proportional to the amount of control an individual possesses over the behaviour and the strength of the individual's intention in performing the behaviour. In his article, Ajzen further hypothesises that self-efficacy is important in determining the strength of the individual's intention to perform a behaviour.

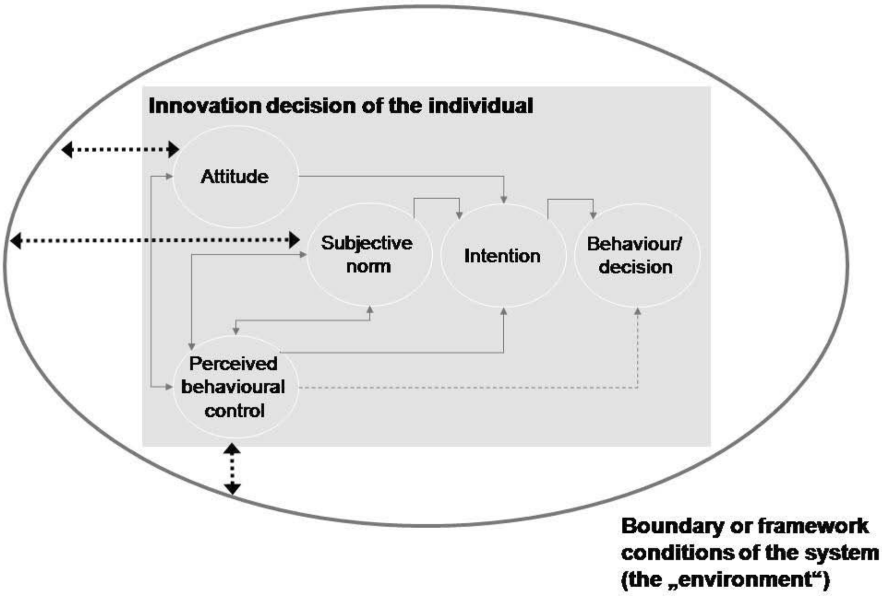


Figure 37: The individual adoption process in interaction with its environment at other levels; Source: Kolo & Breiter, 2009: (after Ajzen 1985) and its interdependence on aspects of the ‘environment’

Determinant

Behavioural and cognitive characteristics of user groups are influential on the individual decision to adopt an innovation. Only specific attitudes toward the behaviour in question can be expected to predict that behaviour. Beliefs and norms are also important. The more favourable the attitude and the subjective norm and the greater the perceived control, the stronger should be the person`s intention to perform the behaviour in question. The environment exerts influence as it forms the boundary or framework condition.

Empirical evidence

Both theories have often been used to explore adoption factors for different e-learning tools, for example the use of blackboard (e.g. N. Ndubisi., 2004[71]), the acceptance of e-learning in the workplace (e.g. Spiros A. Borotis et al. 2007[72]) and also for understanding students' behavioral intention to building e-Portfolio via blog service e-portfolios (Hung et al. 2011)[73].

[71] See conference papers at: http://www.herdsa.org.au/wp-content/uploads/conference/2004/PDF/P057-jt.pdf
[72] See conference papers at: http://dl.acm.org/citation.cfm?id=1323198
[73] See conference papers at: http://www.nectec.or.th/icce2011/program/proceedings/pdf/C3_S8_243S.pdf

Such empirical studies are often connected with the technology acceptance model by Davies (Technology Acceptance Model –TAM by Davis, F.D. Bagozzi, R. & Warshaw, P.R. 1989).

Relevance for ICT-based innovation in education

The value of the approach lies to view the direct interaction of the individual e-learning user. However, it does not say anything about the influence of peers, teachers and parents in the use of e-learning technologies.

4.4.2 Subjectivist approaches

4.4.2.1 Constructivist instructional design and practice

Basic assumptions

Constructivism is a pedagogical paradigm which has developed in parallel to the other works of the diverse schools of constructivism in other disciplines, such as neurobiology, the science of language, communication sciences, cognitive research, systems theory, etc. The basic assumption in constructivist instructional design and practices is that learning is an active process and that learners learn from their subjective experiences and active construction or creation of their own subjective representations of objective reality (Learning Theories Knowledgebase, 2011). It is held that the individual learner is his/her own constructor of knowledge, rather than that "meaning is imposed by the individual rather than existing in the world independently" (Dabbagh, 2011). In Cognitive Psychology and Instruction, by Bruning et al. (1999) the general term of constructivism is defined as a psychological leaning which "generally emphasizes the learner's contribution to meaning and learning through both individual and social activity… In the constructivist view, learners arrive at meaning by selecting information and constructing what they know" (1999: 215). The authors indicate three types of constructivism: exogenous (reconstruction of pre-existing ideas), endogenous (new abstract knowledge developing through cognitive activity based on predictable sequences), and dialectical (source of knowledge is based on social interactions between learners and environments) (Bruning et al., pp. 216-217). Therefore, the approach of activity-based learning, though a constructivist learning design, will be discussed in the section for dialectic thinking, 4.4.4.1.

The pedagogical practice of constructivist thinking is based on a process-oriented instruction, which should support knowledge construction, in contrast to only communicating information and teacher's knowledge. The role of the teacher is regarded rather as a facilitator and/or guide, encouraging students to reflect on experiences, seeking alternative viewpoints, and testing the viability of ideas (ibid.). Representatives of constructivist thinking in education were for exampleDewey (1916), the late works of Piaget (1973), Vygotsky (Zone of Proximal Development, 1978); Knowles (Learning cycle, 1975), Papert (1980) and Kersten Reich (Konstruktivistisches Lernen&Lehren, 1998). Some researchers extend their cognitive-based design principles with constructive design principles (e.g., Reigeluth, 1999; cognitive constructivist instructional design), situated cognition (e.g., Lave & Wenger, Community based learning, 1991). Representative of the radical constructivism was Ernst Glasersfeld (1996), postulating that it is not possible to provide assumptions about a "real" world, but only how human beings find orientation within the world, and what and how they observe it (concept of self-referential, operational closed systems and autonomy).

Determinants

Techno-pedagogical design based on the constructivist school of pedagogical thinking claims that educational software and digital learning material is designed in such a way that it supports different developmental levels, prior experience, socio-cultural backgrounds and diverse contexts. It aims to design authentic tasks and well-structured, realistic problems, foster active individual participation and support for the social process of learning and interpersonal relationships involving imitation, modelling, and joint construction of knowledge.

Empirical evidence

Conole et al. (2004) claim that constructivist ICT-based design focuses on hands-on, self-directed and self-engagement activities, often leading to personal discoveries. Virtual worlds, micro-worlds and simulations would be instantiations of this pedagogical school of thinking. Dede (2006) summarised a wide range of educational technologies identified by the (American) National Research Council, which work on the basis of some principles from constructivism, for example, "simulations to enable students to collect data via probes, to focus on complex skills while a tool does simple underlying tasks, to comprehend complicated ideas through visualizations that take advantage of the mind's ability to recognize patterns in sensory data, to test alternative models of reality via simulation, and to learn science, math, and technical skills through using programming to develop personally expressive representations such as digital art and movies" (National Research Council, 2000 in Dede, 2006: 52). The Internet made it possible to introduce diverse forms of asynchronous and synchronous communication (e.g., chat rooms) and thereby provide digital space for intensive forms of dialogue and interaction between students and tutors and amongst peers. Many diverse e-portfolio software programmes claim to be based on constructivist thinking, because they aim at providing applications for IT-based reflection and peer-assessment.

Relevance for ICT-based innovation in education

The ideas of behaviourism and cognitivism that learning is to be reduced to stimulus-response or to process information sequentially were already being challenged in the early 20th century. Due to the advent of personal computers and the Internet, technologies and applications software developers could more easily incorporate insights from constructivism into e-learning environments. The design of learning activities included collaboration, cooperation, multiple perspectives, real world examples, scaffolding, self-reflection, multiple representations of ideas, and social negotiation. The learning assessment elements consisted of instructor assessment, collaborative assessment, and self-assessment. The instructors' roles are coaching, guiding, mentoring, acknowledging, providing feedback, and assessing student learning. In my view the strength of the approach lies in the instrumental view on technology use of ICTs in education. However, one has to be aware of the fact, that, even a constructivist e-learning design can be used in the traditional way and not automatically support the intended learning objective. The limitation of the constructivist design and practice is its "openness" and that not all students can cope with this "freedom". For example, some of the Web 2.0 tools enable very easily to design an individual personal learning environment or the development of a learning network (see for example Kalz, 2009).

4.4.2.2. Socially situated learning design and practice

Basic assumption

Against the background of constructivist thinking, a new educational school of thought takes into account external social influences on learning and leads to different assumptions about how to shape a techno-pedagogical design and practice. The social/situated learning approach conceptualises that learning takes place through social development, is unintentional and situated within authentic activity, context, and culture (=legitimate peripheral participation; see Learning Theories Knowledgebase, 2011). It focuses on interpersonal relationships involving imitation and modelling and the stress lies on the importance of language as a communicative or cultural tool (how to share information and jointly construct knowledge) and a psychological tool for organising individual thoughts and for reasoning, planning and reviewing actions (see Conole et al., 2004: pp. 19-20).

Representatives of this approach are the early Vygotsky (1978; in Wertsch, 1995: Learning through social development), Jean Lave (Legitimate Peripheral Participation, 1990), Etienne Wenger (Community of practice theory, 1991; 1998) and Brown et al. (Cognitive Apprenticeship ,1989). Lave and Wenger have worked on the role of social interaction and collaboration in communities, and therefore the approach is widely known as the "community of practice" approach. Such communities "embody certain beliefs and behaviours to be acquired. As the beginner or novice moves from the periphery of a community to its centre, he or she becomes more active and engaged within the culture and eventually assumes the role of an expert" (Learning Theories Knowledgebase, 2011). According to Wenger, "[c]ommunities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly". Note that this allows for, but does not require intentionality. Learning can be, and often is, an incidental outcome that accompanies these social processes. Brown, Collins and Duguid (1989) emphasize the idea of cognitive apprenticeship: "Cognitive apprenticeship supports learning in a domain by enabling students to acquire, develop and use cognitive tools in authentic domain activity. Learning, both outside and inside school, advances through collaborative social interaction and the social construction of knowledge".

Determinants

Learning takes places as social participation, meaning that an individual person is an active participant in the practices of social communities, and in the construction of his or her identity through these communities. What is important is that communities are domain-specific and involve people with expertise and experience (=community practice) and share a common interest.

Empirical evidence

The concept of communities of practice has been technically supported by the new generation of educational technologies, such as asynchronous and synchronous online fora, chat environments or online shared virtual classrooms.

Relevance for ICT-based innovation in education

The strength of the theoretical approach lies in the findings of external, social influences on the achievements of learning and especially targeting a micro-view of collaboration. Since we are asking for determinants, influencing the shaping and adoption of e-learning on the micro-level, it is interesting to find that the participation in a community of practise can enable better adoption or acting as lead-user group. As was discussed in the theoretical approaches on the macro-level (section 4.3.; the role of cooperation for testing and further developing new techno-pedagogical practises is substantial to the functioning of a national innovation system. However, the limitation of this concept is, that it is only researched in the context of the group-level and/or closed community. Therefore little is known about cooperative learning networks or online communities enabling informal learning.

4.4.2.3 Self-determination and self-regulated learning theory

As mentioned in the introduction to the micro-level approaches, I will shortly screen the relevance of the two learning theories, brought forward in research on paper-based portfolio and subsequently being adopted in e-portfolio research as theoretical background to shape the software design and process of e-portfolios in practise.

Basic assumptions

A specific learning theory, often used for describing e-portfolio designs and practices, has its roots in constructivist thinking and is called the *self-regulation theory* developed by Zimmermann (1989; 1990) and later extended by Deci and Ryan (1985; 2000) to the *self-determination theory*.

In educational literature there is no clear-cut definition of self-regulated learning. However, the common understanding is that each definition and approach highlights the importance of *cognitive, motivational/volitional and meta-cognitive processes* in the learning processes (see also the model of self-regulated learning by Boekaert,1997; 1999; Zimmerman, 1989; Zimmermann & Martinez-Pons, 1988; 1990). Zimmermann (1989) claims that self-regulated learning implies “having the ability to develop knowledge, skills, and attitudes which enhance and facilitate future learning and which — abstracted from the original learning context — can be transferred to other learning situations (…). Students can be described as self-regulated to the degree that they are meta-cognitively, motivationally, and behaviourally active participants in their own learning process” (1989: p. 4). According to Zimmerman and Martinez-Pons (1990), self-regulated learners are characterised by “the motivational advantage of high levels of self-efficacy and intrinsic motivation. On the behavioural (strategic) level, self-regulated learners actively select, structure, and create social and material environments, which optimize their learning processes. The meta-cognitive activities of self-regulated learners are characterized by extensive planning, organizing, and evaluating”.

The self-regulation theory was extended to the self-determination theory with research findings on human motivation behaviours by Edward Deci and Richard Ryan (1985; 2002). The selfdetermination theory includes the “Organismic-Integration-theory”, aiming at explaining what determines the external and or intrinisc self-direction (see Hagenauer & Hascher, 2011:97-113.) Deci & Ryan concentrate their theories about learners’ self-motivation and personal development on the intrinsic, universal needs of humans, namely autonomy (universal urge to be causal agents of one's own life and act in harmony with one's integrated self), competency (being effective in dealing with the environment in which a person finds oneself), and relatedness (universal desire to interact, be connected to, and experience caring for others) (Deci & Ryan 2002). Depending on the experiences of a person's individual autonomy, being repeatedly competent and belonging to a supportive community influences the degree of personal engagement and motivation and personality. It is claimed that the possibility of students to choose their learning goals, material and pace, higher motivation and achievements can be met. If not, results decline.

Determinant

According to this theory, ICTs and Internet application should support motivational and meta-cognitive strategies of the individual learner. A techno-pedagogical process can help to balance the extrinsic (environmental influence on person) and the self-determined intrinsic (the person) motivation.

Empirical evidence

The self-regulated and self-determination approach is widely cited in the field of e-learning research (see Eifel Conference Proceedings 2004-2010). Moreover, attempts have been made to embed this notion into the design of e-learning applications, for example, the development of the learning management system "iClass", and many e-portfolio tools are regarded as pedagogical models for the technical design (e.g. Aviram, Aviram, Ronen, Somekh, Winer & Ariel Sarid, Ben-Gurion University, 2008 The graphics below show an example of integrating the self-determination theory into the e-portfolio conception of Stony Brook University, State University of New York, USA.

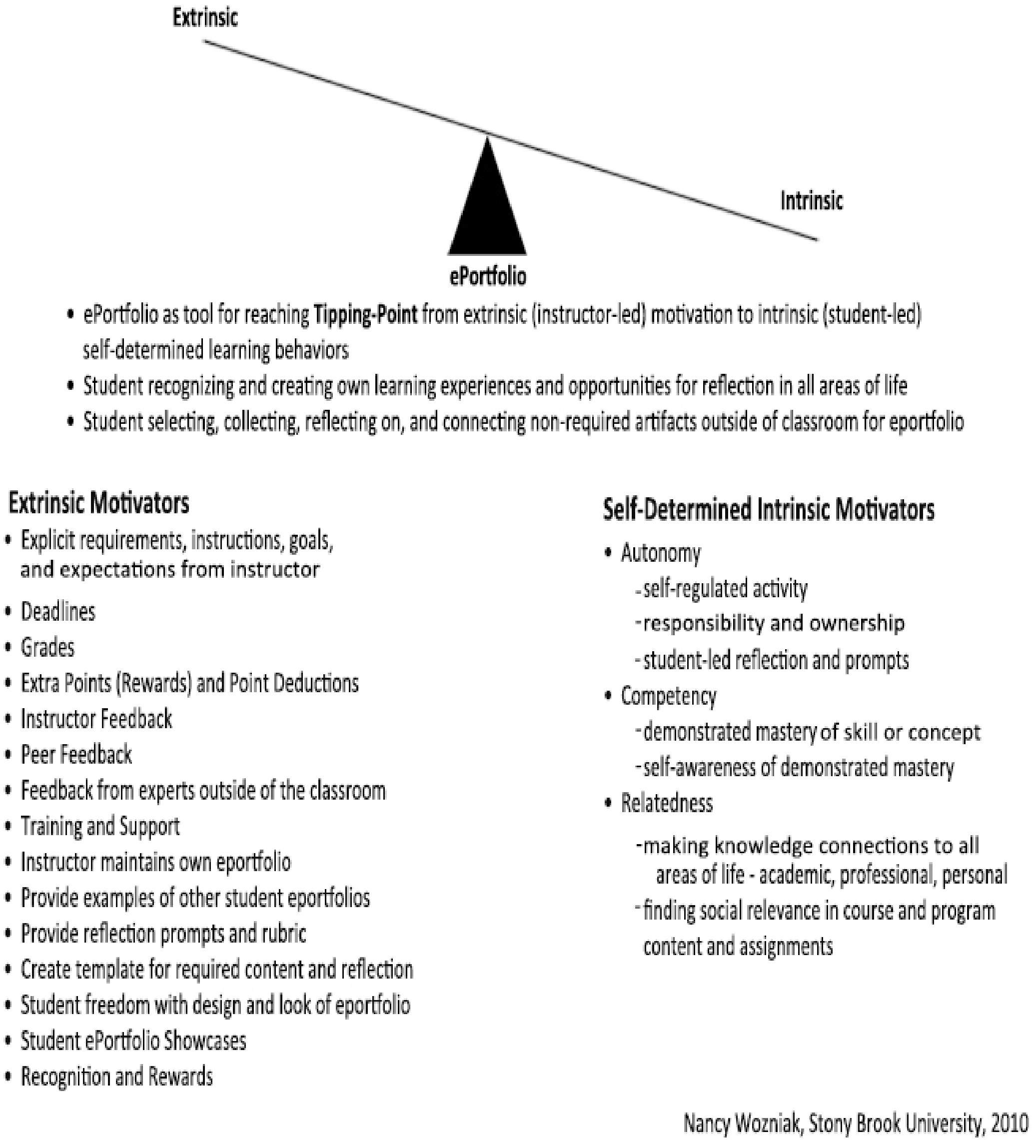


Figure 38: Balancing extrinsic and self-determined intrinsic motivation by the e-portfolio concept.
Source: Stony Brook University http://stonybrook.digication.com/sbu_eportfolio/SBU_ePortfolio_Study

Relevance for ICT-based innovation in education

The specific theories on motivation and learning are important in the current discussion about life-long learning which is promoted by the European Union, including the Lifelong Learning Programme (2007-2013) which has funding of €7 billion Euro. The strength of the approach lies in the notion that learning achievements are not solely based on cognitive structures and abilities. The limitation of the approach is that it was developed at a time before students were working in a digital environment with an overload of information. In e-learning research literature, it is common knowledge that computers and specifically computer games, for example, are useful educational tools because students find them motivating (see Whiton, 2007). However, designing a techno-pedagogical system and practice for sustaining self-motivation and developing personality development will be a challenging task in the future, given the fast development of social software and the range of e-portfolio tools.

4.4.2.4 Experiential learning theory

Basic assumptions

More than the previous constructivist theories, this model specifically targets the process of learning and claims that techno-pedagogical practice and design should always target a learning cycle consisting of four steps: experience (do something), perception (observe and reflect), cognition (think and conceptualise), and behaviour (plan an active experiment) (Learning Theories Knowledgebase, 2011). The experiential learning theory was developed by the American educationalist David A. Kolb (1939), who believed that “learning is the process whereby knowledge is created through the transformation of experience” (1984: p. 38). The theory presents a cyclical model of learning, consisting of four stages shown below. One may begin at any stage, but they must follow each other in the sequence. Kolb’s four-stage learning cycle shows how experience is translated through reflection into concepts, which in turn are used as guides for active experimentation and the choice of new experiences. The first stage, concrete experience, is where the learner actively experiences an activity such as a lab session or fieldwork. The second stage, reflective observation, is when the learner consciously reflects back on that experience. The third stage, abstract conceptualization, is where the learner attempts to conceptualize a theory or model of what is observed. The fourth stage, active experimentation, is where the learner is trying to plan how to test a model or theory or plan for a forthcoming experience.

Determinants

The ICTs should enable learning through the transformation of experience into knowledge, skill, attitudes, values and emotions. All the factors of an environment influence the learning process.

Empirical evidence

Kolb's learning cycle has been used to explain the process of e-portfolio processes. The figure below depicts the cyclical steps in the technologically enhanced e-portfolio learning cycle.

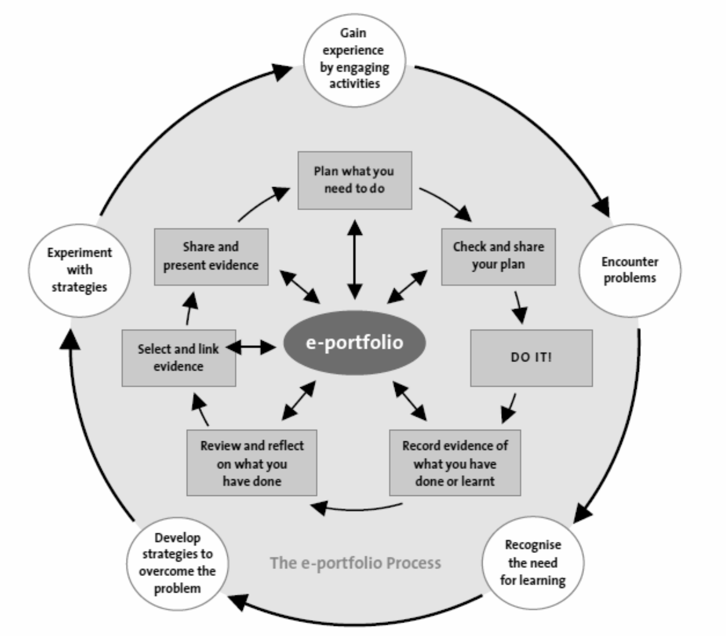


Figure 39: E-portfolio process in the learning loop according to Kolb's learning cycle

Source: Attwell et al. 2007:31

The rationale behind using Kolb's learning cycle is described by the project group for developing a pedagogical based e-portfolio system in the EU project MOSEP: More Self-Esteem with e-Portfolios (2007-2009) as follows:

> The e-portfolio process encourages the learner to review and reflect on what they have done, made, experienced or learnt. They are encouraged to record their reflections in their e-portfolio and share them with others. This gives value to reflection and requires reflection to be explicit and more visible. This in turn might result in the learner deriving more benefit from the reflection stage, previously something of an invisible process. The e-portfolio process informs and supports the planning process. The learner uses their reflections to plan what it is that they must do to move forward, to learn something, to achieve something, to produce something, etc. It simply adds the Record stage to the Plan, Do, Review cycle. The Record stage is very important in that it can make the reflection more 'explicit' which in turn enables and encourages the learner to share their reflections with others. The sharing process might help the learner to take more from the

> learning experience, but more importantly if a learner has to spend time preparing their thinking so that they can share it with others, they might engage in 'deeper' thinking as they try to make sense out of their experiences and fit it into their existing thinking, memories, structures, etc., hopefully enabling them to take more out of the learning experience. (Attwell et al, 2007: 31)

Relevance for ICT-based innovation in education

This approach is helpful for understanding the design of the e-portfolio process, but is limited in explaining factors of how and under what conditions the e-portfolio process will be adopted as regular techno-pedagogical practise.

4.4.3 Dualistic approach

A dualistic way of thinking would consider that individual learning, needed for adopting an innovation and cope with change, takes place *independently* of the technology.

4.4.4 Dialectical approach

4.4.4.1 Activity-based learning framework

Basic assumptions

The so-called Scandinavian activity-based pedagogical school of thought has developed a theoretical framework for describing learning activities or a learning system by focusing not only on the individual person or tutor relation, but by integrating also influential factors from the macro-level or meso-level of a society, e.g., an educational community, history of the person, the culture, or school environment as impacting an activity. The relationship between human agent and objects of the environment is mediated by cultural means, tools and signs. The framework was first originated by the Russian psychologists A. N. Leontiev (1978) and L. S. Vygotsky (cultural-historical theory of activity; zone of proximal development[74]) and later on extended to learning in educational environments by Engestrom (1997: expansive learning 1997; 1999).

The basic assumption of the activity-based learning theory is the idea that people are socio-culturally embedded actors (and not technical processors or system components) and that human activities are hierarchically analysed. Engestrom identifies

[74] The zone of proximal development can be defined as "the difference between the difficulty level of a problem a child can cope with independently and the level that can be accomplished without help." (see (Bruning et al., 1999: 218).

three levels of activities: an activity towards an objective of the community in which rules are applicable; towards an individual and towards the artefact used for the action (1997)

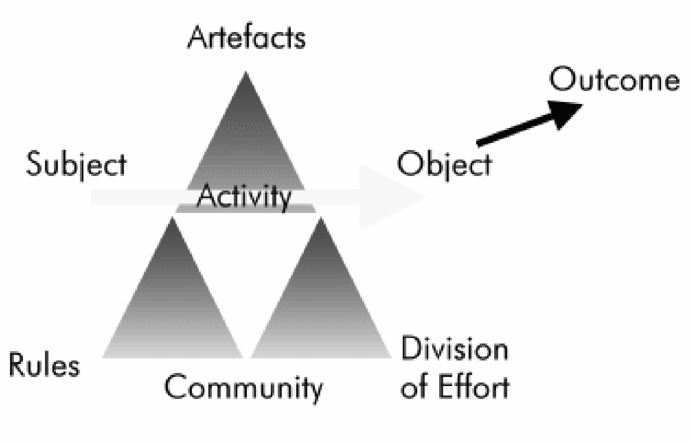


Figure 40: Activity system according to Engestrom.
Source: Learning Theories Knowledgebase, 2011.

Each activity is influenced by four principles: object-orientedness, internalisation/externalisation, mediation and development. All four of the above basic principles should be considered as an integrated system, because they are associated with various aspects of the whole activity (see Engestrom, 1997; 1999 and Learning Theories Knowledgebase, 2011). Conole et al. (2004) point out that the pedagogical focus should be on “bridging the gap between the historical state of an activity and the developmental stage of a person with respect to that activity e.g., the current state of language use and the child’s ability to speak a language” (2004: p. 20).

Determinants

Engestrom’s model above is useful for understanding how a wide range of factors work together to impact a techno-pedagogical design and practice. In order to reach a learning outcome, it is necessary to produce certain objects (e.g., experiences, knowledge, and physical products). Human activity is mediated by artefacts (e.g., tools used, documents, recipes, etc.). Activity is also mediated by an organisation or community. In addition, the community may impose rules that affect activity. The subject works as part of the community to achieve the object.

Empirical evidence

Engestrom has empirically tested his theoretical approach with case studies in educational and medical contexts (see publications and projects of the Center for Activity Theory and Developmental Work Research, University of Helsinki: (Perspectives on Activity Theory (edited with Reijo Miettinen and Raija-Leena Punamäki, 1999), and Between School and Work: New Perspectives on Transfer and Boundary Crossing (edited with Terttu Tuomi-Gröhn, 2003). I have just finished a new book, Collaborative Expertise: Expansive Learning in Medical Work, to be published by Cambridge University Press.

Relevance for ICT-based innovation in education

The strength of the activity theory lies in its attempt to integrate the processes of learning which are taking place at three different analytical levels. For ICT research the framework of the activity theory has been adapted and used in the field of Human Computer Interaction (see Kaptellin & Nardi, 2006; Activity Theory in Interaction Design) and in research work designing techno-social systems (see Allert & Richter; 2008). A Allert et al. explain, it is used as alternative to “current modelling approaches in the field of learning and work resemble the notion of workflows, relating input and output in a means-end-manner and prescribing the processes, and hence fall short in describing the situated and socially mediated nature of practices” (2008).

4.4.5 Micro-level determinants of shaping and integration of innovative techno-pedagogical design and practices

This table summarised the identified determinants of the individual shaping and adoption of the innovation.

View	Theoretical approach	Determinants
Objectivism	Behaviourist instructional design and practices (Watson, 1913; Thorndyke,1939, Skinner, 1950; Bandura, 1963) Cognitivist instructional design and practices (Piaget, 1936, 1951; Gagné, 1965, Merill, 1983; 1996; Mayer/Moreno, 1997; 2002)	• Focus is on learning outcome and results • ICT-based learning takes place like a computer-machine information process through association and reinforcement. Learners are regarded as passive receivers and knowledge creators. • Digital teaching material (=e-content) carries factual information. • Units are designed step by step from simpler units of knowledge or skill to more advanced ones. • Control of learning process takes place via standardised e-assessment tools.
Subjectivism	Social, cognitive and interactive constructivist instructional design and practices (Dewey, 1916; Piaget, 1973; Vygotsky, 1930/1978 in English; Knowles, 1975; Papert, 1980; Reigeluth & Stein, 1983; Reich, 1998) Socially situated learning design and practice (Vygotsky, 1930s/1978; Brown, 1989; Lave, 1990; Wenger, 1991) Self-regulated and self-determined learning theory (Zimmermann, 1989; Deci & Ryan, 1985; 2002) Experiential learning (Kolb, 1939)	• Focus is on learning process. • ICT-based learning depends on personal and individual developmental level, prior experience, socio-cultural background and context. Learning takes place through participation in decentralised, technology-enhanced networks (space of flows, nodes of information, artefacts and knowledge carriers). • ICTs should support authentic tasks and well-structured and realistic problems. • Focus is on social processes of learning and interpersonal relationship • Active individual participation. • ICTs should support effort, agency and commitment, which are best taught by focusing on the potential and growth of the learner. A techno-pedagogical process can help to balance the extrinsic (environmental influence on person) and the self-determined intrinsic (the person) motivation. • Learning takes place by experience; ICTs should support practices enabling experience, perception and reflection, cognition and behavioural change.

Dualism		• Focus is on either learning outcome or process • Learning takes place independently of technology, either individually or organisationally
Dialectics	• Activity-based theory/ dialectic constructivism (Leontiev, Vygotsky, 1930s/1978, Cole and Engestrom, 1997; 1999) • Connectivism (Siemens, 2004; Downes, 2005)	• Focus is both on learning outcome and process and all forms of learning and teaching (formal and informal learning; teacher-centred; learner-centred teaching) • Learning takes place in socio-cultural context • ICT-based learning is a socio-cultural activity mediated by technology/artefacts • Human practices and interactions are all situated and improvised (not prescriptive and rule-bound) • • Knowledge generation changes from individual and information-focused learning to community-based and collaborative learning. • Web 2.0 and social media enable networking capabilities • Potential for democratic participation in education.

Table 20: Micro-level determinants of innovative techno-pedagogical design and practices

4.5. Summary and conclusions for derivation of integrative framework

This chapter aimed to provide the theoretical background for the formulation of the theory-based integrative research framework on the shaping and integration of ICT-based innovations to be developed in the next section. The analysis makes evident that in the social sciences there indeed different ways of scientific thinking exist while researching the same phenomenon. Due to the lack of research attention to the emergence of educational technologies, the chapter has started to analyse the relevance of general technology based innovation approaches and then, whenever possible, has taken a specific route to theoretical approaches explaining the shaping and use of ICTs, as one specific type of technology. What has surprised in the analysis of the theoretical foundations, is the growing awareness of the originators of innovation and e-learning research theories and theoretical approaches for the boundaries to and interlinkages between the determinants of one level of a national education system to the other.

Whereas the Unified Theory of Information explicitly points to systemic implications between the levels of national education system, also other macro-, meso- and micro approaches work on that boundaries, not all of them exclusively, but elements thereof, see especially the attempts by Geels (the multi-level framework for explaining dynamics of socio-technical transition), by Weyer et al. (Network theoretical approach in sociology of technology, by Dolata (framework for technological innovation and sectoral change), by Askarany (the general diffusion model), by Deci&Ryan (self-determination theory) and by Vygotsky/Engestrom (Activity-based learning framework). Some approaches have been discussed as specifically relevant to e-learning research, though directed at explaining factors for the shaping and integration only at one level, see for example the learning theories and individual adoption theories. Finally, interesting has been that the factor of “cooperation” appears within all chapters of the theoretical approaches, on the macro-level as kit for the national innovation systems, on the meso-level, as organisational learning pre-requisite and on the micro-level, in the form of community of practises.

5 Chapter 5: Development and exemplification of an integrative, multi-level research framework for analysing systemic ICT-based innovation in education

5.1 Introduction

The objective of this chapter is to develop a theoretically-based research framework which allows a systematic analysis of the complex shaping of systemic ICT-based innovations and their integration into an educational system. An integrative, multi-level framework can help to formulate policy that is more effective and strategies which support the successful shaping and integration of systemic e-learning innovations. The framework has been developed on the grounds of a dialectical way of thinking scientifically, which views the emergence and integration of systemic ICT-based innovations in terms of the interplay between the structures and actors of the three governance levels of a national educational system. As discussed in chapter one, the dialectical approach makes it possible to avoid the mistake of reducing the complexity of systemic ICT-based innovation to a simple, uni-dimensional phenomenon, which is either techno-deterministic or socially constructed (see chapter 1.2: Research objectives and outline). In the following, the proposed integrative, multi-level framework and its components, which derive from the results of the analysis of theoretical approaches to shaping and integrating innovations (see chapter 4), is sketched out in section 5.2. As a theoretical framework is only as good as its explanatory value, the framework is applied to the case of e-portfolios, a current example of an ICT-based educational innovation with systemic implications. In section 5.3, this work aims to compare the interaction patterns of e-portfolio shaping and integration processes in the higher education sector in three European countries (the United Kingdom, the Netherlands and Austria). The focus lies in particular on the exemplification of the integrative framework approach in identifying patterns of interaction between structures and actors at different governance levels of the educational system and deriving policy options. Finally, the practical experiences and theoretical challenges of applying an integrative, multi-level framework are discussed in section 5.4, and especially the consequences for research and policy formulation.

5.2 Framework development

5.2.1 Analytical levels and boundaries of the framework

According to the critical systems viewpoint, individual actors and the structure of society are regarded as interdependent. In addition, a society emerges as a result of individual actors and actions and, in turn, shapes these actors and actions (see Altrichter, Brüsemeister & Wissinger, 2007; Schimank, 2007; Hofkirchner, 2008). Thus, the proposed research framework integrates interrelated structures and actors from three analytical levels of a national educational system, which itself can be regarded as one subsystem of the global society or a political region, such as the European Union or related subsystems (e.g. the economy, law). Although the global society and/or regional systems and policies (such as European policies on education and culture) may influence the shaping of a national educational system to some degree, they exert no direct legal or financial governance structures or power over it. As Sporn (2005: p. 31) describes, while 'most of European [higher education] is characterized [sic] as a public system, the state ministries are often responsible for transformation and change at the institutional level.' Thus, the integrative framework addresses the national system at the macro-analytical level, and views the global society and/or political regions with their subsystems of culture, politics, economy (here, I would include the IT market and the e-learning market specifically) and law as environments which exist outside of the system, but with permeable boundaries.

Following on from recent educational governance research, the systemic relations of actors and structures in a national educational system can be divided into the macro, meso and micro levels of analysis (see Altrichter et al, 2007; Kolo & Breiter, 2009). The embeddedness and the interlinkages between the different structures and actors in a national educational system are depicted in the figure below:

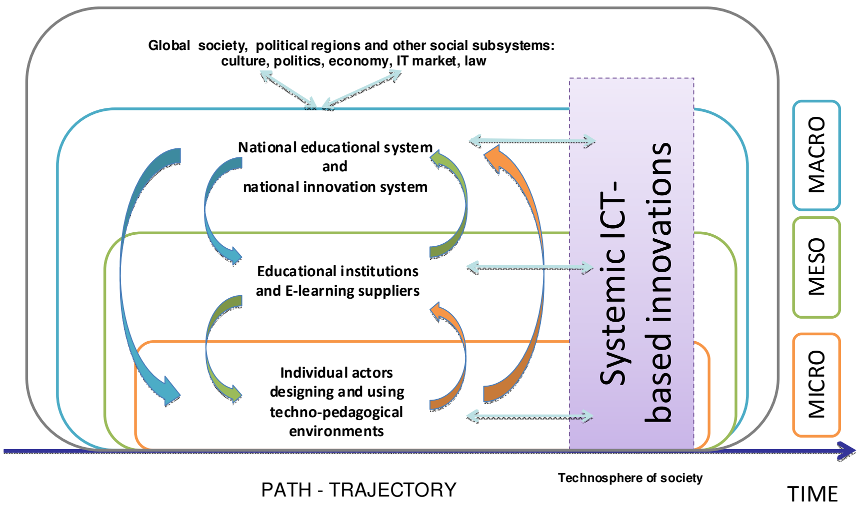


Figure 41: An integrative, multi-level framework for systemic ICT-based innovation in education.

As explained in chapter one, the macro level of the national educational system is characterised by the educational culture and traditions and educational policies (e.g. assessment policies, e-learning infrastructure and e-content policies). In addition, for e-learning innovations, it is important to also address the national educational and technological innovation system as an influential system for shaping and integrating e-learning innovations. The meso level of a national educational system is constituted by a wide range of educational institutions (from primary, secondary and tertiary to adult education) and extremely heterogeneous e-learning software and service companies (e.g. IT companies, e-content publishing houses, e-training consultation companies). The micro level of a national educational system encompasses the individual actors involved in the shaping and integration of e-learning innovations: on the one hand, instructional software programmers and e-learning researchers design and develop e-learning software and tools. On the other hand, students, teachers and/or parents are the users or multipliers of these techno-pedagogical learning innovations.

In contrast to objectivistic or subjectivist theoretical approaches to e-learning, an integrative, multi-level research framework, as promoted here, views systemic ICT based innovations as:

- Multi-dimensional, non-static techno-pedagogical systems;
- Shaped by dynamic macro-meso-micro relations between actors and structures interacting at the three levels of a national educational system;
- Adopted and integrated due to organisational and societal demand and not only because of technological functionality.

What are the advantages and disadvantages of using the view outlined above on systemic ICT-based innovations for the purpose of framework development? As outlined in chapter three, a systemic ICT-based innovation should not only be seen as a 'value-neutral' instrumental technology. It should be regarded as *both* a technological and a pedagogical innovation, changing educational processes and outcomes in more than one educational institution, and eventually, in more than one educational sector. Furthermore, a systemic e-learning innovation entails a minimum of three different interrelated dimensions of change: a change in techno-pedagogical practices (pedagogical innovation); a change in the educational organisation (organisational innovation) and a change in the parts of the educational sector and/or system (systemic innovation). The objectivist-reductionist view looks only at the instrumental functions of an educational technology, while the subjectivist view focuses only on the needs of the users, but either view in isolation cannot help to analyse the systemic changes relating to the mutual shaping and integration process. In my view, the interlinkages between of all of the structures and actors are important, because the system-wide integration of a systemic ICT innovation needs both bottom-up and top-down strategies, policies and support for the interlinked actors and institutions at all levels of a national educational system. An isolated view and/or policy formulation process will limit the potential for mutually favourable conditions for the integration of ICT-based innovations which will continue to support the skills needed for our complex world. Finally, the technology alone does not determine the pace and rate of integration. Only if the demand to enhance the quality of teaching, to enable wider access to academic training for all and to develop self-organising skills and competences for a future participatory society by means of ICTs becomes a 'supervening' demand will the integration of ICT-based innovations occur at a sustainable pace.

5.2.2 Derivation of framework components based on the results of theory analysis

This section describes the proposed integrative framework and its components. The suggested framework is based on three subsets of components, each addressing another factor which influences the shaping and integration process at one or more levels of a national educational system. These components are derived from the systematic review of theoretical approaches in different scientific disciplines, all exploring a specific aspect of the shaping and integration process of technology-based innovations (see chapter four). The framework variables have been selected from the theoretical approaches which were analysed and which offer a dialectic view on the issue and stress specific interrelations between the subset of components and/or the interactions between the three analytical levels, e.g. emphasising macro-meso relations, macro-micro relations or micro-meso relations (see the list of determinants in chapter four). The figure below provides an overview of the three subsets of framework components:

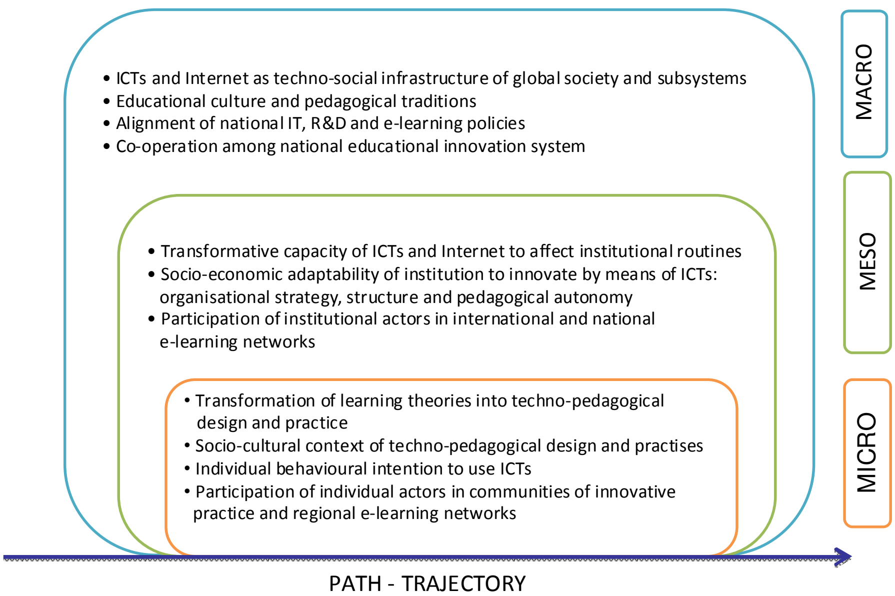


Figure 42: Overview of determinants influencing the shaping and integration of systemic ICT-based innovation in education. Source: Author

5.2.2.1 Macro-level components and their interrelations

The newly-integrated, multi-level research framework proposes a set of factors which determine the socio-economic emergence and evolution of ICT-based innovations at the macro level in national educational systems, derived from four different theoretical approaches to innovation at the macro level, which are summarised in the table below. This set of macro-variables is suggested because the first two frame the techno-pedagogical background against which the emergent innovations appear, while the other two determine the intensity and change level of the systemic innovation. In my view, both the consideration of the techno-pedagogical context of an educational system and the qualitative and quantitative intensity of the change induced by an innovation are very important characteristics for developing sustainable and more effective policy formulations which will have an impact on all governance levels of an educational system.

Analytical level	Theoretical approach	Determinants of systemic innovation integration
Macro	Unified theory of information; critical evolutionary social systems theory (Hofkirchner, 1999, 2010; Fuchs, 2003)	ICTs and the Internet form the technological infrastructure of global society and subsystems (techno-sphere) Techno-social systems are mutually shaped by technology and the social context in which they emerge
	Multi-level framework for technological transitions (Rip & Kemp, 1998; Geels, 2008), which includes assumptions of: classical evolutionary economics (Nelson & Winter, 1977; Dosi, 1985) and science and technology studies; the sociology of technology (MacKenzie & Wajcman, 1985; Pinch & Bijker, 1984; Rammert, 1997, 1999; Weyrer, 1993)	Culture and policies are viewed as exogenous techno-social landscapes of technological transitions Alignment of national IT and R&D policies, which are based on technological regimes and path trajectories, with educational policies, based on pedagogical regimes and social necessity
	Sydow, 1992; Kozma, 2003a; 2033b OECD, 1997; 1999; 2010	The systemic innovation process depends on the type and intensity of cooperation within the national educational innovation system
	Historical model for change of communication technology (Winston, 1998)	The supervening societal demand on the micro level influences the emergence of new technology on the macro level (law of suppression)

Table 21: Theoretical foundations for macro-level determinants of the integrative framework for systemic ICT-based innovations. Source: Author

On the one hand, ICTs and the Internet are regarded as the elements that frame the background, or in other words, the techno-social infrastructure, within which a self-organising society and its subsystems 'inform' themselves (see the unified theory of information, section 4.2.4.1). On the other hand, the prevailing educational culture and educational governance traditions in a national educational system form the pedagogical context within which new e-learning tools and practices emerge (see the multi-level approach to technological transitions, which encompasses the findings from the field of the social construction of science and technology in section 4.2.2.1; see also the theory of the history of communication technology and media in section 4.2.2.3). Moreover, the type of alignment of national IT and R&D policies (based on technological regimes and technological path trajectories) with educational policies, and the type and intensity of participants in the innovation system (effective on all three levels) may enable or hinder system-wide innovation integration. All four determinants are intertwined with processes taking place on another analytical level: the national technological infrastructure of a society influences the scale of institutional adoption of techno-pedagogical innovations on the meso level (e.g. national funds for the IT infrastructure of schools or universities; legal rules for a change in the curriculum) and on the micro level (e.g. national support services for new ICT skills and competence training). Conversely, there is a feedback loop from educational institutions to macro-determinants, e.g. institutions respond to the needs of the labour market by developing specific training courses. In the following, the theoretical background to the set of macro-components and the interrelations of the four variables will be discussed in greater depth.

First, the national telecommunications and Internet infrastructure and services, which have since 1985 been regarded as economic and societal core technologies,[75] frame the techno-social background of today's global society and its self-organising subsystems, such as culture, the economy and politics. They influence the way in which a self-organising society 'informs itself' and provide the background against which new ICT-based techno-pedagogical tools and practices emerge (see Hofkirchner, 2007, 2008, 2010). Wejnert (2002) argues that the pursuit of 'global uniformity,' to be reached via modern communication systems leading to a connected world and similar societal structures, is an important driver for the system-wide adoption of innovations (2002: 315-316). Impact studies of e-learning in the European higher education sector report that ICTs have been integrated across the sector in order to support the administrative process, but rarely to support the quality of teaching (hybrid e-learning arrangements) or to broaden access to higher education (e.g. more online courses), and almost never to replace face-to-face academic teaching (Oliver 2002). The question is still open as to what impact the next wave of ICTs (such as cloud computing and/or the Internet of Things) will have on the shaping of new educational services (e.g. cloud services for the external hosting of virtual universities or hosting e-content archives, see the Horizon Reports on e-learning, 2010, 2011) or new educational tools (e.g. mobile learning technologies enhanced by networked physical objects). The answer is not to leave the issue to software developers alone, but to collaboratively design and decide on the integration of new techno-pedagogical innovations, especially in view of the need for more competences for solving creatively complex societal problems. How can Internet-based technologies be designed in order to support the teaching and acquisition of self-organised learning skills and competences? However, as the objectivist and subjectivist macro-theories on the emergence of technology argue, the mass adoption of technological innovations can take place only if decreasing prices coincide with consumer needs and a supervening societal need (e.g. demand push/pull approach; the

[75] See the theory of long waves, section 4.2.1.1.

law of suppression of radical potential, see Winston, 1988). In any case, according to the objectivist theory of long waves (see section 4.2.1.1), ICTs and Internet technologies, as the current leading technology, will sooner or later be replaced by another core technology (e.g. biotechnology or quant computing), and any macro-level analysis of ICT-based innovations must take this new context into account. However, an integrative framework may help not to look at the impact of future technology in a uni-dimensional way, but to clarify the possibilities for collaboratively shaping technological developments in a way that is desirable to society.

Second, apart from the techno-social infrastructure, the prevailing educational culture and traditions in a national educational system form the social and pedagogical context of e-learning innovations (see Multi-level framework for technological transitions including science and society approaches; table 21:). For example, cheap and publicly-available Internet access is a techno-social practical necessity for the equal diffusion of new learning tools and services on a systemic scale. Therefore, a systemic techno-pedagogical innovation can only emerge and be diffused widely if the necessary practical hardware and software infrastructure (e.g. a high rate of Internet connections per house/persons and computer/person) has emerged and is generally available to a media-literate population which is trained and motivated to use it. However, the provision of such a techno-social infrastructure alone will not suffice for systemic integration – a social/pedagogical need must occur at the same time (see the ‘social closure concept’ of STS studies by Pinch & Bijker, 1984; Rammert, 1997 or the ‘law of supervening necessity’ by Winston, 1998). For example, the new Internet-based language courses and services operated via online social networks will not develop into a systemic innovation through the provision of a network, but through the demand by a large share of the population to be able to learn language competences in easier, more flexible and more authentic ways (by means of connecting with native speakers; see, for example, the online social network for language learning ‘Busuu’[76]). The national technological infrastructure of a society influences the adoption of the techno-pedagogical innovation at the meso level (educational institutions) and at the micro level (user), but is also determined by the character of the international IT and e-learning market.

Third, the way in which IT and R&D policies are aligned and adjusted to each other against the background of the techno-social infrastructure and educational culture and traditions is important for the direction and extent of systemic integration. Technological change within societal subsystems, such as the economy or education, depends to a high degree on predetermined technological paths and the flexibility of a national R&D system to break with existing technological regimes and path trajectories

[76] The online social language network ‘Busuu’ provides informal opportunities to learn languages from and with one’s peers according to one’s own pace and interests: available at www.busuu.com

(see the multi-level framework for technological transitions, including the classical evolutionary economic approach in section 4.2.4.2). Therefore, the structure of national scientific research programmes as incentives for the development of new e-learning tools and practices, which are often based on pre-existing research premises and paradigms, is important. In the past, national e-learning research and policies were more likely to ‘follow’ national IT programmes and policies than the other way around. As Friesen (2009) points out, e-learning policies in particular were influenced by the economic perception of ICTs as having the power to increase the automation and efficiency of cognitive and teaching processes. In my view, pedagogical objectives, such as improving system-wide teaching and educational structures for individualised, self-organised learning competences supported by ICTs, would need a different alignment of a national technology policy, (representing actors pushing technology) ,’ with the national educational policy (representing actors using and demanding ICTs for enhancing new competences).’ Any educational policy which aims to introduce an individualised approach to competence assessment should not be contradicted by the national technology or ICT policy, e.g. one which fosters standardised assessments only.

Finally, the role, strength and characteristics of cooperation among individual and/or institutional members of a national innovation network system have been theoretically suggested as success factors for the development of systemic innovations (see table 21: Innovation system theory by Sydow, 1992). Network theory approaches at the macro level discuss the intensity of cooperation between members of the same and different sectors (within a hierarchical or vertical network) and the influence of macro-policies (e.g. the institutional governance model of a regional innovation system influences the shaping and adoption of new innovations,Sydow ibid). Kozma (2003a, 2003b; Kozma et al. 2002) adopted the network approach to the national educational system of innovation, and argued that the linkages and cooperation among members of a national educational innovation system (e.g. the educational ministry, piloting schools and/or piloting universities, e-learning lead-user networks, associations of education professionals, IT companies and educational technology and media pedagogical researchers) are very important factors for driving the initial invention and innovation phases. The informal and institutionalised cooperation among the institutional members of a national educational innovation system serve as a sort of incubator for new ideas and inventions, and influences the early phases of the emergence of a system-wide innovation (e.g. by lead-user teams, pilot experiences, testing etc.; see Weyer, 2008) However, the social closure and necessity of it must be worked out with individual users and actors at the micro level.

5.2.2.2 Meso-level components and their interrelations

As the OECD Observatory on Higher Education claims, ICTs in the field of higher education have been used mainly for administrative purposes and as supplements to traditional ways of teaching over the last 15 years (OECD Policy Brief, 2005). However, some universities have been extremely successful in changing their traditional academic teaching style (e.g. through new online courses and services for open educational material at the Massachusset Institute of Technology (Merlot); online supplements to face-to-face classes or even new forms of distance training, e.g. virtual universities). Therefore, the new integrative, multi-level research framework proposes the integration of a second subset of determinants, which focus on the organisational characteristics of an educational institution/sector. These determinants are derived from the analysis of the theoretical approaches which deal with innovation capacity and the characteristics of organisations' innovation processes on the meso level (see section 4.3). The framework components for the meso-level analysis were selected from the screened innovation theories, because they point to variables which influence institutional adoption and diffusion at all levels of a national educational system. They are summarised in the table below.

Analytical level	Theoretical approach	Determinants of systemic innovation integration
Meso	Theory of technology-based sectoral change (Dolata, 2009)	Transformative capacity of ICT and the Internet to affect institutional routines Socio-economic adaptability of institutions to innovate by means of ICT
	Technology innovation and diffusion theory (Rogers, 1962) Systems-oriented organisation and management theory (Schein 1998; Argyris & Schön 2008, Senge 1990; Fullan, 1993; 2010)	Communication strategy Organisational structure, level of autonomy, explicit institutional e-learning strategy
	Science and technology studies; sociology of technology (MacKenzie & Wajcman, 1985;, Pinch & Bijker, 1984; Rammert, 1993; oder1999; Weyrer, 1993)	The innovation undergoes different phases in which the constellation and power of stakeholders and their networks changes permanently. For the system-wide adoption of a new technology, the 'social closure phase' is very important
	Disruptive innovation theory for organisation (Christensen, 2008)	Disruptive innovations are successfully integrated if simple and cheaper for mass of clients in contrast to expensive gadgets for a small group of lead-users.
	Critical theory of ICTs in education (Feenberg, 2009; Friesen, 2009)	The educational institution is influenced by the environment outside of the system (e.g. the international IT and national e-learning markets) and views ICTs as an instrument for improving the automation and efficiency of teaching processes

Table 22: Theoretical foundations for meso-level determinants of the integrative framework for systemic ICT-based innovations. Source: Author

The framework proposes analysing the adoption and diffusion of a system-wide techno-pedagogical innovation by educational organisations at the meso level using four aspects: the potential of the applied ICT to change institutional core processes; the characteristics of the organisational structure and communication strategy; the characteristics of companies acting as e-learning suppliers and the intensity of cooperation (networks) among educational institutions in one educational sector or several related sectors.

First, the theory of technology-based sectoral change argues that the shaping and integration of a new technology in a specific sector of society (e.g. the economic or educational sector) depends on the capacity of the technology (here ICTs and the Internet) to affect institutional routines and the ability of the organisation to adapt to changing routines (Dolata & Mayntz, 2009). The greater the effect of a new technology on traditional institutional patterns, the lower the probability that it can be implemented on a system-wide scale within the existing organisational framework (see section 4.3.4.1). Dolata and Mayntz (2009) point to the revolutionising impact of ICT on the banking sector (e.g. electronic banking) and the music sector (e.g. downloading and sharing digital music made CDs obsolete). Empirical studies show that the application of ICTs has created a new educational sector, namely that of virtual universities and online training campuses, which have emerged due to the innovative application and use of ICTs and the Internet for learning. This new sector has created a new market, especially in the adult education and workforce training sector (Oliver, 2002). The founding phase of virtual training campuses and digital universities has been supported by the European E-learning Programme of 2000.[77] In order to become sustainable, educational institutions, such as new universities and academic programmes, need to be embedded within national curricula or accreditation schemes. However, online services and digital universities have not yet replaced traditional universities (Oliver, 2002; OECD, 2005) and thus far, the effect of ICTs on institutional routines on a systemic level has been limited. As the OECD survey on the status of e-learning in the tertiary sector in OECD countries reports, the effects of ICT integration thus far have been mainly administrative and not pedagogical, e.g. improving the quality of teaching, supporting new self-organising skills or broadening access by a population to academic training via e-learning courses (OECD, 2005: p. 5).

Another focus of the meso set of components is therefore on analysing not only the potential for change of the ICT-based innovation as a ‘technological instrument,’ but also the organisational and managerial characteristics of an organisation which will enable systemic techno-pedagogical change and systemic integration. In my view, the shaping and integration of ICT-based innovations is determined not only by the

[77] See list of virtual universities by Susan D'Antoni on the UNESCO forum for virtual universities: Available from: http://www.unesco.org/iiep/virtualuniversity/home.php [Accessed on 25th July 2011].

transformative capacity of the material technology, but also by the organisational culture and potential of educational institutions to change their structure and strategies (socio-economic adaptability). Many e-learning pilot projects, funded by European Union learning programmes or national research programmes, are still only experiments, and are seeking system-wide or institution-wide diffusion (see, for example, the annual EU funding programme for transferring innovation). As outlined in section 4.3, the innovation diffusion theory of Rogers (1962, 2002) and organisational management theories argue that the organisational culture and structure (e.g. size and hierarchy; centralisation versus decentralisation) exert a fundamental influence on the rate of institutional diffusion and adoption of an innovation. Centrality and the hierarchy of decision-making in an organisation in particular are decisive factors in terms of the change caused by innovations. The more an institution is centralised, the more it needs extra managerial and communicative support in order to change its routines (see section 4.3.2.2. Organisational and management theories on innovation). The systems theory-based model of change agents and organisational development, which was originally developed for private companies, has been recently transferred to educational institutions (see Fullan, 2010; Reigeluth, 2011). They argue that e-learning policy and strategy-makers either at the macro level (national e-learning policy) or at the meso level (institutional e-learning policy) should support the additional effort required for innovation management, communication and services (e.g. IT support service centres; extra personnel), because a new innovation will not replace the old routine immediately, but will require extra work, time, training and infrastructure costs. The interrelation of teachers and faculty financed by the state and not the institution decreases institutional autonomy to finance innovation support processes.

Third, theories from the field of the sociology of technology claim that the system-wide adoption and diffusion of new technologies depends on the constellation of individual or institutional actors in the network dealing with the ICT-based innovation (Weyer, 2008). Whereas in the emergence phase, a loosely-structured network of outsiders (who are often on the edge of a community) develop or try out the innovation as lead users, during the stabilisation phase, a small network of actors begins to tighten their relationships and responsibilities (creating a tightly-structured network). During the diffusion or implementation phase, a very widely structured network of both institutional and individual members influence the successful ‘social closure’ and acceptance of an innovation (see the network approach in section 4.2.2.2).

Finally, Geels (2004) argues that traditional techno-social regimes and institutional routines are not easily relinquished, because they stabilise a system. In the context of e-learning, Reinmann (2006) claims that educational institutions tend to integrate incremental innovations rather than disruptive or systemic innovations (for definitions and types of innovations, see section 3.4.) She argues that the reluctance to adopt ICT-based innovations on a systemic scale has the advantage of keeping the educational system stable and manageable. An educational institution is more likely to change and adopt systemic innovations if the organisational hierarchy is flat and/or if the innovation has led to a disruptive new business or organisation model, such as the founding of a new virtual university (e.g. distance education via ICTs at the Open University of Barcelona).

5.2.2.3 Micro-level components and their interrelations

Overall, the structures of the educational actors at the macro and meso levels of the national educational system can support or hinder the intensity of the integration of ICT-enabled innovations in education. The direct effect of the adoption of a techno-pedagogical tool or practice can only be assessed according to the individual actions of actors at the micro level. What happens at the micro level frames the conditions for all planning and policy-making at the meso level, according to Schimank (2007: p. 236). Educational actors at the micro level work very autonomously, and the added value of changing from one teaching medium to another (e.g. books instead of oral teaching) becomes effective only in the individual learning and teaching process of a learner, with his/her teacher and a third party (e.g. parents) (ibid). Therefore, the integrative, multi-level research framework proposes that it is necessary to pay attention to a third subset of framework components, which determine the individual shaping and use of techno-pedagogical designs and practices of ICT-based innovations at the micro level. This is important, because micro-level activities influence/stabilise the other two levels (feedback/stability; Altrichter et al. 2007). This subset of micro-determinants originates from the theoretical approaches to innovations which were reviewed in section 4.4 and which are summarised in the table below.

Analytical level	Theoretical approach	Determinants of systemic innovation integration
Micro	Instructional design theories	Transformation of learning theories into techno-pedagogical design and practice
	Technology acceptance model; (Aijzen; Fishbein)	Individual behavioural intention to use ICTs (intrinsic/extrinsic motivation)
	Activity theory (Engestrom; Vygotsky)	Socio-cultural context of techno-pedagogical design and practice
	COP and network-based learning theory (Wenger, Lave & Weyer9	Participation in communities of (innovative) practice; co-operation in e-learning networks; networked learning

Table 23: Theoretical foundations for micro-level determinants of the integrative framework for systemic ICT-based innovations. Source: Author

The adoption of a new techno-pedagogical learning innovation depends, to a large degree, both on the inscription of learning theories into the e-learning software (see instructional design theories: section 4.4.1), the socio-cultural context of use (see activity theory: section 4.4.4.) and the individual behavioural and community-based intention to use these techno-pedagogical tools (see technology acceptance model: section 4.4.4.3; community-based practice: section 4.4.2.2).

First, the transformation of learning theories and changing pedagogical paradigms are affecting the adoption of systemic ICT-based innovations on the micro level. However, the development of an instructional design and its evaluation by e-learning lead-users does not take place in an isolated IT company, but often through collaboration between e-learning researchers and software developers in computing and/or educational technology research centres (e.g. the e-portfolio tool Pebble Pad was developed by the Pedagogical Institute of Wolverhampton and the informatics department). ICTs are shaped and integrated by individual actors in communities of (innovative) practice, either as early adopters (e.g. e-learning pilots) or in (subject-oriented) e-learning networks, often as lead-users. In order to move beyond an early majority, ICT integration must take into account the notion that learning takes place as a form of social participation, meaning that an individual is an active participant in the practices of social communities, and in the construction of his or her identity through these communities. It is important that these communities are domain-specific and involve people with expertise and experience, and who share a common interest (see the theory of community practice and networked learning theories).

Second, the technology acceptance model (Aijzen, Fishbein) proposes that the adoptaion of e-learning practise depends on the individual benefits. The OECD Report on ICT use by teachers made evident that teachers use ICTs for their personal preparation of the classes, however, not in class (see the Austrian report by Hornung-Prähauser & Geser 2010). Therefore, the individual approach and benefits not only of innovation lead-users, but also of traditionally minded persons, seems to enable or hinder the system-wide adoption of an ICT-based innovation.

Third, activity theory claims that in addition to techno-pedagogical design and practice, the socio-cultural context of the learning environment influences the shaping and use of techno-pedagogical design and practice. According to Engestrom's model (1997; 1999), in order to reach a learning outcome, it is necessary to produce certain objects (e.g. experiences, knowledge and physical products). Human activity is mediated by artefacts (e.g. tools, documents, recipes etc.). Activity is also mediated by an organisation or community. In addition, the community may impose rules that affect activity. The subject works as part of the community in order to achieve the objective (see section 4.4.4.1).

Finally, all of these factors are interrelated, because there is no such thing as neutral technology, and the functionality of a tool alone does not determine how an individual will ultimately use this technology. Even if a piece of technology is designed for constructivist teaching, it can also be used for a very different teaching style, or it may be used in different ways in specific educational cultures and settings. Take, for example, the introduction of so-called electronic 'whiteboards': one can use the electronic board in precisely the same manner as a traditional 'blackboard.' Only the adoption of a new teaching style and the facilitation of dynamic interaction with students and digital possibilities (e.g. inserting real-life data, links and pictures) will allow the use of this ICT-based innovation to make a difference. Moreover, individual change occurs only if the benefit for the individual can be discerned (see the theory of planned behaviour by Aizen & Fishbein). As mentioned before, this would explain why, in a recent OECD study on ICTs in teaching (2010), the integration of ICTs for supporting the personal work of teachers was scored very highly, but individual student-teacher usage was not. However, the techno-pedagogical tools and practices chosen by individuals are a matter of the 'we too syndrome' (social group influence). Although the use of e-learning is regarded as 'modern' teaching and many institutions and active faculty members are therefore trying to participate, very little change is occurring, because the process of changing pedagogical routines and mindsets takes longer.

5.2.3 Discussion of the interactions between the three framework levels

This section discusses how the three sets of variables interact with one another. As Mayntz (2006: p. 25) states: 'In reality interdependence/interrelations are the normal case on the continuum either total control or total autonomy.' An awareness of such interlinkages might be helpful in researching systemic implications and formulating effective, sustainable policies and strategies.

5.2.3.1 Macro-level interactions with the meso and micro levels

The table below summarises examples of the dynamic interaction which takes place between the national educational system (macro-level frameworks) and individual educational institutions and e-learning users.

Analytical level	Framework determinants	Interaction of variables
Macro-analysis: macro <-> meso interconnections; macro <-> micro interconnections	ICTs and the Internet as socio-technical infrastructure of global society and its subsystems	External influence on the macro level: International IT and e-learning markets; EU policies (e.g. the Lisbon and Bologna processes) Meso-level influence: Support for institutional IT infrastructure (IT budgets; national service agency) Micro-level influence: Enabling general access to computers; development of ICT skills/literacy for all groups in society, and not only e-learning freaks
	Educational culture and educational governance traditions	Meso-level influence: Quality assurance rules (assessment guidelines); financial autonomy Micro-level influence: Influence on the transfer of learning theory (SOL) into techno-pedagogical tools and practice
	Alignment of national IT, e-learning and R&D policies based on technological paradigms and trajectories	Meso-level influence: Institutional governance; institutional quality assurance policies; institutional e-learning policies; different standards/formats (e-books z.B.) Micro-level influence: E-learning lead-users needed for social closure processes; non-compliance by faculty
	Structure of national educational innovation system	Funding of the national system facilitates cooperation on the meso and micro levels of the network; extra work is needed to develop for innovation

Table 24 Interactions between the macro level of the framework and other levels.

National educational systems have permeable boundaries with the other subsystems of society, such as other political regions and/or the economic system. The proposed framework suggests that the shaping and emergence of ICT innovations depends on the national ICT infrastructure, which itself is influenced by external policies or markets (e.g. the ICT market).

On the one hand, national e-learning policies can be influenced by global or European policies, such as the Lisbon process and/or the European inclusion or innovation strategy. Some authors claim that the current trend for promoting self-organised learning in European e-learning and educational policies (e.g. by means of social media and e-portfolios) is grounded in the world's capitalistic market economy and the need for flexible workers with changing qualifications due to the rapidly-changing demands of the globalised international economy (Pasuchin & Häcker, 2008). Any analysis of systemic ICT-based innovations needs to be aware of the influence of global pressures or regional policies (such as the Bologna process or mobilisation/transparency strategies of workers) on meso-strategies. The quality of an ICT-based infrastructure influences the potential of educational institutions and learners to use e-learning and to develop the qualifications required by the nation and society, enhanced by ICT teaching and learning. In my view, the support of the national educational system enables the widespread adoption of e-learning tools and practices by all relevant groups in society, and not only those who can afford new and expensive consumer electronics. On the other hand, research into systemic e-learning innovations should pay more attention to the influence of the international and national IT and e-learning markets on the integration of ICT innovations into the national educational system (see Friesen, 2009; Feenberg, 2002). Expectations for the use of ICTs in education are connected to the general idea of ICTs as having the power to enhance the efficiency (via automation) and efficacy of an organisational process. This way of thinking has prevailed and is still, to some extent, dictated by the economic objective of standardising education and developing a uniform workforce. Nowadays, the mindset regarding ICT has changed slightly, as techno-deterministic thinking argues that e-portfolios or ICT should support the development of innovation capacity and creativity (see, for example, the use of e-portfolios to enhance creativity by Brunner et al., 2006).

Furthermore, the prevailing educational culture and educational governance on the macro level influences the structures and decisions of actors at the meso level, e.g. quality assurance guidelines. The integration of e-learning innovations can be hindered or enabled by the type of institutional governance model (high/low intensity of public/private control). Educational culture and assessment traditions influence what is measured in national quality assurance and accreditation programmes. The flexibility of such structural quality programmes enables or hinders the integration of new pedagogical directions, e.g. those used in 'informal learning 2.0.'

Third, there seems to be a need for the alignment of IT and educational policies between the macro and meso levels because, if they contradict one another, system-wide integration will be difficult (e.g. the national promotion of open-source software versus the institutional promotion of commercial software and the national accreditation of institutional curricula). The intensity of the change induced by the integration of e-portfolios is determined by the interaction of the diverse policies involved with ICTs and the Internet. The better these policies are aligned, the easier it is to develop joint institutional standards (e.g. e-portfolio guidelines) and sectoral quality assurance guidelines or even to react more quickly to the need for more e-learning research (e.g. the adoption of e-portfolio tools) or joint support structures (e.g. an e-portfolio server centre). However, the changing educational sector (due to ICT-based innovations) might influence national policies in other domains (e.g. labour market policies and workforce training). The intensity of the cooperation between educational institutions in e-learning networks and the constellation of power (stakeholders) within such networks influences the feasibility of institutional change. Acquired knowledge (international and national best practices) helps to change and to create an open climate for innovation by motivating lead-users. The more educational institutions use ICT to improve teaching practices and work together in networks, the more it is possible to influence market supply and R&D activities.

Another interconnection can be analysed between previous decisions made on national IT and e-learning policies on the macro level and new strategies which are likely to be developed on the meso level (see the transition model by Geels, 2004 and techno-social regimes). For example, national support for a specific e-learning tool and practice (for example, government support of IT purchases and services such as whiteboards and learning management systems) leaves little room to switch rapidly to another system offered by the global IT market. Therefore, educational institutions cannot change easily from one techno-pedagogical innovation to another (techno-social regime, see Geels, 2004).

Finally, the structure of the national educational innovation system influences the drivers of innovation on other levels, e.g. funding for the national system facilitates the level of cooperation in meso- and micro-level networks.

5.2.3.2 Meso-level interactions with the macro and micro levels

The table below summarises the dynamics and interaction of meso variables influencing the integration of ICT-based innovations at the micro and macro levels.

Analytical level	Framework determinants	Interactions of variables
Meso level: Meso -> macro interconnections Meso -> micro interconnections	Transformative capacity of ICT and the Internet to affect institutional routines	Macro-level influence: The need for consistency between macro- and meso-policies Micro-level influence: The permanent change to institutions caused by the change in ICTs requires continuous learning (additional costs to institutions)
	Socio-economic adaptability of institution to innovation by means of ICT: Organisational structure, autonomy and e-learning strategy	Macro-level influence: Institutional governance structures in education sector influence university achievement agreements Influence on changes to the curriculum (autonomy) Micro-level influence: Support structures for e-learning lead-users and networks; ICT literacy and skills training Knowledge management for workplace training
	Position in network	Macro-level influence: Networks on regional/national levels as well as topic-based networks Micro-level influence: Support for e-learning practitioner networks

Table 25: Interactions between the meso level of the framework and other levels. Source: Author

If an educational organisation changes due to the integration of an ICT-based innovation, this may have consequences for the actors involved, working on the individual micro level. For example, due to the rapid changes in the IT market and the e-learning product range, teachers and faculty have to be trained and retrained frequently, meaning rising adoption costs. However, it is not only individuals who have to change their routine. Some e-learning innovations necessitate changes to curricula, study programmes or minimum course requirements (e.g. an e-portfolio as a study planning instrument). If networks and communities among a high number of educational institutions adopt a specific e-learning system, they can exert power over actors at the macro level, e.g. central IT purchasing powers, either at the ministry level or within a specific region (e.g. in the Austrian school sector, regions are organising IT support).

5.2.3.3 Micro-level interactions with the macro and meso levels

The table below summarises the interactions between users at the micro level and educational organisations and governmental structures and representatives at the meso level.

Analytical level	Framework determinants	Interactions of variables
Micro level: Micro <-> macro interconnections Micro <-> meso interconnections	Transformation of learning theories into techno-pedagogical design and practice	External influence: Demand changes for another supply in the international and national markets Meso-level influence: E-learning strategy development by institutions/departments/networks
	Socio-cultural context of techno-pedagogical design and practice	Macro-level influence: Labour union conflicts (teachers/faculty unions) Meso-level influence: Incentive systems needed due to autonomy of teaching
	Individual benefit	The individual user can reap his/her benefit only in interaction with his school or university administration (e.g. career advancement) and/or colleagues (e.g.professional network membership)
	Participation in communities of (innovative) practice Constellation of individual actors in regional networks	Macro-level influence: Users and policy-makers work independently of one another; lobbying Meso-level influence: Emerging e-learning networks are bound to the life-cycle of an innovation

Table 26: Interactions of the micro level of the framework with the other levels. Source: Author

If the techno-pedagogical design of e-learning software changes and the demand is large enough, a national R&D and/or educational policy may take into account the change and support the pilot phase and/or diffusion, or further phases of the research. If the demand changes and increases, the e-learning market may also react and may consider different marketing and training strategies. In many cases, the demand for e-learning software has often been driven by academic departments of pedagogy in cooperation with IT departments as academic research projects (e.g. the learning platform Ilias and Claroline in the 1990s). The development of e-learning competences by lead-users is a bottom-up approach: e-learning lead-users invest their free time in developing e-learning software and producing multi-media content.

5.2.4 Conclusions: Sensitivity to interaction patterns

The integrative, multi-level framework approach aims to provide a sound theoretical base for explaining and exploring the difficult dynamic of the systemic integration of new e-learning technologies within a national educational system. The value of the proposed framework lies in its pursuit of the integration of various theoretical approaches, dealing with innovation processes, which are usually explored individually. However, its strength lies not only in this holistic approach to the theoretical problems inherent in the shaping and integration of ICT-based innovations: the framework stresses sensitivity to the interactions between structures and actors on the three analytical levels and their related subsets of variables which determine the. It is important to take such interrelations into account, because thus far, the aims of educational/e-learning policy have not been fulfilled. This sensitivity to interactions leads to an increase in the quantity of dimensions in the framework which interact with one another, and which need to be researched collectively. As Schimank (2007: 232) argues, 'one actor designs the structural context for the other actors.' In addition, there will always be an 'interdependency problem,' because, as Schimank points out, in the real world, total autonomy and complete independence do not exist (Schimank, 2007: ibid). Thus, this thesis proposes a research framework which identifies boundaries and disparities, through which different structures and actors influence the shaping and integration of ICT-based innovations. The dynamic between a system, its environment and its subsystems is an important element of how one level of a system forms the context of a 'lower' system level (see the concepts of 'reflexive monitoring' and 'recontextualisation' by Fend, 2006). Some authors argue that in education, it is easier to manage and influence developments on the meso level than on the micro level (see Schiman, 2007:65), while others maintain that it depends on the fine-tuning of the interactions between the meso level and the micro level (see Altrichter & Maag-Merki, 2010: 249). Altrichter proposes avoiding the notion that it is up to the individual actors, such as teachers and faculty, to adopt an innovation, because a system transformation needs different co-ordination strategies between the actors at the two levels (e.g. new forms of co-operation between individual staff from different departments, and formal and informal exchanges of experience).

In order to describe the dynamic relationships between the three analytical levels of the research framework, a number of theoretical determinants were proposed. Such a set of variables can be used to describe and analyse systematically the ICT-based innovation process as an unstructured, complex empirical phenomenon which is taking place within all of our national educational systems (see also Altrichter & Maag-Merki, 2010:74). It helps to generate a systematic view on the influence of actors and structures on governance, and the effect of the integration of innovations, and supports the identification of correlations between variables in a significant ‘interaction pattern.’ Given a sound empirical database, it should be possible to compare differences or similarities in the ICT-based innovation patterns of national educational systems and countries. In order to explore the potential and limitations of such a framework, this thesis aims to exemplify this approach with the empirically-observable phenomenon of the emergence, development and integration of e-portfolios into national educational systems. This will be done in the following chapter.

5.3 Framework exemplification: Comparing interaction patterns of e-portfolio integration processes in Higher Education systems in three European countries

5.3.1 Objectives of the framework exemplification

The utility of the integrative framework and the proposed components for applied e-learning research will be exemplified by the case of e-portfolios. As outlined in chapter three, e-portfolios are an example of an e-learning method and tool that is characterised as a multi-dimensional, systemic ICT-based innovation affecting change by more than one actor in the educational system and leading to change in other educational sectors. The objective of the exemplification is to explore the appropriateness of the proposed integrative, multi-level framework to systematically reduce the complexity of an empirically observable e-learning innovation process, which has been taking place in the sector of European Higher Education during the last fifteen years. This chapter aims:

- To identify patterns of interactions of structures and actors involved in the shaping and integration processes of e-portfolios in a national educational system,
- To identify mechanisms dealing with these interdependencies in the sector of Higher Education
- To derive implications for developing sustainable policy and strategy formulations in respect of the identified interaction patterns.

The figure below depicts the systemic implications and macro-meso-micro problem of e-portfolios at all levels of an educational sector.

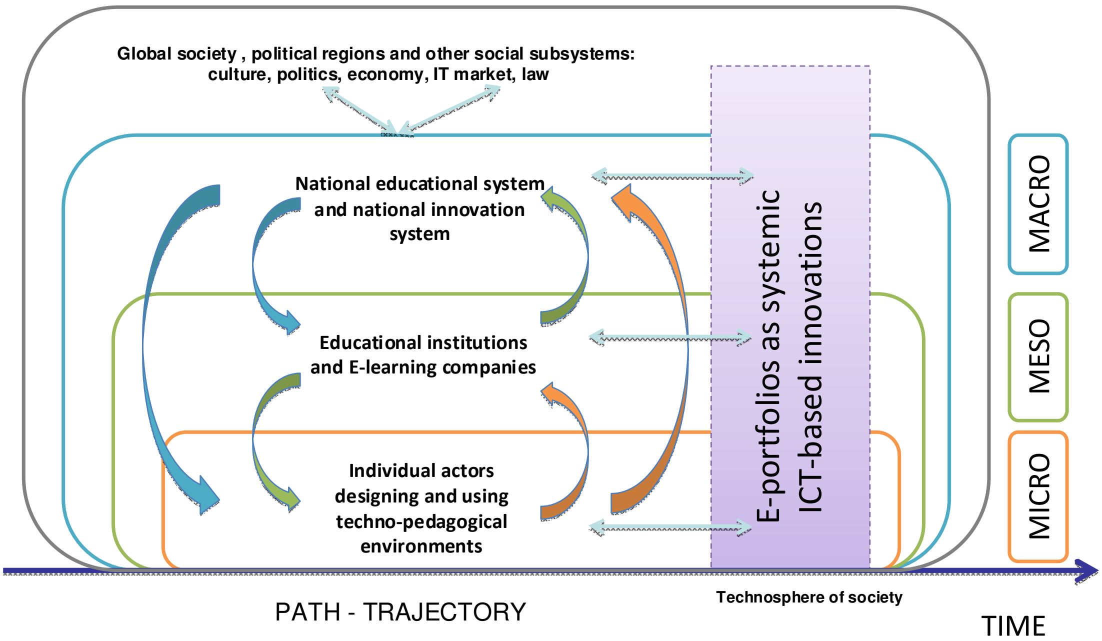


Figure 43: The dynamics of e-portfolio as systemic ICT-based innovation.

The application of the framework will be done in three steps. First, indicators are proposed specifying the components of the framework (section 5.3.2) and the selection criteria and the used data for the explorative cases are described (sections 5.3.3 and 5.3.4). Second, the cases are systematically described and analysed according to the proposed set of framework components. The interacting dimensions influencing the shaping and integration process of e-portfolios are explored for the Higher Education sector in the United Kingdom (section 5.3.5), in the Netherlands (section 5.3.6) and in Austria (5.3.7). Section 5.4 compares the different patterns of interactions of e-portfolio integration as result of the framework application and discusses the practical and theoretical challenges in using such a framework approach: What problems arise given the amount of determinants and data needed for such a huge framework? Is the integration of selected theoretical approaches building the framework satisfactory? Is more research in theory development necessary and what issues are still to be explored? What theoretical gaps can be identified?

5.3.2 Mapping characteristics to the framework components

In order to apply the large theoretical framework as guiding structure to the cases, the three sets of components are mapped with quantifiable and/or qualitative characteristics. Such a mapping is necessary to better perceive and operationalise the empirically observable process of e-portfolio integration in practice. However, in order to make this first exemplification feasible, I will pool together the characteristics for similar determinants and summarise the characteristics for those determinants that appear relevant at each analytical level. The last aspect concerns especially the determinant of “co-operation and networking”, which is considered an important shaping and integrating factor at the macro-, meso- and micro-level.

Level	Determinants for ICT-based innovations	Indicators for determinants and interactions
MACRO	National ICT and Internet infrastructure as techno—societal background	Indicators for national telecommunications infrastructure and for digital skills, literacy and inclusion for information society
	Educational culture and Higher Education governance system	Educational tradition in academic teaching and student assessment ; level of public/private interventions; academic and managerial self-governance/autonomy
	Alignment of national ICT policy and e-learning policy	Technological preferences and prior investment Formalised/ informal e-portfolio policy
	Cooperative structure of national educational innovation system	Intensity of links and co-operation between innovation stakeholders at all levels of educational system; monitoring and evaluation processes

MESO	Transformative capacity of ICT to affect institutional routines	Role of ICT in university as business model: traditional universities, new (applied) universities, virtual campuses, online courses etc. Indicators for sectoral/ institutional ICT infrastructure (computers per student; Internet access points in universities; used systems)
	Organisational culture, institutional governance and strategies for e-portfolio integration	Institutional e-learning and assessment tradition Level of autonomy; degree of centrality of curricula reforms Formalized or informal institutional e-portfolio strategy and measures E-portfolio guidance and training service (institutionally installed change agents)
	Co-operation of institutional actors in national e-learning networks	Type of membership in international and national e-portfolio networks (cross-sectional e-portfolio networks), from tight to wide social connection
MICRO	Techno-pedagogical design and practice	Type of used e-portfolio concept and tools (reflection portfolio, work & presentation portfolio; read only/collaborative portfolio)
	Socio-cultural context for transformation of techno-pedagogical design and practice	See characteristics of educational culture and governance traditions in Higher Education at the macro-level
	Individual behavioural intention to use ICTs	Individual benefit can be for example career advancement, new professional competences; membership to other professional networks, higher salary.
	Co-operation of individual actors in regional e-learning networks	Type of membership in national and regional e-portfolio networks; exchange of cross-sectional e-portfolio work Type of activities (pilot-projects, joint papers)
	Participation in communities of innovative e-learning practice	Level of “openness” of e-portfolio communities; duration and sustainability of communities etc.

Table 27: Indicators for framework components. Source: author

Since the information society as statistical "construct" is a rather young phenomenon, methods for measuring the national performance are also relatively young and not all societally relevant ICT-based developments have already been definitional and statistically conceived. In order to gain a picture of the diffusion and provision of the ICT and Internet infrastructure and its societal embeddedness in the information society, in this exemplification I use the statistical indicators worked out by the OECD and the European Union (Directorate General for Industry and Media; Eurydice[78]). These statistics include economic, technical and societal indicators developed specifically to compare the different levels of the emerging "information society" in Europe.

It is more difficult to characterise the educational culture and academic traditions of a national educational system. For the exemplification, I will use a rather simple distinction of the educational cultural background as known from educational science, namely the Anglo-American, European continental and Humboldt academic tradition (see Boer, Ender & Schimank 2008).

The alignment of a national ICT policy and e-learning policy can be characterised by past technological preferences and prior national IT-investment programmes and policies and by official e-learning or e-portfolio policies or national strategy plans adopted by the ministries or related technology agencies.

Cooperation is an important dimension and takes place at all levels: at the micro-level, the co-operation between teachers of the same school; at the meso-level, teachers/faculty staff of the same subject exchange experiences at the same cluster or professional association; at the macro-level, the same people interact with funding agencies for e-learning pilots and/or with e-learning policy makers. These are all linked in the national innovation system.

The cooperative structure of a national educational innovation system can be characterised by the relations and linkages to the various stakeholders of a national educational innovation system, be it actors in educational science research, educational technology research, educational and IT-policy makers, e-learning providers and e-learning lead-users as innovation adopters and multipliers (see Pedró 2010). It seems important to compare the intensity and level of co-operation (from tight to wide social closure and networks) and the existence of monitoring and evaluation systems of a systemic innovation processes within such a national educational innovation system (ibid). These characteristics are also valid for institutional co-operation and individual co-operation.

The interactions at the meso-level can be characterised by the role of ICT in changing the institutional routines, which is manifested in the "e-learning business model". Depending on the intensity of e-learning usage in a university, different modes

[78] This is the European service for statistics about European education systems and policies http://eacea.ec.europa.eu/education/eurydice/index_en.php

can be distinguised: traditional universities (ICT supporting administration of learning process and on-line delivering of study-material), new (applied) universities (as before; but additionally ICTs are used for study guidance), virtual campuses (study takes place completely via online e-learning instruments (online-lecturing; virtual classroom, online-co-operation among students; online-guidance etc).

A very important determinant linking actors at the macro and meso-level is an institution's adaptability to change, which relates to its specific organisational culture, the institutional governance and the institutional strategies of a university to integrate e-portfolio as innovation. Here we will analyse whether the university has an explicit and formulated e-portfolio strategy (homepage analysis) and whether it provides additional resources to support the change process (e.g. e-portfolio support centres, materials, software). Furthermore, it is important to take into consideration how autonomously the universities are able to launch new processes within the university (central or autonom curricula development in core-study and post-graduate courses).

The transformation of the learning theory into the techno-pedagogical design and practice influences all actors involved in the e-portfolio integration. This feature emerges at the micro-level between the actual adopters of the e-portfolio concept and tool and the developers thereof. As was set out in chapter three, different types and understanding of e-portfolios are possible: objectivistic, subjectivistic or dialectic concept. In practice the focus can be on the work and presentation portfolio (objectivistic view), the study process portfolio and/or both (dialectic view).

As mentioned before, the characterisation of the benefits for an individual user depend on the role why using ICTs: as student one has very personal benefits (e.g. self-motivation; better grades); as teacher one may advance his/her career or become part of a new professional network.

The characterisation of co-operation and participation in communities at the individualised level can be done with the same features as set out for co-operation among the national innovation system (macro-level). Interesting indicators would be the level of "openness" of e-portfolio communities and their duration and sustainability.

5.3.3 Multiple case-study design

5.3.3.1 E-portfolios in higher education

During the last ten years the European e-learning community has discussed the benefits and ambiguities of e-portfolios in the various educational sectors. The figure below summarizes arguments for and expectations of e-portfolios in HEIs as discussed in literature and conference presentations depending on the analytical level of the educational system.

The emergence of the topic of using e-portfolios in the higher education sector began in the Anglo-american countries and swapped over to Europe in the early years of the 21st century. Many studies examined the impact on the micro-level (see HEI 2009 Conference: Session on Assessing Impact: E-Portfolios in Higher Education; Thornton et al 2009). As sketched out, on the macro-level, e-portfolios should support the current European and national university policies, foremost the Bologna Process and European Lifelong learning strategies (e.g. lower student drop-out rates, shorter period of studies, re-organisatoin of the educational sector-higher employability; co-operation among HEIs, internationalisation of HEIs etc). E-portfolios should support a more transparent and comparable system of educational courses and certificates among the European Union memberstates, which would support the political and economic goal of increasing mobility. E-portfolios as technical instruments are expected to efficiently archive data on qualifications and work (e.g. European curriculum vitae) . E-portfolios as form of self-organised learning should support the Lifewide learning (integration of formal and informal learning) and lifelonglearning policies of the Europen Union (learning throughout the men`s ligelong learning biography and beyond an educational institution).

On the meso-level, e-portfolios are expected to support the introduction of a different learning culture (self-determined, competence-oriented study processes) and of a new assessment instrument for meta-skills (e.g. self-organisation and self-reflection skills). Such skills are needed by professions such as teachers and thus, e-portfolios have become very popular in the domain of teacher-education). By the institutional integration of e-portfolios it is expected to reduce hierarchies between students and tutors and open the communication beyond academic fences (reflective, exchanged feed-back instead the ivory tower). If both students and faculty have to use e-portfolios, reflect their teaching and student support processes, then another culture of evaluation and improvement of teaching quality can be envisaged. E-portfolios are viewed as instrument to introduction an “open learning culture” within an instititution.

On the micro-level, e-portfolios are implemented as didactical concept of portfolio work aiming at developing meta-skills, such as self-organised decision-making, self-directed learning and motivation skills all very much enhanced by digital technologies (easier handling of data, archiving, inclusion of video and audio-messages.

Very often e-portfolios are expected to support the transition phases from one school/graduation to another, e.g. by technical transmission of report data. In many e-portfolio projects concepts for supporting disadvantage groups with little formal qualifications were being developed (e.g. e-portfolios for adults and migrants). In such cases the focus of using e-portfolios lies in the presentation function of skills For case studies and a further more detailed taxonomy see also the conference proceedings from: Baumgartner, Zauchner & Bauer (2010 eds)

Summing up, e-portfolios can be used in higher education for different purposes and lengths of time: study planning (Course feedback); project planning, management and coaching; scientific working; problem-solving; competence-based portfolio (subject-oriented), digital CV – application (see Hornung-Prähauser & Wieden-Bischof, 2010).

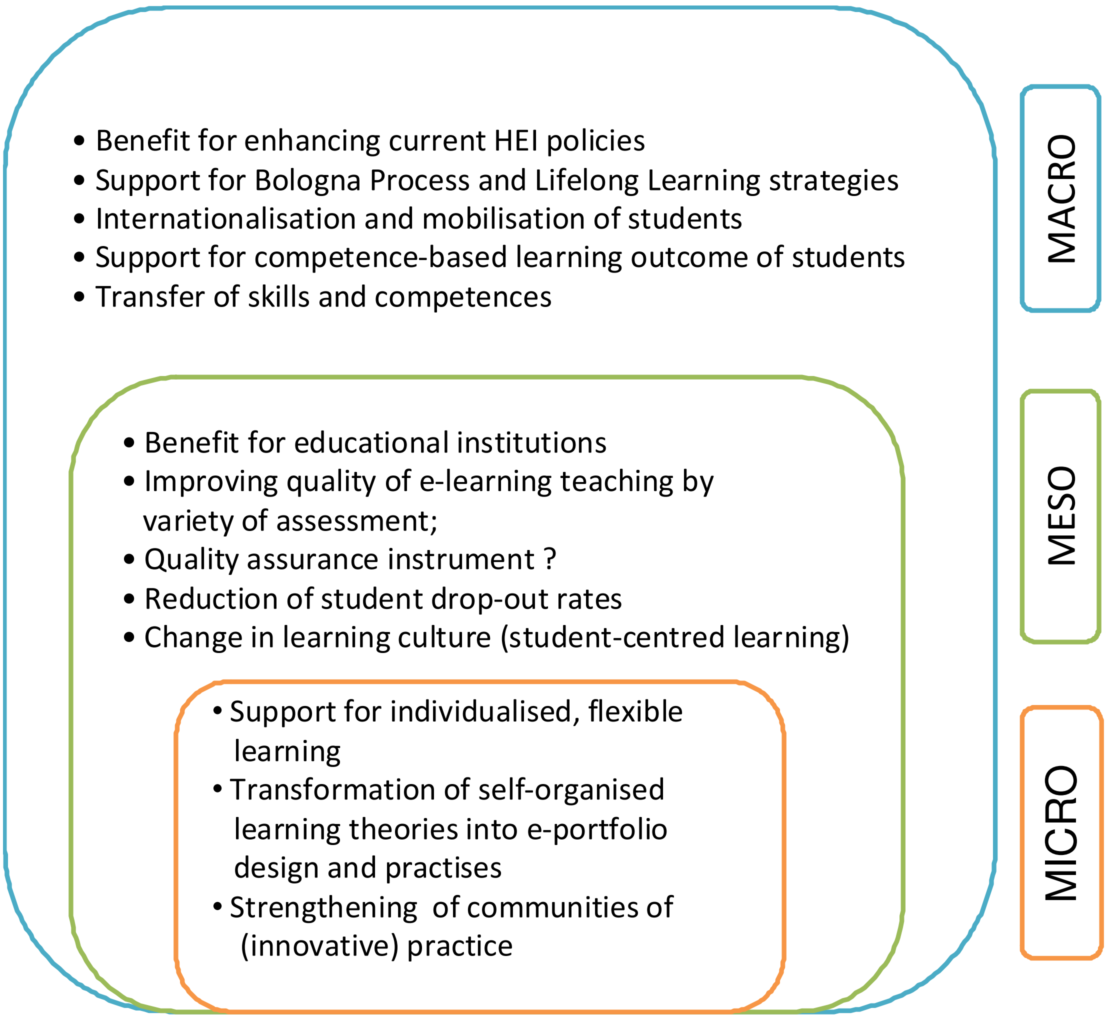


Figure 44: Motivations and expectations of e-portfolio integration into sector of Higher Education Institutions (HEI) Source: Adapted to Hornung-Prähauser et al. (2007: 35)

5.3.3.2 Case selection criteria

The utility of the theoretical-based framework is explored by applying it to the case of e-portfolio integration processes in the Higher Education sector in three different European countries. The application of the framework to the selected cases should illustrate whether such a framework helps to systematically identify interacting structures and actors at the different levels of an educational system. Moreover, it should make explicit the different interaction patterns and intensities of interlinkages between the wide range of e-portfolio actors. Therefore, the research strategy follows a multiple-case study approach, which is used if a research field is young and little knowledge about it exists (for case study methodology see Yin 1994). The cases should meet the following criteria:

- Different educational culture and institutional governance models
- Different levels of experience with e-portfolio integration
- Different intensity of change induced by the integration of e-portfolio as an example of an ICT-based innovation.

Although the e-portfolio concept emerged in the USA, this exemplification concentrates on the European developments, because the comparison of educational systems is already difficult within one main cultural system. Thus, three European countries were selected in order to find out how the framework is useful for analysing their different interaction patterns and problems in a systemic ICT-based innovation process. The table below provides an overview of the selected cases:

Case characteristics	Case 1	Case 2	Case 3
European countries	United Kingdom	Netherlands	Austria
Academic culture	Anglo-Saxon university tradition	European Humboldtian and reform pedagogy tradition	European Humboldtian academic tradition
Educational institutional governance system of HEI	From loosely regulated to more state regulated	From state regulated to more private regulation	From state regulated to more private regulation
E-portfolio integration experience	Innovators/lead-user Very experienced	Early adopters Experienced	Early majority Newcomers
Intensity of change induced by e-portfolio integration	Systemic innovation	Organisational innovation	Techno-pedagogical innovation

Table 28: Multiple case study approach for framework exemplification

Criteria of academic culture and institutional governance:

The first selection criteria for the cases relates to a different academic culture and tradition spanning the European sector of Higher Education. As Strivens (2010) rightly points out, the European e-portfolio shaping and integration has taken place against different backgrounds and cultures:

> "Secondly, e-Portfolios have developed more or less simultaneously within different cultural and educational traditions. The emphasis on personal celebration in the US tradition can seem alien to some UK practitioners: conversely assessment in US HEIs seems less driven and constrained by an externally imposed quality regime than with their UK and Australian counterparts. The practice which is presented to showcase what e-Portfolios can offer thus varies somewhat in its emphasis between countries." (Strivens 2010: 9).

For the purpose of the exemplification, we therefore explore cases that represent the Anglo-Saxon vs. Continental European, also known as the Humboldtian academic tradition (see Boer, Ender & Schimank 2008; Anderson 2010). Furthermore, the cases should represent different institutional governance systems in Higher Education. During the last fifteen years university structure and Higher Education sector have changed significantly (partly because of the European Lissabon process and due to the new public management approaches (Sporn 2002). This development took place during the same period that e-learning was introduced in the educational sector. The new governance research has worked out cases or criteria for different governance systems and rules in Higher Education (see Boer et al. 2008). The following table illustrates the new models and changes of institutional governance for the United Kingdom, the Netherlands and Austria. The OECD Report argues that there have been similar changes in governance models in Austria and the Netherlands (2003: 71).

Table 3.3 New models of institutional governance: country examples

Country	Year	Main governing body	What changed?
United Kingdom	1988	In the "new" universities (mainly former polytechnics) the main governing body is a *Board of Governors* which generally comprises about 25 members, the majority of whom are external; there is also generally an *Academic Board* which comprises academic staff only.	Established a small Executive Board, half of whom must be from outside the university with experience in industrial, commercial or employment matters.
			Strengthened the power of the Chief Executive.
			Subordinated the Academic Board to the Board of Governors in all aspects and to the Chief Executive in some respects.
		In the "old" universities the main governing body is generally a *Council* of 25-60 members, the majority of whom are external, and a Senate comprising academic staff only.	Although the "old" universities were not affected by the 1988 Education Reform Act, the report of the National Committee of Enquiry into Higher Education in 1997 made recommendations about governance which have, in the main, been adopted by them.
Netherlands	1997	*Supervisory Board*, 5 external members appointed by Ministers.	Replaced joint decision-making by Administrative Board and Academic Council.
		Executive Board, 3 internal members including the Rector.	Introduced Supervisory Board, which supervises and appoints members of the Executive Board. The Executive Board is accountable for governance and administration to the Supervisory Board.
		University Council, academic, administrative staff, plus students; mainly advisory function.	University and Faculty Councils became largely advisory bodies for students and employees.
			Executive strengthened relative to University and Faculty Councils; Dean's power increased within faculty.
			Abolition of the previously powerful Disciplinary Research Groups.
Austria	2002	*University Council*, 5-9 external members, nominated by the Ministry and the University Senate.	Introduced the University Council which will appoint the Rector, and decide on the organisational plan, budget, and employment structure.
		Rectorate, the Rector and up to 4 Vice-Rectors.	The Rector takes on a senior management function, supported by a team of Vice-Rectors.
		Senate, academic, administrative staff, students; majority of members are professors.	The Senate was retained, but lost much of its power, and is to focus mainly on academic programmes.

Table 29: The changing governance models for Higher Education for the UK, NL and AT.

Source: OECD (2003: 72): Educational Policy Analysis. Changing governance models.

Criteria of e-portfolio integration experience:

I have been unable to find any studies or rankings about the status of e-portfolio integration in the e-portfolio literature. However, two very experienced e-portfolio experts and practitioners, Veugelers and Chen (2010), have assessed the different levels of experiences with e-portfolios in HEIs for different countries. According to them, the Anglo-American countries, the Netherlands and the Scandinavian countries are very experienced in e-portfolio integration, and the German-speaking countries and southern European countries are continuously gaining experience (see presentation at the Australian e-portfolio conference 2010).

Case one: United Kingdom: Longstanding e-portfolio integration experience; almost a systemic innovation:

- The implementation of e-portfolios in the higher education sector had already started in the UK at the end of the 1990s. The national e-portfolio strategy was supported by funds for piloting the software development and the organisational integration of an electronic e-portfolio system (=PDP),[79] supervised by the Quality Assurance Agency for Higher Education (QAA). This institution published regulations for a national implementation. In 1998 six HEIs piloted the electronic "RAPID Progress File" (developed by the Loughborough University). In the early years of 2001 the goal of the national e-portfolio policy was to avoid individual administrative and technical solutions and was therefore an IT-system governing the whole national educational sector of Higher Education was promoted (see Policy statement on a progress file for Higher Education (2000).[80] The current range of diffusion of e-portfolio systems and practices was estimated by a study on E-Portfolio Practice in UK Higher Education in 2006 (Strivens 2007; issued by BECTA, the former e-learning support agency for UK). This report highlighted the fact that 83% of the participating institutions (66 HEI institutions) have installed a specific technical e-portfolio system for the offered e-portfolio supported study planning process. In total 56% (37 HEIs institutions) confirm that they use a larger range of software applications supporting a PDP process chosen by the faculty (see Strivens 2007). In summary, the Higher Education sector has a longstanding experience in paper-based portfolio work and in IT-supported portfolio processes. They have utilised a national e-portfolio guidance system and thea majority of the British institutions in the Higher Educational sector use an electronic tool to support e-portfolio processes (or Personal Planning Processes).

Case two: The Netherlands: Medium e-portfolio integration experience; towards an organisational innovation

Since the early years of 2000, there has been a large number of e-portfolio piloting activities in the Netherlands, both at institutional level and in national projects by a Dutch special e-learning promotion programme, called digital university and by the Dutch national e-learning support organisation "SURF" (Aalderink & Veugelers 2007a, 2007b, 2006). Another study by Rubens and Kemps (2006) provides insight into the Dutch landscape of e-portfolio integration in the emergence phase. They found that in 2006 many Dutch Higher Education institutes had already experimented with the organisational wide implementation of e-portfolios, especially at universities of

[79] In the United Kingdom e-portfolios were originally called "Personal Development Planning" or "Progress File"; see section 5.4.3.1. Type of e-portfolios.

[80] More details: Quality Assurance Agency for Higher Education (2001): Guidelines for HE Progress Files: Available from http://www.qaa.ac.uk/academicinfrastructure/progressFiles/guidelines/progfile2001.asp [5-10-2010]

professional teacher training education. The table below shows how heterogeneous universities participated in e-portfolio piloting, many of them already integrated beyond pilots. Aalderink and Veugelers state that the Netherlands have already surpassed the "exploration phase" with e-portfolios and are in the process of integrating them in many organisations. However, the Dutch current national e-learning policy report makes it evident that the e-portfolio integration process has taken place at the institutional level (see SURF Report 2011), and macro-solutions to transfer the concept into other educational sectors or the labour market has not started yet. For an overview of how many Dutch institutions have piloted and integrated e-portfolios see chapter 3.5.5 and the figure on "The ePortfolio landscape in Dutch higher education" by Rubens and Kemps (2006).

Case 3: Austria: Low level of e-portfolio experience – towards a single techno-pedagogical innovation

The Austrian e-portfolio scene in the field of higher education has not yet reached an integration level larger than on the individual course level. In the period between 2007 and 2008 six universities experimented with a two-year phase of e-portfolio integration in diverse forms. The universities did so on the basis of R&D funding from the Austrian Ministry of Finance and under supervision of the Austrian association of e-learning universities (FNMA). Six different types of e-portfolio integrations have taken place and some of them have been integrated on an organisation scale (embedded into curricula like that at the Danube University; adult education – master course teacher training, but not in the whole Austrian university system (Zwiauer & Kopp 2008: 63).

For the purpose of the exemplification and in accordance with the innovation adoption model of E. Rogers (see chapter 4.3.2.1), I suggest addressing the actors in the national educational system of the United Kingdom as "innovators" or "lead-users" (e-portfolio emergence and adoption around late 1990s/early 2000), those in the Netherlands as "early adopters" (e-portfolio emergence between 2000 and 2006) and those in Austria as "early majority" (e-portfolio piloting starting between 2006 and 2008).

5.3.3.3 Empirical data for case studies

The primary objective of this exemplification is not to derive new objectivist insight into the individual e-portfolio integration processes, but to identify interrelated actions and instruments used/characteristics for the mechanisms, policies and strategies that have taken place at the different levels of the national educational system. Therefore data for the description of the case studies are derived from a mix of secondary literature, especially from reports about e-portfolio pilot-studies presented at e-portfolio conferences or published in e-portfolio proceedings (2005–2010) and from national and international e-portfolio case study reports (see Hornung-Prähauser, Geser, Hilzensauer & Schaffert 2007). In order to characterise the national ICT infrastructure and national techno-societal background, official statistics that are of relevance to the domain of e-learning were screened, especially the European Information Society and ICT statistics, data from the OECD and UNESCO. A rough assessment of the national e-learning and IT-policies can be extracted from related national strategy reports, published by the ministries for education, science and infrastructure. Institutional policies were analysed from information provided by the university homepages (website analyses).

5.3.4 Case 1: Multi-level dynamics of e-portfolio integration in Higher Education in the United Kingdom

5.3.4.1 Techno-societal infrastructure

The framework proposes to analyse the techno-societal background and explore how it influences actor constellations at the meso-level (educational institutions) and at the micro-level (individual users). The techno-societal infrastructure at the macro-level of a society influences the possibilities of educational institutions adopting new ICTs through, for example, funding of the national IT infrastructure (e.g. broadband and Internet coverage) and the institutional infrastructure (IT budget for hard- and software purchases for faculty and students). Moreover, it influences the possibilities of individual learners getting a chance to adopt the ICT-based innovation by access to hardware and software and by ability to use it (e.g. support of development of ICT media competences).

The techno-societal infrastructure in the United Kingdom provides a fruitful background for the almost systemic e-portfolio integration: the country review on the digital competitiveness of the European Union and its member states has addressed the United Kingdom (UK) as the “best performing” country in Europe, with the majority of the benchmarking indicators for digital competitiveness above EU-average (European Commission 2009: 192). The report states that due to a high level of household Internet connectivity and broadband service (92.7% digital subscriber line connections in general, and in rural areas 78.6% of the total population), there is a widespread use of Internet services. The national ICT policy for a “digital Britain” focuses on four aims: delivery of an effective modern communications infrastructure to private households (especially access to 2MB/s broadband services by 2012) and the development of a next generation broadband to those areas that will not benefit from commercial deployments; legal support for creative industries in the digital age resp. provisions for public service content); support for ICT skills and participation in digital society digital procurement and the digital delivery of public services (see Digital Britain report cited in European Commission 2009:192). The report ranks the United Kingdom as sixth in terms of the percentage of regular and frequent Internet users in the population for a large range of Internet services. However, although an outstanding national integration of ICT by the population was assessed for 2009, a slight gap was recorded for ICT use in health and education for seeking learning information via the Internet (ibid).

5.3.4.2 Educational culture and Higher Education governance systems

The educational culture and educational governance in the United Kingdom can be characterised as a very "competitive landscape" for introducing e-portfolios on a systemic scale: the tradition of the United Kingdom for academic teaching and student assessment focuses more on individual, but very competitive assessment methods and formats. The national e-learning board favours electronic assessment methods way of assessing student knowledge ("E-assessment"), and follows a very techno-deterministic approach on testing quantitatively and objectively with ICT support. Examination carried out externally of the institution has a long-standing tradition; see for example the guidelines on so-called examination boards.[81] From the 1980s onwards, the time when the personal computer began to emerge, the UK government shifted from a loosely regulated to a more state-regulated, market-dominated educational governance model and introduced state-induced quality measurements for academic teaching and research (e.g. research assessment exercises; academic audits), which was an answer to the increasing costs of mass higher education and the financial crisis of the state (Boer et al. 2008: 41). The regulatory role of the state targeted firstly only the new universities and polytechnics, but later on, also addressed traditional universities with high academic self-governance (ibid). The idea of using ICT as an instrument enhancing "efficiency in education", particularly assessment efficiency, might have had an influence on the emergence of the techno-pedagogical e-portfolio tool-design and practices predominantly used in the UK (objective view on e-portfolio; e-portfolio as presentation instrument for assessed competences of students with less formal qualifications; see RAPID Progress files and Personnel Developing Planning System; see QAA Guidelines, 2001; 2009).

The governance system in the Higher Education sector changed in the beginning of the 1990s with the introduction of the "new" universities (mainly former polytechnics that were upgraded). Whereas the "old" universities have not been affected by the 1988 Education Reform Act, they and the new universities now have external people in their governing bodies (more than half are external) (OECD 2003: 72). UK universities enjoy a high level of autonomy, which has been reduced by the new reforms. In the Executive Boards, half of the representatives bring external expertise and experience in industrial, commercial or employment matters (ibid).

[81] As an example view the Examination Board Guidelines of the Edinburgh College of Art (2004). Available from: http://www.eca.ac.uk/foi/files/ExamBoardGuidelines.pdf [5-8-2011].

5.3.4.3 Alignment of ICT-, R&D- and educational policies

The United Kingdom was a forerunner for integrating ICTs in education and incorporating ICT in their national educational and technology plans. Since the middle of the 1990s, the educational policy has been embedded in a national "e-strategy" that aims to improve the technical, didactical and organisational quality of all educational sectors from an early age onwards (see BECTA-Summary Report 2005: 3: Harnessing Technology Transforming Learning and Children's Services). These goals and support mechanisms for implementing the e-learning strategy and the e-portfolio strategy on the systemic, institutional or private level are discussed in a number of policy reports and strategies (for the collection and archives of it see the section JISC Briefing paper, 2006).

Besides the overall e-learning and national ICT strategy, the UK has been engaged in discussing specific national e-portfolios strategies and instruments for integrating e-portfolios from an early stage. Such initiatives were, for example, the so-called "Burgess Report" (Burgess Report 2004), which envisages all HE students using an e-portfolio in the medium term, with students themselves the crucial translators and conveyors of information about their learning and achievement; the "e-Strategy Harnessing Technology" by the Department for Education and Skills (2005:); the "Review of fair admissions to Higher Education" by the Department for Education and Skills (2004); and the "Blueprint for e-Assessment" by Quality Assurance Agency for Higher Education. This report proposes that by 2009 all awarding bodies should be set up to accept and assess e-portfolios. In summary, the macro-policies in education, ICT and educational research are closely aligned, steered by different actors in education at the macro-level, such as the national skills and quality assurance agency. Furthermore, for fifteen years the UK has financed a national service centre called the Joint Information Systems Committee (JISC; http://www.jisc.ac.uk), supporting ICT-based innovations in education.

5.3.4.4 Multi-level co-operation in a national educational innovation system

The national educational innovation system of the United Kingdom links a wide range of national e-portfolio stakeholders (e.g. assessment steering committees, e-portfolio co-ordinators) and links institutional and individual members in regional e-portfolio networks and community of practices. It supports e-portfolio pilot projects, e-portfolio evaluations and a number of studies researching technical and administrative e-portfolio issues. In the UK the following institutions were responsible for the first phases of e-portfolio integration at national level: the Centre for Recording Achievement (CRA) operates as an Associate Centre of the Higher Education Academy (HEA), with a specific focus on supporting higher education institutions and their communities with the implementation of Progress Files, personal development planning and e-portfolios (CRA, 2009). Membership encompasses major higher education institutions, smaller organisations and individuals, providing a forum for dialogue about policy and practice in the area of e-portfolios. The previously mentioned Joint Information Systems Committee (JISC) and the Quality Assurance Agency (QAA) are involved in supporting ICT-based innovation in all sectors of education by providing material, training and developing guidance and testing software. Most of the national practical support is done by the JISC e-learning innovation association, which is a governmental funded agency responsible for transforming ICT-enhanced education. The association offers a rich source of information about e-portfolio technology, methods and implementation processes (see e-portfolio homepage); it provides practical material and supports the exchange of innovators. Grant attributes a strong influence of the American e-portfolio movement on the United Kingdom, but differences in type and integration have occurred (see Grant S. 2004).

As regards the market of e-portfolio tools Batson (2010) argues that electronic portfolio software that have been used internationally but not in the United States, such as PebblePad (U.K. and Australia) and Mahara (New Zealand), are beginning to penetrate the American market.

> Mahara, in particular, is enjoying its recent integration with Moodle. FolioSpaces, a free electronic portfolio built on Mahara, is making inroads. And traditional electronic portfolio companies such as Digication, Pearson, TaskStream, Desire2Learn, Blackboard, Chalk and Wire, Epsilen, and FolioTek are enjoying a very good year, indeed. Adobe has entered the electronic portfolio market and in terms of authoring and providing standard file formats brings a lot to the ePortfolio market. Other companies that have not been in the spotlight, such as Remote-Learner, which has just become the second North American partner for Mahara after Serensoft, have suddenly come to the forefront.[82] (Batson 2010.)

In UK a close cooperation of individual e-portfolio actors, especially e-portfolio software developers (technical concept) and pedagogical faculties/institutes (pedagogical e-portfolio concept) exists. For example, the e-portfolio software product “Pepple Pad” was developed together with the pedagogical institute of the University of Wolverhampton, UK. This is a product supporting the subjective concept of e-portfolios, focusing on e-portfolio process and training reflection as meta-skills learning.

[82] Blog Batson T. Available from: http://campustechnology.com/Articles/2010/04/07/ePortfolios-Finally.aspx?p=1 [5 June 2011].

5.3.4.5 The organisational characteristics and e-portfolio integration strategies

As mentioned in section 5.3.5.2 there has been a change in governance in the whole Higher Education sector in the UK since the 1980s (Boer et al. 2008). The traditional universities enjoy a high level of autonomy and self-governance, which has been slightly reduced by the educational state reforms (ibid p. 42). However, the newly founded universities, originating from the polytechnics, have less freedom to choose their own institutional strategies. As regards e-portfolios, the idea behind pushing e-portfolios in the new universities was connected to the hope of increasing the quality of teaching of the faculty and ensuring the transfer from the students of the new institutions into the labour market. Therefore the macro-policies influenced the curricula design usually done at the educational institution itself (meso-level). Many universities in the UK offer e-portfolio/PDP guidelines and service centres. Strivens lists as examples the guides accessible at the homepages of the University of Bolton (since 2005), University of Bristol (since 2009) and University of Manchester (since 2010). Moreover, the UK institutions support the e-portfolio integration on different terms. Whereas, for example the University of Bournemouth represents a rather loose form of integrating e-portfolios (free tool choice for students and faculty; self-studying tutorials and e-portfolio guidelines and templates for download), the Queen's University offers a highly (technically) integrated e-portfolio/PDP system, a central unit for technical and pedagogical support and guidelines (more examples are also available in the e-portfolio study by Hornung-Prähauser et al. 2007)

5.3.4.6 The used e-portfolio design and practices

The transformation of the e-portfolio concept used in the last 15 years follows a rather objectivist view focusing on the multimedia presentation of competences and skills, which should enhance the transition periods from one academic study phase to the other or to later employment (e.g. input data for digital curriculum vitae). As early as 1984 the British Ministry for Education funded pilot projects trying to systematically review and collect student´s achievements (New Records of Achievements), used primarily in secondary education for improving the job applications and rates of success (see Dalziel et al. 2006: 371). Based on the so-called Dearing Report, the National Committee of Inquiry into Higher Education, chaired by Sir Ron Dearing (1997), recommended the development of more formal files, the 'Progress Files', which consisted of a formal academic transcript and the ability to record and reflect on personal development planning (PDP). In the years between 1998 and 2001 the technical concept of "progress files" was developed on the didactical concept of personal development planning. The Dearing report (1997)[83] suggested:

[83] National Committee of Inquiry into Higher Education: Higher Education in a Learning Society, 1997, http://www.leeds.ac.uk/educol/ncihe/

> [...] institutions of higher education begin immediately to develop, for each programme they offer, a “programme specification” which identifies potential stopping-off points and gives the intended outcomes of the programme in terms of the knowledge and understanding that a student will be expected to have upon completion; the key skills: communication, numeracy, the use of information technology and learning how to learn and the cognitive skills, such as an understanding of methodologies or ability in critical analysis. (Dearing 1997).

The QAA summarises the idea of an e-portfolio as follows and recommended:

> ...that institutions of higher education, over the medium term, develop a Progress File. The file should consist of two elements: a transcript recording student achievement which should follow a common format devised by institutions collectively through their representative bodies; a means by which students can monitor, build and reflect upon their personal development (National Committee of Inquiry in Higher Education 1997). http://www.qaa.ac.uk/Publications/InformationAndGuidance/Documents/PDPguide.pdf (cited in: QAA Updated Guidelines, 2009: 3)

The national strategy suggested that HEI institutions should include the progress and PDP (personal developing system) (see description in section 5.4.6). The updated version of the QAA guidelines define e-portfolios, better known in the UK as Personal Development Planning (PDP), as follows:

> PDP is a structured and supported process undertaken by a learner to reflect upon their own learning, performance and/or achievement and to plan for their personal, educational and career development. It is an inclusive process, open to all learners, in all HE provision settings, and at all levels. 3 Effective PDP improves the capacity of individuals to review, plan and take responsibility for their own learning and to understand what and how they learn. PDP helps learners articulate their learning and the achievements and outcomes of HE more explicitly, and supports the concept that learning is a lifelong and life-wide activity. (QAA Guidelines 2009: 2[84])

The figure below depicts the concept and the structural elements of an e-portfolio with the focus on personal (study) development planning.

[84] For details see: http://www.qaa.ac.uk/Publications/InformationAndGuidance/Documents/PDPguide.pdf [7-30-2011]

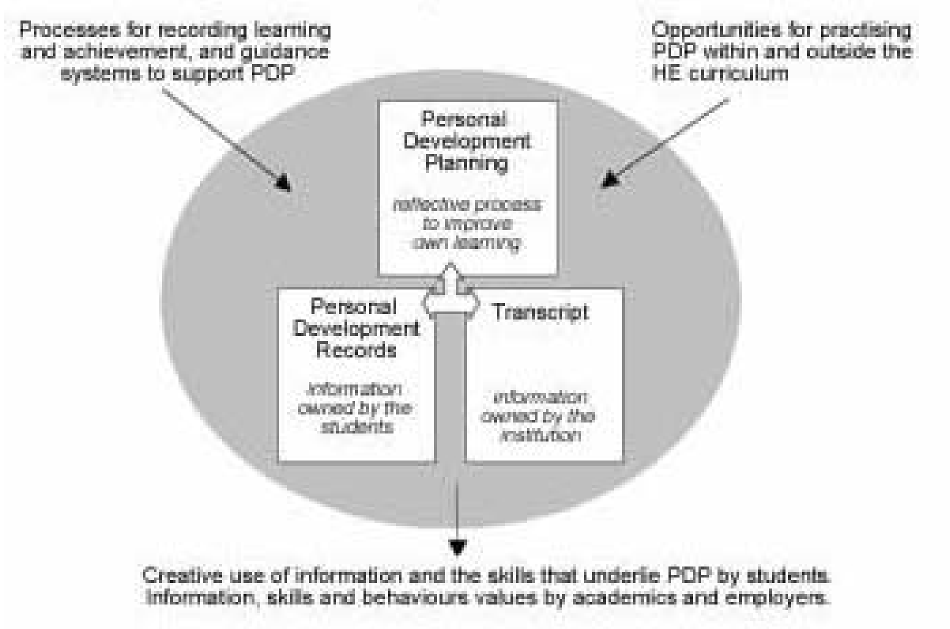


Figure 45: Concept of e-portfolios (PDP) in United Kingdom. Source: QAA Guidelines 2009

Typical elements of an e-portfolio in UK are: a digital curriculum vitae (digital CV), learning biography (development focus), key skills, formal qualifications/awards (appraisal), action plan (learning diary), study results (portfolio content), documentation of feedback and meeting with personal tutor/ coach (see Hornung-Prähauser et al. 2007). As a recent survey found out, although all those guidelines exist, there is still great confusion about which concept to use (Strivens 2010).

5.3.4.7 Conclusions: Interaction patterns in the case of a systemic e-portfolio integration

The case of e-portfolio integration in the United Kingdom is a good example in which the alignment of eduational policy and IT and innovation policy has enabled a high level of systemic integration at all three levels of the national educational system. As the studies report more than half of the universities (especially the "new universities") at least have a rough idea what and how to use the national wide portfolio approach. Sometimes, esp. in schools, the electronically enhanced e-portfolio approach has been used to dvelop ICT and media skills (which is an unintended effect of this innovation). The e-portfolio integration process was initiated top-down, which is not so surprising, given the fact, that the external influences from the Anglo-Saxon e-portfolio movement, the strong English speaking IT market and the type of e-portfolio design and practise. The national e-portfolio strategies promote a rather objectivist e-portfolio design and practise, which has its reasoning on the motivation of e-portfolio policies at the macro- and meso-level. Due to the changing governance system in the sector of Higher Education, it was hoped that a nationally uniform Personal Planning system would ease the student transfer from one university to the other. Effects and co-operation to other sectors occur, for example e-portfolio integration to regions (see project in Wales: Career Wales Online).

5.3.5 Case 2: Multi-level dynamics of e-portfolio integration in Higher Education in the Netherlands

5.3.5.1 Techno-societal infrastructure

In the European ranking of the national techno-societal infrastructure, the Netherlands ranks among the best performing countries in Europe (European Commission 2009: 192). The national-wide Internet-coverage and provision of broadband enables a high percentage of Internet usage (e.g. 83% of the population access Internet services weekly, 67% almost daily) and also of innovative web-based services. Speeds are reported as generally high, the Internet-coverage as almost complete and mobile connectivity well above average (second highest proportion of Internet household connectivity and broadband households' connectivity in Europe). The EU-report states that the national level of e-skills is above average (ibid). However, it is interesting that the use of ICTs for education does not meet the same high standard. "Netherlands is also leading the way in the take-up of Internet services, with well above average rates of use for all but one of the indicators: seeking information for the purpose of learning" (see European Commission 2009: 192).

5.3.5.2 Educational culture and Higher Education governance systems

Due to the history of the country, involved in religious conflicts and challenges with religious refugees some authors describe the educational culture in the Netherlands as driven by the strong mindset of "tolerance and freedom" (Goote & Lynch 1961). In school education, a prominent strand of reform-pedagogy is derived from the educational scientist Maria Montessori, who in her later years lived and worked in the Netherlands. Thus the concept of "teachers as coach and facilitator" and the "student as self-directed individual" is a well known concept in the Netherlands educational discourse. As regards the Higher Education governance system, there has been a change from strong state interventions to the introduction of a more loosely regulated system. In the late 1980s, the Dutch government introduced a concept, called "steering from a distance", in which the government provides framework conditions and output oriented goals (OECD 2003; Boer et al. 2008). Academic institutions should increase their self-governance with reduced state regulation. It is against this context that the Dutch e-portfolio movement could emerge. On the hand, a well-known pedagogical concept and a national and institutional academic governance allow experimentation with a new approach. The technological possibilities for e-portfolios in the late 1990s/beginning of 2000 paved the way for large-scale e-portfolio pilots. The interest in e-portfolios was based on the need to structure the new universities and the pedagogical objective to introduce a competence-oriented education in universities of professional education, institutions that were newly founded in the beginning of the second millennium. The emphasis is placed on student development and recognition of non-formal learning processes and outcomes enabling the transition into the practical job market.

5.3.5.3 Alignment of ICT, R&D and educational policies

The Dutch government aligned their ICTs and digital policies at the macro-level in the national ICT agenda (2008–2011) and formulated national policies and objectives around five areas: eSkills, eGovernment, interoperability and standards, ICT and public domains, and services innovation and ICT (European Commission 2008: 176). The national e-portfolio strategy has been embedded in the national e-learning strategy and support mechanisms and coordinated by a specific national agency called the Surf Foundation. Although the multiplier organisations in the general e-learning field support and advance the integration of e-portfolios (see the initiatives of the SURF foundation on e-portfolio in the Netherlands Surf, 2004), no overall national e-portfolio strategy targeting all institutions can be found. In the current strategy on "ICT investments 2011–2014", e-portfolios do not get special attention (Riksen 2010).

5.3.5.4 Multi-level co-operation in a national educational innovation system

SURF is the "collaborative organisation for higher education institutions and research institutes with the aim of breakthrough innovations in ICT. SURF provides the foundation for the excellence of higher education and research in the Netherlands.The organisation SURF Foundation (SURF) evolved in response to government policy issues in the 1980s, with Dutch universities challenged to develop and introduce ideas associated with the use of ICT in higher education. SURF NL Portfolio is a special interest group (SIG) within SURF, established in 2004, which aims to "combine, share and develop further the knowledge in the field of digital portfolios in higher education" (SURF NL 2008). Currently, the SURF NL Portfolio team coordinates research projects across the higher education sector to explore the potential for ePortfolios in learning and assessment and to support academics with scalability issues as they move out of the experimental phase of ePortfolio practice to face the challenges of implementation at the institutional level. International collaboration is also a key focus of NL Portfolio activities. A team of six community members manages the CoP with funding for logistical support provided by SURF. A limited amount of funding is offered for a number of small projects that draw on the distributed enquiry process to resolve a range of questions associated with ePortfolio practice. Knowledge is shared via the NL Portfolio portal, publications, seminars and congresses" (see Surf Homepage, self-description).

5.3.5.5 The organisational characteristics and strategies for e-portfolio integration

The Dutch educational sector has experienced a new development in the emergence of new universities that are focused more on a competence-based vocational education. The idea of integrating e-portfolios was to enhance the planning process of a new study and to develop a new culture of assessment (Veugelers & Aalderink 006). In 2004 the NL Portfolio association of the SURF Stiftung coordinated the e-portfolio pilot work and initiatives in the whole sector. As has been mentioned before, the institutional e-portfolio integration was enabled by the phase of new emerging organisational structures due to the reforms, especially for new universities. For example, the university of applied science "INHOLLAND" was founded by merging four other high schools, namely Alkmaar, Diemen, Haarlem und Ichthus/Delft in 2002. Now a campus distributed over nine cities, with 48,000 students and staff has been founded. The expectation was that by means of ICT the administrative and pedagogical challenges (quality teaching, study guidance etc.) for the huge amount of students could be made easier. The university INHOLLAND[85] has realised the digital portfolio with the Microsoft-Sharepoint system and aims to develop a competence-based study (see Hornung-Prähauser et al. 2007).

5.3.5.6 The used e-portfolio design and practices

The models presented below shows a common approach in the Netherlands to the e-portfolio topic from different perspectives in an integrated and balanced way, paying attention to technical, educational and organizational issues.

Figure 46: e-portfolio concept, the attention areas for educational innovation and the role of the support; University of Amsterdam 2005. Based on the model by Van Tartwijk (n.d.. Source: Aalderink and Veugelers (2005)

---

[85] INHOLLAND was formed by merging of Hogeschool van Arnhem en Nijmegen, Hanzehogeschool, Hogeschool, Rotterdam, Hogeschool Utrecht, Technische Universiteit Eindhoven, Universiteit Utrecht, Universiteit van Amsterdam, Vrije Universiteitt Amsterdam, Christelijke Hogeschool Windesheim sowie Wageningen Universiteit. See more at: http://www.inholland.nl/inhollandcom/

The figure below shows the process and elements of an e-portfolio concept of the Dutch approach:

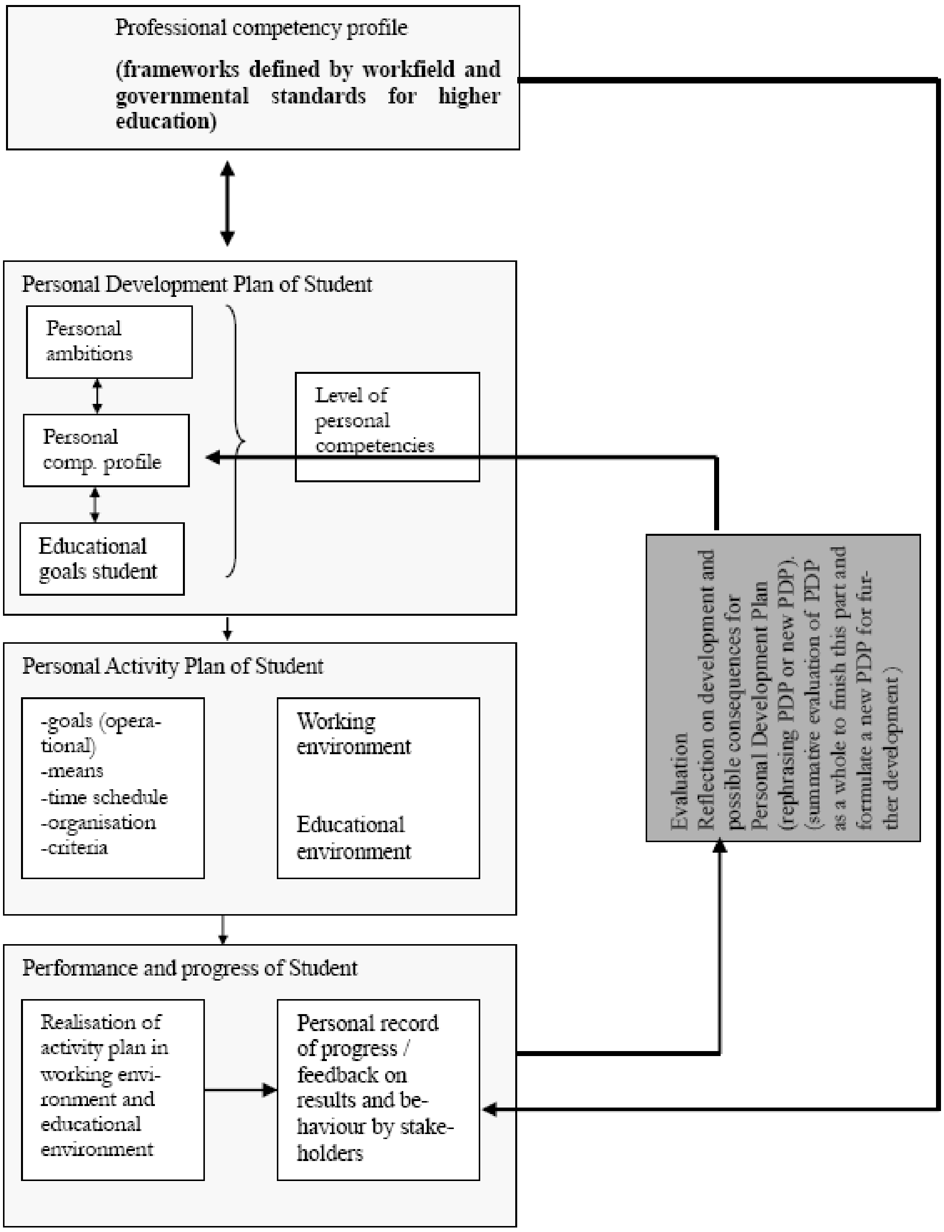


Figure 47: Concept of competence based portfolio.

Source: Aalderink (2007; 2006)

The Dutch e-portfolio concept follows a rather more subjectivist approach to personal development planning, self-assessment and the pursuit of installing a new learning culture. This is eased by the fact that the integration of e-portfolios was intensively started in the new universities (hogheschool), with new management structures and less established educational cultures and assessment traditions. The new universities are oriented more towards vocational training and employment and thus the e-portfolios concept reflects that.

5.3.5.7 Conclusions: Interaction patterns in the case of e-portfolio integration as organisational innovation

The case of e-portfolio integration in the Netherlands serves a good example in which the alignment of eduational policy and IT and innovation policy at the institutional (meso) level has worked out successfully. The results of the case descriptions indicate that in the Netherlands there is a strong connection on the general e-learning issues, however, as regards the specific concept of e-portfolios, the co-operation is more loosley organised. The Netherland did not work out a national e-portfolio strategy. This has been done by those universities which aimed at redesigning their core concept of academic teaching, especially in the new academic colleges. What seems interesting ist the close connection to the international e-portfolio community of the e-portfolio multipliers to Australia and USA, although the techno-pedagogical design and practise is oriented to a more subjectivist view on e-portfolios. The main motivation has been to introduce the e-portfolio concept in order to develop self-organising study skills for the new universities (e.g. Inholland university). Due to the lack of national support many e-portfolio pilot-projects seem to have come to a halt (e.g. no e-portfolio investment strategy in the national e-learning plan 2011-2014). We will need to observe the future of e-portfolios in the Netherlands, being primarily based on bottom-up approaches.

5.3.6 Case 3: Multi-level dynamics of e-portfolio integration in Higher Education in Austria

5.3.6.1 Techno-societal infrastructure

In Austria the interest in e-portfolios emerged during a time in which the IT market and the Austrian government pushed ICTs for societal infrastructure and for application in applied IT domains, such as e-culture, e-health and e-learning. The report on digital competitiveness ranks Austria in the middle of the EU-27 (European Commission 2009: 140). In the period between 2005 and 2009 it is reported to have enlarged its "connectivity, ICT usage by households, enterprises and government" (ibid). The Austrian government made many efforts to develop e-Government services, especially for supporting the social service services, such as the digital social security card ("e-card") to be used for authentication in both public and private transactions. The percentage of wireless mobile use is reported to be increasing, whereby the development was accelerated by the spread of the 3G telephone system and private households purchasing wireless laptops. On the one hand, as regards the use of the Internet, Austria is among the top ten players in Europe (ranked ninth with 66% of the population regular Internet users; for at least once a week and frequent (almost every day) (2009: 140). On the other hand, ICT skills and access to the Internet are not evenly distributed in Austria. As is the case in other countries, Austrian Internet users prefer daily services (e-mail, looking for information on goods and services, online shopping and seeking health information, but they do are not interested in a new Internet TV service, seeking information with the purpose of learning, downloading video games or watching/downloading films and music (ibid).

5.3.6.2 Educational culture and Higher Education governance systems

The Austrian academic culture and governance system has the same roots as Dutch universities, namely, the ideal of the Humboldtian university that can be traced back to the reforms of Wilhelm von Humboldt in Prussia, founder of the University of Berlin in 1810 (Anderson 2010). In this longstanding university tradition the teaching and research activities of faculties were intertwined with the objective of finding "impartial truth". This approach is characterised by the pursuit "intellectual freedom in research and teaching, university autonomy, the growth of independent disciplines with their own standards and priorities, and internationalism" (ibid). In the late 1980s throughout Europe new thinking on Higher Education governance systems emerged, which favoured a more applied research and vocational form of education. The reforms in Austria came later, but also encompassed a change towards more "institutional autonomy, including new organisational forms of leadership and governance; expansion and diversification of higher education; harmonisation of degree structures and programs; marketisation, including privatisation, financial management, and entrepreneurial activities; and the quality movement, including measures for accountability, performance and accreditation" (Sporn 2003: 34). In particular, the movement towards more quality in academic teaching and support for developing student`s meta-competence for self-organising their studies have been important concepts influencing the early e-portfolio pilots in Austria (Zwiauer & Kopp 2008).

5.3.6.3 Alignment of ICT, R&D and educational policies

In Austria the agenda for how to use ICTs in the national educational system is split between a minimum of three ministries (Ministry for Education, Ministry for Science, Ministry for Infrastructure and Traffic). For many years, the Ministry of Education has observed and pushed the development of ICT use in schools not only for administrative purposes, but also for supporting teaching and learning processes. Thus, a national e-learning strategy is worked out regularly and e-portfolios and web 2.0 play a prominent role in it (see concept a national e-learning strategy eFit by the Ministry of Education[86]). Such a coherent e-portfolio strategy for all Austrian universities has not been feasible, because of the autonomy of individual universities. The policies for the ICT as infrastructure are worked out and pushed by the government and related science and infrastructure ministries (R&D and Technology..). It is interesting that in Austria the use of Internet technologies is being pushed by a private association, however, the members thereof are the big players in the telecom business such as A1, Compass Verlag, HP, IBM, Orange, Raiffeisen Informatik Consulting, Microsoft and T-Mobile (Förderverein Internet[87]).

5.3.6.4 Multi-level co-operation in a national educational innovation system

The co-operation between the Austrian HEIs is rather loose, however (old) universities and applied universities have co-operated for many years in developing and informing about their e-learning strategies in the association for new media, called "Verein Forum Neue Medien in der Lehre Austria" (fnm-austria). The association was founded in 2003 as a support project for integrating ICTs for academic teaching and learning in universities. This project can be seen as a service provider to universities to exchange experiences, support joint content development or provide legal information on e-learning issues.[88] The members of the association meet twice a year (fnma forum). The association supported the e-portfolio implementation project from January 2007 to December 2008. The Austrian e-portfolio group engaged itself in the joint e-portfolio association, encompassing representatives from all educational sectors (schools,

86 For english version see here: available from: http://www.bmukk.gv.at/medienpool/17141/konzept_en_kurz.pdf [2 August 2011]

87 available from: http://www.Internet offensive.at[2 August 2011]

88 For history on fnma: see http://www.fnm-austria.at/verein/Historie/

universities and adult education), e-portfolio research, ministries and technology providers. However, in the meantime this association is not really active anymore.

5.3.6.5 The organisational characteristics and strategies of institutional e-portfolio integration

It is difficult to discuss the general organisational characteristics and strategies of Austrian e-portfolio integration, because at the present status, the use of e-portfolios in Austria is done on a very low systemic integration level. In general, the support for e-learning is well-organised in Austria, in specific "e-learning co-ordinating" centres, combining technical and pedagogical support for using ICTs in practical teaching and research. However, e-portfolios are used in single academic courses and in such cases there is full support for the departments running the course. The Danube University Krems offers its students an e-portfolio system (Mahara), training and support. In the teacher trainings institutions (new universities), e-portfolios are very important, however, the support is offered by the individual universities due to a lack of national co-ordination (Hornung-Prähauser & Geser 2010).

5.3.6.6 The used e-portfolio design and practices

In the Austrian e-portfolio pilots two types of e-portfolio design and practices emerged: the learning and process portfolio at the Donau-Universität Krems, Universität Salzburg, Universität Wien, Fachhochschul-Studiengänge Burgenland) and the competence and presentation portfolio (Universität Graz, Universität Klagenfurt) (Zwiauer & Kopp 2008: 62). E-portfolios are used in traditional lectures, are embedded in the study plan and curricula and even in joint-programmes. In the last case the e-portfolio concept is connected to the envisaged competence acquisition, which in the case of post-graduate courses is relatively clearly defined and not subject to individual study choices (Donau-Universität Krems and Fachhochschul-Studiengänge Burgenland, Universität Wien) (ibid).

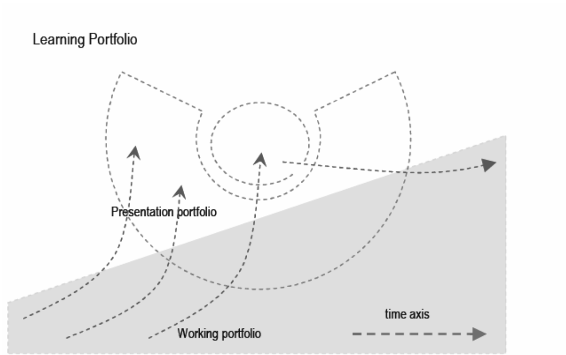


Figure 48: Concept of learning portfolio for individualised learning.

Source: Dorninger & Schrack (2008.)

5.3.6.7 Conclusions: Patterns of interaction and challenges in the case of e-portfolio integration as techno-pedagogical innovation

In Austria, we cannot really speak of a national e-portfolio integration, because the Austrian innovator in the e-learning movement, have already finalised the first piloting and testing of how to use e-portfolio in academic teaching. What does become evident is the circumstance that there is a strong(er) interest for e-portfolios in the new academic initial teacher training colleges than using it for enhancing traditional academic studies and courses. Some universities of the pilot sample report from regular use of e-portfolios accompanying post-graduate courses within the department, (e.g. the Danube Universities-Department für Interaktive Medien und Bildungstechnologien). In all other universities it is up to the individual faculty to decide about using the concept or not. Up until now it also seems that it has not been clarified among the e-portfolio lead users, which conceptual e-portfolio-approach will dominate on a national scale. This is still a process to discuss and work out between the multipliers in the e-learning innovation system. In the future it will be interesting to observe the “social closure” phase of e-portfolio software and didactis development. However, it will remain to be seen, whether the Austrian universities can move to the next phase of a national e-portfolio integration process soon. In my view, due to the strong financial restrictions in the university sector, the necessary support mechanisms for early innovations (e.g. pedagogical and organisational training and ICT support) will not be offered by macro- or meso-level soon and that will make a national integration rather difficult.

5.4 Framework evaluation and discussion

5.4.1 Comparative results of interaction patterns resulting from the framework systematic

5.4.1.1 Overview of different interaction patterns

Having used the proposed integrative, multi-level framework for systematically describing the dynamics of the e-portfolio integration processes in the Higher Education sector in three European countries, the table below collates the results of that exemplification.

Case characteristics	Case 1 United Kingdom	Case 2 Netherlands	Case 3 Austria
Academic culture	Anglo-American tradition	Continental-European tradition	Continental-European / Humboldt tradition
E-portfolio integration experience	Lead-user Very experienced	Early adopters Experienced	Early adopters Newcomers
Innovation change level	Towards systemic innovation	Towards organisational innovation	Towards techno-pedagogical innovation
Determinants for ICT-based innovation			
National ICT and Internet infrastructure as techno—societal background	Best developed EU-Ranking Largest European market value; heterogeneous e-portfolio vendors	Well developed EU-Ranking: Medium European market value; heterogeneous e-portfolio vendors	Medium developed EU-Ranking: Small European market value; heterogeneous e-portfolio vendors
Educational culture and Higher Education governance system	Traditional assessment (standardised and competitive assessment) Loosely regulated to more state regulation	Change from traditional to competence-based self-assessment (individualised assessment) From state regulation to more private governance	Traditional assessment (standardised assessment) From state regulation to more private governance
Alignment of national ICT policy and e-learning policy	Funding of e-portfolio pilots good public implementation support Strong aligned: labour market orientated; quality of education	Funding of e-portfolio pilots; no public implementation support Medium aligned: labour market and study support orientated; new competence assessment	Funding of e-portfolio pilots; no public implementation support Weakly aligned: oriented to support personal study guidance
Intensity of co-operation among actors at all levels of	Intensive co-operation among stakeholders	Intensive co-operation among stakeholders	Medium level of co-operation

the educational system			
	Strong international collaboration	Medium international collaboration Strong national collaboration; loose international coop.	Minor international collaboration Loose national co-operation; no international coop.
	Strong e-learning community	Strong e-learning community	Strong e-learning community
Characteristics of institution and adaptability to change: organisational structure and autonomy	Sectoral e-portfolio integration beyond pilot phases in traditional and new universities	Sectoral e-portfolio integration beyond pilot phase only in new sector of HE (hogheschools)	E-portfolio integration in pilot phases in traditional and applied universities
	Formal e-portfolio policies and quality assurance; Top-down approach	Informal e-portfolio policies ; no quality assurance Bottom-up approach	No formal e-portfolio policies ; no quality assurance
	Central e-portfolio support structures (JISC))	Central e-portfolio support structures (SURF NL)	No central e-portfolio support structures
Type of E-portfolio design and practise	Objectivist e-portfolio approach: focus on presentation of skills, meta-skills and transparency of qualifications Focus: presentation portfolio	Subjectivist e-portfolio approach: Support for personnel development and study planning Competence portfolio	Heterogeneous e-portfolio view; not yet clear Mix between presentation and competence portfolio

Figure 49: Comparison of interaction patterns of e-portfolio shaping and integration in the HE sector.

Although all countries rank high in the information society index and all of them have a well-developed national IT infrastructure and IT-skilled "academic population", the e-portfolio integration processes have been different.

In the first case (UK), there is a strong interaction between the very well developed ICT techno-societal background. The strong alignment of the IT policies with the e-portfolio policies and the strong collaboration among all e-learning and e-portfolio actors of the educational innovation system has led to an almost systemic integration of e-portfolios in Higher Education. However, as Strivens (2010) points out:

> "In summary, the concept and vision of PDP appears to have become embedded in thinking about higher education policy in the UK. Associated practices have developed internationally, with a range of aims from the full development of individual potential or the lifelong upskilling of the national workforce. E-Portfolio technologies continue to spread, with many institutions seeing e-Portfolio provision for all students, and staff, as a strong marketing tool. Still, many questions remain, particularly around achieving the widest possible learner engagement with both processes and supporting technologies. The field remains one with enticing visions and possibilities alongside many frustrations in implementation; rich in opportunities but with much work still to be done before they are fully realised". (Strivens 2010: 17-18)

In the UK, the educational oriented paper-based portfolio policy preceded the technological e-portfolio policies. The pedagogical concept of personal development planning and assessment guides had been already proposed and implemented before the e-portfolio technologies emerged in the UK. The PDP concept emerged in a phase of changing institutional governance of the Higher Education sector. Therefore, the electronic support of the PDP process was oriented especially to support the assessment and regulation of students at the "newly" established universities and colleges. All actors of the national educational system were interacting with each other. The national educational policy enabled the funding of pilot-implementations and also research of both pedagogical and technical e-portfolio concepts (e.g. JISC evaluation projects). Many institutions developed general e-portfolio support structures and national guidelines and standards were worked out. However, although, a larger proportion of institutions in the UK have integrated the e-portfolio concept, the institutions do not all follow the same strategy. The strong macro-influence favours the objectivist approach on e-portfolios (e.g. the support of a digital CV and standardised transcripts easing the change from one institution to the other). However, it seems that these approaches to ICT and pedagogy only re-enforce what is done with the paper-based e-portfolio concept, but does not take account of the potentially possible enhancement. However, it may be also a danger of worsening the paper-based portfolio by using a contradicting ICT approach. All cases work on the bases of very intersting and active e-learning and e-portfolio communities, especially as regards the UK and NL with strong connections to American and Australian partners. Did change occur from one sector to other sector? The sector of academic teacher training seems the area, in which the mix of policies and guidelines (e-portfolio as part of the final exam; or as part of summative training of student teacher, see OECD-CERI study on European ICT in student teacher training.

In the second case, the Netherlands, there seems to be a weaker alignment between educational and IT policies at the macro-level. There has also been an active nationally steered e-learning and e-portfolio programmes, centrally supported by a national e-learning agency (SURF NL), but the universities piloted and implemented a very wide range of different e-portfolio concepts and tools. In contrast to the UK, the Dutch Higher Education sector has experimented individually, with a less standardised-concept of e-portfolio shaping and integration. The institutions favour a more subjectivist approach of the e-portfolio concept focusing on study guidance and development of self-organising competences. The last issue has been important for the Netherlands; the e-portfolio integration has taken place in a period in which changes occurred in the institutional governance of HEI institutions. The new universities, especially those that were merged into a large system (INHOLLAND) used the e-portfolio concept to integrate the diversity of student competences.

In Austria, the e-portfolio integration lags behind the other two countries. The current status of e-portfolio integration in Austrian HEI is still in the phase of piloting. The use of the pedagogical concept (paper and IT-supported) is accepted in the teacher-training colleges (now universities) as a means to clarify/reflect on teacher competences for teacher students. There is a strong e-learning community, but little support and funding from macro-level actors. The e-learning agenda in the Higher Education sector in Austria is not institutionalised in, but split up among many ministries (science, education, infrastructure ministry). Although in Austria the schools formulate explicit e-portfolio strategies (as support for individualised learning), the universities also have diverging interests and approaches. Individual e-learning innovators were very active in e-portfolio. However, due to lack of national macro-support, problems arose as soon as the e-portfolio was used in more than one course. In Austria mainly two concepts are represented: a subjectivist approach for study support in post-graduate courses (see Danube University; Vienna University) and competence-based portfolios in student teacher training (e.g. University of Innsbruck).

5.4.1.2 Similarities

It becomes apparent from the case descriptions that at the end of the 1990s and the beginning of 2000, actors at all levels of the three national educational countries had been seeking a role for e-learning applications. In all three countries, lead-users from active e-learning communities were among the first to experiment with the electronically enhanced e-portfolio method, in many cases within publicly funded R&D or e-learning transfer projects. These actors, such as e-learning experts, students, teacher trainers, educational technologists, e-learning strategists etc. played an active role in the "social closure" process of e-portfolio adoption. However, the expectations that the technical implementation of e-portfolio software will simply lead to the acquisition of more self-organised learning skills, has not been met, as e-learning experts from all countries have reported (Strivens 2010 (in the case of UK); Veugeler 2010 (in the case of the Netherlands; Zwiauer & Kopp 2008 (in the case of Austria). Furthermore, it is interesting that in all three cases the e-portfolio processes have been taking place during a period in which the national and institutional governance systems in the Higher Education sector have been changing. The more the academic colleges and universities have gained institutional autonomy (e.g. budget, personnel etc.), the easier it has become to integrate e-learning initiatives (in the case of the Netherlands and Austria). In the Netherlands, the e-portfolio implementations were sometimes used as an instrument to redesign the university processes (see the Dutch example of the college-merger INHOLLAND). In the case of the UK, the governance system changed from less state influenced to more state influenced; however, the individual universities still have a high level of autonomous status (see Boer et al. 2008). This can be seen also when comparing the levels of institutional autonomy.

Institutions are free to:

	1 Own their buildings and equipment	2 Borrow funds	3 Spend budgets to achieve their objectives	4 Set academic structure/ course content	5 Employ and dismiss academic staff[2]	6 Set salaries[2]	7 Decide size of student enrolment[3]	8 Decide level of tuition fees
Mexico	●	◗	●	●	●	◗	●	●
Netherlands	●	●	●	◗	●	●	●	◗
Poland	●	●	●	●	●	◗	●	◗
Australia	●	◗	●	●	●	●	◗	◗
Ireland	●	◗	●	●	●	◗	●	◗
United Kingdom	●	◗	●	●	●	●	◗	◗
Denmark	◗	●	●	◗	●	◗	●	◗
Sweden	◗	◗	●	●	●	●	◗	
Norway	◗		●	●	●	◗	●	
Finland	◗		●	◗	●	●	◗	
Austria	◗		●	●	●	●		
Korea (national – public)			◗	◗		◗	●	
Turkey				◗	◗		◗	
Japan (national – public)				◗	◗			

Legend: Aspects in which institutions:
● have autonomy
◗ have autonomy in some respects (see the Appendix for details).

1. Data in Table 3.1 are based on responses to a 2003 survey of university governance by members of the OECD's Institutional Management in Higher Education (IMHE) programme. Participation in the survey was voluntary, responses were not received from institutions in all OECD countries, and the IMHE members do not necessarily represent the full range of higher education institutions in the countries concerned. Institutional responses were cross-checked for consistency against each other, and published sources and national experts were consulted in preparing the table. However, the table shows a simplified picture, and countries vary in many detailed respects, as described in the Appendix. Countries are ranked in order of the number of areas in which universities reported autonomy, and alphabetically where the number is the same.

2. "Employ and dismiss academic staff" (column 5) and "Set salaries" (column 6) include cases where any legal requirements for minimum qualifications and minimum salaries have to be met.

3. "Decide size of student enrolment" (column 7) includes cases where some departments or study fields have limits on the number of students able to enrol.

Figure 50: Autonomy in an organisation from macro-level.

Source: Education Policy Analysis (OECD 2003: 63)

In the beginning of the e-portfolio emergence phase, all the e-portfolio innovations used e-portfolio software or services developed by American e-learning companies or research centres. This is somewhat natural for the UK, because of the low language barrier. However, the Netherlands and Austria also first experimented with "imported" stand-alone e-portfolio tools (e.g. Open Source Portfolio or ElGG). In the beginning of the technological emergence, stand-alone e-portfolio tools were developed, mainly as open source software. As the market matured, the providers of learning-management systems tried to incorporate some of these stand-alone-tools into their systems (e.g. Blackboard – e-portfolio module; Moodle – ePortfolio plug-in; or the merger of the Australian e-portfolio stand-alone-tool "Mahara" with the learning management system "Moodle" (now called Mahoodle). In parallel, many research projects by educational technologists tried to invent new systems, meeting the demands not only of an institutional e-learning policy, but also of the faculty and students, as pedagogical concept. Thus, a new generation of e-portfolio software emerged, in the meantime, also under the premise of new Web 2.0 possibilities (e.g. the blog as e-portfolio).

All countries have an educational innovation system and strong e-learning community in which the relevant lead-users have been heavily engaged in e-portfolio piloting. However, both the complexity of the tools, and the new objective of teaching are barriers for a system-wide integration. Two countries have central e-learning support centres (JISC/SURF NL); in Austria the responsibilities are strictly separated for schools and universities. For universities a private association (FNMA), initiated by the universities themselves, took up the issue. They serve as an important link to the educational innovation system.

5.4.1.3 Differences

The intensity of alignment of IT and educational/HEI policies differs among the three cases. Whereas in the United Kingdom, with the longest experience, the interactions from policy levels to individual institutions have been very strong (e.g. Quality Assurance Agency for PDP/e-portfolio; nationally standardised guidelines and templates funding), the interactions in the other two cases have been rather informal and the interactions were loosely structured.

The comparison of the interaction patterns in the emergence and integration process shows that, despite the same external influence of the international e-learning market pushing educational technologies, and, despite a rather even techno-societal background in all three countries, in all three cases a different concept of e-portfolio design and practise has emerged. The UK, characterised by an Anglo-Saxon educational culture assessment tradition has been the forerunner in Europe and work with the objectivist e-portfolio concept. The Netherlands, characterised by a Continental European/reform pedagogical tradition follows the subjectivist e-portfolio approach. In Austria, characterised by a Humboldt academic tradition, a mix of concepts has emerged. Regardless of the educational tradition, in teacher training institutes the subjectivist approach is favoured, maybe due to the fact that young teacher training students should acquire reflection skills.

5.4.1.4 Conclusions

The overview of the different interaction patterns makes it clear that policy makers at macro-level and meso-level should develop support and policies fine-tuning with demands from the micro-level. The policy makers should find a good balance between a bottom-up and top-down approach: on the one hand, the case of the UK is a good example, in which the top-down approach has had systemic implications; however, this has been only appropriate for launching the objectivist e-portfolio design and practice. On the other hand, a bottom-up strategy, as was tried in the Netherlands and in Austria, meets the integration of a more subjectivist e-portfolio design and practice. The more the pedagogical objectives move in the centre of an e-portfolio integration process, the more need there is to integrate the interest and individual behavioural adoption strategies of the users at the micro-level. The integrative, multi-level framework can help to systematically analyse the position of a national educational system in its e-portfolio orientation.

5.4.2 Practical challenges using the framework

5.4.2.1 Operationalisation of framework components

The first challenge in using the integrative, multi-level framework lies in the mapping of the three sets of determinants with meaningful characteristics and for which an empirical researcher can observe or collect reliable and significant qualitative and/or quantitative data. The application process made evident that, with the macro-level analysis, the quantitative figures on ICT in the educational context (e.g. number of computers in the lecture hall; number and type Internet access in universities, rate of usage during lectures, in study programmes etc.) is of little relevance to official statistical institutions producing IT and/or educational relevant macro-statistics such as the OECD (Education at a Glance, 2005–2010) or the European Commission (Annual Information Society Report 2009). The statistic support service "Eurydice" of the European Union provides country key-facts for ICT in education, but only for the context of schools E-portfolio investments are not collected at all.[89] E-learning statistics suffer from the inadequate definitions and diverse approaches not yet fully understood and accepted (see also chapter 2 Definitional problems in e-learning). It is very difficult to grasp the complexity of an ICT-based process and its changing dimension even for quantitative researchers and professional data collectors.

Critical pedagogic thinkers argue that the adoption of e-learning is connected to its relation with the general development of the IT-market. The e-learning and e-portfolio vendor market can be described as a market with a few large system providers, many proprietary university knitted systems and a few open-source systems

[89] For Eurydice services see: http://eacea.ec.europa.eu/education/eurydice/documents/key_data_series/129EN.pdf [03-05-2011]

(such as Mahara and Mahara-Moodle; see Bateson 2010). This is an argument that still has to be validated by sound market studies.

5.4.2.2 Amount and precision of (historical) survey data

The number of determinants for the proposed integrative framework has constituted another problem. Given the large number of determinants, it has not been easy to collect survey data that related to the same period of time. Moreover, given the fast-changing technological development of ICT and Internet products and services, it has been difficult to provide a retrospective look at e-portfolio emergence phases.

5.4.2.3 Measurement of intensity of interactions

Moreover, the challenge of the integrative framework is to identify the core influential variables that enable policy makers to care for “favourable conditions” of sustainable, valuable ICT-based integration. It is the identification of the boundaries between the three levels that could help to formulate interlinked ICT and sustainable policies and work out strategies and implementation instruments. Moreover, due to the focus of the work, other linkages to the system-external influence, such as legal regulations of e-portfolio data-protection, could not be taken into account.

5.4.3 Theoretical challenges using the framework

The exemplification of the theoretical model with e-portfolios has illustrated that the role of ICT in education and the interdependence with the emergence patterns of technological innovations cannot be explained by linear macro or only by micro-level-theories. The experience with the first attempt to apply such a multi-level framework to a concrete, empirical phenomenon makes it evident that there is still need for more theoretical exploration of the dynamics of ICT-based innovations.

The Unified Theory of Information helps to clarify the complexity and dynamics of the background of the techno-sphere of the global and national society. However, it would be interesting in the future to better conceive the intensity and directions of the interlinked, changing effects. The organisational management and technological sociology helps to explain the needed intensities of the institutional networks or individual actors co-operating while shaping a new ICT-based innovation. However, the innovation network systems theories need to research further theoretical approaches and settings for analysing co-operative behaviour and strategies not only at the macro-level, because the e-learning stakeholders are involved on each level of a national educational system. For example a pedagogical researcher and software developer can be supported as “co-inventor”, teachers and academic staff can be trained as early adopters and “co-designers”, policy makers should be involved in providing the framework conditions for e-learning. An educational innovation system should monitor its innovation activities. However, the analysis of all three cases has made it clear that more research is needed on who should monitor what in an educational innovation system so that it provides added-value to the societal demand of the users.

Educational science could spread its interest from pure ICT-impact studies to research what identifies the boundaries and dynamics at the edge of the user-group at the micro-level. The introduction of an e-portfolio concept has an impact on the individual learner, but also on the faculty and peers who are involved in the assessment process, and, on parents and future employers who are partly the receivers of e-portfolio information and assessment.

Chapter 6: Summary and outlook

6.1 Results of research work

The thesis has dealt with systemic ICT-based innovations, especially e-portfolios, in education, because this type of e-learning innovation has a special character. It can be understood as a techno-pedagogical innovation, and, if integrated on a systemic scale, it is not only adopted by a wide range of actors, but also deeply embedded in the structures of an educational system, and, has boundaries even to other subsystems, such as the economy (job market). Empirical evidence shows that the shaping and integration process of e-portfolios is a very dynamic process taking place in a complex national educational system. The thesis has aimed to:

- Provide a systematic, interdisciplinary synopsis of the theoretical approaches on ICT-based innovations relevant for the societal subsystem of education from different disciplines of the social sciences (communication and media science, sociology of technology, education/media pedagogy, economics and organisational studies) and the natural sciences (computer sciences),
- Analyse the theoretical strands with regards their aptness for advancing research in the field of e-learning (strengths, limitations, contradictions) and investigate relevant determinants influencing the systemic integration process at the macro-, meso- and micro-levels of an educational system, and
- Develop a theoretical multi-level model of the determinants that shape the system-wide integration of ICT-based innovation.

The last objective addresses especially the questions of how we can theoretically explain the shaping and emerging process of such systemic ICT-based innovations, and how should a new theoretical analytical framework for researching the interdependencies of the different levels (macro-meso-micro) of systemic ICT-based innovations in education look?

The thesis has met the objectives with the following results: Chapter two (The changing role of ICTs in education) illustrated the dynamic relation of technical (ICT) development and pedagogical paradigms. Chapter three (Characterisation of ICT-enabled innovations in education) prepared the definitional and conceptual ground for the theoretical framework development. It explored and highlighted the different scientific approaches used in e-learning research, such as education, technology, innovation and e-portfolios. The major achievements of the thesis has been the proposition of a new integrative, multi-level research framework, which integrates a number of theoretical approaches from the field of innovation and technology research, educational science and Internet science research. The framework development has been done on the basis of a dialectical way of scientific thinking, which addresses the emergence and integration of systemic ICT-based innovations as an interplay of the structures and the actors between the three governance levels of a national educational system, the macro-level (national educational system), the meso-level (educational institutions and e-learning providers) and the micro-level (the e-learning users and software developers). After a thorough screening of the most important innovation and educational theories, I analysed their relevance to the e-learning shaping and integration process in chapter four (Theoretical background to the shaping and integration of systemic ICT-enabled innovations in education). Based on that, the individual determinants of a new framework were derived. Three interrelated subsets of determinants were proposed to influence the shaping and integration process of an ICT-based innovation. The table inserted below summarises again the framework determinants, which were then exemplified by the case of e-portfolio integration in the Higher Education sector in three European countries (see chapter five: Development and exemplification of an integrative, multi-level research framework for analysing systemic ICT-based innovation in education).

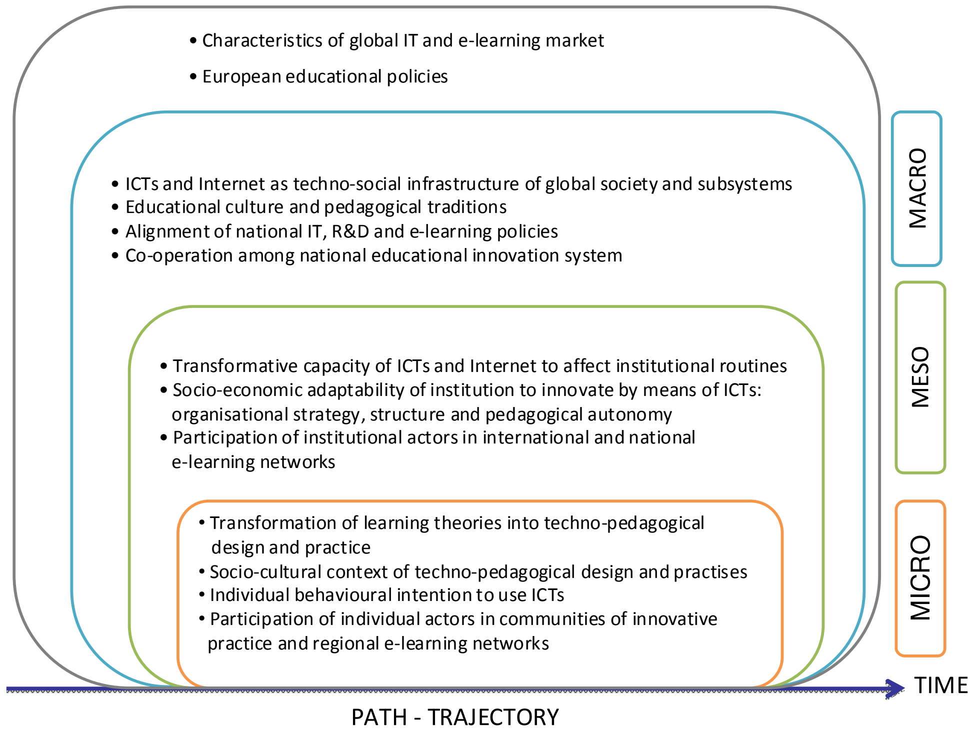


Figure 51: Overview of external and internal influences on the shaping and integration of systemic ICT-based innovation in education. Source: Author

6.2 Future research agenda for integrative e-learning analysis and policy formulation

As highlighted in the discussion of the utility of the framework, the dynamics and interlinkages of systemic ICT-based innovations are a phenomenon to be further explored by interdisciplinary, dialectical e-learning and innovation research. The exemplification showed that there is still need for more fundamental research in the e-learning research field on the boundaries of the analysed systems and identify system-internal, but also system-external influences on the e-learning innovation processes. In addition to the attempt to develop better indicators for the framework determinants, there is still little theoretical knowledge about the drivers and barriers, the strengths and weaknesses and the relevance of determinants influencing the shaping and the emergence of ICT-based innovations in specific contexts (e.g. culture, economic system, geographical settings). This thesis has started the journey about interactions between actors and structures at all levels of a national education system in e-learning, but there is more work to be done.

Bibliography

Aalderink, W. & Veugelers, M. (2007a). (Eds.). *Stimulating Lifelong Learning: The ePortfolio in Dutch Higher Education*. Stichting SURF. Available from: <http://www.surffoundation.nl/SFDocuments/Stimulating%20Lifelong%20Learning%20-%20ePortfolio.pdf >. [26 May 2011].

Aalderink, W. & Veugelers, M. (2007b). Introduction: The ePortfolio, a promise of lifelong learning? In: *Stimulating Lifelong Learning: The ePortfolio in Dutch Higher Education*. Stichting SURF. pp. 9-11. Available from: <http://www.surffoundation.nl/SFDocuments/Stimulating%20Lifelong%20Learning%20-%20ePortfolio.pdf >. [26 May 2011].

Aalderink, W. (2007c). ePortfolio practice and opportunities in the countries of Knowledge Exchange (Germany, Denmark, United Kingdom and The Netherlands). As above

Aalderink, W. and Veugelers, M. (2006). ePortfolio and Educational Change in Higher Education in the Netherlands. In: Jafari, A. and Kaufman, C. (Eds.), Handbook of Research on ePortfolios, Idea Group (USA), 356-367.

Abadie, F., Codagnone C., Lieshout M., Pascu C., Baum P., Hoikkanen A., Valverde J.A., Maghiros I. (2011). Strategic Intelligence Monitor on Personal Health Systems (SIMPHS): Report on Typology/Segmentation of the PHS Market. European Commission. JRC Centre: 24737 EN.

Allert, H. & Richter, C. (2008). Practices, Systems, and Context Working as Core Concepts in Modeling Socio-Technical Systems. *Proceedings of the Fifth International Workshop on Philosophy and Informatics* (WSPI 2008), Kaiserslautern, Deutschland, 2008, pp. 19-33.

Altrichter, H., Brüsemeister, T. & Wissinger, J. (Eds.) (2007). *Educational Governance – Handlungskoordination und Steuerung im Bildungssystem.* Wiesbaden: VS.

Altrichter, H. & Maag-Merki, K. (Eds.) (2010). *Handbuch Neue Steuerung im Schulsystem.* Verlag für Sozialwissenschaften. Wiesbaden.

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl, & J. Beckman (Eds.), Action-control: From cognition to behavior (pp. 11-39). Heidelberg: Springer.

Aslan S. & Reigeluth, C.M. (2011). A Trip to the Past and Future of Educational Computing: Understanding Its Evolution. *Journal Contemporary Educational Technology 2011, 2(1), 1-17.* Available from: http://cedtech.net/articles/211.pdf[5 May 2011]

Attwell, G., Chrzaszcz, A., Hilzensauer, W., Hornung-Prähauser, V. & Pallister, J. (2007). Grab your future with an e-portfolio – Study on new qualifications and skills needed by teachers and career counsellors to empower young learners with the e-portfolio concept and tools – Summary report. Available from: <http://www.mosep.org>. [26 May 2011].

Argyris, C. & Schön, D.(1978). Argyris, C., & Schön, D. (1978) *Organizational learning: A theory of action perspective*, Reading, Mass: Addison Wesley.

Argyris, C. & Schön, D. (2008). *Die Lernende Organisation: Grundlagen, Methode, Praxis* (3rd ed.). Klett-Cotta Verlag. Stuttgart.

Anderson, R. (2010). The 'Idea of a University' today. Policy paper: http://www.historyandpolicy.org/papers/policy-paper-98.html#S4

Andrews, R. (2009). Does e-learning require a new theory of learning? Presentation and paper at the ECER conference 2009, 28 - 30 September 2009. *Proceedings of the ECER European Conference on Educational Research 2009 (ECER)*, Vienna, Austria. Available from: <http://ecer2009.univie.ac.at/>-. [15 July 2010].

Andrews, R. & Haythornthwaite, C. (2007). *SAGE Handbook of E-learning Research*. Sage Publications Ltd.London.

Aslan, S. & Reigeluth, C.M. (2011). A Trip to the Past and Future of Educational Computing: Understanding Its Evolution. *Contemporary Educational Technology, 2011,* Vol. 2 No. 1, pp.1-17. Available from: <http://www.cedtech.net/articles/211.pdf>. [15 March 2011].

Association for Educational Communications and Technology (AECT) (2004). *The Meanings of Educational Technology*. Washington DC: AECT. Available from: <http://www.indiana.edu/~molpage/Meanings%20of%20ET_4.0.pdf>.[15 March 2011].

Askarany, D. (2005). Diffusion of Innovations in Organizations. In: *Encyclopedia of Information Science and Technology*. Khosrow-Pour (Eds). Pp.Idea Group Inc. (pp. 853-857).

Aviram, A., Ronen, Y., Somekh, S., Winer, A., & Sarid, A. (2008). Self-Regulated Personalized Learning (SRPL) (2008). Developing iClass's pedagogical model. In: *eLearning Papers*. No. 9 July 2008. ISSN 1887-1542. Available from: <http://www.elearningeuropa.info/files/media/media15974.pdf [26 May 2010].

Baecker, D. (2007). *Studien zur nächsten Gesellschaft*. Suhrkamp Verlag. Berlin.

Baecker, D. (2006). Niklas Luhmann in the Society of the Computer. In: *Cybernetics And Human Knowing*. Vol. 13, No. 2.

Bacigalupo, M., Ferrari, A. & Punie, Y. (2009). Learning 2.0: *The Impact of Web 2.0 Innovations on Education and Training in Europe Final Report*. Joint Research Centre Institute for Prospective Technological Studies. Available from: http://ftp.jrc.es/EURdoc/JRC55629.pdf [23 May 2011]

Baker, J. (2005). *Pedagogical Innovation via Instructional Technology*. Available from: <http://www.educause.edu/blog/jbaker/PedagogicalInnovationviaInstru/164835; Educause-Blog 24th August, 2005 >. [15 July 2010]

Baltaci-Goktalay, S. (2006). Faculty adoption of online technology in higher education. *The Turkish Online Journal of Educational Technology,* Vol. 5, No. 4, article 5. ISSN: 1303-6521. Available from: <http://www.tojet.net/articles/545.pdf>. [26 May 2011].

Bandura, A. & Walters, R.H. (1963). *Social Learning and personality development*. New York. New York: Holt, Rinehart, & Winston.

Banathy, B.H. (1991). *Systems Design of Education*. Englewood Cliffs, New York: Educational Technology Publications.

Barrett, H. (1994). Technology-Supported Portfolio Assessment. *The Computing Teacher*, March, 1994. Available from: <http://electronicportfolios. com/portfolios/compteach0394.html>. [08 September, 2009].

Barrett, He. (2000). Create Your Own Electronic Portfolio. *Learning & Leading with Technology* Vol. 27, No. 7, pp. 14-21

Barrett, H. (2011). Is the Future of E-Portfolio Development in Your Pocket? MacLearning, 7 April, 2011. Available from: <http://maclearning.org/article/72/is-the-future-of-e-portfolios-in-your-pocket.>. [08 June 2011].

Barrett, H. (2008). The REFLECT Initiative Research Project. Researching Electronic portFolios: Learning, Engagement and Collaboration through Technology with a focus on high school students in the Arizona Education Professions program. *Paper at American Educational Research Association (AERA), 27th March, 2008.* Available from: <http://electronicportfolios.com/reflect/ AERA2008paper.pdf>. [08 May 2011].

Barrett, H. (2011). Balancing the Two Faces of E-Portfolios. British Columbia Ministry of Education, Innovations in Education, 2nd Edition. Available from: <http://electronicportfolios.org/balance/balancingarticle2.pdf>. [08 June 2011].

Barrett, H. (2001; also available in versions 1999/2001). Electronic Portfolios – A Chapter in Educational Technology. *An Encyclopedia to be published by ABC-CLIO, 2001*. Available from: <http://electronicportfolios.com/portfolios/ encyclopediaentry.htm>. [08 May 2011].

Bassi, A. (2011). Social Innovation: Some Definitions. *Positionpaper to the European Summerschool on Social Enterprise and Social Innovation (ESSE 2011). 8th – 23rd July, 2011. University Residential Centre of Bertinoro.* Available from conference homepage: < http://www.esse.unibo.it/paper.pdf >. [15 June 2011]

Bates, M., Manuel, S. & Oppenheim, C. (2007). Models of Early Adoption of ICT Innovations in Higher Education. Available from: <http://www.ariadne.ac.uk/issue50/oppenheim-et-al/>. [26 May 2011].

Batinic, B. & Appel, M. (2008). *Medienpsychologie*. Heidelberg: Springer Medizin Verlag.

Batson, T. (2009). The Portfolio Enigma in a Time of Ephemera. *Journal Campus Technology*. Available from: <http://campustechnology.com/articles/2009/01/07/the-portfolio-enigma-in-a-time-of-ephemera.aspx >. [08 June 2011].

Batson, T. (2010). ePortfolios, Finally! 4 July 2010. *Campus Technology Blog*. Available from: <http://campustechnology.com/Articles/2010/04/07/ePortfolios-Finally.aspx?p=1 >. [22 August 2011].

Baumgartner, P. (2008). Eine Taxonomie für E-Portfolios - Teil II des BMWF-Abschlussberichts “EPortfolio an Hochschulen”: GZ 51.700/0064-VII/10/2006. Forschungsbericht, Krems: Department für Interaktive Medien und Bildungstechnologien, Donau Universität Krems.

Baumgartner, P., Himpsl, K. & Zauchner, S. (2009). Einsatz von E-Portfolios an (österreichischen) Hochschulen: Zusammenfassung - Teil I des BMWF-Abschlussberichts “E-Portfolio an Hochschulen”: GZ 51.700/0064-VII/10/2006. Forschungsbericht. Krems: Department für Interaktive Medien und Bildungstechnologien, Donau Universität Krems.

Baumgartner, P., Zauchner, S., & Bauer R. (Eds.) (2010). The Potential of E-Portfolios in Higher Education. Studienverlag Innsbruck-Bozen.

Barrett, H. (2005). Researching Electronic Portfolios and Learner Engagement. Available from. http://electronicportfolios.com/reflect/whitepaper.pdf[15-May-2010]

Barrett, H. (1999, 2000). Electronic Portfolios = Multimedia Development + Portfolio Development. The Electronic Portfolio Development Process. Available from: < http://electronicportfolios.com/portfolios/EPDevProcess.html>. [25 July 2011].

Beetham, H. (2005d). *e-portfolios in post-16 learning in the UK: developments, issues and opportunities*. A report prepared for the JISC e-Learning and Pedagogy strand of the JISC e-Learning Programme. Available from: < http://www.jisc.ac.uk/media/documents/themes/elearning/eportfolioped.pdf>. [08 June 2011].

Belliger, D., Krieger J., Herber E. & Waba, S. (2011). Die Akteur-Netzwerk-Theorie – Eine Techniktheorie für das Lernen und Lehren mit Technologien. In: *Lehrbuch zum Lernen und Lehren mit Technologien,* (Eds.) Ebner, M. & Schön, S. (2011). O.a. Available from: <http://l3t.eu>. [07 July 2011].

Belt van den, H. & Rip, A. (1987). The Nelson-Winter-Dosi model and synthetic dye chemistry. In: *The social construction of technological systems : new directions* *in the sociology and history of technology*. Cambridge, MA: MIT Press, pp. 135-158.

Berliner, D.C. (2002). Comment: Educational Research: The Hardest Science of All. Educational Researcher, *Journal of the American Educational Research Association*, vol. 31, no. 8. pp. 18-20. SAGE Publications.

Behrendt, W., Hornung-Prähauser, V. & Hilzensauer, W. (2006). Technology must follow Policy – A socio-technological re-assessment of the concept of Lifetime Personal Web Spaces. In: Proceedings of the ePortfolio 2006 Conference. eStrategies for Empowering Learners, Oxford, England, 11.-13.10.2006.

Bijker, W.E. (2006). Why and How Technology Matters. In Goodin, R. E. & C. Tilly (eds.): *Oxford Handbook of Contextual Political Analysis*, pp. 681-706.

Bijker, W.E., Hughes, T. & Pinch, T.J. (eds.). (1987). The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology. Cambridge, MA: MIT Press.

Blumenfeld, P. at al. (2000). Creating Uable Innovations in Systemic Reform: Scaling up Technology-embbeded Project-Based Science in Urban Schools; Educational Psychologist, vol. 35, no3.pp.149-64)

Blurton, C. (2002). New Directions of ICT-Use in Education. Available from: <http://www.unesco.org/education/educprog/lwf/dl/edict.pdf;>. [7 August 2002].

Boekaerts, M. (1997). Self-regulated learning: A new concept embraced by researchers, policy makers, educators, teachers, and students. *Learning and Instruction*, 7(2), 161-186.

Boekaerts, M. (1999). Self-regulated learning: Where we are today. *International Journal of Educational Research*, 31, 445-475.

Boekaerts, M, Pintrich, P, & Zeidner, M. (2000). *Handbook of Self-Regulation*. Academic Press.

Boer, F.F., Enders, J. & Schimank, U. (2008). Comparing Higher Education Governance Systems in Four European Countries. In N.C. Soguel and P. Jaccard (eds.). Governance and Performance of Education Systems, pp.35-54. Springer Verlag. Heidelberg.

Bradford, G., Hess, T. & Regan, D. (2008). Design Portfolio. 16 March 2008 .Course paper. Advanced Instructional Design University Available from: http://www.heybradfords.com/moonlight/files/CV/DoctoralCourseFiles/Design%20Portfolio_r1.pdf [23 June 2011]

Braun-Thürmann, H. (2005). *Innovation. Reihe Einsichten Soziologische Themen*. Bielefeld: Transcript Verlag.

Breiter, A., & Kolo, C. (2008). Dynamics of innovations in education – The case of electronic gaming in Germany. In R. Ferdig (Ed.), *Handbook of Research on*

Effective Electronic Gaming in Education (pp. 163-177). Hershey PA: IGI Global.

British Educational Communications and Technology Agency (2005). Summary Report 2005: Harnessing Technology Transforming Learning and Children's Services. <http://www.beet.co.uk/Guidance%20Docs/Becta%20Files/Publications/26.%20 Harnessing%20technology%20delivery%20plan.pdf>. [25 July 2011].

British Educational Communications and Technology Agency (2007). *Impact study of e-portfolios on learning.* Report available from: <http://myportfolio.school.nz/ artefact/file/download.php?file=383997&view=77494>. [08 June 2011].

British British Educational Communications and Technology Agency (2006). Harnessing technology delivery plan. Available from: Bruning, R.H., Schraw, G.J. & Ronning, R.R. (1999). *Cognitive psychology and instruction*. (3rd ed.). Columbus: Prentice Hall.

Brown, J.S., Collins, A. & Duguid, S. (1989). Situated cognition and the culture of learnin. *Educational Researcher*, Vol. 8, No. 1, pp. 32-42Brunner, I., Häcker, T., & Winter, F. (Hrsg.), (2006). Handbuch Portfolioarbeit. Konzepte und Erfahrungen aus Schule und Lehrerbildung. Seelze: Kallmeyer.

Bruning, R.H., Schraw, G.J., Ronning, R.R. (1999). Cognitive psychology and instruction. (Third edition). Columbus: Prentice Hall.

Brüsemeister, T. (2008). Bildungssoziologie: *Einführung in Perspektiven und Probleme*. VS Verlag.Wiesbaden.

Burgess, R. 2004: Measuring and Recording Student Achievement. Report of the Scoping Group chaired by Professor Robert Burgess. Available from: <bookshop.universitiesuk.ac.uk/downloads/measuringachievement.> [10 June 2011].

Bradford, G., Hess, T. & Regan D. (2008). Comparison of design of e-portfolios Advanced Instructional Design. Course paper

Bundesministerium für Unterricht, Kunst und Kultur (n.d.). *efit21 – digitale Agenda für Bildung, Kunst und Kultur.* Available from: <.http://www.bmukk.gv.at/ schulen/efit21/index.xml> [08 June 2011].

Butler. P. (2006). A Review Of The Literature On Portfolios And Electronic Portfolios, Massey University College of Education, New Zealand and eCDF ePortfolio Project Steering Committee.

Buzzetto-More, N. (2010). The E-Portfolio Paradigm: Informing, Educating, Assessing, and Managing With E-Portfolios. Informing Science Press. California.

Callon, M. (1986). Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay. In J. Law (Ed.), *Power, Action and Belief: A New Sociology of Knowledge*. London: Routledge & Kegan Paul.

Cameron, C. (2009). *The history and evolution of social media*. Blog: Webdesigner Depot. Available from: http://www.webdesignerdepot.com/2009/10/the-history-and-evolution-of-social-media/. [3 February, 2011]

Castells, M. & Cardoso, G. (2006). *The Network Society: From Knowledge to Policy*. Washington, DC: Johns Hopkins Center for Transatlantic Relations.

Castells, M. (1996). *The Rise of the Network Society. The Information Age: Economy, Society and Culture*. Vol 1. Oxford.

Challis, (2005). Towards the mature ePortfolio: Some implications for higher education. Canadian Journal of Technology. V31(3) Fall / 2005. Available from: http://www.cjlt.ca/index.php/cjlt/article/view/93.[7 July 2001].

Christensen, C.M.,. (1997). *The Innovator's Dilemma. When New Technologies Cause Great Firms to Fail.* Boston, MA: Harvard.Business School Press.

Christensen, C.M., Horn, B.M, & Johnson, C.W. (2008). *Disrupting class. How disruptive innovation will change the way the world learns*. US: McGraw-Hill.

Cross, J. (2004). A History of eLearning. The Future of eLearning. Internettime – Draft. Berkeley, California. Available from Blog: http://www.internettime.com/Learning/articles/OTH.doc.> [21 January 2007].

Crosta, L., & Prieto, V. (2009). How to measure innovation in eLearning. The i-AFIEL methodology. In: *eLearning Papers*, Vol. 13, April 2009, Publ.: elearningeuropa.info Edited by: P.A.U. Education. Available from: <http://www.elearningeuropa.info/files/media/media19187.pdf>

Cole, M. (1996) Cultural Psychology: A Once and Future Discipline. Harvard University Press.

Conole, G., Dyke, M., Oliver, M. & Seale, J. (2004). Mapping pedagogy and tools for effective learning design. In: *Computers & Education*, Vol. 43, pp. 17-33. Elsevier. München.

Cortez, J.J., Luppicini, R. & Fang, B. (2007). The emergence of Educational Technology in North America. Session papers in the conference Society of History of Technology, October 2007. Available from: http://www.historyoftechnology.org

Cox, R., Beers, M. & Verma, S. (2008). *SF State Leadership Activity: ePortfolio Development*. Report For The CSU Office Of The Chancellor Academic Technology Services Department. San Francisco State University. Available from: <http://teachingcommons.cdl.edu/eportfolio/documents/CSU_eport6-30-08SFSU.pdf>. [3 July 2011].

Coverdale A. (2009). Critical Theories on Education and Technology. PHD wiki available at: < http://sites.google.com/site/andycoverdale/texts/critical-theories-on-education-and-technology>.[8 July 2011].

Dabbagh, N. (2011). The Instructional Design Knowledge Base. Available from Nada Dabbagh's Homepage, George Mason University, Instructional Technology Program. Available from: <http://classweb.gmu.edu/ndabbagh/Resources/IDKB/index.htm>. [15 June 2011].

Dalziel, C., Challen R. & Sutherland S. ePortfolio in the UK: Emerging Practice. In: Jafari (Kaufmann (2006). *Handbook of Research on E-portfolios*. pp.-371.

Danneels E. (2004). Disruptive Technology Reconsidered: A Critique and Research Agenda. *Journal of Product Innovation Management*. 21:246–258. Product Development & Management Association. Available from <http://tourism.wu-wien.ac.at/lehrv/lven/05ws/lv4/danneels_disruptive.pdf>. [5 June 2011].

Davis, F.D. Bagozzi, R. & Warshaw, P.R. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoretical Models, Management Science, 35,8, 982-1003.

Davis, C, Edmunds, E, & Kelly-Bateman, V. (2008). Connectivism. In M. Orey (Ed.), *Emerging perspectives on learning, teaching, and technology*. Available from: <http://projects.coe.uga.edu/epltt/>. [9 May 2011].

Dearing Report (1997). The National Committee of Inquiry into Higher Education. Available from: <https://bei.leeds.ac.uk/Partners/NCIHE/>. [5 June 2011].

Deci, E.L., & Ryan, R.M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum.

Deci, E.L., & Ryan, R.M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, 11, 227-268.

Deci, E.L., & Ryan, R.M. (2000). Handbook of Self-determination Research. Rochester: University of Rochester Press.

Dede, C. (2008). Theoretical perspectives influencing the use of information technology in teaching and learning". In*: International Handbook of Information Technology in Primary and Secondary Education*. Springer International Handbooks of Education, 2008, Vol. 20, 1, pp. 43-62. Wiesbaden.

Degele, N. (2002). *Einführung in die Techniksoziologie*. München: Wilhelm Fink Verlag GmbH&Co KG.

Dolata, U., 2008. Das Internet und die Transformation der Musikindustrie. Rekonstruktion und Erklärung eines unkontrollierten Wandels. *Berliner Journal für Soziologie 1*8 (3), 344–369.

Dolata, U. (2009): Technological innovations and sectoral change Transformative capacity, adaptability, patterns of change: An analytical framework. In: *Research Policy: Policy and management of science, technology and innovation.* Vol. 38 pp. 1066-1076.

Dorninger, C. & Schrack C. (2008). Futur(e)Learning – a strategy for individualisation in learning by e-learning and e-portfolios. Paper at the ICL conference 2008.

Available from: http://www.bmukk.gv.at/medienpool/17142/fl_icl08.pdf.>. [9 May 2011].

Dosi, G., Freeman, C. and Fabiani, S., The Process of Economic Development: Introducing Some Stylized Facts and Theories on Technologies, Firms and Institutions, Industrial and Corporate Change, 3(1), (1994).

Downes, S. (2005). An introduction to connective knowledge. 12-12-2005. *Stephen Downes*: Blog Available from: <http://www.downes.ca/cgi-bin/page.cgi?post=33034/>. [15 September 2010].

Downes, S. (2007). What Connectivism Is. Blog entry: Saturday, February 03, 2007 Available from: http://halfanhour.blogspot.com/2007/02/what-connectivism-is.htm.>. [20 September 2010].

Ebner, M. & Schön, S. (Eds.) (2011). *Lehrbuch zum Lernen und Lehren mit Technologien*. Available from: <http://l3t.eu>. [07 July 2011].

Economist Intelligence Unit (2008). The future of higher education: How technology will shape learning. Available from: <http://www.nmc.org/pdf/Future-of-Higher-Ed-%28NMC%29.pdf> [25 August 2010]

Elgort, I. (2005). E-learning adoption: Bridging the chasm. Pp.181.-185. Paper presented at the 22nd Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education (ASCILITE). Brisbane, Australia. Vol.1 pp. 181-185.Available from: http://www.ascilite.org.au/ conferences/brisbane05/blogs/proceedings/20_Elgort.pdf.[5 Septembre 2009].

Engeström, Y. (1987). *Learning by expanding: An activity-theoretical approach to developmental research*. Helsinki: Orienta-Konsultit.

Engeström, Y. (1999) Innovative learning in work teams: analysing cycles of knowledge creation in practice. In Engeström, Miettinen & Punamäk (Eds.) *Perspectives on Activity Theory*. Cambridge University Press, pp. 377-406.

EuropeLearning Theories Knowledgebase (2011, August). Paradigms and Perspectives at Learning-Theories.com. Retrieved August 23rd, 2011 from http://www.learning-theories.com/design-based-research-methods.htmlan Commission (2009). Europe's Digital Competitiveness Report Main achievements of the i2010 strategy 2005-2009. COM(2009) 390. Available from:http://ec.europa.eu/information_society/eeurope/i2010/docs/annual_report/ 2009/digital_competitiveness.pdf >. [26 August 2011].

Faßler, M. (1997). *Was ist Kommunikation?* München: Fink.

Faulstich, W. (2004). Grundwissen Medien. 5. Aufl., München: Fink.

Faulstich, W. (2004) *Medienwissenschaft*. Paderborn: Fink.

Fend, H. (2008). Schule gestalten. Systemsteuerung, Schulentwicklung und Unterrichtsqualität. Wiesbaden: Verlag für Sozialwissenschaften.

Feenberg, A. (2002). Transforming Technology: A Critical Theory Revisited. Oxford University Press. Oxford.

Fischer & Delitz (2005). Guidelines on theoretical comparisons in sociology. Available from:<http://www.fischerjoachim.org/protokoll_ps/PS%20Theorietechnik/PS%20Theorienvergleich-Richtlinie.pdf >. [26 August 2011].

Fishbein, M., & Ajzen, I. (1975). Belief, attitude, intention and behavior: An introduction to theory and research. Reading, MA: Addison-Wesley.

Forkosh-Baruch, A.. & Nachmias, R. (2005). "Islands of innovation" and "school-wide implementations": two patterns of ICT-based pedagogical innovations in schools." In: *An Interdisciplinary Journal on Humans in ICT Environments*. Vol. 1 (2), October 2005, 202-215. Available from: < http://www.humantechnology.jyu.fi/articles/volume1/2005/forkosh-baruch-mioduser-nachmias-tubin.pdf >. [11 July 2011].

Freeman, C. (1995), "The National System of Innovation in Historical Perspective", Cambridge Journal of Economics, No. 19, pp. 5–24

Frick, T. (1991). A Journey from the Past. Text: Restructuring Education Through Technology, by Theodore W. Frick, Phi Delta Kappa Educational Foundation,1991. Available from: <http://www.indiana.edu/~tedfrick/fastback/fastback326.>. [19 June 2010].

Friesen, N. (2009). *Re-Thinking E-Learning Research. Foundations, Methods and Practises*. New York: Peter Land, Publishing Inc.

Friesen N. & Hug T., (2009). The Mediatic Turn Exploring Consequences for Media Pedagogy. Available from: <http://tru.academia.edu/NormFriesen/Papers/107606/The_Mediatic_Turn_Exploring_Consequences_for_Media_Pedagogy>. [11 March 2011].

Flindt, N. (2005). E-Learning. Theoriekonzepte und Praxiswirklichkeit. Dissertation an der Universität Heidelberg. http://archiv.ub.uni-heidelberg.de/volltextserver/volltexte/2006/6907/pdf/Diss_Flindt.pdf

Freire, P. (1970). *Pedagogy of the oppressed*. New York: Continuum.

Freire, P. (2004). *Pedagogy of Indignation*. Boulder, Colorado: Paradigm.

Fuchs, C. (2003). Globalization and Self-Organization in the Knowledge-Based Society. *Journal tripleC* 1(2): 105-169, 2003.. Available from: <http://tripleC.uti.at>. [11 May 2011].

Fuchs, C. (2005). Knowledge and Society from the Perspective of the Unified Theory of Information (UTI) Approach. In M. Petitjean (Ed.) *Proceedigns of FIS 2005*: Third Conference on the Foundations of Information Science. Paris, 4-7 July 2005. Available from: http://www.mdpi.org/fis2005/proceedings.html ISBN 3-906980-17-0.

Fuchs C. (2008). *Internet and Society: Social Theory in the Information Age*. Routledge Research in Information Technology and Society Series, No. 8. New York: Routledge.

Fuchs, C. & Hofkirchner, W. (2005). Self-Organization, Knowledge, and Responsibility. *Kybernetes*, Special Issue on Heinz von Foerster, Vol. 34, Nos. 1-2, pp. 241-260.

Fuchs, C. & Hofkirchner, W. (2005): The Dialectic of Bottom-up and Top-down Emergence in Social Systems. Jo*urnal tripleC*. Vol. 2, 28-50.

Fuchs, C. & Hofkirchner, W. (2003). Studienbuch Informatik und Gesellschaft. Norderstedt. Libri Verlag.

Fullan, M.G. (1999). *Change Forces: The sequel.* Philadelphia, PA: Falmer Press.

Fullan, M.G. (1993). The complexity of the change process. In Change forces: Probing the depth of educational reform. Falme Press, pp. 19-41.

Fullan, M.G. (2010 The Role of the District in Tri Level Reform. University of Toronto, Toronto, ON, Canada 2010 Elsevier Ltd. Available from: http://www.michaelfullan.ca/Articles_10/IntlEnclyclopedia.pdf

Gagné, R.M. (1965; 1985). *The conditions of learning and theory of instruction* (1st ed.). New York: Holt, Rinehart & Winston.

Geels, F.W., (2002). 'Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study', *Research Policy,* 31(8/9), 1257-1274. Available from: <http://www.sussex.ac.uk/profiles/228052.>. [12 August 2011].

Geels, F.W. (2004). From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory, *Research Policy*, 33(6/7), 897-920. Available from: <http://www.sussex.ac.uk/profiles/228052.>. [12 August 2011].

Geels, F.W. (2005). Processes and patterns in transitions and system innovations: Refining the co-evolutionary multi-level perspective. *Technological Forecasting & Social Change* 72 (2005) 681–696 Available from: <http://www.sussex.ac.uk/profiles/228052.>. [12 August 2011].

Geels, F.W. & Kemp, R., 2007, Dynamics in socio-technical systems: Typology of change processes and contrasting case studies, *Technology in Society*, 29(4), 441-455. (11 August 2011]Geels, F.W. (2008). Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. SPRU, *Science and Technology Policy Research*, University of Sussex, United Kingdom. Available from: <http://www.sussex.ac.uk/profiles/228052.>. [12 August 2011].

Geser, G. ed. (2007). Open Educational Practices and Resources: OLCOS Roadmap 2012. Salzburg Research, EduMedia Group.

.Gieseke, M. (n.d.). In Search of Post-Typographical Educational Ideals. Translated by Otto Peters. Available from: <http://www.michael-giesecke.de/giesecke/dokumente/267/final_version.pdf> [4 May 2011].

Giroux, H. A. (19). *Critical Theory & Educational Practice*. Hyperion Books.

Gläser-Zikuda M. & Hascher, T. (Eds). (2007). Lernprozesse dokumentieren, reflektieren und beurteilen. Lerntagebuch und Portfolio in Bildungsforschung und Bildungspraxis. Bad Heilbrunn: Klinkhard.

Goertz L. & Hedergott, K. (2006). Social software and the future of learning. Presentation at the Online Educa conference 2006. Institute for Media Competence. Essen, Germany. Available from: <http://www.mmbinstitut.de/download/vortraege/MMB_Pres_SocialSoftware_2006_Go_He.pdf.>. [4 May 2011].

Gordon, J. (2010). JISC Effective Practice with e-Portfolios – Where are we now? Presentation at e-Portfolio conference Scotland. Available from: < http://www.rsc-ne-scotland.ac.uk/portfolio.php#Gordon_J> [4 May 2011].

Grant S., Jones, P.R. & Ward, R. (2004). E-portfolio and its relationship to personal development planning: A view from the UK for Europe and beyond. Available from: http://www.estandard.no/eportfolio/2004-1103/terminologiavklaringUK.pdf. [26 May 2011].

Griffin, S.(n.d). Internet Pioneers. Available from:<http://www.ibiblio.org/pioneers/author.html> [8 May 2011].

Gray, L & Joyes, G. (2010). What's so difficult about implementing e-Portfolios? A threshold concepts perspective arising from research into JISC projects University of Nottingham.Presentation

Gutknecht-Gmeiner, M. (2011). Netbooks im Unterricht 2010-2011. Evaluationsbericht. BMUKK. http://eeducation.at/download_mat/Bericht_Netbooks_im_Unterricht_2011.pdf

Hallam, G., Creagh, T., Gillespie, A., Harper W., Hauville, K., Moody, K. & McAllister (2009). Australian ePortfolio Project ePortfolio use by university students in Australia: Developing a sustainable community of practice Final project report: December 2009. Australian Learning and Teaching Council, December 2009. Publ. QUT Department of Teaching and Learning Support Services, December 2009. Available from: <http://www.eportfoliopractice.qut.edu.au/docs/Aep_Final_Report/AeP_Report_ebook.pdf>. [5 February 2011].

Hartnell-Young, E. (2006). *ePortfolios for knowledge and learning*. In Jafari, A. & Kaufmann, C. (Eds.) Handbook of Research on ePortfolios. Idea Publishing. pp. 124-133.

Hansen, R. (2007). The Human Tendency to Be Technical. *Journal of Technology Education*, Vol. 19, No. 1, Fall 2007.

Hartmann, F. (2003). Überblick: Theorienspektrum Medienwissenschaft. Available from: <http://www.medienphilosophie.net/texte/Techniktheorien.pdf>[5 Ma 2011].

Häcker, T. (2006a). *Portfolio: ein Entwicklungsinstrument für selbstbestimmtes Lernen.* Eine explorative Studie zur Arbeit mit Portfolios in der Sekundarstufe 1. Baltmannsweiler: Schneider Verlag Hohengehren.

Häcker, T. (2006b). *Portfolio als Medium des Wandels der Lernkultur.* In I. Brunner, T. Häcker, & F. Winter (Hrsg.), Handbuch Portfolioarbeit. Konzepte und Erfahrungen aus Schule und Lehrerbildung. Seelze: Kallmeyer.

Hagenauer G. & Hascher, T. (2011). Lernfreude, engagierte Mitarbeit im Unterricht und erfolgreiches Leisten bei instrumentellen Formen der Lernmotivation – ein Widerspruch in sich?. Zeitung für Bildungsforschung 2011.vol.1 97-113.VS-Verlag. Wiesbaden.

Hascher, T. & Schratz, M. (2001). Portfolio in der Lehrer/innen-Bildung. Ein Weg zum Ei-genständigen Lernen auf der Tertiärstufe. *Journal für Lehrerinnen- und Lehrerbildung, 4*, 4-7.

Hascher, T. (2007). Lerntagebuch und Portfolio. Ermöglichung echter Lernzeit. In M. Gläser-Zikuda & T. Hascher (Eds). Lernprozesse dokumentieren, reflektieren und beurteilen. Lerntagebuch und Portfolio in Bildungsforschung und Bildungspraxis. (Eds). Gläser-Zikuda M. & Hascher, T. Klinkhard. Bad Heilbrunn, pp. 295-301.

Hascher, T. & Astleitner, H. (2007). Blickpunkt Lernprozess. In M. Gläser-Zikuda & T. Hascher, Klinkhard (Eds.). Lernprozesse dokumentieren, reflektieren und beurteilen. Lerntagebuch und Portfolio in Bildungsforschung und Bildungspraxis. . Bad Heilbrunn, pp. 25-43.

Hede, T., & Hede, A. (2002). Multimedia effects on learning: Design implications of an integrated model. In S. McNamara and E. Stacey (Eds), Untangling the Web: Establishing Learning Links. Proceedings ASET Conference 2002. Melbourne, 7-10 July. Available from:http://www.aset.org.au/confs/2002/hede-t.html.[30 March 2011]

Haythornthwaite, C. and Andrews, R. (2011) *E-learning Theory and Practices*. London: Sage Publications Ltd.

Heinen R. (2010). Nachhaltige Integration digitaler Medien in Schulen aus Sicht der Educational Governance. Available from: http://www.richard-heinen.de/wp-content/uploads/2010/09/heinen-Nachhaltige-Integration-Educational-Governance.pdf [5 August 2011].

Heil, R. (1999). Systemische Pädagogik im Licht ihrer Ideengeschichte. Ein kritische Auseinandersetzung mit einer neuen Richtung. Tectum Verlag.Marburg.

Hiemstra, R. & Brockett G.R. (1994) From behaviorism to humanism: Incorporating self-direction in learning concepts into the instructional design process. In H. B. Long & Associates, New ideas about self-directed learning. Norman, OK: Oklahoma Research Center for Continuing Professional and Higher Education, http://www-distance.syr.edu/PROmodel.jpg

Himpsel, K. (2009). E-Portfolios und ihre Umsetzung im Web. Presentation at the Austrian FNMA Meeting. Was ist übrig geblieben von dem Heiligen Gral "E-Portfolio"? 11. Mai 2010. Available from:http://www.fnm-austria.at/file/308417/2010-05-11-Himpsl-E-Portfolio-FNMA-Online-Meeting.PDF.[20 August 2011].

Himpsl, K. (2010). E-Portfolios in berufsbegleitenden Studiengängen zu Neuen Medien. *Journal der MedienPädagogik.Vol.*18. Available from: <http://www.medienpaed.com/18/himpsl1004.pdf>[3 May 2011].

Hofkirchner, W. (1998). Zur Grundlegung eines integrativen Informationsbegriffes. In: Fenzl, N.; Hofkirchner W., Stockinger G. *Information und Selbstorganisation. Annäherungen an eine vereinheitlichte Theorie der Information*. Innsbruck-Wien. StudienVerlag.

Hofkirchner, W. (Ed.) (1999). The Quest for a Unified Theory of Information: Proceedings of the Second Conference on the Foundations of Information Science.

Hofkirchner, W. (2002). Projekt eine Welt. Oder Kognition, Kommuniation, Kooperation. Versuch über die Selbstorganisation der Informationsgesellschaft. Münster. LIT.

Hofkirchner, W. (2004). Unity through diversity: Dialectics – systems thinking – semiotics, *Trans: Internet-Zeitschrift für Kulturwissenschaften*,Vol.15 Available from: http://www.inst.at/trans/15Nr/01_2/hofkirchner15.htm.[5 September 2011]

Hofkirchner, W. (2005). Ludwig von Bertalanffy. Forerunner of Evolutionary Systems Theory. In J. Gu and G. Chroust, (Eds.) The New Role of Systems Sciences For a Knowledge-based Society, *Proceedings of the First World Congress of the International Federation for Systems Research* 6, 2005. Kobe.

Hofkirchner, W. (2006). Society as a self-organising system. In: Yevtuh, V., Dobronravova, I. (eds.), Cultural Context of Social Self-Organization, Kyiv University Press, 27-34. Also in Russian, ibidem, 91-98. [15 January 2011].

Hofkirchner, W., Fuchs, C., Raffl, C. Schafranek, M., Sandoval, M. & Bichler, R. (2007a). ICTs and Society – The Salzburg Approach. Towards a Theory for, about, and by means of the Information Society. In: ICT&S Center Research

Paper Series, No. 3, Dec., Available from: <http://icts.sbg.ac.at/media/pdf/pdf1490.pdf<. [2 March 2011].

Hofkirchner, W. (2007b). A Critical Social Systems. View of the Internet.*Philosophy of the Social Sciences* December 2007 37: 471-500,

Hofkirchner, W. (2008). A Taxonomy of Theories about ICTs and Society. Journal tripleC - Cognition, Communication, Co-operation, Vol 8, No 2 (2010) Available from: <http://www.triple-c.at.>[2 March 2011].

Hofkirchner, W. (2010a). Twenty Questions about a Unified Theory of Information: A Short Exploration Into Information from a Complex Systems View. Isce Publishing.

Hofkirchner, W. (2010b). Four ways of thinking. In *Proceedings of the 4th Int. Conf. Found. Inf. Sci.*, 21-24 August 2010; Sciforum Electronic Conferences Series, 2010, fis007:1-7. Available from: http://www.sciforum.net/presentation/339

Hofkirchner, W. (2010c). Four Ways of Thinking about Information. Journal tripleC - Cognition, Communication, Co-*operation, Vol 9, No 1 (2011)* Available from: http://www.triple-c.at/index.php/tripleC/article/view/156/188 [05 January 2011].

Hofkirchner, W. & Fuchs, C. (2005). In: Wilby, Jennifer/Allen, Janet K. (Eds.) (2003) *Proceedings of the 47th Annual Conference of the In-ternational Society for the Systems Sciences (ISSS):* Agoras of the Global Village, Iraklion, Crete, July 7th-11th, 2003.Available from: <http://fuchs.uti.at/wp-content/uploads/ArchitectureInformationSociety.pdf.>. [5 March 2011].

Hornung-Prähauser,V., Geser G., Hilzensauer, W. & Schaffert S. (2007). Didaktische, organisatorische und technologische Grundlagen von E-Portfolios und Analyse internationaler Beispiele und Erfahrungen mit E-Portfolio-Implementierungen an Hochschulen StudienautorInnen. Report for the Austrian FNMA. Available from: http://edumedia.salzburgresearch.at/images/stories/e-portfolio_studie_srfg_fnma.pdf .>.[3 September 2011].>

Hornung-Prähauser, V. & Luckmann, M. (2008). E-Portfolios als medienpädagogische Herausforderung. In, E. Blaschitz & M. Seibt (Eds.). *Medienbildung in Österreich.* Münster, Wien, u.a.: LITVerlag, pp. 248-259.

Hornung-Prähauser, V., Luckmann M. & Kalz, M. (2008). Eine Landkarte internetgestützten Lernens. In: dies. (Hrsg.), *Selbstorganisiertes Lernen im Internet. Einblick in die Landschaft der webbasierten Bildungsinnovationen*. Innsbruck: Studienverlag, pp. 13-25.

Hornung-Prähauser, V., Luckmann M., (eds. (2009). *Kreativität und Innovationskompetenz im digitalen Netz. EduMedia Tagungsband*. Norderstedt: Salzburg Research Forschungsgesellschaft/ Books on Demand GmbH.

Hornung-Prähauser, V. & Wieden-Bischof, D. (2010). In K. Hugger & M. Walber (Eds.) Selbstorganisiertes Lernen und Lehren in einer digitalen Umwelt: Theorie und Praxis zu E-Portfolios in der Hochschule. In Digitale Lernwelten: Konzepte, Beispiele und Perspektiven . Verlag für Sozialwissenschaften, pp. 245-268.

Hornung-Prähauser, V. & Geser G, (2010). ICT in Initial Teacher Training. Use of Information and Communication Technology in Initial Teacher Training. Case studies on the frameworks, the requirements and the ways of preparing student teachers in their ICT enhanced subject teaching. OECD/CERI Study in ICT in Initial Teacher Training–Austrian Country Report. Available from: <http://www.oecd.org/dataoecd/43/43/45935675.pdf>[5 September 2011].

Howaldt &Michael Schwarz (2010). Social Innovation: Concepts, research fields and international trends. IMO. Available from: http://www.internationalmonitoring.com/fileadmin/Downloads/Trendstudien/IMO%20Trendstudie_Howaldt_englisch_Final%20ds.pdf>[5 September 2011].

Hung J., (2010). Trends of e-learning research from 2000-2008: Use of text mining and bibloimetrics. *British Journal of Educational Technology*. BECTA.

Illich, Ivan (1970). *Deschooling Society*. New York: Harper and Row. Available from: http://www.preservenet.com/theory/Illich/Deschooling/intro.html [3 August 2010]

Jaeger, W. (1989). Paideia. Die Formung des griechischen Menschen. Gruyter Verlag.

Jafari, A. & Kaufman, C. (2006). *Handbook of Research on E-Portfolios*. Idea Group Inc. Hershey. US.

Joint Information Systems Committee (2006). e-Portfolios.What institutions really need to know. Briefing Paper. Available from: <http://www.jisc.ac.uk/uploaded_documents/JISC-BP-ePortfolio-v1-final.pdf> [2 April 2011]

Joint Information Systems Committee (2008). *Effective practice with e-portfolios: Supporting 21st century learning*. Available from: <http://www.jisc.ac.uk/media/documents/publications/effectivepracticeeportfolios.pdf> [5 March 2011]

Jeffries, M. (n.d.). The history of distance learning. Research in Distance Education). Available from: >www.digitalschool.net.[15 Nov. 2011]

Johnstone, J. & Hascher, T. (2001). Portfolios als Zugang zu einer auf Standards basierenden Lehrer/innen-Bildung. *Journal für Lehrerinnen- und Lehrerbildung*, *4*, 34-43.

Johnson, L., Levine, A., Smith, R., & Stone, S. (2010). The 2010 Horizon Report. Austin, Texas: The New Media Consortium. Available from: < http://www.nmc.org/pdf/2010-Horizon-Report.pdf>. [26 May 2011].

Joseph, R. & Reigeluth, M.C. (2010). The Systemic Change Process in Education. British Journal of Educational Technology Vol 36.No 6 2005. pp937–956.

Joyes, G. & Gray, J. (2010a). What's so difficult about implementing e-Portfolios? A threshold concepts perspective arising from research into JISC projects University of Nottingham. Powerpoint presentation. Available from: <www.**jisc**.ac.uk>. [26 May 2011].

Joyes, G., Gray, L. & Hartnell-Young, E. (2010b). Effective practice with e-portfolios: How can the UK experience inform implementation? *Australasian Journal of Educational Technology*, 26(1), 15-27. Available from: http://www.ascilite.org.au/ajet/ajet26/joyes.html

Kalz, M. (2009). Placement support for learners in learning networks.. *SIKS Dissertation Serious No.20009-36*. Open Universiteit Nederlands.

Kaptelinin, V., Kuutti, K. & Bannon, L. (1995). Activity Theory: Basic Concepts and Applications. In Blumenthal et al. (Eds.) *Human-Computer Interaction. Lecture Notes in Computer Science*. Springer.

Kaptelinin, V. & Nardi, B.A. (2006). Acting with Technology: Activity Theory and Interaction Design. MIT Press. Washington DC.

Karrer T. (2007), Understanding E-Learning 2.0. Available from: http://www.learningcircuits.org/2007/0707karrer.html [2008-09-12].

Kemper, M. & de Boer, I. (2006). The implementation of ePortfolio at INHOLLANDUniversity: strategy and implementation issues, two. Presentation at ePortfolio Conference Oxford, 11. th -13th. October 2006. Available from: < http://www.eifel.org/publications/eportfolio/proceedings2/ep06/O3_Kemper_DeBoer.pdf>.Kincsei, A. (2008). Technology and society in the information age. In R. Pintér (Ed.) *Information Society. From Theory to Political Practise. Coursebook*. Gondolat – Új Mandátum, Budapest, pp.47-62.

Kittler, F. (1995). Aufschreibesysteme 1800/ 1900. München.Fink.

Klausmeir, H.J. & Lambert, P. (1961). *Teaching Machines and the Learning Process. Educational Leadership*. Kolo & Breiter, 2009

Klebl, M. (2007). Die Verflechtung von Technik und Bildung – Technikforschung in der Bildung. Available from: www.bildungsforschung.org, 2007.Vol. 2- [12 September 2008]

Kolb, D.A. (1984). Experiential Learning: Experience as the Source of Learning and Development. Englewood Cliffs, N.J: Prentice-Hall, Inc., Available from: http://www.learning-theories.com/experiential-learning-kolb.html

Kolb, D.A. (1984). Experiential Learning: Experience as the Source of Learning and Development. Englewood Cliffs, N.J.: Prentice-Hall, Inc..

Kolo, F. & Breiter, A. (2009): An Integrative Model for the Dynamics of ICT-based Innovations in Education. University of Bremen.Available from: http://www.digitalcultureandeducation.com/cms/wpcontent/uploads/2010/01/dce1019_kolo_breiter_2009.pdf[5 May 2011]

Koohang, A. (2009). A learner-centered model for blended learning design. *International Journal of Innovation and Learning*, 6 (1), 76-91.Inder Science Publishing.

Kozma, R. & Anderson, R. (2002). Qualitative case studies of innovative pedagogical practices using ICT. *Journal of Computer Assisted Learnin*g, 18, 4 387-394. Center for Technology in Learning, SRI International and University of Minnesota: Available from: http://robertkozma.com/images/kozma_anderson_jcal.pdf>[20 March 2011].

Kozma, B.R. (2003a). Global Perspectives – Innovative Technology Integration Practices from Around the World. Available from: http://robertkozma.com/images/kozma_ll_article.pdf>[8 August 2011].

Kozma, R. (2003b). Information and communication technologies and educational change: A global phenomena. In R. Kozma (Ed.), *Technology, innovation, and educational change: A global perspective*. Eugene, OR: International Society for Educational Technology.

Kozma, B.R. (n.d.). Comparative Analysis of Policies for ICT in Education. Internatonal Handbook on Information Technology in Education. Center for Technology in Learning.

Kranzberg, M. (1985). The information age: evolution or revolution. In Guile, Bruce R. (Ed.) *Information Technologies and Social Transformation, National Academy of Engineering*. Washington DC.

Latour, B. (1987). Science in Action: How to Follow Scientists and Engineers Through Society. Milton Keynes: Open University Press.

Latour, B. (2005). Reassembling the Social: An Introduction to Actor-Network-Theory. Oxford: Oxford University Press.

Laurels, B. (1993*). Computers as Theatre.* Addison-Wesley Professional.

Lave, J. (1988). Cognition in Practice: Mind, mathematics, and culture in everyday life. Cambridge, UK: Cambridge University Press.

Lave, J., & Wenger, E. (1990). *Situated Learning: Legitimate Periperal Participation.* Cambridge, UK: Cambridge University Press. Available from: <http://www.learning-theories.com/situated-learning-theory-lave.html>.[08 June 2011].

Law, J. (1987). Technology and Heterogeneous Engineering: The Case of Portuguese Expansion. In W.E. Bijker, T.P. Hughes, and T.J. Pinch (Eds.), *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology.* Cambridge, MA: MIT Press.

Learning Theories Knowledgebase (2011, August). Cognitive Theories at Learning-Theories.com. Retrieved 2 August, 2011. Available from: http://www.learning-theories.com/weiners-attribution-theory.html>.[08 June 2011].

Learning Theories Knowledgebase (2011, August). Activity Theory at Learning-Theories.com. Available from: http://www.learning-theories.com/activity-theory.html .[20 March 2011]

Leont'ev, A.N. (1978). *Activity, Consciousness, Personality*. Englewood Cliffs, NJ, Prentice Hall.

Lewin, K. (1952). Field theory in social science: Selected theoretical papers by Kurt Lewin. London: Tavistock.

Luhmann, N. (2005). Translated by QVARSTRUPP in Seminar.net - *International journal of media, technology and lifelong learning* Vol. 1 – Issue 1 – 2005 12.

Lundvall, B-Å. (ed.) (1992). National Innovation Systems: Towards a Theory of Innovation and Interactive Learning, Pinter, London.

Luppicini, R. (2005). A Systems Definition of Educational Technology in Society. *Educational Technology & Society*, 8 (3), 103-109.

Markham, S. (2008). A SocioCybernetic Approach to Pedagogical Systems. Computing Education Research Group. Technical Report 2008-1. Monash University.

Maier-Rabler, U., Neumayer, C. (2009) Political Education and e-Participation: Technology, Politics and Culture. In: *Proceedings of 3rd Conference on Electronic Democracy EDEM 2009*, September 6 - 8, Vienna

Maletzke, G. (1998). Kommunikationswissenschaft im Überblick. Grundlagen, Probleme, Perspektiven, Opladen Verlag.

Manovich, L. (2001). The Language of New Media. Cambridge: MIT Press, 2001.

Marshall, S., and Mitchell, G. (2002) An E-Learning Maturity Model? In A. Williamson, K. Gunn, A. Young, and T. Clear (eds), *Proceedings of the 19th Annual Conference of the Australian Society for Computers in Learning in Tertiary Education* (Auckland, Australian Society for Computers in Learning in Tertiary Education, 2002). Available from: <http://www.unitec.ac.nz/ascilite/proceedings/papers/173.pdfl [2 May 2011].

Mayer, R.E. & Moreno, R. (1998). A Cognitive Theory of Multimedia Learning: Implications for Design Principles. Available from: http://www.unm.edu/~moreno/PDFS/chi.pdf.[2 September 2010].

Mayer, R.E. (Ed.) (2005). *The Cambridge Handbook of Multimedia Learning*. New York: Cambridge University Press.

Mayntz R. , Hughes, T.H. (2006). The Development of Large Technical Systems. Acls History E Book Project.

McLuhan, Marshall. Understanding Media: The Extensions of Man. New York: McGraw Hill, 1964.

McLuhan, H.M. (1992). Die magischen Kanäle. Understanding Media. Düsseldorf. ECON.

Mcmillan C.K., Honey, M. & Mandinach, E., (2005). A Retrospective on Twenty Years of Education Technol-ogy Policy. *Journal of Educational Computing Research*, 279-307. Available from: http://www2.ed.gov/rschstat/eval/tech/20years.pdf [2 Oct. 2010].

Meyer T. & Schwalbe, C. (2009). Neue Medien in der Bildung.-technische oder kulturelle Herausforderungen.In: Apostolopoulos, N. et al. (eds). E-learning 2009. Lernen im digitalen Zeitalter. Waxmann Verlag.

Merrill, M.D. (1983). Component display theory. In C. Reigeluth (Ed.), *Instructional design theories and models*. Hillsdale, NJ: Erlbaum Associates.

Mioduser, D., Tubin, D., Nachmias, R., & Baruch, A. (2003). Analysis schema for the study of domains and levels of pedagogical innovation in schools using ICT. *Education and Information Technologies*, 8(1), 23-36. Available from: http://muse.tau.ac.il/david/publicationsP.html

Molenda, M., Reigeluth, C.M., & Nelson, L.M. (2003). Instructional Design. In L. Nadel (Ed.), Encyclopedia of Cognitive Science. Vol. 2, pp. 574 - 578. London: Nature Publishing Group.

Moore, g. (1991; edit.2002). Crossing the Chasm: Marketing and Selling High-tech Products to Mainstream Customers.Harper Paperbacks

Morrision, K. (2006). Complexity Theory and Education. *Proceedings APERA Conference 2006 28 – 30 November 2006 Hong Kong*. Available from: <http://edisdat.ied.edu.hk/pubarch/b15907314/full_paper/SYMPO-000004_Keith%20Morrison.pdf> [2 May 2011].

Murray, J. (1997). Hamlet on the Holodeck. Cambridge, MA: MIT Press.

Nardi, B. (Ed.) (1996). Context and Consciousness: Activity Theory and Human-Computer Interaction. Cambridge, MA, MIT Press.

Nelson, R. & Winter, S.G. (1977). In search of useful theory of innovation. In: *Research Policy*, Vol. 6, Issue 1, January 1977, pp. 36-76

Nelson, R. (ed.) (1993), National Innovation Systems. A Comparative Analysis, Oxford University Press, New York/Oxford.

Nelson, R. & Winter, S.G. (1985). An Evolutionary Theory of Economic Change. Belknap Press of Harvard University Press (October 15, 1985)

Nemeth, F.G. (2009) Demand-pull, technology-push, and government-led incentives for non-incremental technical change. In: *Journal Research Policy* 38 (2009) 700–709. Available from: http://www.sage.wisc.edu/pubs/articles/M-Z/Nemet/nemetRP09.pdf.[2-July-2011].

Nicholson, P. (2007). A history of E-learning. Echoes of the Pioneers. Springer. pp. 1-12. Netherlands. Publishing. In Baltasar, Sánchez-Pérez, Gómez-Pulido, Vega-Rodríguez & Bravo-Rodríguez (Eds.). *Computers and Education: E-learning, From Theory to Practice.* . Springer. Heidelberg.

Nolan, R. (1973). Managing The Crisis In Data Processing. *Harvard Business Review* 57 (2): 115–126.

Nuissl, (n.d.). Pedagogical innovation –Erwachsenenbildung Available from: http://www.diezeitschrift.de/197/nuissl97_01.htm

Nygen, F. (2007). The interaction between technologies and society: Lessons learned from 160 evolutionary years of online news services. Available from: http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/1627/1542.[5 September 2010].

Denzin, N.K. (1992). Symbolic interactionism and cultural studies. The politics of interpretation. Oxford, CA: Blackwell.

Norman, D.K. (1997). Interpretive ethnography. Ethnographic practices for the 21st century. London : Sage.

OECD (1997). National Innovation System. Paris: OECD.

OECD (1999). Managing National Systems of Innovation. Paris: OECD.

OECD (1997 1st. edt.; 2005 a 3rd ed.). The measurement of scientific and technological activities proposed guidelines for collecting and interpreting technological innovation dat. OSLO MANUAL. Available at: http://www.oecd.org/dataoecd/35/61/2367580.pdf

OECD Education at a Glance)2005–2010a). Paris. OECD.

(OECD Policy Brief 2005b). E-learning in tertiary education. Paris. OECD.

OECD (2005c) E-Learning in Tertiary Education: Where Do We Stand? Paris: OECD

OECD, 2007 Knowledge Management. Evidence in Education. Linking research and policy. Paris.OECE.

OECD-CERI Report, (2009a). Working Out Change. Systemic innovation in vocational education and training.

OECD-CERI Report (2009b). Beyond textbooks. Digital learning resources as sytemic innovatin in the nordic countries.

Oerter, R. & Dreher, E. (2002). Jugendalter. In Oerter, R. ; Montada, L. (Hrsg.), Entwicklungspsychologie (S. 258-318). Weinheim: Beltz/PVU.268 in Batininc-Appelt (2008: pp.362).

Oliver, R. (2002). The role of ICT in higher education for the 21st century: ICT as change agent for education. Conference Proceedings HEI.

Patterson, D., Jung, G., Broadhead, G. & Renate Halton (2011). Summary Report: The UK e-learning market 2010 Including a snapshot analysis on 19 European markets. Available from: http://www.e-learningcentre.co.uk

Panke, S. (2006). *Medientheorien des Computers*. Report. Available from: http://www.eteaching.org/didaktik/theorie/medientheorie/Medienthoerien_sp_16.02.06_27.7.06.pdf

Pasuchin, I., Häcker, T. (2008): Lernen 2.0 in politökonomischen Kontexten am Beispiel des Portfolioansatzes. In: *Journal merz/ medien und erziehung*, 08-2, p.30-36.

Perez, C. (2002). Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages. UK: Edward Elgar Publishing Limited.

Peschl. M.F. (2009). Innovation as collaborative socio-epistemological technology. In: Hornung-Prähauser, V., Luckmann M., (eds.. (2009). *Kreativität und Innovationskompetenz im digitalen Netz. EduMedia Tagungsband*. Norderstedt: Salzburg Research Forschungsgesellschaft/ Books on Demand GmbH. (pp. 46-67)

Piaget, J. (1951). *The Psychology of Intelligence*. London: Routledge and Kegan Paul.

Piaget, Jean. (1973). To Understand is to Invent. New York: Grossman.

Pintér, R. (Ed.) (2008). *Information Society. From Theory to Political Practise. Coursebook*. Gondolat – Új Mandátum, Budapest. Book available at: http://www.ittk.hu/netis/teachm.htm

Pinch, T.J. & Bijker, W.E. (1984). The Social Construction of Facts and Artefacts: Or How the Sociol-ogy of Science and the Sociology of Technology Might Benefit Each Other. *Social Studies of Science* 14 (August 1984): 399-441.

Poser, H. (2001). Wissenschaftstheorie. Eine philosophische Einführung. Reclam GmbH&Co. Stuttgart. Germany

QAA (2001) Guidelines for HE progress files. Available at: http://www.qaa.ac.uk/academicinfrastructure/progressFiles/guidelines/progfile2001.asp.>[5 May 2011].

QAA (2009) *Personal development planning: guidance for institutional policy and practice in higher education*. Available at: http://www.qaa.ac.uk/academicinfrastructure/progressfiles/guidelines/pdp/pdpguide.pdf> 5 May 2011].

Raffl. C., Hofkirchner, W., Fuchs, C. & Schafranek, M.(2008.). The Web as Techno-Social System: The Emergence of Web 3.0. In: Trappl, R. (ed.*), Cybernetics and Systems 2008, Proceedings of the Nineteenth European Meeting on Cybernetics and Systems Research, organized by the Austrian Society for Cybernetic Studies,* held at the University of Vienna, 25-28 March 2008, Proceedings:Austrian Society for Cybernetic Studies, 604-609. Available from: http://www.hofkirchner.uti.at/icts-wh-profile/pdf39.pdf. [5 May 2011].

Rammert, W. (1993). Konturen der Techniksoziologie. Begriffe, Entwicklungen und Forschungsfelder einer neuen soziologischen Teildisziplin. In Rammert, W. (Ed.). *Technik aus soziologischer Perspektive, Forschungsstand – Theorieansätze – Fallbeispiele. Ein Überblick*. Opladen. Westdeutscher Verlag, 9-27.

Rammert, W. (1999). Relations that constitute technology and media that make a difference: Toward a social pragmatic theory of technicization. *Journal PHIL & TECH* 4:3 Spring, 1999.

Reich, K. (1999; 2006) Konstruktivistisches Didaktik. Beltz; Auflage: 3.,

Reich, K., Sehnbruch, L. & Wild, R. (2005). Medien und Konstruktivismus: Eine Einführung in die Simulation als Kommunikation.Waxmann.

Renner, K.H. (2008). Theoretische Perspektiven für die Medienpsychologie. In B. Batinic & M. Appel (eds). *Medienpsychologie.* Heidelberg: Springer Medizin Verlag.. pp.77-107.

Richardson, H., & Ward, R. (2005). *Developing and Implementing a Methodology for Reviewing E-portfolio Products.* A report to the JISC, encompassing a review of existing e-portfolio software applications in use in the UK, and a synthesis of literature reviews on e-portfolio systems. The Centre for Recording Achievement.

Raffl, C., Hofkirchner, W. , Fuchs, C. & Schaffranek, M. (n.d.). *The Web as Techno-social system: the Web 3.0*. (pre-paper).

Reigeluth, C.M. (1983). Instructional design: What is it and why is it? In C.M. Reigeluth, (Ed.), *Instructional-design theories and models: An Overview of their current status* (Vol. 1, pp.3-36). Hillsdale, NJ: Erlbaum.

Reigeluth, C. M. (1993). Principles of educational systems design. *International Journal of Educational Research,* 19 (2), 117-131.

Reinmann, G. (2006). Nur "Forschung danach"? Vom faktischen und potentiellen Beitrag der Forschung zu alltagstauglichen Innovationen beim E-Learning (Arbeitsbericht Nr. 14). Augsburg: Universität Augsburg, Medienpädagogik.

Reinmann, G. (2010). Studientext Didaktisches Design. München. Available from: URL: http://lernen-unibw.de/studientexte

Rogers, E.M. (2003). *Diffusion of Innovations*, 5th Edition. Free Press; 5th edition. Older versions: areRogers, E. M. (1962 1st; 1983 3rd ed.; 20035th ed.). *Diffusion of innovations*. New York: Free Press

Rubens, W. & Kemps, A. (2007). The ePortfolio landscape in Dutch higher education (2006 pp.13-21). In W. Aalderink & M. Veugelers (Eds.). *Stimulating Lifelong Learning: The ePortfolio in Dutch Higher Education*. (pp. 13-22). Stichting SURF. Available from: <http://www.surffoundation.nl/SFDocuments/Stimulating%20Lifelong%20Learning%20-%20ePortfolio.pdf >. [26 May 2011].

Ryan, R.M., & Deci, E.L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55, 68-78. Available from: <http://www.psych.rochester.edu/SDT/theory.php>. [26 May 2010].

Qvortrup, L. (2005). Society's Educational System – An introduction to Niklas Luhmann's pedagogical theory. Seminar.net – *International journal of media, technology and lifelong learning*, Vol. 1 – Issue 1 – 2005 Availabel from: http://seminar.net/files/LarsQvortrup-SocietysEdSystem.pdf

Salomon, G. (1997). *Distributed cognitions: Psychological and educational considerations.* Cambridge University Press. Cambridge.

Schaffert, S., Hornung-Prähauser, V., Hilzensauer W. & Wieden-Bischof, D. (2007). E-Portfolio-Einsatz an Hochschulen: Möglichkeiten und Herausforderungen. In: Brahm & Seufert (Eds.) *"Ne(x)t Generation Learning": E-Assessment und E-Portfolio: Halten sie, was sie versprechen?* SCIL-Arbeitsbericht 13, Universität St. Gallen, Schweiz, (pp.74-89.)

Sampaio, C.H. & Perin, M.G. (n.d.). The impact of organisational learning on innovation.

Sandbothe, (2000) Interactivity - Hypertextuality – Transversality. A Media-Philosophical Analysis of the Internet. Hermes. Journal of Linguistics, Vol. 24, edited by Carlo Grevy, February 2000.Available from: http://www.sandbothe.net/241.html> [8 May 2011]

Sargut G. & Mcgrath, R.G. (2011). Mit Komplexität leben lernen. In: Strategien für eine komplexe Welt. Harvard Business Manager. Nov. 2011. Year 33.

Scardamalia, M., Bereiter, C., & Lamon, M. (1994). 'The CSILE project: Trying to bring the classroom into World 3.' In K. McGilly (Ed.), *Classroom lessons: Integrating cognitive theory and classroom practice* (pp. 201-228). Cambridge, MA: MIT Press.

Schein, E.H. (1989).Organizational Culture: What It Is and How To Change It. *Human Resource Management in International Firms.* Eds. P. Evans, Y. Doz, and A. Laurent. London: Macmillan, 1989

Schein, E.H. (1996). Three Cultures of Management: The Key to Organizational Learning. *Sloan Management Review* 38:1 (Fall 1996): 9-20.

Schulmeister (2002) Schulmeister, R.: Grundlagen hypermedialer Lernsysteme – Theorie, Didaktik, Design. Oldenbourg Verlag, München, Wien 2002.

Schulmeister (2005) Schulmeister, R.: Lernplattformen für das virtuelle Lernen – Evaluation und Didaktik. Oldenbourg Verlag, München, Wien.

Schulmeister, R. (2006) Schulmeister, R.: eLearning: Einsichten und Aussichten. Oldenbourg Verlag, München, Wien 2006.

Schulmeister (2011) Generation upload Available from: http://www.zhw.uni-hamburg.de/uploads/generation-upload.pdf

Schumpeter, J.A. (1934): The Theory of Economic Development, In *13th Printing 2007*, New Jersey: Transaction Publishers.

Schulz-Schäfer, I. (2006). Introduction: What Comes after Constructivism in Science and Technology Studies. *Science, Technology & Innovation Studies*, Special Issue 1, July 2006 Available from: STI Studies www.sti-studies.de

Scott D. et al. (2008). Innovator's Guide to Growth: Putting Disruptive Innovation to Work .Harvard Business Press.

Senge, P. M. (1990) The Fifth Discipline: The Art and Practice of The Learning Organization. New York: Doubleday, 1990.

Seufert, S. & Miller, D. (2003): Nachhaltigkeit von eLearning-Innovationen: Von der Pionierphase zur nachhaltigen Implementierung. Available from: http://www.medienpaed.com/03-2/seufert1.pdf > [23 July 2011].

Seufert, S. & Euler, D. (2004). Nachhaltigkeit von eLearning-Innovationen. Ergebnisse einer Delphi-Studie. SCIL-Arbeitsbericht 2. Januar 2004.

Siemens, G. (12 December 2004). A Learning Theory for the Digital Age. Available from: http://www.elearnspace.org/Articles/connectivism.htm

Simsek, N. (2005). Perceptions and Opinions of Educational Technologists Related to Educational Technology. *Educational Technology & Society*, Vol. 8, No. 4, 178-190.

Skinner (1950). Skinner, B. F. (1950). Are theories of learning necessary? Psychological Review, 57, 193–216.

Šmihula, D. (2009). The waves of the technological innovations of the modern age and the present crisis as the end of the wave of the informational technological revolution, Studia politica Slovaca, 1/2009, Bratislava, ISSN-1337-8163, pp. 32-47

Sporn, B. (2003).Convergence or Divergenc in International Higher Education Policy: Lessons from Europe. Publications from the Forum for the Future of Higher Education. http://net.educause.edu/ir/library/pdf/ffp0312s.pdf

Solow, R.M. (1956). A Contribution to the Theory of Economic Growth. In: Quarterly Journal of Economics, Band 70, 1956, S. 65–94.

Stokols, D., Fuqua, J., Gress, J., Harvey, R., Phillips, K., Baezconde-Garbanati, L., Unger, J., Palmer, P., Clark, M.A., Colby, S.M., Morgan, G. & Trochim, W. (2003). Evaluating transdisciplinary science. Available from: http://www.socialresearchmethods.net/research/Evaluating%20Transdisciplinary%20Science.pdf

Stowasser W.& Petschenig M. (1980). Der kleine Stowasser. Lateinisch-Deutsches Schulwörterbuch.Wien.Hölder.

Strivens, J. (2007). A survey of e-pdp and e-portfolio practice in UK higher education. Available from: http://www.heacademy.ac.uk/assets/York/documents/ourwork/tla/personal_devel opment_plan/survey_of_epdp_and_eportfolio_practice_in_uk_higher_education.pdf [3 November 2010].

Strivens, J.& Ward, R. (2010): An overview of the development of Personal Development Planning (PDP) and e-Portfolio practice in UK higher education. Journal of Learning Development in Higher Education ISSN: 1759-667X. Special Edition: Researching PDP Practice, November 2010.

Somekh, B. (2007) The Interplay between Policy and Research in relation to ICT in Education in the UK: Issues from Twenty years of Programme Evaluation, in Saunders, L. (ed) Educational Research and Education Policy-Making London and New York: Routledge

Süss, D. (2004). Mediensozialisation und Medienkompetenhz in Batinic, B. & Appel, M. (2008). Medienpsychologie. Heidelberg: Springer Medizin Verlag. Chap. 15. 362-379).

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, 12(2), 257–285.

Swertz, C.(2009): Medium und Medientheorien. In: Meder, Norbert; Allemann-Ghionda, Christina; Uhlendorff, Uwe: Umwelten. Sozialpädagogik/Medienpädagogik/Interkulturelle und Vergleichende Erziehungswissenschaft/Umweltpädagogik. Handbuch der Erziehungswissenschaft Band III/2: Ferdinand Schöningh: Paderborn u.a., S. 751-780. and available: http://homepage.univie.ac.at/christian.swertz/

Sydow, J. (1992): Strategische Netzwerke - Evolution und Organisation. Gabler. Wiesbaden. (5. Nachdruck 2001).

Szabo, M. & Sobon, A.S (2003). A Case Study of Institutional Reform Based on Innovation Diffusion Theory Through Instructional Technology. *Canadian Journal of Learning and Technology*, Volume 29(2) Spring 2003. Available from: <http://www.cjlt.ca/index.php/cjlt/article/view/42/39> [5 August 2011]

Taylor, John E. and. Levitt, Raymond E (2004). A New Model for Systemic Innovation Diffusion in Project-based Industries. CIFE Working Paper #WP086.

Teece, D.(2008). Special Section: Technological Paradigms: Past, Present and Future: Dosi's technological paradigms and trajectories: insights for economics and management ICC (2008) 17(3): 507-512.

Tertel, J. Blog-Entry (January 26, 2010): *Marketing Strategies for Innovation*. Available from: http://www.jplcreative.com/blog/index.php/2010/01/26/marketing-strategies-for-innovation [5 August 2011].

Tubin, D., Mioduser, D., Nachmias, D. & Forkosh-Baruch, A. (2003). Domains and Levels of Pedagogical Innovation in Schools Using ICT: Ten Innovative Schools in Israel. In: *Education and Information Technologies Journal*.8:2, 127–145, 2003. 2003 Kluwer Academic Publishers. Netherlands.

Veugelers, M. & Chen, H.L. (2010). Implementing ePortfolios: An international perspective on challenges and successes. Presentation atAAEEBL conference July 2010.Vygotsky, L.S. (1978). *Mind and society: The development of higher mental processes.* Cambridge, MA: Harvard University Press. Available from: http://www.psy.cmu.edu/~siegler/vygotsky78.pdf

Vygotsky, L.S. (1978). *Mind and society: The development of higher mental processes.* Cambridge, MA: Harvard University Press.

Watson, D. (2006: 212). Understanding the relationship between ICT and education means exploring innovation and change. Educ Inf Technol (2006) 11: 199–216. Springer Science + Business Media, LLC 2006. Available from: http://users.ntua.gr/vvesk/ictedu/article7_watson.pdf

Wertsch, J.V. & Sohmer, R. (1995). Vygotsky on learning and development. *Human Development*. (38) 332-37.

Weidenmann, B. 2002: Multicodierung und Multimodalität im Lernprozuss. In L.J. Issing, & P. Klimsa, (Eds.) *Information und Lernen mit Multimedia und Internet*. BeltzPVU, Weihnhein 45-62. (IN Postemdiale wirklichkeit)

Wehnes, F.J. (2001). Theorie der Bildung – Bildung als historisches und aktuelles Problem. In Roth, Leo (Ed.) *Pädagogik: Handbuch für Studium und Praxis.* München. S. 277–292. Available from: <http://miami.uni-muenster.de/servlets/DerivateServlet/Derivate5705/studium_im_alter_diskurs_winter_2009.pdf>. [23 June 2011]

Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. *Annual Review of Sociology*; 2002; 28, ABI/INFORM Global pp. 297.

Westley, F. & Nino, A. (2010). Making a Difference: Strategies for Scaling Social Innovation for Greater Impact, *The Innovation Journal: The Public Sector Innovation Journal*, Vol. 15 (2). Available from: http://www.esse.unibo.it/paper.pdf

Wertsch, J.V. & Sohmer, R. (1995). Vygotsky on learning and development. *Human Development*. (38) 332-37.

Weyer, J.(1997). Vernetzte Innovationen-innovative Netzwerke. In: Rammert & Bechmann (eds). Innovationen-Prozesse, Produkte, Politik (Technik and Gesellschaft, Jahrbuch 9. Frankfurt a.Main. Campus. Pp125-152.

Weyer, J. (2008). *Techniksoziologie. Genese, Gestaltung und Steuerung sozio-technischer Systeme*. Juventa Verlag Weinheim und München.

Willams & Edge (1996). The Introduction to paper: The social shaping of technology. . *Research Policy* Vol. 25, (1996) pp. 856-899 Available from: http://www.rcss.ed.ac.uk/technology/SSTRP.html

Wilson, B., Sherry, L., Dobrovolny, J., Batty, M., & Ryder, M. (2001). Adoption factors and processes. In H.H. Adelsberger, B. Collis, & J.M. Pawlowski (Eds.), *Handbook on information technologies for education & training* (pp. 293-307). New York: Springer-Verlag.

Winston, N. (2007). Let Them Eat Laptops: The Limits of Technicism. *International Journal of Communication*, 1 (170-176.)

Winston, B. (1998). *Media, Technology and Society. Media Technology and Society: A History From the Telegraph to the Internet*. London/New York: Routledge.

Winner, L. (1993). Social Constructivism: Opening the Black Box and Finding It Empty. *Science as Culture*, Vol. 3, part 3, No. 16, 427–452.

Yin, R. (1994). *Case study research: Design and methods* (2nd ed.). Thousand Oaks, CA: Sage Publishing.

Zaman G. & Goschin G (2010). Multidisciplinarity, Interdisciplinarity and Transdisciplinarity: Theoretical Approaches and Implications for the Strategy of Post-Crisis Sustainable Development. *Theoretical and Applied Economics.Volume XVII (2010), No. 12(553), pp. 5-20.*

Zimmerman, B.J. (1990). Self-regulated learning and academic achievement: An overview. *Educational Psychologist*, 25, 3-17.

Voogt, J. & Knezek, G. (2008). International Handbook of Information Technology in Primary and Secondary Education: Preliminary Entry 2.0.Springer International.

Whitton, N. (2007). Motivation and computer game based learning. In ICT: Providing choices for learners and learning. Proceedings ascilite Singapore 2007. Available from: http://www.ascilite.org.au/conferences/singapore07/procs/whitton.pdf.> [7 July 2011]

Zellweger Moser, F. (2007). Faculty Adoption of Educational Technology. Educational technology support plays a critical role in helping faculty add technology to their teaching. *Educause Quarterly*. Vol. 30 No.1.

Zemsky, R. & Massy, W.F. (2004). Thwarted Innovation. What Happened to e-learning and Why. Final Project Report. The Learning Alliance at the University of Pennsyvlania.

Annex:

Thesis declaration

Hiermit versichere ich an Eides statt, dass ich die vorliegende Dissertation ohne fremde Hilfe und ohne Benutzung anderer als der angegebenen Quellen und Hilfsmittel angefertigt und die den benutzten Quellen wörtlich oder inhaltlich entnommenen Stellen als solche kenntlich gemacht habe. Diese Arbeit wurde in gleicher oder ähnlicher Form noch bei keiner anderen Prüferin/ keinem anderen Prüfer als Prüfungsleistung eingereicht. Mir ist bekannt, dass Zuwiderhandeln mit der Note „nicht genügend“ (ohne Möglichkeit einer Nachbesserung oder Wiederholung) geahndet wird und weitere rechtliche Schritte nach sich ziehen kann. Diese Arbeit wurde neben der gedruckten Version auch auf CD-Rom zur Prüfung der o.g. Erklärung bei der zuständigen Prüferin/dem zuständigen Prüfer hinterlegt.

——————————————— ——————————————————

Date: 12. 12. 2011, Salzburg, Austria