GÁBOR KISMIHÓK

# FLEXIBLE LEARNING, FLEXIBLE WORKING

# EXPLOITING THE POTENTIALS OF ONTOLOGY BASED CONTENT MANAGEMENT

Department of Information Systems

Supervisor

Dr. András Gábor

Corvinus University of Budapest
Management and Business Administration Doctoral Programme

# Flexible Learning, Flexible Working

# Exploiting the Potentials of Ontology Based Content Management

PhD theses

by

Gábor Kismihók

CUB, Department of Information Systems

Supervisor

Dr. András Gábor

Budapest, 2011

## CONTENTS

## LIST OF FIGURES

# LIST OF TABLES

# PART I
# Research Model

# INTRODUCTION

## MOTIVATION

Education has never been as important as today. Traditional forms of education have never been in such a difficult situation as today. These two sentences sound incoherent, but they aren't. They show the emerging crisis in present education. Talking about our outdated, inefficient or even disastrous educational system is nothing new (Robinson 2008; Prensky 2007; Sharples 2006; Ala-Mutka, Punie, et al. 2008; Downes 2005), as our knowledge based society is getting more and more complex, and we need to come up with new, efficient ways of learning. Academics and practitioners have been discussing various types of reforms on different levels of education for many years. Some of them suggest improvements in the current system, some pronounce that incremental changes are necessary and there are thinkers saying that the paradigm of current education should be changed.

An inspiring talk of Sir Ken Robinson (2008) also targeted a paradigm shift in present education. In the years of "*digital natives and digital immigrants*" (Prensky 2007), educational systems created in the years of enlightenment don't work anymore. Systems constructed for serving the industrial revolution were once novel and revolutionary, but now they are dated and screaming for fundamental reform. Current forms of formal education are not sustainable, not efficient and not flexible enough to meet the criteria of the digital, knowledge based society in the 21$^{st}$ century.

There is a forceful impact of technology on our life these days. This impact is everywhere, as our life is moving towards a digital world, where Information Technology (IT) will be – or already is – part of our everyday life (both private and professional lives). Education is not an exception, which results in that learning has never been so easy, but also never been so difficult as nowadays. ELearning has been booming in the last 20 years, educational institutions invest remarkable amount in educational IT infrastructure, digital content and underlying IT infrastructure. These systems however – of course with significant benefits – are still supporting the old industrial model.

There are signs however, which show that this technology driven society demands something different, than the traditional academic style classroom education. One important indicator is the rise of informal education. Networked technologies, the internet and its services now enable learners to get personalised information about subjects they are interested in regardless of time and geographical location. This personalised content is a key issue and a big difference compared to the bulk-learning practices of traditional education systems. Learners need flexibility, personalised content and services in their learning. Educational organisations should be aware of this phenomenon and get accustomed to the growing need of mass-customized learning. Both Robinson and Prensky say that education should concentrate more on learners, having different interests, different values and different goals in life. These learners also articulate their demands, what education should fulfil and serve. With the help of Information Technology these people can identify, access and consume learning content, which suits their needs the best.

Learners are also more mobile nowadays. They are owners of mobile technology – pocket-sized, personal devices, which are used for telecommunication and content delivery –, which ownership comes with a flexible lifestyle, requires constant changes in their geographical location. Travelling and commuting, distance working and mobile entertainment are more and more a getting into the daily practice of these citizens. Nevertheless mobile technology based educational services are still far away from being a daily practice. Again, this technology driven flexible, personalised education don't really fit into the traditional systems.

As a result of networked and mobile information technologies the digital natives of our society live in a world of constant collaboration. These people talk, share, experience together with their peers using social software on many technical platforms (desktop, mobile, digital TV, etc...). This collaboration has a huge impact on learning. Research shows that collaborative learning can significantly improve problem solving, critical thinking and the general quality of learning outcomes (Gokhale 1995; Vygotskiĭ 1978). But again, traditional educational settings can't really cope with this IT inducted collaboration. A good indicator of this is the growing importance of standardised testing, which hardly ever considers the ability of learning with peers (Kohn 2000).

Moreover, it is important to emphasize that education is not a stand-alone system! Its output has serious implications on workplaces, on labour markets and of course on the general well being of individuals and societies. For this reason, it is advisable to create more links, more collaboration between these overlapping and interdependent domains.

Answering all the issues above would be a work of a lifetime, which definitely needs more consideration than a 'simple' PhD Theses. Therefore in this piece of work I am trying to demonstrate a possible way of how technology enhanced learning can assist learners and educators in order to work with personalised educational content in several different contexts (formal education, workplace learning, selection and recruitment).

### STRUCTURE OF THIS BOOK

As it is visible in Figure 1, this work has five main parts, all around the – I believe revolutionary - idea of ontology based learning content management. I have been working on and with this ontology based learning content management system in the past 6 years, therefore I have enough ammunition to share results and thoughts about this approach. This work has been emerging from selected research and development projects on the social implications of eLearning, on the role of mobile technology in education and on intermediary processes between education and the labour market.

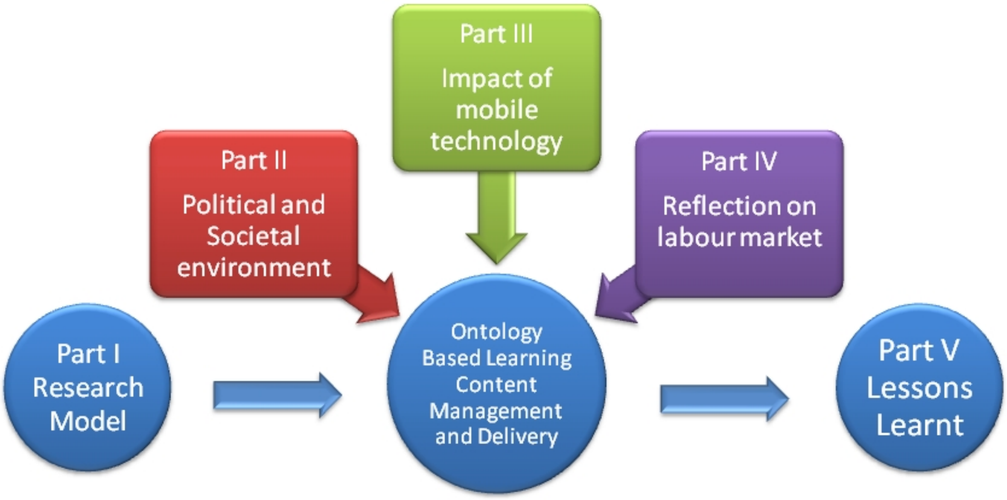



**Figure 1: Structure of this book**

In the first part I will detail what research methods and models have been followed during the various studies I have been engaged with in the past 6 years (see Figure 3). That includes a conceptual framework concerning each project and their interrelatedness, thus the most important research questions – theses – are formulated there. I will also show the range of applied research methods in that section.

The second part of this work discusses the political and societal environment of eLearning. I will detail the results of two research projects in that section. The first one is a comparative study of ten European countries regarding the current state of art in eLearning (eLearning in EU10 project). The second one investigates the role of mobile technologies in lifelong learning with an evidence based approach (Motill project). Both aspects are crucial if we want to put our system development activities into a wider context.

In the third part, I will talk on one hand about the impact and implications of mobile technology on learners (IMPACT project) and on the other hand – based on these findings – how did we set up and verified a mobilised, ontology based learning content management and delivery system (mStudio).

The fourth part goes further and demonstrates two pilot projects, which enlarge the scope and the potential of the novel content management system detailed in the third part. These two approaches are the contextualisation of learning (Contsens Project) and the establishment of linkages to the world of labour (OntoHR Project).

I finish my work with part five, which includes my conclusions pertaining the theses and the other relevant research outputs. I will also give some possible ideas of future research to show how one can exploit the potential of these cutting edge content management systems.

## ACKNOWLEDGMENTS

I would like to show gratitude for my supervisor, András Gábor, for his trust and support during the years of my research. His push towards the field of eLearning and project-based research contributed and will contribute significantly to my research and to my professional carrier. I would also like to say thank you to the faculty members of the Department of Information Systems, at the Corvinus University of Budapest, especially to those I closely collaborated with on my projects. This book wouldn't be complete if Réka, Barna, Zoli, Ildi and Bálint were not behind me. I am also grateful to Zoli for his efforts on translating this long document.

The same goes also to the staff of the Amsterdam Business School, at the University of Amsterdam, especially to the HRM-OB department. They welcomed me and my 'strange' ideas about eLearning with arms wide open. Special thanks go to Stefan as partner in hard work but also in quality leisure time and to Jan and Dianne who provided me the possibility to be a guest researcher in Amsterdam. I also need to show appreciation for Niamh, Joris and Hella for all the beers and fun time at the UvA.

In addition, I would like to thank to all the people I collaborated throughout the various projects. Besides hard working, international friendships have been established! From this crowd I must express special thanks to Desmond, Judy, Ber, Macu, Fintan, Agnes, Damjan, Nevena, Renáta, John, Carl, Claire, Valentina and Bernd. Furthermore, I'm grateful to the European Commission[1] for its funding for most of this research. This funding includes the following projects MOTILL[2], IMPACT[3], CONTSENS[4], PLATO[5] and ONTOHR[6].

Last but not at least I want to say how important the support was from my beloved partner Svenja-Marei, who gave me strength, power and self reflection during my research. A big thank you goes also to my mum, dad and to my sister Judit. Without them in the background this work would have been impossible to finish.


[1] This communication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein. Projects listed here were financed under the Lifelong Learning Programme:

[2] http://www.motill.eu

[3] http://www.ericsson.com/impact

[4] http://www.ericsson.com/contsens

[5] http://deis.ie/previous/plato/

[6] http://www.ontohr.eu

# PART I – RESEARCH MODEL

## RESEARCH CONFIGURATION

Human Resource Management (HRM) and Information Technology (IT) supported education and training have never been so close to one another as nowadays. Scientists and academics in both fields have started to recognize the interdependencies of these fields. A growing number of publications tackle the possible interactions and collaboration possibilities (Biesalski & Abecker 2008; Mochol et al. 2007; Reich, Brockhausen, Lau & Reimer 2002a; A. Schmidt & Kunzmann 2006; A. Schmidt et al. 2009). This has led to many exciting new questions and a search for models and theories, which are valid in all fields and which will create a strong foundation for collaboration among researchers.

Moreover, given the fundamental nature and the scope of this multidisciplinary subject, the societal (Lifelong Learning) and the Industrial relevance (hands on, usable models and systems in everyday business processes) of such an endeavour is substantial, and its results will eventually feed through into society and into the corporate sector. By working at the cutting edge of HRM and KM supported learning systems, it is likely to attract great international interest, with the added scientific benefit of advancing this new intersectoral field in Europe, where structural unemployment is a great risk emerging from the global financial crisis. As it will be visible, this research also attempts to address this problem. As a result of this collaboration the theoretical and empirical foundations of an innovative job-qualifications matching system in a mobilised learning environment will be elaborated. Using this envisaged system, students and/or employees can assess their job knowledge against criteria of possible fields of employment, getting detailed information about their knowledge gaps. This enables them to target their learning efforts in order to gain or regain employment. Figure 2 shows the configuration of this research.

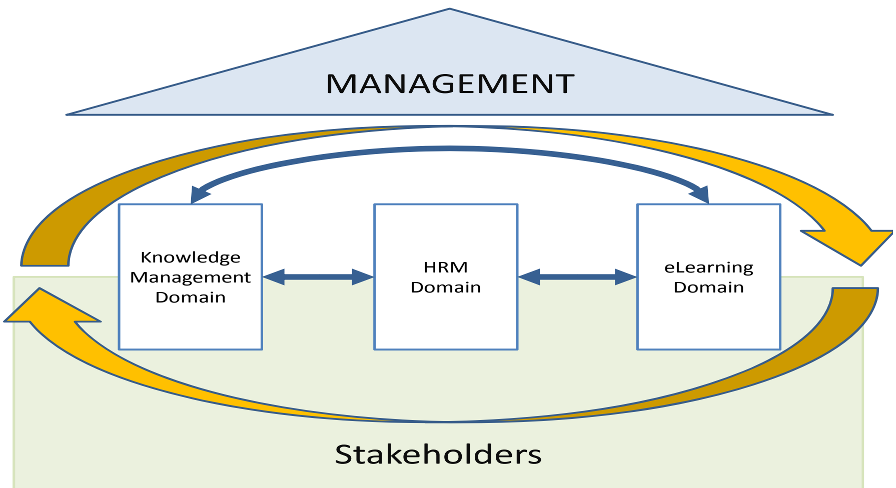



**Figure 2: Research Configuration**

This multi-domain research is highly interdisciplinary:

- HRM Domain is dealing with issues regarding selection, recruitment, managerial issues emerging from corporate trainings, social attitudes towards employment and training.
- Knowledge Management Domain has an emphasis on semantic applications and ontologies.
- eLearning Domain considering mobilised learning environments, incubating perspectives from Lifelong Learning, Context Sensitive Learning, Adaptive Learning Systems integration and Content Authoring issues.

There are experts, professors helping me in my work from all domains. These people have remarkable prior experience and knowledge on the given field with appropriate scientific research results. This domain based research challenges the theoretical foundations, aiming to develop new models for adaptive content management in many contexts, like selection and recruitment. The detailed description of the research objectives can be found in the subsequent sections. Although the theoretical work is domain specific, there are means in the project, which foster horizontal collaboration between the domains. This collaboration is indicated by the blue arrows (see Figure 2). Stakeholders (governments, industry, higher and vocational education) are connected to all domains, as the outputs, (described also in the sections, chapters below) should be leveraged into real, valid scenarios in case of success. These stakeholders do not only benefit from the results of academia, but also contribute with knowledge and information about the characteristics of their problems and expectations on the fields, in which the various results will be applied (orange arrows show this information flow). When deciding on research questions, the emphasis was on interdisciplinary and intersectoral issues, such as:

- Improving the accurate assessment of job performance by adequately mapping the knowledge, skill and ability requirements for jobs
- Content, construct and criterion related validity validation approaches
- Greater theoretical understanding of the work process connected to job-roles
- Better mapping of students and employees to changing contexts
- Using technology to provide a mobile environment for learning and self assessment/development
- Incorporating semantic applications and business intelligence solutions to learning organisations
- Benefiting from ontologies in education

This research has been financed by a chain of research projects by the European Commission, which projects give also the foundation of this thesis. Altogether six projects have been carried out in the frames of this research idea. Half of them were analytical studies in order to identify several influencing factors on learning content management. The other half were projects, aiming for evidences to validate our ontology based content management approach (See Figure 3).

The first three studies were analysing and scaffolding the underlying political and societal factors essential for our system development. This work includes:

- A state of the art investigation about current eLearning trends in 10 European Union countries in comparison with the general performance of the European Union in the selected variables (eLearning in EU10).
- Setting up a framework about evaluating the importance and the impact of mobile technology on European lifelong learning actions. This evidence-based approach includes the development of an evaluation methodology and a set of good practices in this domain (Motill).
- The last analytical study concentrates on the impact of mobile technology and eLearning on learners, as it is critical to know, how they perceive our approach and what do they think about mobile technology in learning in general (Impact).

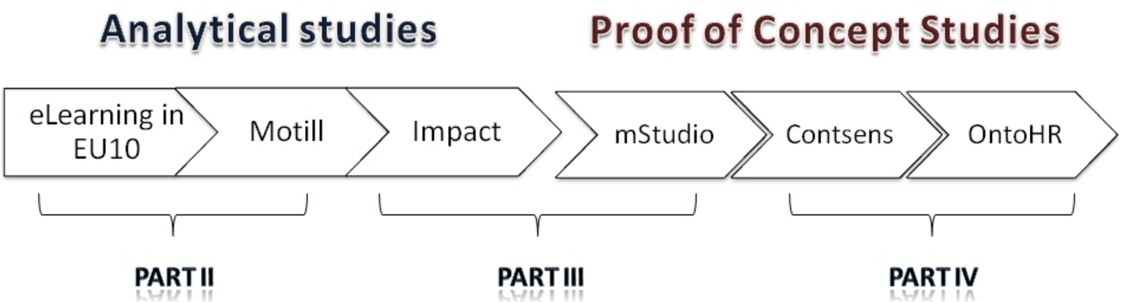



**Figure 3: Studies in this book**

After scaffolding the concept with analytical studies, three pilots have been organised in order to prove the concept of this mobilised learning content management system:

- A pilot study has been conducted about integrating a mobile interface and mobilised content delivery technology into the ontology based content management system (mStudio)
- The second study is investigating whether the incorporated mobile technology is capable of handling different learning contexts (from the learner's point of view) or not (Contsens).

- Finally it was attempted to enlarge the scope of this application and set it up as a selection and recruitment software. Regarding to this attempt the customization and the integration of workplace related concepts have been a key issue (OntoHR).

## THESES

As it is visible from the previous pages, in this research I want to investigate the following problems:

- How did mobile learning manage to break in the world of education? What are the student's attitudes towards this technology?
- How semantic educational applications delivered by mobile technology impact on Higher Education qualifications measurement and workplace enrolment?

These questions cover the complete cycle of a learner's educational activity from competency testing, through context based learning content delivery, until job-role suitability assessment in a mobilised learning environment.

### Mobilised Learning Environment (MLE)

Fascinating questions arising when we take a closer look at Mobilised Learning Environments. Are these MLEs still in their infancy or did they make a step forward towards being an everyday learning experience? What do students and teachers think about mobile Learning? The extant literature of the impact of technology on learning is fragile and inconclusive according to the view of the World Bank (InfoDev 2005) in the USA and the Becta in the UK (Cox et al. 2003a; Cox et al. 2003b). These detailed researches of literature show that what research has been carried out is nearly all on the impact of technology on pupils in schools. There is little or nothing on higher education, on adult education, on lifelong learning or on distance learning. This research situation is unacceptable in an area that is costing European governments millions of Euros annually.

One of the major manifestations of the use of technology in education is lifelong learning, where use of technology is essential. The European Union therefore financed an empirical research project (IMPACT[7]), which aimed to fill the missing research areas on the following fields:

- Distance education – the provision of education and training at a distance by Open Universities, distance education institutions and distance education departments of conventional institutions

[7] http://www.ericsson.com/impact

- E-learning – e-learning is the provision of education and training via the World Wide Web (WWW) for students who study mainly as individuals using Learning Management Systems (LMS) like SumTotal and Blackboard
- Synchronous e-learning systems – these are the provision of education and training on the WWW to students who study mainly in groups using LMSs like Centra or Horizon Wimba
- The use of the WWW for the provision of education and training on university and college campuses as a supplement to lectures and Instructor Led Training (ILT) given on campus or, alternatively, as a substitute for lectures when the courseware is provided on the WWW in the institution in place of lectures
- Mobile learning – the provision of education and training on PDAs (including palmtops and handhelds), smartphones and mobile phones.

The ultimate goal was to provide a set of findings that help instructors to understand the implications of various technologies for their students, and to provide research-based principles for how instructors and learning environment developers can best use technology in their teaching.

My research was an element of the Impact research series, covering the last item of the list above: mobile learning in higher educational provision. This research focuses on Europe, as a culturally and technologically developed area, which may be considered paradigmatic of other situations elsewhere in other countries. Institutions from five different EU member states (Bulgaria, Germany, Hungary, Ireland and Italy) collected and analysed data.

### *Research Hypotheses*

As it was mentioned before, one of the main ideas of this research was to investigate the students' attainments towards technology – in my case especially towards mobile technology – in education. In order to reach this goal the following domain specific assumptions have been made:

**Hypothesis 1 – H1:**

*There is no significant difference in the judgement of people with or without experience in mobile learning that the use of mobile technology can enhance the general quality of learning.*

**Hypothesis 2 – H2:**

*It is generally accepted that the use of mobile learning in education is beneficial for improving the communication between students and educators.*

**Hypothesis 3 – H3:**

*Incorporating Mobile learning into educational activities adds additional value for the learning programmes provided by higher educational institutions.*

**Hypothesis 4 – H4:**

*Learner's context is a crucial constituent of education. Therefore the deployment of context aware services in a mobilised virtual learning environment is a valid approach, with quantifiable benefits for learners in a personalised learning environment.*

### Proof of concept

To support H4, proof of concept studies were organised. In order to take benefits from the abovementioned research approach, we redesigned our ontology based content authoring and management system. The positive feature of educational ontologies, that they are capable to describe complex systems in a well structured way, therefore it is believed to be useable in a corporate environment for recruitment and selection.

**Hypothesis 4.1 – H4.1:**

*It is possible to build up an ontology based personnel selection and training system, which can be employed to provide support for the inferences pertaining to the construct-, content- and criterion- related validity approaches that are described by Binning and Barrett (1989)*

The aim is to build an information system, which can sample the skills, competencies and knowledge of an existing employee or an applicant. Based on this sampling this system evaluates whether the selected individual meets the criteria of a given job profile. The Binning and Barrett model with its 'predictor measure', 'criterion measure' and 'underlying psychological construct domains' also demonstrate a sampling mixture, which enables the predictor to facilitate decision making about an employment contract. These measures can be described by knowledge and competencies, which – as will be elucidated later – are also part of the educational ontology.

**Hypothesis 4.2 – H4.2:**

*It is possible to sample jobs based on a competency based logic, which is modelled by the enhanced educational ontology model.*

A Job-role is a set of personality, skills, technical competencies and factual knowledge. These items can be formalised and interpreted in an explicit way – e.g. widely used Job descriptions. I strongly support the idea of creating an organisational view of these sets with their descriptions, interdependencies and 'cause and effect' relations, which can be plotted by an ontology. Therefore as a part of the research plan a Job role will be chosen at a corporation, where the job specific constructs will be incorporated to and tested in a job specific (Domain) ontology.

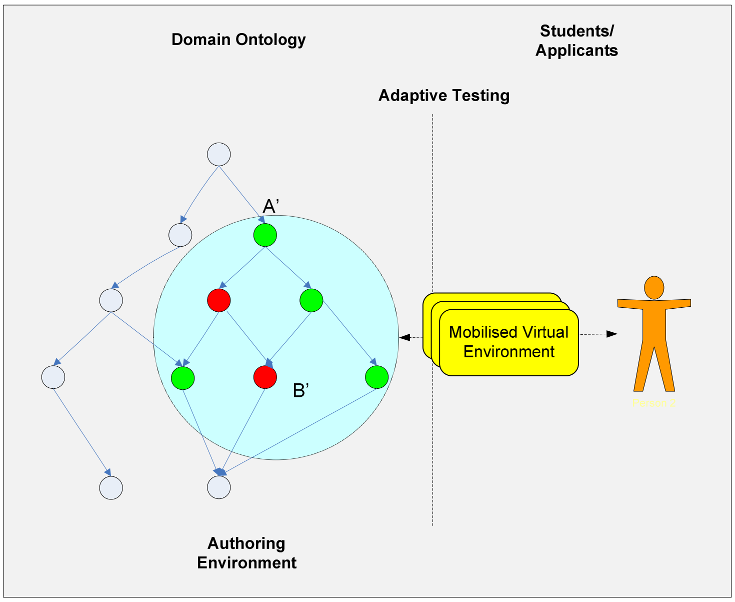



**Figure 4: Framework for an ontology supported personnel selection system**

As is visible on Figure 4 (The graph simplifies the structures to enhance understanding.) there are the Domain Ontology, an adaptive testing engine and a mobilised virtual (learning) environment in this proposed framework. The basic structure of the Domain ontology is generated from the enhanced Education Ontology. The Domain Ontology refers to a "global" view about the organisation's activities. This organised interpretation of tasks and activities also provides a detailed description about essential skills and competencies, which are required for employees to fulfil the given tasks.

A Job-role (The blue circle on Figure 4) is a subset of this Domain Ontology. The schema describes what skills and competencies one needs to fulfil this position and also how these skills and competencies are constructed – for instance the factual knowledge they require – and their inter-relatedness.

## RESEARCH METHODOLOGY

This research used a variety of approaches to the subject areas subsumed under the three research domains (eLearning, Knowledge Management and HRM). In particular, desktop research played an important role as a research instrument for the generation of testable and falsifiable hypotheses. Data generated by questionnaires and experiments will both be brought to bear on my hypotheses. Other predictions will be tested through laboratory experiments, field experiments, and questionnaire methods. A particularly exciting innovation concerns the conduct of field experiments in collaboration with industry stakeholders. For many of the empirical research questions that I am interested in, experiments are an important instrument because they allow me to focus on fundamental aspects and mechanisms (control), and to check the robustness of results through replication. At times, this will be the only empirical method available to investigate the hypotheses.

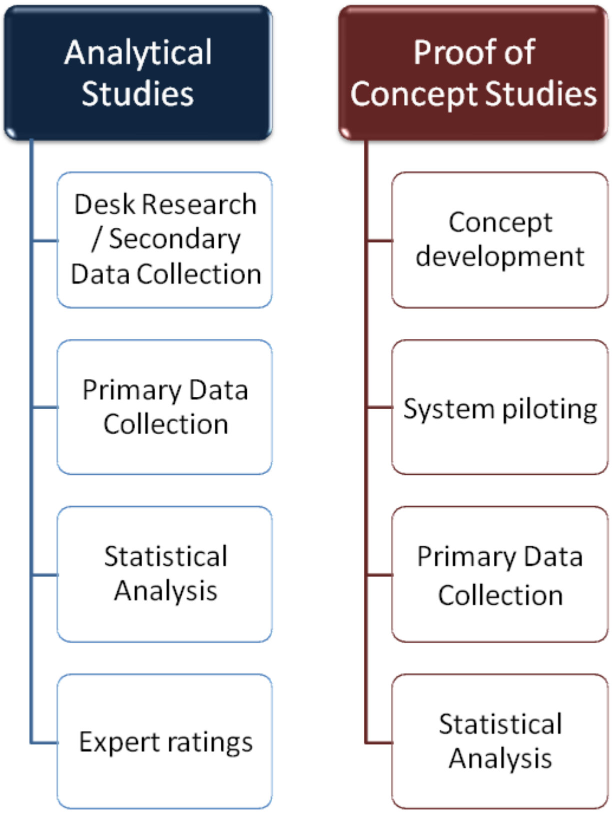



**Figure 5: Applied methods**

As it was mentioned before, my hypotheses were examined throughout analytical studies and proof of concept experiments. These two groups require different research methodologies (See Figure 5). By the analytical studies I will rely partly on secondary data and partly on primary data, which will be the foundation of several statistical analyses. In some cases quantitative aspects had to be considered, there I relied on expert ratings.

By the proof of concept studies, first the circumstances of experiments had to be defined together with the details of system piloting. Primary data has been gathered and analysed from these pilots. Table 1 depicts the methods have been used in the various studies.

| | eLearning in EU10 | Motill | Impact | mStudio | Contsens | OntoHR |
|---|---|---|---|---|---|---|
| **Desk research** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Secondary Data Collection** | ✓ | ✓ | | | | ✓ |
| **Comparative data analysis** | ✓ | ✓ | | | | ✓ |
| **Expert ratings** | ✓ | ✓ | | | | ✓ |
| **System Piloting** | | | | ✓ | ✓ | ✓ |
| **Primary Data Collection** | | | ✓ | ✓ | ✓ | |
| **Statistical Analysis** | | | ✓ | ✓ | ✓ | |

**Table 1: Research Methods matrix**

Evident that the most common research method was desk research. This has been used for identifying relevant academic and practical background research results, setting up theoretical and practical frameworks and identifying measurable variables. Secondary data collection has been used in the ‘eLearing in EU10’, Motill and OntoHR projects, where wide ranges of databases have been exploited for existing data. It is not surprising that the data gathered has also gone through a comparative data analysis. These comparative analyses have been validated by domain experts in all cases. In case of the Impact project primary data was gathered and analysed. Altogether three system pilots have been organised in the frames of this theses, what in two cases followed primary data collection and analysis. In case of OntoHR, the primary data collection and analysis will be completed after the submission of this piece of work.

At the statistical analyses the employed methodology was based on the ‘Identifying and implementing educational practices supported by rigorous evidence’ of the US Department of Education, (U.S. Department of Education, Institute of Education Sciences 2003), probably the most recent and most authoritative educational research methodology. This research methodology is a combination of blended quantitative techniques (questionnaire with general learning questions plus specific questions and questions on educational background of respondents) and qualitative analysis (in-depth statistical analyses).

During the various stages of this research the below mentioned procedure had to be followed:

- Collect topics and related issues to be investigated from partner institutions
- Constitute a sub-committee of experts in social science data analysis. This task force was responsible for: (a) developing a conceptual model guiding the data analysis and (b) editing a questionnaire based on the problems contributed in stage 1.
- Project teams review, test and approve the questionnaire
- Project teams administer the questionnaire to the six target groups after translating into the local language – if necessary.
- Project teams assemble the responses acquired by each institution and perform suitable data analyses individually on their respective fields of expertise (in my case: mobile learning).
- Project teams evaluate the analysis results and present them in a comprehensive report individually

By the particular chapters further, more detailed information is given about the applied methodologies.

The tools build to provide support for these emergent theories, follow the latest system development methods. In general, two-phase iterative prototyping approach has been followed during the development work. This approach is superior to the waterfall approach (completing in strict sequence the phases of requirement analysis, design, Implementation/ integration, and test) because:

- It allows taking into account changing requirements.
- Integration is not one "big bang" at the end; instead, elements are integrated progressively – almost continuously.

Risks are usually discovered or addressed during integration. With the iterative approach, one can mitigate risks earlier. As developers unroll the early iterations, they test all process components, exercising many aspects of the project, such as tools, off-the-shelf software, people skills, etc. The responsible actors can quickly see whether perceived risks prove to be real and also uncover new, unsuspected risks when they are easier and less costly to address. Iteration facilitates reuse; it is easier to identify common parts as they are partially designed or implemented than to recognize them during planning. When one can correct errors over several iterations, the result is a more robust architecture.

### Hypotheses testing

My general goal was to extrapolate from the data collected to obtain general and in depth conclusions regarding my theses. The research hypotheses were validated through outcomes provided by indicators. Null hypothesises were defined for each question in the questionnaire. These statistical hypotheses are indicators for these outcomes:

- Build knowledge and connect to the workplace
- Promote active learning and authentic assessment
- Engage students by motivation
- Provide tools to improve student performance
- Support high-level thinking
- Increase learner autonomy
- Increase collaboration and cooperation
- Provide learner-centred approaches
- Overcome physical disabilities

### Questionnaire Design

The conceptual model underlying the themes to which this and follow-on investigations should provide replies include:

- Reaction of learners: Did they enjoy and benefit from the education using ICT?
- Learning outcome: Did the students increase in knowledge or intellectual capacity?
- Behaviour: Did the students apply technology-enhanced learning and thereby change their behaviour?
- Result: Were there quantifiable aspects of organisational performance gain?
- Technology: Can we prove or disprove that the increasing use of technology in education is perceived positively?
- Attitudes: What are people’s attitudes to the impact of technology on learning?
- Gender: Does the use of technology enhance the learning process of female students? Do female students benefit from learning traditionally "male" subject areas (engineering) through gender-neutral media like Centra?
- Student-centred and task-based learning: Does the use of technology in the learning process create opportunities to prioritise task-based learning?

These facets of the conceptual model guided the design of the items and structure of the questionnaires used in these empirical studies.

It is also necessary to point out which were the possible sources of biases in the proposed questionnaires. This list includes:

- A non-representative sample;
- Leading questions;
- Question misinterpretation;
- Untruthful answers.

# PART II

# Research on the Current Impact of Technology Enhanced Learning (TEL) on European Lifelong Learning Actions

# PART II - IMPACT OF TEL ON EUROPEAN LIFELONG LEARNING

At the European Council in Lisbon in March 2000, the EU15 Heads of Government set the goal for Europe to become the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion (European Parliament 2005). The renewed Lisbon goals of 2005 lay emphasis on working for growth and jobs, and include plans that facilitate innovation through the uptake of Information and Communication Technologies (ICT) and higher investment in human capital (European Parliament 2005). ICT and related policies play a key role in achieving the goals of the Lisbon strategy. In 2005, the strategic framework for Information Society policy - i2010 - identified three policy priorities: the completion of a single European information space; strengthening innovation and investment in ICT research; and achieving an inclusive European Information Society (European Commission 2005b).

As ICT can enable inclusion, better public services and quality of life, all citizens need to be equipped with the skills to benefit from and participate in the Information Society. Education and training systems play an important role in reaching these goals. The European i2010 initiative on e-Inclusion (European Commission 2007a) emphasises the importance of enabling conditions for everyone to take part in information society, paying attention to broadband and internet connections, e-Accessibility of the services (European Commission 2005a), and tackling gaps in digital competence. Using the tools that ICT can offer to enable lifelong learning (LLL) for citizens is an important way of fostering competitiveness and employability, social inclusion, active citizenship and personal development. Policy actions such as the Education and Training 2020 Work Programme (European Council 2009) and the Lifelong Learning Programme (LLP) (European Parliament 2006) aim to develop learning in the Knowledge Society, emphasising effectiveness, equity and quality. As a Commission Staff Working Paper (2008b) emphasises, the role of ICT as a lever for transformation and innovation in education and learning is so as to meet the need of the European Information Society.

# ELEARNING IN EUROPE

The European Union in 2003 launched its eLearning development programme and named it as „Programme for the Effective Integration of Information and Communication Technologies (ICT) in Education and Training Systems in Europe (2004 – 2006)". This initiative had three major action lines impacting the European Higher Education (European Parliament 2003):

1. Promoting digital literacy
   European citizens must develop skills, which are indispensable to use and to process digital content. Without these skills Europeans can't participate in the so called digital society. The establishment of the European Digital Society is one of the most critical issues in Europe, as digital literacy is a key contributor to a competitive European economy (European Council 2009). Therefore, an important objective of this initiative is to provide ICT assistance to the people, who have restricted access to electronic content, due to geographical location or social situation.
2. Establishing and supporting European digital campuses
   Improving educational institutions is another central priority of the European Commission. Implementation of new organisational models like virtual campuses, encouragement of co-operation between European higher education institutions and development of new mobility schemas for this sector are also focal points of the agenda.
3. Promote eLearning throughout transversal actions
   Promoting best practices, products and services, which were developed and deployed by assorted innovation projects, funded from European or member state sources should be promoted for an extended usage.

The infrastructural differences in the provision of Information Society development between EU member states, especially between the EU15[8] and the recently joined EU10[9], are still critical. The need of modernisation, the new competitive global environment, the social inequalities – especially in the post socialist New Member States (NMS) – and nevertheless the incessant push from the EU accession policies (like regional development strategies or legislative unification issues) are forcing countries to incorporate ICT related technology and innovation into their basic educational activities. National development strategies, National Information Development Strategies, National Broadband Strategies,

---

[8] EU Member states before 1st May 2004: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom

[9] EU Member states joined on the 1st May 2004: Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia

Development Strategies for the Information Society have emerged between the mid 1990's and the nowadays, emphasizing the value of investments in ICT supported education.

When it comes to the success of these strategies, it is exciting to look at the Networked Readiness Index (NRI) as computed by the World Economic Forum in its Global Information Technology Report 2004-2005. The NRI measures how prepared economies are to participate in and benefit from ICT developments. In this index three important stakeholders are considered: individuals, business and government bodies regarding to their macroeconomic and regulatory environment, their degrees of ICT usage and their degrees of ICT readiness. As it's visible from Table 2 below, NMS are in the middle part of this list, starting with Estonia (25th) and ending up with Poland (72nd) (World Economic Forum 2004). From an eLearning point of view, NRI shows how prepared the NMS are and how deeply they are involved into educational eServices. With regards that there were continuous developments in these countries since the last available NRI report, other researchers also justified NRI results. According to a current study of ICEG EC Estonia is apparently the leader of eLearning deployment, while the rest of EU10 countries, especially the post socialist Central-Eastern European (CEE) states have some serious lopsided deficiencies (Chytilová et al. 2009; Vehovar 2008).

In the past 15 years, economies of New Memb-er States have gone through a major political and economical transition. The Central-Eastern European and the Baltic countries had to transform their industry and agriculture based economies into a service oriented structure, where knowledge based activities are dominant. The referenced country reports show that this revolution is clearly on the way. (Suurna & Kattel 2008; Christodoulou et al. 2008; Magai & Simonics 2008; Gudauskas & Remigijus 2008; Restall 2008; Runiewicz 2008; Druga 2008; Vehovar 2008; Chytilová 2008; Kalis 2008) The share of services is oscillating around 60% of the GDP. The growing necessity of the ICT supported human capital, the need for information workers in the service sector create a significant demand for ICT skill inclusion. These reports also show that the existence of this ICT skill demand incubates the spiral of investments into ICT related service industries. The initial push, which was made by the national governments (setting up the national telecommunication infrastructure, tax allowance for ICT related investments, mandatory ICT education, etc.), increased value of the knowledge intensive Foreign Direct Investments (FDI).

| NRI RANK | COUNTRY | SCORE |
|---|---|---|
| 1 | Singapore | 1.73 |
| 2 | Iceland | 1.66 |
| 3 | Finland | 1.62 |
| 4 | Denmark | 1.60 |
| 5 | United States | 1.58 |
| 6 | Sweden | 1.53 |
| 7 | Hong Kong | 1.39 |
| 8 | Japan | 1.35 |
| 9 | Switzerland | 1.30 |
| 10 | Canada | 1.27 |
| 11 | Australia | 1.23 |
| 12 | United Kingdom | 1.21 |
| 13 | Norway | 1.19 |
| 14 | Germany | 1.16 |
| 15 | Taiwan | 1.12 |
| 16 | Netherlands | 1.08 |
| 17 | Luxembourg | 1.04 |
| 18 | Israel | 1.02 |
| 19 | Austria | 1.01 |
| 20 | France | 0.96 |
| 21 | New Zealand | 0.95 |
| 22 | Ireland | 0.89 |
| 23 | United Arab Emirates | 0.84 |
| 24 | Korea | 0.81 |
| 25 | Estonia | 0.80 |
| 26 | Belgium | 0.74 |
| 27 | Malaysia | 0.69 |
| 28 | Malta | 0.50 |
| 29 | Spain | 0.43 |
| 30 | Portugal | 0.39 |
| 31 | Tunisia | 0.39 |
| 32 | Slovenia | 0.37 |
| 33 | Bahrain | 0.37 |
| 34 | South Africa | 0.33 |
| 35 | Chile | 0.29 |
| 36 | Thailand | 0.27 |
| 37 | Cyprus | 0.25 |
| 38 | Hungary | 0.24 |
| 39 | India | 0.23 |
| 40 | Czech Republic | 0.21 |
| 41 | China | 0.17 |
| 42 | Greece | 0.17 |
| 43 | Lithuania | 0.13 |
| 44 | Jordan | 0.10 |
| 45 | Italy | 0.10 |
| 46 | Brazil | 0.08 |
| 47 | Mauritius | 0.08 |
| 48 | Slovak Republic | 0.03 |
| 49 | Jamaica | –0.03 |
| 50 | Botswana | –0.10 |
| 51 | Indonesia | –0.13 |
| 52 | Turkey | –0.14 |
| 53 | Romania | –0.15 |
| 54 | Morocco | –0.17 |
| 55 | Namibia | –0.21 |
| 56 | Latvia | –0.23 |
| 57 | Egypt | –0.24 |
| 58 | Croatia | –0.25 |
| 59 | Trinidad and Tobago | –0.28 |
| 60 | Mexico | –0.28 |
| 61 | Costa Rica | –0.29 |
| 62 | Russian Federation | –0.36 |
| 63 | Pakistan | –0.38 |
| 64 | Uruguay | –0.39 |
| 65 | Ghana | –0.41 |
| 66 | Colombia | –0.42 |
| 67 | Philippines | –0.43 |
| 68 | Vietnam | –0.46 |
| 69 | Panama | –0.47 |
| 70 | El Salvador | –0.49 |
| 71 | Sri Lanka | –0.49 |
| 72 | Poland | –0.50 |
| 73 | Bulgaria | –0.51 |
| 74 | Gambia | –0.52 |
| 75 | Kenya | –0.62 |
| 76 | Argentina | –0.62 |
| 77 | Uganda | –0.63 |
| 78 | Dominican Republic | –0.65 |
| 79 | Serbia and Montenegro | –0.65 |
| 80 | Algeria | –0.66 |
| 81 | Zambia | –0.68 |
| 82 | Ukraine | –0.68 |
| 83 | Tanzania | –0.71 |
| 84 | Venezuela | –0.72 |
| 85 | Macedonia | –0.73 |
| 86 | Nigeria | –0.73 |
| 87 | Madagascar | –0.77 |
| 88 | Guatemala | –0.78 |
| 89 | Bosnia and Herzegovina | –0.86 |
| 90 | Peru | –0.91 |
| 91 | Georgia | –0.94 |
| 92 | Mali | –0.96 |
| 93 | Malawi | –0.98 |
| 94 | Zimbabwe | –1.02 |
| 95 | Ecuador | –1.08 |
| 96 | Mozambique | –1.11 |
| 97 | Honduras | –1.19 |
| 98 | Paraguay | –1.20 |
| 99 | Bolivia | –1.25 |
| 100 | Bangladesh | –1.30 |
| 101 | Angola | –1.36 |
| 102 | Ethiopia | –1.52 |
| 103 | Nicaragua | –1.61 |
| 104 | Chad | –1.69 |

**Table 2: The NRI Index 2004 (World Economic Forum 2004)**

This improvement is not sustainable without sufficient, well educated employees in knowledge intensive sectors, which implies that local policy makers should support the reform and the modernisation of all levels of education. Constructing the domains of

Information Society attracts more investors, which forces the state to invest into the underlying nationwide Information Society infrastructure and enforce the elaboration of digital divide. It is proved that eLearning is one of the key contributors to a valid and reliable IS infrastructure, pushing the NMS' economies towards a structural transformation resulting in growing proportion of knowledge intensive industries.

## PUSH OR PULL?

From the previous section the question emerges: Is the development of eLearning services driven by demand or supply? Do people use these services because they have no other option or there is a significant need from the society and/or from the industry towards these services? The picture is quite colourful. On one hand, big players in the private sector (especially large multinational companies) have a growing need for IS infrastructure: they need skilled labour, thus they use their ICT infrastructure in their internal educational and core business processes. On the other hand, a remarkable share of citizens in the NMS still possesses insufficient information about the possibilities of ICT supported learning and its predicted importance in the future. However individuals bear in mind that after the political transition of Central-Eastern Europe unemployment is a real danger, which contributes towards the recognition of the importance of education and training, especially ICT related education and training. ICT skills provide remarkable advantage for individuals on the labour market, but there are still various segments where eLearning is not acknowledged as a well working tool for enhancing competitiveness. The general low level of SME involvement, the attainment of primary and secondary education, the elaboration of the effects of structural unemployment, the inclusion of citizens living in rural areas or living with disabilities are still issues, where dissemination and promotion need to be done.

The telecommunication and information technology sectors and their influence on manufacturing and service industries (and also on organisations) established an adaptation reflex especially by higher education institutions. The continuous and rapid change of the abovementioned sectors force education institutions to be flexible and adapt educational processes to the current needs of the IS driven labour market at all times. This results in skilled workers, which increases employment, productivity and through these factors the general competitiveness of the EU10 countries.

Unfortunately this elasticity is not yet visible in all NMS. Considering eLearning, there are immense differences between the leader countries (Estonia or Slovenia) and the underdeveloped countries (Slovakia, Poland). In case of the falling behind members, the proposed sectoral push hasn't invoked a governmental pull yet. ELearning is still not considered as one of the major cornerstones in the development of knowledge and information based societies, however when it comes to innovation and competitiveness the term knowledge is among the first few key elements what policy makers emphasise.

## IMPACT ON LABOUR SKILLS

According to Eurostat, computer based training started growing its roots within the societies of NMS (Eurostat 2006)(See Table 3).

| **Computer based learning participants by educational attainment and working status (%)** | **CY** | **CZ** | **EE** | **HU** | **LV** | **LT** | **MT** | **PL** | **SK** | **SI** | **EU-10** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total population** | 14.9 | 12.4 | 10.3 | 2.8 | 14 | 8.9 | 19.1 | 10.7 | 12.2 | 29.9 | 15.0 |
| **Employment** | 18.1 | 15.5 | 13 | 3.9 | 18.2 | 11.2 | 24.8 | 15.4 | 16.4 | 36.7 | 19.2 |
| **Unemployment** | 12.7 | 4.9 | 5.8 | 0.8 | 8.4 | 2.8 | 19.9 | 5.4 | 3.5 | 30.6 | 10.5 |
| **Inactive population** | 3.4 | 3.8 | 2.4 | 0.7 | 3.1 | 2 | 11.1 | 2.6 | 3.3 | 10.5 | 4.8 |

**Table 3: Computer based learning participants by educational attainment and working status (Eurostat 2006)**

In general, 15% of the total population participated in eLearning activities. Almost 20% of employees have some computer based training experience, which mostly comes from the activities of big multinational companies, as they consider ICT based education as one of the main facilitator of corporate knowledge. Governments are less successful in implementing eLearning for unemployed (10,5%) and inactive population (4,8). As it's visible, there are immense differences between countries regarding to participation in ICT based learning (Hungary 2.8% - Slovenia 29,9%).

As the numbers and country reports show, the share of private companies in eLearning delivery towards employees is greater than the public sectors'. This market driven push from companies force the employees to use technology for keeping their factual knowledge and labour skills updated continuously. This form of Lifelong Learning is getting more and more accepted, resulting in better qualified workforce and enhanced productivity. If we take a closer look, three groups could be identified regarding to their eLearning performance.

- The "Mediterranean group"
  Cyprus and Malta had no great economical transformation in the past decades, as they were not part of the former eastern bloc. Regarding to eLearning developments both countries take IS issues as a part of other strategic designs like national development plans (Christodoulou et al. 2008; Restall 2008). ELearning and educational programs are subsets of policies discussing issues of various industrial and human capital developments. For this reason, implementation of diverse eLearning related development programs were also concentrating in general

(mostly) infrastructural challenges: broadband networks, ICT penetration of schools, households' internet access were successfully deployed in these countries.

- Central-European Countries

  These ex-socialist countries (Czech Republic, Hungary, Poland, Slovakia and Slovenia) are quite heterogeneous, several models were applied for modernising their economies. The same applies for eLearning developments, however the general level of eLearning is more or less the same in these countries (Magai & Simonics 2008; Runiewicz 2008; Druga 2008; Vehovar 2008; Chytilová 2008). The leader of the group is evidently Slovenia, where ICT related industrial and educational investments are mostly centrally coordinated and monitored. A strong growth of IT and telecommunication markets are forecasted, which even overlap the average GDP growth of these countries (Chytilová et al. 2009).

- Baltic Countries

  The Baltic countries (Estonia, Latvia, and Lithuania) were the fastest growing countries in Europe before the global financial crisis. Based on this success, national governments are working with strong political commitments to establish the domains of Information Society. According to the country studies (Suurna & Kattel 2008; Kalis 2008; Gudauskas & Remigijus 2008), the investments into the ICT related sectors (including education) had valuable contribution towards the economic success. The big picture nevertheless is not spotless: in Estonia and Lithuania the general productivity of knowledge based industries have been still falling behind the EU leaders, as these countries can't exploit all benefits from rapid modernisation. The difference between the level of ICT in use by SMEs and immense enterprises in provision of learning and training activities is significant. As long as big organisations deployed educational eServices into their everyday activities, SMEs are still trying to learn the term of eLearning. In case of Latvia, the country is still struggling from heritage of the political transformation, when the recovery of infrastructure was more important than creating a modern ICT market, which ended up in a small sector with bright possibilities.

## CONTEXT FOR ELEARNING IN 10 EU COUNTRIES[10]

The abovementioned research, which was carried out by a consortium led by ICEG EC in 2006-2007 (Chytilová et al. 2009), focused on eLearning with the purpose of assessing the following: its current status and developments in the field, the most important opportunities and challenges eLearning faces, the lessons other member states may learn from eLearning, and the related policy options. National experts from each country gathered the relevant qualitative and quantitative data for analysis, with a view to developing an assessment of each country's current state and trajectory, to determine their main factors, and draw conclusions. The situation of each country was captured through various sources and tools such as desk research on both national and international data, via literature and policy documents, and also by means of several expert interviews in each country.

In this study, *eLearning was defined as encompassing both the aspect of learning through the use of ICT and that of acquiring the necessary competences to make use of ICT in the knowledge society*. For this reason the study considered the use of ICT in formal education (schools and higher education), in training and learning at the workplace (professional education), in non-formal education (including re-skilling and training for jobseekers) and in everyday life (digital literacy/digital competence and informal learning).

The economies of the EU10 are changing, with the decrease of the share of agriculture and industry being compensated by the growth of the tertiary sector both in employment and its output.[11] Structural changes and fast economic growth are however accompanied by deepening regional divides in income, age and employment disparities. These disparities partly contribute and, partly explain the widening digital divide. They are broadened by an unbalanced regional development since EU10 countries are often characterised by high concentration in larger cities and especially in the capital cities. The EU10 countries are characterised overall by similar or somewhat higher unemployment figures: in 2007 unemployment rate in Poland, Slovakia and Hungary was around 20% as opposed to the EU15 average of 14.7% (Eurostat 2006). In these countries, this fact strongly influences the income level of inhabitants, their purchasing power and opportunities to increase their ICT usage and skills.

### Educational context

In most of the EU10 countries, public expenditure as a percentage of GDP is typically on the same level as, or higher than, it is in the EU15. In 2004, the EU10 average was 5.4% vs.

[10] This chapter has partly been published as: Ala-Mutka, K., Gáspár, P., Kismihók, G., Suurna, M., & Vehovar, V. (2010). Status and Developments of eLearning in the EU10 Member States: the cases of Estonia, Hungary and Slovenia. *European Journal of Education*, *45*(3), 494-513.

[11] The service sector currently produces on average around 60% of the GDP of EU10, and its share has been continuously increasing: a similar trend is observed in case of employment (Chytilová et al. 2009).

5.2% in the EU15. A positive feature of the EU10's education systems on the whole is the high rate of schooling[12], especially at primary and secondary education levels. Table 4 demonstrates that three of the EU10 (Slovenia, Czech Republic, Poland) were, in 2007, the best EU performers against the European benchmarks for Education and Training 2010 on the share of early school leavers and the upper secondary completion rate.[13]

Participation in tertiary education has grown rapidly in many of the 10 new member states. Slovakia and Poland have shown the strongest growth in the whole EU with regards to the number of Mathematics, Science and Technology graduates in recent years and Lithuania is among top ten (19.5%) in EU. Many EU10 countries show good scores for their share of female graduates, with Estonia achieving top value of (42.0%) in 2006 in Europe (European Commission 2008a).

However, despite the good level of basic education and public investment, EU10 countries are generally behind the EU15 countries in the adult participation rates in lifelong learning, i.e. participating in organised education and training activities. The share of adults participating in Education and Training remains in the EU10 well below the EU15 values, with the exception of Slovenia (14.8% in 2007) with 6th best performance in whole EU (European Commission 2008b).

### ICT access, use and skills

Although many of the EU10 countries are still behind the EU15 in ICT development, they have been catching up quickly and the statistics regarding access, usage and skills are getting close to the EU15 average (see Figures 6 and 7). Therefore, diffusion of ICT is no longer a primary barrier, and the example of Slovakia shows that lower household internet access does not necessarily hinder the development of ICT usage and skills. Many of the EU10 countries have invested in public internet access points, in order to improve their citizens' access to ICT.

---

[12] One aspect of the good heritage of the education sectors of EU8 (EU10 without Cyprus and Malta) from the past regime in the early 1990s was in the relatively high education indicators, internationally comparable strengths in several areas (including natural sciences, maths), very high levels of primary and secondary enrolment and total youth education attainment level.

[13] In these participation measurements, only Malta shows values that are clearly behind the EU averages. In 2007, only 54.7% of 20-24 year-olds had completed their upper secondary education in Malta, while the EU-27 average was 78.1% (European Commission 2008a). The share of early school leavers was 37.6% against the EU average of 14.8%. The Maltese national report suggests that this comes from the traditional family oriented culture, i.e. which emphasises family values more than participation in education (Restall 2008).

Table I. EU10 values for the E&T2010 benchmarks

| Benchmark area | Target for 2010 | Three best performers in the EU, EU10 highlighted | | | EU27 average | The other EU10 countries according to their success in achieving the target, highlighted values better or equal to the EU27 average | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Early schools leavers (18–24, %) in 2007 | No more than 10% | SI 4.3% | PL 5.0% | CZ 5.5% | 14.8% | SK 7.2% | LT 8.7% | HU 10.9% | CY 12.6% | EE 14.3% | LV 16% | MT 37.6% | | | |
| Upper-secondary attainment (20–24, %) in 2007 | At least 85 % | CZ 91,8% | PL 91.6% | SI 91.5% | 78.1 % | SK 91.3% | LT 89.0% | CY 85.8% | HU 84.0% | EE 80.9% | LV 80.2% | MT 54.7% | | | |
| Ratio of low-achieving 15-year-olds in reading literacy (measured by PISA) | At least 20 % decrease (to reach 15,5 %) | Change in the share of low achievers in % (2000–2006) | | | | | | | | | | | | | |
| | | FI -31.4 % | PL -30.2% | LV -29.6% | +13.1 % | HU -9.3% | CZ 41.7% | SK, SI, LT, EE, CY, MT n.a. | | | | | | | |
| | | % of low achievers in 2006 | | | | | | | | | | | | | |
| | | FI 4.8 % | IE 12.1% | EE 13.6% | 24.1 % | PL 16.2% | SI 16.5% | HU 20.6% | LV 21.2% | CZ 24.8% | LT 25.7% | SK 27.8% | MT, CY n.a. | | |
| Graduates in MST | Increase of at least 15 % | Average annual increase 2000–2006 | | | | | | | | | | | | | |
| | | PL +13.8 % | IT 13.8% | SK 12.3% | +4.4 % | CZ 8.9% | CY +8.1% | MT +8.1% | EE +7.1% | LT +6.3% | HU +3.2% | LV +2.4% | SI +0.9% | | |
| | | Graduates per 1000 population aged 20–29 in 2006 | | | | | | | | | | | | | |
| | | IE 21.4% | FR 20.7% | LT 19.5% | 13.0% | PL 13.3% | EE 11.2% | SK 10.3% | CZ 10.0% | SI 9.5% | LV 8.9% | HU 5.8% | MT 5.0% | CY 4.3% | |
| | | % of females among graduates in 2006 | | | | | | | | | | | | | |
| | | EE 42.9% | BG 41.2% | PT 39.7% | 31.6% | PL 39.2% | CY 35.9% | SK 34.8% | LV 32.4% | LT 31.6% | HU 27.9% | CZ 26.5% | MT 25.9% | SI 25.7% | |
| Adult participation in lifelong learning (25–64) in 2007 | At least 12.5 % | SE 32.0% | DK 29.2% | UK 26.6% | 9.7 % | SI 14.8% | CY 8.4 % | LV 7.1 % | EE 7.0% | CZ 5.7% | MT 6.0% | LT 5.3% | PL 5.1% | SK 3.9% | HU 3.6% |

**Table 4: EU10 values for the E&T2010 benchmarks (European Commission 2008a)**

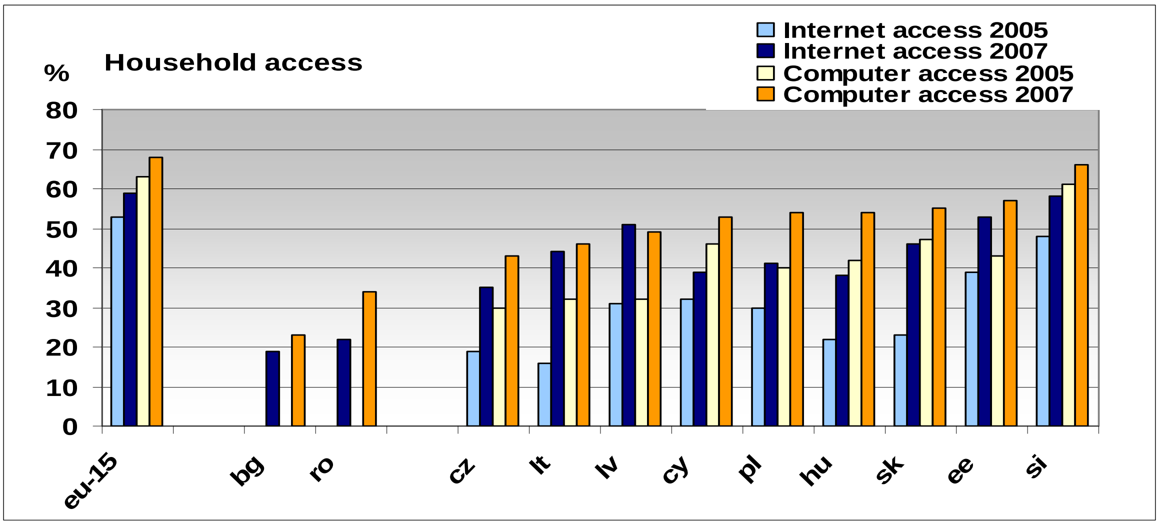



**Figure 6: Development of household internet access rates in the New Member States (data source: Eurostat – data from Malta not available)**

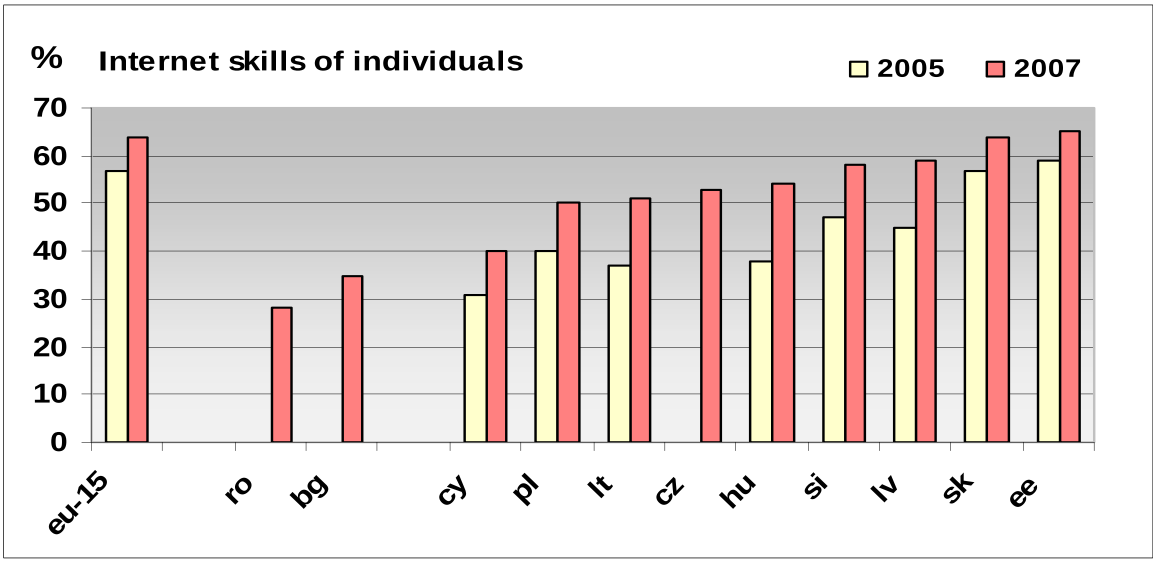



**Figure 7: Development of internet skills (people with completed internet activities), (data source: Eurostat)**

However, access and skills still remain a constraint for remote areas, usually less developed regions, and some user groups such as ethnic minorities, the elderly, or the unemployed (see examples in Figure 8). In most of the EU10 countries, these divides are larger than the EU15 average. ICT take-up is highest among the young and the well educated. For example, while in 2007, in EU15, 41% of the 55-74 year-olds had used a computer during the previous year, in EU10 this value ranges between 12% in Lithuania to 25% in Hungary.

However, as opposed to the other divides, the gender gap in computer usage in the EU10 countries is often smaller than the EU15 average.[14]

## OVERALL ELEARNING DEVELOPMENTS

This chapter gives an overview of the developments in eLearning in EU10 on different levels and in various aspects of education. This overview is based on both European statistics and the country reports developed in the previously mentioned project (Chytilová et al. 2009).

### Primary and secondary education

Empirica (2006) provides a good data source for comparing computer use at schools in Europe. In EU10, schools provide separate ICT courses more often than in EU15, with an EU10 average of 91% vs. 46% in the EU15. However, computers are used less in classes in general. In EU10, only 54% of pupils use computers in class vs. 69% in EU15. Teacher usage reflects the same – in EU10, only 56% of teachers use computers in class whereas 65% in EU15 use them. This seems to be related to the fact that there are fewer computers available: on average, there are only 6 computers per 10 students in EU10 and 11 in EU15. In fact, teachers (49%) mention the lack of computers as a main barrier – although so do teachers in the EU15.

The Empirica (2006) survey showed similar ICT skills levels for teachers in EU10 to those in EU15. It also demonstrated that fewer teachers in the EU10 countries consider ICT skills as a barrier for using computers in class than in the EU15 countries. Furthermore, those teachers who used computers in the classroom used them very actively. Survey responses also imply that teachers in EU10 are more interested in using computers in class than their EU15 counterparts.[15] There are, however, considerable differences between teacher generations; e.g. according to a Maltese national study, 59.5% of teachers aged 55-59 are not confident with ICT, while only 2.8% of teachers younger than 25 express the same concern (Restall 2008). National studies reported that those teachers who had been using ICT in their own training were the ones making use of it most actively also in their own classes.

---

[14] For example, Eurostat surveys show that EU15 average for females who had never used a computer in 2008 was 26% vs. 21% for men, i.e. demonstrating a difference of 5 percentage points. In Estonia, women had used computers more than men, with 1 percentage point difference, 5 of the EU10 countries showed 1-2 percentage point differences for the benefit of men, and only in Cyprus had a larger gap (7 percentage points) for the benefit of men than the EU15 average. A similar phenomenon holds true also for the indicator on usage of computers during previous 3 months.

[15] The EU15 average of teachers stating 'lack of interest' as a barrier for using computers was 11%, and all EU10 countries had values below that. The share of teachers not perceiving clear benefits from using computers in class was 19.6% in EU15, while the EU10 average was 6.8% and only Czech Republic had a value higher than EU15 average (Empirica 2006).

### Higher education

A common feature of ICT in higher education in EU10 is that all the countries provide distance learning courses with ICT. For example, the Estonian report describes a distance learning programme of 17 courses developed by the Estonian Banking Association and University of Tartu (Suurna & Kattel 2008). In the Polish virtual university, there are more than 100 e-courses available, which support traditional teaching or are offered as separate courses on the internet (Runiewicz 2008). Universities often employ learning management systems in order to support both their local and distance students.

The study reports did not find much quantitative nor qualitative information on the ways in which ICT is actually incorporated into teaching and learning at the universities, i.e. what kind of learning activities it supports and enables. The national reports give the impression that the focus of eLearning has been on developing digital materials and online courses, rather than innovative learning approaches for different types of settings.[16] Furthermore, country reports do not show many networking activities or much collaboration between universities. In Estonia on the other hand, with its national eUniversity (and eVocational school) networks, the opposite occurs.

### Universities in the ICT age

The socio-economic environment where the European universities have to produce useful workforce is getting standardised. Digital learning objects, electronic lecture notes follow broadly accepted standards. Hence, considering the facts detailed in the previous chapter it is not a surprise that the concept of virtual universities is spreading rapidly in the EU, especially in countries, which have excellent ICT infrastructure.

According Carswell a virtual university (VU) has several differences compared to a traditional university. A VU is much more: besides education (normally distance education) it supports educational research, employs the latest educational technology, and on this basis creates remarkable networking possibilities for students and educators as well (Carswell 1998). VU's aiming to provide lifelong learning services, which do not depend on the geographical location. They also consider including the idea of sustainable growth into their activities. Normally VU activities include the following tasks (FVU 2003):

- Providing valuable, network based learning services
- Coordinate the activities of the on-line educational services, the student advisor systems and the research networks
- Record and organize learning content, including the development of suitable learning object repositories

[16] Similarly, this seems to be true for the whole of Europe, as discussed in a Commission Staff Working Paper (European Commission 2008b).

- Establishing and maintaining student administration
- Researching ICT supported education throughout providing a motivating, rewarding working environment, which supports creativity. They usual participate in international networks and innovation projects
- Promoting equal access to their research and education services among their stakeholders

A Danish organisation, PLS RAMBOL Management, has carried out an empirical research for the European Commission, DG Education and Culture during 2002-2003. The study recognized that universities can be categorised into four clusters concerning their current use of ICT and eLearning in their organisational and educational setting (PLS Rambol 2004):

1. Front-runners; (16% of universities in the sample)
   These universities already managed to integrate ICT solutions into their on-campus administrational and educational activities. They offer a range of eLearning courses for academic and supplementary academic programmes. A wide international research and development network is established and strategic co-operation has been set up with several universities and private companies.
2. Co-operating universities; (33%)
   These universities also possess a well developed ICT infrastructure, but eLearning courses are not offered as regularly as in the front runners group. They mostly offer minor academic courses, but the number of these courses in their virtual learning environment is expected to increase. The co-operating universities have also a very efficient international network in their background.
3. Self-sufficient universities; (36%)
   These institutions think about ICT development as a key success factor, but improvements are slow. The management cannot motivate teachers in order to use the latest technology in the education. The involvement of these universities in European projects is not clearly visible; their international partner network still needs further enlargement.
4. Sceptical universities. (15%)
   These universities are exceptionally poorly equipped with ICT. Integrated electronic administration systems, virtual learning environments still need to be implemented. In some cases they offer eLearning courses, but these initiatives are quite rare. The university staff and also students are sceptical towards eLearning and ICT applications in education. Some of them are already participating in major European partnerships, but the general co-operating activities are still lagging behind the first three groups.

## Adult learning

Information about non-formal adult training is scarce, both for enterprises and for general adult learning, therefore local expert estimations became important sources for information in this area. Besides this, some Eurostat surveys gather information on this area. Figure 8 illustrates the individual internet usage for training and education in EU10. People aged 16-24 (i.e. including students) form a major group among these internet users. Many reports raise interest in ICT as a factor that has driven eLearning. However, reports also suggest that adult learners and employers are suspicious of the quality of online courses, asking for quality assurance mechanisms for online courses in adult training.

Companies declare to use eLearning more in EU10 than in EU15 (see Figure 9), but the surveys regarding internet usage for education among people of a working age show much lower shares. The country reports assert that often employers are not very supportive of learning, something they consider to be the responsibility of the employees. Furthermore, the reports suggest that eLearning is unequally distributed among enterprises and employees; larger enterprises have more broadband connections and employees in higher positions have more opportunities for eLearning. With regards to types of training, enterprises seem to favour standardised online courses with internationally recognised certification, such as ECDL.

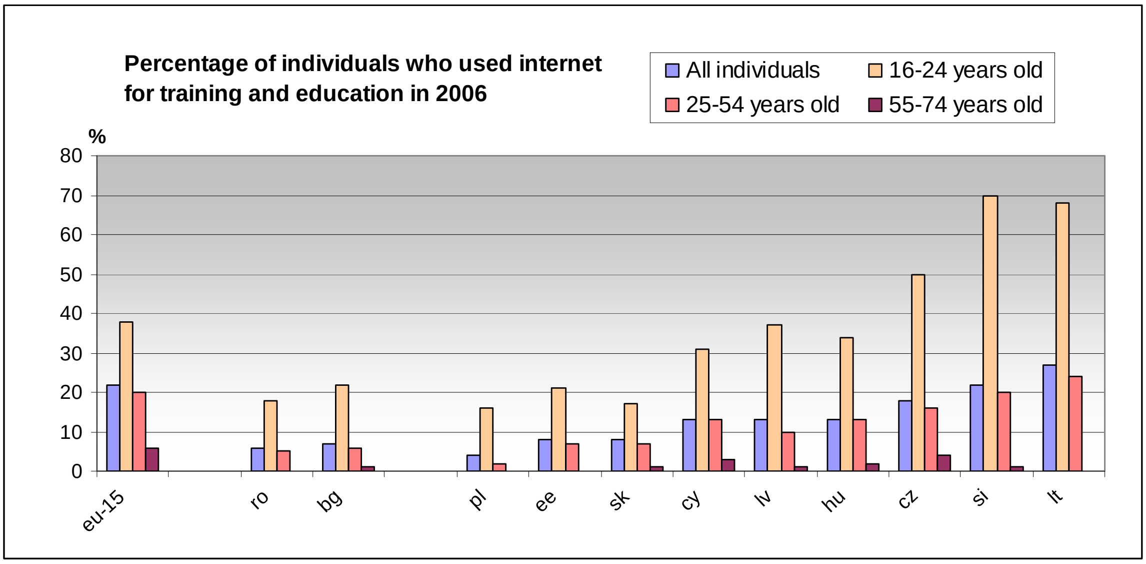



**Figure 8: individuals using internet for training and education, showing different age groups (data source: Eurostat)**

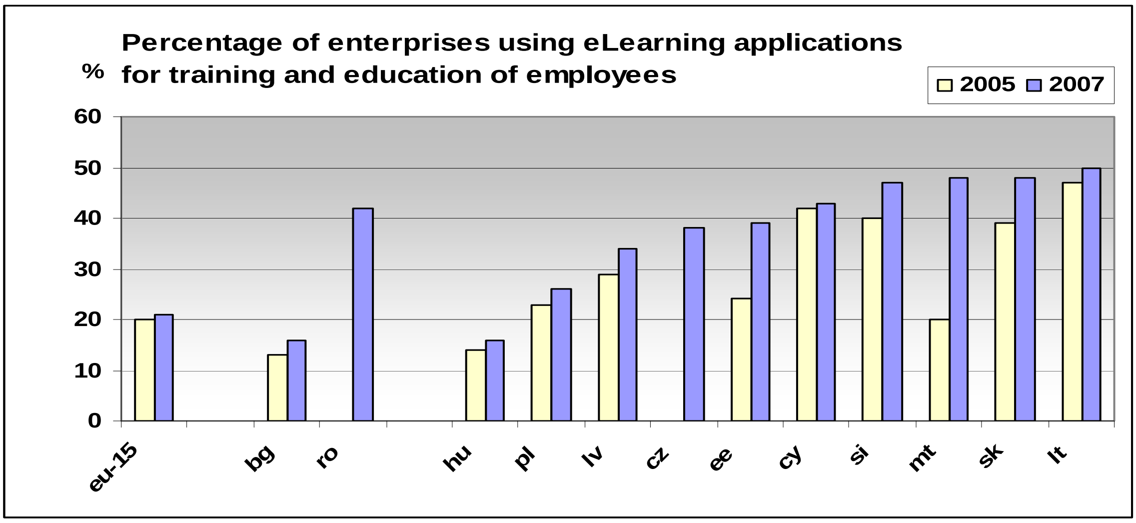



**Figure 9: Enterprises using eLearning applications for employees (data source: Eurostat)**

## eLearning and Inclusion

The country studies also report eLearning initiatives set up so as to improve inclusion in the knowledge society, supported by both public and private funding, and sometimes partnered by international companies. For example, the Hungarian Digital Secondary School helps adults through distance education to finish their secondary school exams. It is specifically targeted at the Roma minority who have difficulty in accessing labour markets (Magai & Simonics 2008). In Latvia, the Latvia@World project provides training for the unemployed in poorer districts, rewarding participants who complete the course with a certificate and providing them with internet access, in order to help them to look for and get jobs (Kalis 2008).

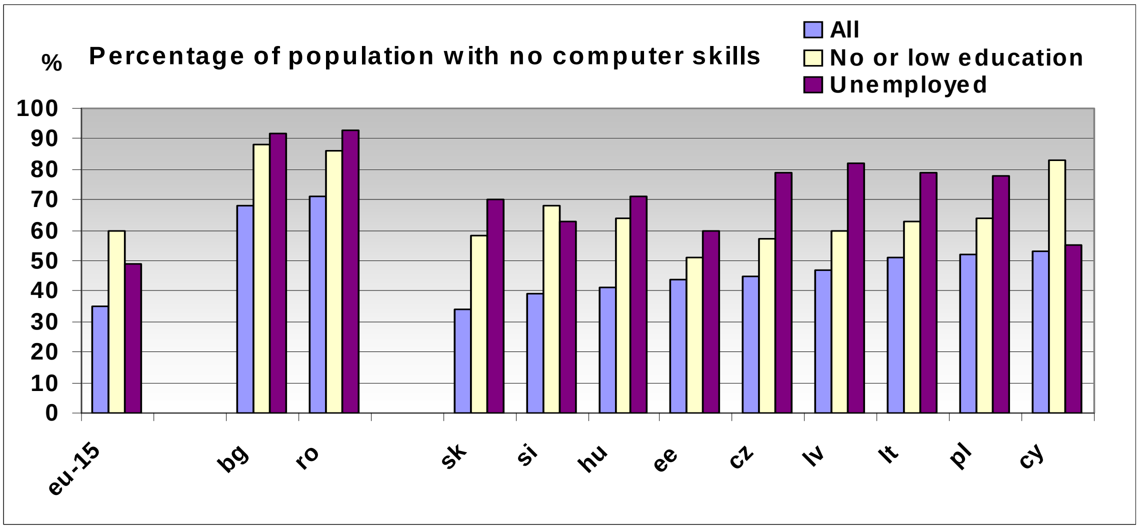



**Figure 10: Computer skill divides between different groups of people in 2007 (data source: Eurostat)**

### Heterogeneous countries

As discussed above, the EU10 is not a homogeneous group. Each country has different characteristics, both in an educational context and terms of developments with information society. Comparing only the EU10 average to that of EU15 would mask important differences, not least since weighted EU10 average reflects the fact that Polish population makes up half of the total population in EU10.

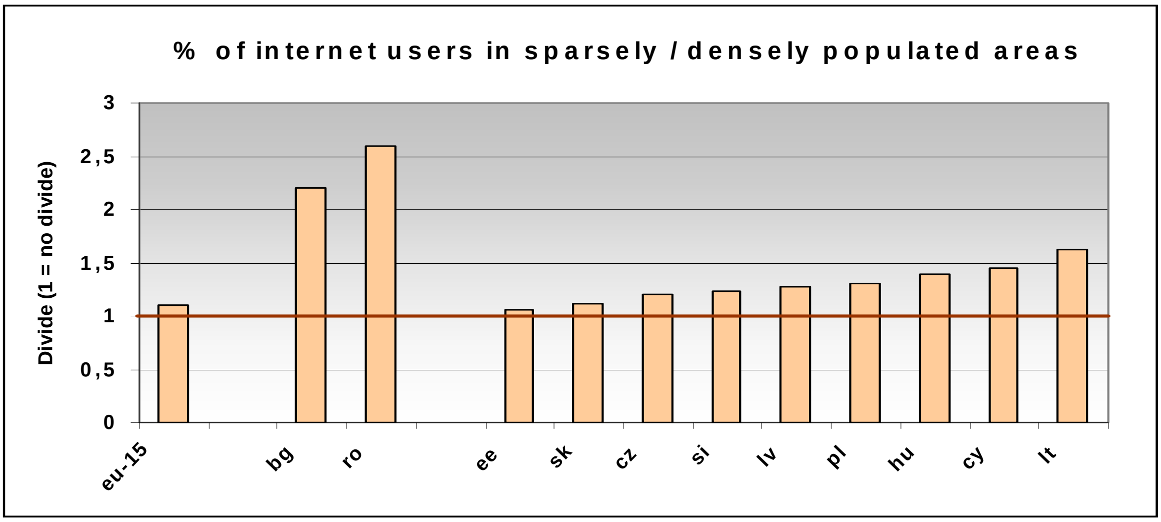



**Figure 11: Divides in internet use based on area of living in the New Member States in 2007 (data source: Eurostat)**

### ELEARNING IN HUNGARY

Hungary is a middle-sized country – the number of inhabitants is a little over 10 million – in Central-Eastern Europe. When joining the European Union, this country's ICT developments were well behind the western European level and there is still lot of catching up with the EU15 levels to do: Internet-connected computer penetration (38% vs. 59% in EU15 in 2007) and broadband internet connection (33% vs. 46% in EU15) of households are still far below the EU15 average. The digital divide is still one of the main issues of the Hungarian society, as more than 40% of the population lack basic computer skills. The younger generation and wealthy, well educated people, living in the cities are mostly digitally literate. Citizens living in rural areas with poor ICT infrastructure have very limited access to electronic services.

The spread of mobile technology is very dynamic and remarkable and might in fact be a solution to providing recent ICT infrastructure in rural areas. According to the NHH (Nemzeti Hírközlési Hatóság – National Communications Authority)[17] the penetration of mobile phones in November 2008 was 119,1%, meaning that there are more mobile phone

[17] National Communications Authority, http://www.nhh.hu/index.php?id=hir&cid=6672

subscriptions in the country than citizens. Currently there are three main providers present in this field, but in 2009 at least two new providers are expected to enter the market, enabling better quality of service and greater coverage of mobile data-communication services, like mobile broadband internet access.

### Status of eLearning in the country

The figures relating to both digital literacy and the general usage of ICT indicate that Hungary is not among the leader European countries in the field of ICT supported educational activities. Regarding Education and Training 2010 benchmarks, Hungary is catching up in almost all fields of education, except Lifelong Learning, where further falling behind is experienced (European Commission 2008a). In 2007, adult participation in Lifelong Learning was only 3,6% (in 2000 it was 2,9%). Among the 27 current EU member states Hungary only performs better than Greece, Bulgaria and Romania (European Commission 2008a).

Still, Hungary is one of the best countries in the EU regarding the increase in public spending on education. Between 2000 and 2005 the increase was 0,95% of the GDP, ranking second best among EU25[18] countries.This rate is much higher than the EU average 0,35% (European Commission 2008a). The abovementioned effort was enough to provide a computer for every 10 pupils, cover 77% of the schools with broadband internet connection and foster website development among schools (56% of public schools had a website in 2006) (Empirica 2006). There is a sufficient number of digital learning content available both in primary and secondary schools and every school runs a compulsory course covering the basic topics of computer science. But despite these promising numbers there are still serious drawbacks in schools using ICT in education, especially in rural areas due to their weak ICT infrastucture.

There is no real infrastructural problem in the higher education. Universities and colleges are well equipped with ICT and they are slowly incorporating technology into their academic processess. Web-based learning is used extensively and there is a growing number of institutions providing eLearning based distance education programmes (e.g. Dennis Gabor College or Szecheny Istvan University), which includes standardised digital content delivery. Learning Management Systems are also present (mostly open-source solutions), but they are not yet widespread.

11,7% of the Hungarian adult population participated in educational activities in 2005 (Magai & Simonics 2008). This number is very low compared to the EU15 average (43,9%) and if we consider the abovementioned lifelong learning participation, the numbers get even

[18]EU25 consist of all EU member states, except Bulgaria and Romania. These countries were not members at the time of this study.

lower. However, as there is no reliable data from the eLearning activities that were carried out by the private sector. Multinational companies are actively using ICT for employee training, therefore experts assume that the private sector in Hungary is also a dominant player of the eLearning area. There are numerous companies developing Learning Management Systems, student admistration systems, digital learning content or offering consultancy (Magai & Simonics 2008).

### Positive developments

The intense investment into ICT in the Hungarian educational sector resulted in a reasonably good coverage of computers and broadband internet connection in schools, universities and in libraries. The infrastructure is generally fine, only schools in the east – in the least developed regions – have serious drawbacks. The government's Information Society Strategy provides a general framework for the developments, which in the last few years has resulted in a significant elaboration of the society's digital divide.

In public education a massive progress was visible in the last few years. The most important development was the ministerial initiative Sulinet (Schoolnet) Digital Knowledge base, which contains and provides digital learning content on all fields taught in schools for free of charge and acts as an important information hub for pupils and teachers. Digital content can be officially accredited by the government and there are also dedicated advisory bodies (like the Digital Content Accreditation Committee), whose main task is to foster the inclusion of eLearning in the public eductional sector.

Sulinet provides training and support for school teachers, helping them with digital content development and delivery that covers technical and pedagogical issues. Currently teachers are trained to use ICT in the classroom during their studies, as ICT related subjects are incorporated in various educational BSc and MSc programmes. But despite these efforts with training most of the teachers still have very limited knowledge of ICT supported educational technologies, related methodologies and pedagogical approaches.

ICT is very well integrated in Hungarian higher education, whereby students use computers for their studies on a daily basis. There are several institutions providing eLearning courses with standardised content available through Learning Management Systems. Student administration in the higher education is almost completely digitalised and in some cases student administration, institutional back office and academic content delivery systems are integrated.

Another positive sign of the Hungarian educational scene is the growing number of educational research activities in higher education. Mobile learning, for instance, is a new emerging field of technology enhanced learning, where academic groups undertake cutting edge, world class research (e.g.: Corvinus University of Budapest[19], Technical University of Budapest[20]). There are also attempts to establish a new generation of learning content management, which is driven by semantic applications.

The government initiated several programmes for the inclusion of citizens living in rural areas (mostly Roma pople). These programmes include access to ICT infrastructure (computers or internet) mostly at no charge, where courses and tutoring activities are also offered. There is a positive discrimination towards Roma students, making their entrance to higher educational programmes and institutions easier than citizens from other ethnic groups. Despite all these efforts, there is no reliable data available nor independent studies carried out regarding the efficiency of these Roma inclusion projects.

## Challenges for content and interest

One of the most important challenges is that the take-up of ICT-based educational services is still quite low, despite the well established infrastructure. Current reports (Magai & Simonics 2008) identified several hindering factors, which need to be tackled:

- Higher education and adult education lack quality learning content. Most of the higher and adult education institutions have limited expertise in digital content development and delivery. Compared to schools, these sectors don't have a common repository with standard, sharable and reusable learning objects, which may foster the development of eLearning based courses. Not only the common repository is missing between educational institutions and content providers, but also the eLearning related cooperation.
- The digital rights of learning objects already produced are not handled carefully enough. Content developers and owners are not used to the phenomenon of sharing content, nor do they see the benefits of it. There are no general guidelines, legal support nor explanations about the benefits of content sharing.
- In general, teacher's motivation and expertise for using ICT for their work is still quite low. Teachers are reluctant and they often experience difficulties in applying different pedagogies and tools compared to those of traditional classroom education. An attempt has been made to incorporate ICT driven education subject matters in teacher's education and also in teacher's further education, but so far they have not proven to be effective.
- The demand side of the educational market for eLearning is very low, people do not understand this novel educational approach, which results in a lack of interest in

[19] The center of mLearning research is the Department of Information Systems, http://informatika.uni-corvinus.hu

[20] http://www.bme.hu/

eLearning. Another problem is the lack of a tradition of distance education, which also contributes the lower eLearning adoption.

- The low level of digital literacy in the Hungarian society also hinders eLearning developments. The focal points of the digital divide are (1) the vast differences between the central (Budapest) area and the rural countryside and (2) the extremely low level of education among Roma people. In the first case the main issue is in providing access to electronic services in small villages and townships far away from cities. One solution might be the spread of mobile broadband networks, which is a promising ongoing process at the moment. The problem with the inclusion of Roma minorities needs more attention, as cultural differences and their extreme poverty result in a peripheral social status. Roma people (8% of the population) still have very low access to education, a fact which forecasts the growth of social inequalities in the future.
- There are no policies dedicated to promoting ICT supported learning. The government could do more in order to develop eLearning in all levels of the educational system. The efforts made at the beginning of this century were important and partly successful, but eLearning is still not being focused on by policy makers. Incorporating eLearning in official, national educational strategies would force local decision makers to help and promote the implementation of educational technology in mainstream education.

While Hungary possesses the necessary ICT infrastructure for eLearning activities in most areas, regional divides exist. There have been several promising and successful developments since the mid '90s, resulting in significant improvements in information society and ICT-based services, which are now relatively widespread. Public schools and universities are adopting eLearning slowly but meanwhile offer ICT skills and ICT as a working and learning tool for the students continuously. Content creation is still an issue, and a bottleneck especially in higher education and vocational education. Private companies seem to be more successful in using technologies for education. The general eLearning uptake however is still quite low due to several socio-economical issues, which requires attention from the government.

### POLICY IMPLICATIONS

The previous sections demonstrated some of the differences and similarities between EU countries, indicating how EU10 averages can mask large differences. Structural changes and fast economic growth have been drivers for ICT investments and for a demand in eLearning but they have also been accompanied by deepening regional, income, and age divides, and also by employment disparities. These partly contribute and partly explain the widening digital divide, which has been one of the hindering factors of eLearning developments in EU10. As demonstrated by the Hungarian case, although indicators for ICT infrastructure and skills have been catching up with EU15 rapidly, investments are still needed. Public policies should continue to improve ICT infrastructure and promote digital literacy initiatives in order to close the gap between richer and poorer regions and different social groups. In their financial decision-making, the states should take into account the expected expenditure on future maintenance and a renewal of ICT equipment at schools. They should also invest in both ICT and human resources for user support. EU structural funds provide an opportunity for the EU10 countries for these purposes.

Several other national studies have pointed out that the lack of knowledge on the opportunities brought about with eLearning as such is one of the biggest problems. There is a need to better inform learners, teachers, and organisations about the benefits that ICT can offer. Furthermore, policy makers themselves are not necessarily aware of the opportunities of eLearning either. Improving the visibility of existing eLearning solutions could contribute to solving this. . For example, public institutions should provide and administer public research grants supporting innovative projects on eLearning at different educational levels. The results could be then made visible in a central portal giving access to interested stakeholders and learners, promoting existing materials and eLearning approaches in general. This could also support networking between different educational partners.

Although several developments have been taking place in many countries, cases demonstrate how the absence of a comprehensive approach in developing ICT in education can be considered to be a barrier. Without specific approaches, eLearning can be absent or receive little attention as only a part of related other policies. As dispersed policies have been considered as a major barrier for the developments this far, many country studies called for national eLearning strategies, or otherwise better coordination and focused effort for developing eLearning. The majority of experts in the project shared the opinion that there should be one institution with a comprehensive responsibility for eLearning and support of Internet and broadband diffusion.

A lack of ICT skills and requirements for students, teachers and principals has been seen as a regulatory barrier, as these factors could improve the proficiency and interest in ICT-enabled learning approaches in educational institutions. Where present, mandatory basic informatics courses at schools have been considered as means of encouraging ICT use, both for the young learners themselves as well as for their families. Those who apply ICT in education become better prepared for eLearning after their formal education. In addition to the question of ICT skills lacking among older teachers, teachers often lack the opportunities to develop new learning and teaching approaches that would be possible with ICT. The institutions should be able to provide flexible curricula and financing systems, which would allow and encourage teachers to develop ICT-enabled learning approaches.

Attention should be paid to embedding eLearning aspects into teacher training curriculum and to promoting in-service training on ICT skills and eLearning didactics, possibly as part of a promotion system. Teacher networks, guidance materials, and best practice exchanges should also be developed in order to support teachers in implementing eLearning approaches and in being innovative with regards to developing new ones.

Research challenges for eLearning in EU10 are often not specific challenges to these countries, but arise from the needs shared with other countries for developing and pooling resources in the following: good practices, research on quality learning approaches, personal data management, material interoperability and sustainable models for partnerships. Specific EU10 R&D challenges arise mainly from the fact that these countries have inherited old models for their educational systems. Additionally, the business environment in EU10 is different from that of EU15, and the EU10 countries are mostly small nations with their own languages, which makes it difficult to find a critical mass of users for the services provided. The study suggests that more (although not only) EU10-specific research issues are as follows:

- The basic problem for a large number of potential learners in EU10 is access. Research efforts should therefore concentrate on finding easily usable and achievable solutions, which, for example, take advantage of the opportunities offered by mobile technologies and use the local language. Open source software may provide a cost-efficient solution for more easily obtainable tools that could be tailored to the target audience.
- Approaches to evaluate the impact and quality of eLearning projects need to be developed, as these approaches would help in making investment and financing decisions. Quality certification systems for courses could increase the attractiveness of lifelong learning and eLearning solutions among the adult population.
- Lifelong learning participation is very low in EU10 despite a high basic educational attainment. Research is required to determine how ICT-enabled learning could be best used so as to reach new groups of lifelong learners in EU10. Furthermore, developing ways to collect and store information on adult learning is needed to support research and investments in this area.

Overall, eLearning is progressing in the EU10 countries, although information society developments started much later in most of these countries than in EU15. The take up of the Information society has been fast and the development of other eServices (eGovernment, eHealth) has also increased capabilities and interest in using ICT for learning. Because the expanding service sector is labour intensive, and requires highly-qualified employees who have a growing need for ICT knowledge and skills, the demand for learning both to use ICT and to use ICT as a tool for lifelong learning has also been rising.

The overall study show dispersed IS and education policy approaches for eLearning developments in EU10, often lacking coordination and common objectives (Chytilová et al. 2009). Policies have mainly concentrated on developing ICT infrastructure and digital literacy and have looked at distance learning considering eLearning mostly in terms of developing digital materials for online (often self-learning) courses. ICT has not been considered as a means to enable educational innovations, which was highlighted by the European Commission (2008b) as a challenge for the whole of Europe. However, the countries do show many positive developments in this area, rising from individual actors or specific projects.

Compared to EU15, eLearning lags in its development in the NMS more than economic development, general educational achievements or even general ICT developments do. As using ICT for learning is new (compared to education in general) and much more sophisticated and complicated than basic ICT diffusion, it cannot emerge just by itself, but needs active support by policies. Study shows that EU10 countries have been following EU15 policies, but more active and proactive approach is needed to stimulate eLearning developments. However, the study suggests that eLearning is now receiving more policy attention in all these countries and its importance is starting to be recognised in connection with reforming educational systems.

Research challenges for eLearning in EU10 are often not specific to these countries, and collaboration and sharing of research developments should be encouraged. Specific challenges rise from the deep regional and social divides threatening to exclude a large portion of the population from the Information Society. The younger population is often on par with EU15 in ICT usage and skills and consequently demonstrate capabilities for new learning opportunities. That said a specific effort still needs to be made to engage new groups of people so that they benefit from the potential ICT offers for lifelong learning.

# MOBILE TECHNOLOGY IN THE WORLD OF LIFELONG LEARNING

## INTRODUCTION[21]

The complexity of our lives puts pressure on employees, employers and policymakers to sustain an efficient and competitive labour market in Europe. The European Union (EU) has found it difficult to respond to the rapid transformation associated with globalization, which has imposed different kinds of jobs and skills, in a faster moving economic climate where technology is constantly changing. In this context, the Lifelong Learning (LLL) paradigm was welcomed as the "picklock", which could overcome national resistance and bring together education and vocational training once more. Naturally, other factors also affected the success of LLL within the EU context, such as the opportunity to develop a common educational area – see the Bologna declaration of European Ministers of Education – (European Commission 2005c), the need to bridge cultural and social gaps between western and eastern European countries after the Fall of the Berlin Wall, demographic considerations about ageing as a consequence of the 60's baby boom, and so on. But according to Arrigo et al. (2010) all these factors do not explain the differences that exist throughout EU nations regarding learning standards and policies. Incompatible scholastic curricula, different higher education curricula, and mismatched qualifications characterize the current European situation; the mobility of individuals from one member country to another for study and work purposes is still limited, and all indicators used to measure participation in education and training show that there is no homogeneity within the EU. Globalization, ageing and diffusion of new technologies, are transversal phenomena that have involved almost all European countries in the last few years, but the consequences of these phenomena have not been uniform across the EU, and the lack of a shared educational policy has often been highlighted as one of the most pertinent reasons to explain the different impacts that global economic and social transformations have had at a local level (Becker 1993; Romer 1990).

Mobile technologies have been evaluated as being particularly suited to the implementation of the LLL paradigm (Sharples 2000): some mobile technology features and some LLL methodological issues combine almost perfectly (as demonstrated in Sharples (2000, p.179)), and this suggests that they could be the choice technology for fulfilling the LLL vision. Moreover, mobile learning has been considered by many researchers as the future of learning or as an integral part of any other form of educational process in the future. In EU countries, the widespread diffusion of mobile technologies offers an opportunity to develop

[21] This section is currently under publication as:
Arrigo, M., Kukulska-Hulme, A., Arnedillo-Sánchez, I., & Kismihók, G. (2011). Meta-analyses from a collaborative project in mobile lifelong learning. *British Educational Research Journal*, (accepted, to be published in 2011).

policies aimed at participation and social inclusion, considering that the use of mobile devices transcends age, social status, economic level, gender and ethnic origins. The literature suggests a positive impact of mobile technologies upon lifelong learning (Carril et al. 2008; Agrusti et al. 2008), but there has been a lack of clear evidence. There is no overall model to describe the relations, which link adoption of mobile technologies and enhancement of LLL. Mobile technologies seem to be able to promote social inclusion, mainly by increasing participation in learning, expanding learner choice, and favouring flexible or personalised learning programmes, which can take place everywhere and at anytime. Moreover, mobile technologies have been shown to be particularly effective at reaching learners who are often overlooked by traditional forms of technology-enhanced learning and so can contribute to meet lifelong learning targets. However, in order to maximize the benefits of mobile technologies for increasing and widening participation, learners, and especially adult learners, should be given adequate support when developing their use of mobile technologies.

These considerations suggest that the impact of mobile technologies on LLL is mediated by some pedagogical variables, such as participation, choice, flexibility and personalization. In particular, this impact can broaden the number and the type of people involved in LLL. But this effect can also be moderated by contextual variables, for example, the level of support in the use of new technologies. Another important moderator to consider is the national political framework aiming to encourage LLL.

These important issues formed the backdrop to our European project, MOTILL ("Mobile Technologies in Lifelong Learning: best practices", 2009-10), which was funded with support from the European Commission within the National Lifelong Learning Strategies (NLLS) programme. Here, I want to present and discuss the main outcomes of the project, including three distinctive meta-analyses:

- a collaborative tagging activity to categorize initiatives and published literature
- a collaborative reviewing activity to make published literature accessible to a wider audience
- a collaborative meta-analysis of a set of case studies produced by the project

MOTILL focused on the use of mobile technologies as a key factor in developing flexible LLL frameworks for education. As one of the MOTILL project results, an Evaluation Grid was developed to analyse and identify good practice in mobile lifelong learning. Subsequently the consortium was able to formulate some suggestions as well as considerations on the use of the mobile technologies in lifelong learning. The MOTILL project also provided policy makers with evidence and good practices on the use of the mobile technologies to improve LLL, for example to help them in: setting out strategic priorities that contribute to meeting existing and future targets for adult learning, vocational training, and higher education; and to support the development of next-generation mobile networks and the reform of European telecommunication sector.

## MOBILE LIFELONG LEARNING

Lifelong learning has a wide range of interpretations in current literature. Indeed, the articulation and conceptualisation of lifelong learning has witnessed developments over recent time. From an academic point of view, there is nothing new about the general phenomenon of lifelong learning (Knapper & Cropley 2000, p.1): *"It is that deliberate learning can and should occur throughout each person's lifetime."* According to Bentley (Bentley 2000, p.3) *"people will need to return to formal education more often during their lifetime and ... learning will become a more explicit goal in activities not formally designated as education, especially work"*. But stepping away from the learner's perspective, lifelong learning also has implications for the institutional infrastructure of learning services. Day argues that only those institutions which are *"concerned about the lifelong development of all their members"* can develop lifelong learners (Day 1999, p.20).

Early understanding of the construct associated it with adult workforce up-skilling to adapt to rapidly changing society and world demands (Sharples 2000). A view, which Field et al. (2009) argue, promotes the economic relevance of adult learning rather than the learners' need for self-actualisation' through experiential and transformative learning (Gouthro 2010). For Fischer (2001) LLL encompasses more than adult education and training; it is a mindset, a habit for people to acquire.

While Fischer & Konomi (2007) argue that LLL learning outside school is different to school-based learning because it is self-directed, driven by interests and needs, informal, often collaborative and carried out in tool-rich environments, Thorpe maintains that LLL is ubiquitous (2000). Thus, it should include education, training, informal, formal and non-formal learning. The European Commission's definition reflects Thorpe's view stating that LLL is "*All learning activity undertaken throughout life, with the aim of improving knowledge, skills and competencies within a personal, civic, social and/or employment-related perspective*"[22] (European Commission 2002, p.7). In order to ensure people are equipped with the skills required to engage in LLL, eight key competences have been identified: 1. Communication in the mother tongue; 2. Communication in foreign languages; 3. Mathematical competence and basic competences in science and technology; 4. Digital competence; 5. Learning to learn; 6. Social and civic competences; 7. Sense of

[22] Taken from the European Report on Quality Indicators of Lifelong Learning

initiative and entrepreneurship; and 8. Cultural awareness and expression (European Commission 2007b).

### Mobile technologies in educational settings

The emergence of mobile technology in our society has added a new dimension to education. Mobile learning emerged gradually from the middle of the 1990s and has become a controversial topic for all stakeholders of educational activities. There are various definitions available for mobile learning. Approaching this from a technical perspective, Keegan declared that mobile learning is *"the provision of education and training on PDAs/palmtops/handhelds, smartphones and mobile phones"* (Keegan 2002, p.3). Quinn (2000) offered a similar definition. But this technology also has to serve the needs of learners' increased mobility needs. Learners want to navigate through their learning path, regardless of time and physical space (Brown 2006) and at the same time they want to stay connected with their peers throughout their learning (Siemens 2005). The barriers between formal and informal learning are slowly disappearing as use of mobile technology becomes a daily routine for learners. Sharples recognized this movement early and suggested that lifelong learning is collaborative and contextual (Sharples 2000), which are also key components of mobile learning. Furthermore, Sharples and colleagues (Sharples et al. 2009) attribute the conceptual foundations of mobile learning to Kay's articulation of the Xerox Dynabook, a *"self-contained knowledge manipulator in a portable package the size and shape of an ordinary notebook"* (Kay 1972). However, it is only over the past ten years that technological progress has enabled the implementation of mobile learning constructs and contributed to the popularization of the topic as an area of research.

Those concerned with understanding the underlying learning processes supported by mobile learning assert that it *"is not simply a variant of e-learning enacted with portable devices, nor an extension of classroom learning into less formal settings"* (Sharples 2009, p.18). For Hummel, Hlavacs, & Weissenboumlck (2002), mobility is a clear distinguishing factor between mobile learning and e-learning. Likewise, a learner-centered conceptualization of mobile learning must be concerned with "*how the mobility of learners augmented by personal and public technology can contribute to the process of gaining new knowledge, skills and experience"* (Sharples et al. 2009). Thus, mobile learning *"supports education across contexts and life transitions"* (Sharples 2009, p.17) as it pervades dimensions of learners' mobility such as physical, conceptual and social space as well as mobility of technology and learning dispersed over time.

The possible use cases for higher education is well characterised by a Hungarian national project[23], which has been launched 2005 to modernize the structure of the Hungarian higher education through redefining its processes (institutional and operational processes, academic processes and supporting innovative processes). The final research output was a major milestone in the reform of the Hungarian higher educational sector (Gabor 2006). This project also concentrated on the inclusion of innovative technologies, which scaffold the academic performance of universities. Among these technologies, mobile learning or was mentioned as a key instrument of educational technology in the near future. The idea of using handheld devices in education provides flexibility, spare time and increase work efficiency. Nowadays it is clear that with the last generation of mobile networks and with the latest mobile devices, it is possible to develop an efficient mobilised distance learning system, which delivers multimedia rich learning objects (Kukulska-Hulme & Traxler 2005). Therefore the research output of this Hungarian project also emphasizes the importance of implementing mobile learning technologies in the following main institutional activities (HEFOP FOI Project 2006):

- **Administrational processes**
  Educational institutions are advised to use mobile communication technologies to contact students regarding administrational issues. This technique should also substitute costly and slow postal services, especially in distance education.
- **Educational processes**
  There is a visible demand from students for learning anytime, anywhere. To meet this demand, educational institutions should design courses considering possibilities of learning object mobilisation. Therefore they should offer access to educational infrastructure for mobile devices, which enables instructional designers to implement courses (mobilise content) for mobile learners.

### Convergence and synchronicity between mobile and lifelong learning

In identifying design features for personal mobile technologies for lifelong learning (LLL), Sharples (2000) stresses that while LLL can be characterised as: individualised, learner centred, situated, collaborative, ubiquitous and lifelong; new technologies are: personal, user centred, mobile, networked, ubiquitous and durable. Thus the convergence of both may enable people to take ownership of their own learning as they transition throughout their lives. More specifically, according to Okada et al. (2003) mobility provides authentic settings for situated learning and wireless network channels for communication and collaboration across physical boundaries.

[23] HEFOP FOI project created a reference process model for the complete Hungarian higher education domain. Details (in Hungarian) are available here: http://informatika.uni-corvinus.hu/hefop

An analysis of mobile learning projects over the last decade illustrates that mobile learning research has been very proliferate in enabling LLL through supporting its key competences (European Commission 2007b). For instance, communication in the mother tongue has been supported by the FÓN[24] (Foghlaim Ón Nuatheicneolaíocht) project which uses mobile technologies to support the teaching and assessment of spoken Irish in second level schools in Ireland. Developing mathematical competence and basic science have been the target of the MobiMaths (Tangney et al. 2010) and Personal Inquiry[25] (PI) projects (Scanlon et al. 2009) respectively. The acquisition of digital competence was examined and facilitated for instance by the DNA (Digital Narrative Approach) project (Arnedillo-Sánchez 2008), the eMapps[26] project (building communities of primary school children from different countries) and the BLOOM[27] project in Austria focusing on employees' digital competences in the passenger transport and logistics sector. The Mobile Game Based[28]Learning project aims to support decision making in critical situations. Mobile learning is also useful when completing task in an educational process, which idea has been materialised as a performance centred mobile learning model by the mPSS project[29]. People with disabilities also benefit from mobile technologies. Quite a few projects target learners with special needs, like the "Collaborative Additional Language Learning for Dyslexic Students" project[30].

## European policy perspective

European lifelong learning policies – as it was mentioned in the previous sections of this part – are an integral part of the EU Information Society development programmes, treated as a key factor for enhancing the competitiveness of Europe in global markets. As part of the Lisbon strategy the European Commission launched the *"Education and Training 2010"* work programme in 2001 with various sub programmes such as the *"Programme for the Effective Integration of Information and Communication Technologies (ICT) in Education and Training Systems in Europe (2004 – 2006)"*. This initiative consisted of 4 major action lines (European Council 2009; European Parliament 2003):

- Promoting digital literacy
- Establishing and supporting European digital campuses
- Developing partnerships between schools
- Promoting e-Learning throughout transversal actions

---

[24] http://www.foghlaim.edublogs.org/
[25] http://www.pi-project.ac.uk/
[26] http://www.emapps.com
[27] http://www.bloom-eten.org/
[28] http://www.mg-bl.com/index.php?id=57&no_cache=1
[29] http://mpss.dipseil.net/
[30] http://www.calldysc.info/

During the last decade, priorities of the Lisbon strategy have continuously moved towards supporting social dimensions of education and training (DG Education and Culture et al. 2008) and establishing the abovementioned key competencies needed for lifelong learning (European Commission 2007b). This movement concluded in the latest *"strategic framework for European cooperation in education and training 'ET2020'"* notice from the European Council, which forces competency based education, creativity, social cohesion, active citizenship, mobility and innovation to be appear at all levels of education (European Council 2009). The current lifelong learning programme (2006-2013) of the European Commission identified four target sectors for development: schools, higher education, vocational education and training, and adult education (European Parliament 2006). Furthermore, four transversal (key) activities were envisaged, namely: policy cooperation and innovation, languages, information and communication technologies (ICT) and dissemination and exploitation of results (European Parliament 2006). The majority of these target sectors and key activities require the use – not the development – of advanced technology.

European policy makers do not require that participants of this programme incorporate particular technologies into their activities. Their goals are different: enhancing learning environments and experiences, promoting formal learning and supporting learners in expanding their relevant skills and competencies in order to be digitally literate (European Commission 2007a).

### European lifelong learning projects

Several projects have been carried out in the past in order to provide inputs for European lifelong learning policy formulation, investigating in particular the role of technology in (future) education. The main organisation behind these inputs is the European Commission Joint Research Centre – The Institute for Prospective Technological Studies (IPTS). This organisation's Information Society unit has been engaged with European policy research for many years.

Among their past projects, eLFUT (Learning spaces in 2020: Future learning in the Knowledge-based Society in Europe enabled by Information and Communication Technology) forecasted an incremental need of fundamental transformation of education (Ala-Mutka & Punie 2007). Development of citizens' digital competencies, citizen's social inclusion, the impact of web2.0 on learning and the issue of providing learning opportunities to elderly people using ICT have also been investigated in detail, resulting in reports stimulating policy making (Ala-Mutka et al. 2008; Ala-Mutka et al. 2008; Ala-Mutka et al. 2009).

The current research agenda looks into ICTs as stimuli of creativity and innovation. European legislators need to understand what skills have to be developed or upgraded in order to supply sufficient qualified workforce for future jobs, enable sustainable European economy growth and tackle unemployment (IS unit website - IPTS - JRC - EC 2010). Projects like ICEAC (Creative Learning & Innovative Teaching: A study on Creativity and Innovation in Education in EU Member States) and FutLearn (The Future of Learning: New Ways to Learn New Skills for Future Jobs) provide outputs targeting the abovementioned objectives (IS unit website - IPTS - JRC - EC 2008; 2009).

Besides official projects managed by the European Commission there are also several lifelong learning policy recommendations coming from professional networks. One example is the EDEN network, which is one of the largest groups of professionals active in the European eLearning area. Apart from publishing white papers on learning innovation (European ODL Liaison Committee 2004; 2006), the network is also contributing to the European policy agenda through projects like LEARNOVATION forecasting innovation needs in learning processes and triggering dialogues among stakeholders of lifelong learning activities in Europe (Learnovation Project 2008).

## MOTILL: CREATING RESOURCES FOR POLICY AND PRACTICE

One of the most important objectives of the MOTILL project has been the involvement of policy makers to promote the use of mobile technologies in lifelong learning strategies, according to local and national targets for lifelong learning in line with European benchmarks and strategic objectives. To achieve this goal, the partnership introduced policymakers to the state of the art on how mobile technologies can best support lifelong learning, as well as the good practices in this field resulting from the main activities carried out in the partner countries. In this section, first we introduce the rigorous approach adopted to build the Scientific Annotated Review Database (SARD), a database that provides a comprehensive set of references to the major research initiatives and publications concerning the use of mobile technologies in lifelong learning, supported by integrative and critical commentary. Next, we report on the methodology adopted to design the Evaluation Grid, a methodological framework to analyse and highlight mobile learning experiences.

Considering that the SARD is aimed at researchers as well as policy makers, the partnership worked to define an appropriate methodology to obtain validity and quality of the selected papers as well as scientific reliability and quality of critical reviews. For this to happen, a rigorous approach was adopted to collect, tag, and review the selected research initiatives and publications. The project team first identified appropriate descriptive ‘common tags’ and key concepts in mLearning and lifelong learning and grouped these into categories; then, the tags were used to classify the research initiatives. Finally the project team designed an Evaluation Grid. The process is described below.

### Identification of representative tags

The purpose of this phase was to come to an agreement about a way of classifying initiatives and publications in the area of mobile lifelong learning. To identify appropriate descriptive 'common tags' and key concepts, each of the project's four partners selected and studied at least 10 papers about mobile technologies in LLL. For each paper, using a bottom-up approach, individual researchers created suitable descriptive tags. Next, collectively we defined some categories and grouped tags with a similar level of granularity. As shown in Table 1, our classification identified the main concerns of papers on mobile-enhanced lifelong learning as belonging to 9 categories. Furthermore, for each category we identified some subcategories and a list of representative tags. Thus, the result of this phase was a group of common tags to be applied in a paper reviewing process in the subsequent phase of the project.

| Categories | Subcategories | Tags |
|---|---|---|
| Learning, pedagogical support, and related theories | 5 | 21 |
| Technologies and media | 11 | 71 |
| Learners | 4 | 19 |
| Contexts of learning experiences | 4 | 13 |
| Behaviours, activities and processes | 7 | 13 |
| Subjects being learnt | 1 | 1 |
| Competences | 1 | 9 |
| Political, economic and social issues related to LLL | 1 | 9 |
| Research methodologies and data analysis | 3 | 10 |

**Table 5: MOTILL Tag classification.**

### The MOTILL Scientific Annotated Review Database (SARD)

An important objective of the MOTILL project was to create a database of reviews of published papers dealing with mobile learning and lifelong learning. The purpose of this database was to make key issues and evidences from research and practice more accessible to policy-makers and other interested stakeholders. Following the Tagging phase, in order to build the SARD database, more than 40 papers were selected, tagged again and finally reviewed by the project team. A structure for each review as agreed, comprising:

- A *summary*: including the national context where the work or research took place (or 'international'/'European' context), and the age of the learners. If available, the education level was considered to be useful information, e.g. first year of university.
- A comment about the *Lifelong learning context*: encapsulating the paper's interpretation of lifelong learning (if available) and/or our own interpretation.
- A comment about *Mobile technology and learning*: including values or characteristics mentioned explicitly in the paper, followed by other opportunities or potentials we could see (e.g. supporting transitions, widening participation,

development of competences, work experience capture, continuity of contact, transcending age/status/gender).

- A *Critique***:** including some issues mentioned in the paper, and other issues or challenges that could arise.
- A comment about *Implications for policymakers*: any implications mentioned in the paper and other implications we could foresee. Comments were made mainly in relation to exploiting learning opportunities, increased participation, social inclusion, difficult to reach learners, informal learning, learner choice, personalized learning, flexible learning, digital competences and communication skills.
- *Type of publication*: This could be as brief as 'Journal article', or slightly more elaborate, e.g. 'An interim report with preliminary findings"
- A selection of relevant *Tags*, taken from the classification shown in Table 1.

Moreover, in our reviews we paid attention to distinguishing between what authors had actually written in the paper and what was our interpretation. The reviews were carried out by applying a 4-phase procedure:

- First review: The papers were split in 4 groups and assigned to each partner to be reviewed;
- Peer review: Each review was then peer reviewed by a researcher belonging to a different partner;
- Super review: The reviews were checked, and if necessary amended, by one designated team member, in order to guarantee a common quality level from a scientific point of view;
- Editorial review: The super reviews were edited by the UK partner in order to improve the documents' linguistic quality.

Finally, a list of additional relevant papers was proposed by external experts involved in the project. Eight of these papers were then reviewed, thus bringing the total to 51. The extra review phase was exactly the same as the planned review phase. A schema of the Methodology is illustrated in Figure 12.

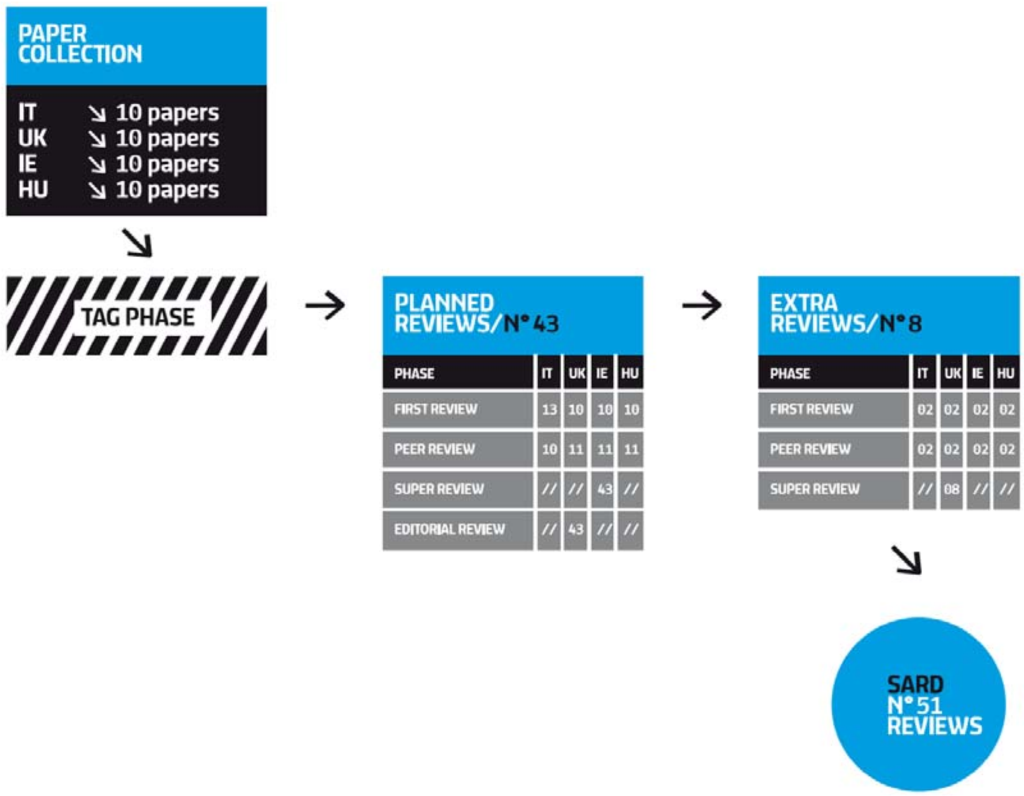



**Figure 12: Scientific Annotated Review Database methodology**

The SARD creation and reviewing activity established that mobile technologies are being used in ways that support lifelong learning, or that have a clear potential to support lifelong learning. At the same time, it revealed that the potential remains under-exploited. Mobile learning projects are typically of short duration, so that support for lifelong learning can only be glimpsed or imagined, but not fully investigated or developed. Furthermore, researchers may fail to reflect fully on how their particular project, focused on school-based learning for instance, could contribute towards building a long term vision for the use of mobile technologies in lifelong learning.

## The MOTILL Evaluation Grid

Following the review of published papers, the next stage of the MOTILL project focused on identifying 'best practices' in mobile lifelong learning by making contact with a number of mobile learning projects. The Evaluation Grid was conceived as a tool that enabled MOTILL project partners to work in a consistent manner to identify 'best practices' in the use of mobile technologies for lifelong learning, whilst taking national and local contexts into consideration. In particular, it was used in interviews with those involved in the best practice projects, to get more information about each instance of best practice.

The development and implementation of the Evaluation Grid enabled MOTILL partners to look at current practices in greater depth, with the aim of highlighting 'best practice' aspects for interested audiences such as policymakers and teachers. These practices were ones that had already been described in papers chosen for the SARD, or they were other projects and initiatives that were not represented in the scholarly literature (for example because they were very recent). Moreover, throughout the creation of the Evaluation Grid the team addressed the challenge of understanding contextual factors that may inhibit the transfer of practice.

The Evaluation Grid (Figure 13) was designed taking into account the work done by MOTILL researchers for the identification of the representative tags and the SARD described above. Starting from some of the key concepts identified in the tag categorization phase, the partnership generated 18 criteria for evaluation, grouped into the categories of Management, Pedagogy and Policy. As detailed in Table 18 in the Appendix 1, the criteria consist of one or more questions that can guide a best practice in-depth examination. In the Evaluation Grid, ethical considerations are transversal to all the dimensions considered. Table 18 also shows the questions used for the interviews.

Although the main focus of the Evaluation Grid was the identification of practices that support lifelong learning, it was also informed by our definition of lifelong learning and the associated concept of 'transitions'. Within the MOTILL project, 'lifelong learning' was interpreted in its broadest sense, that is, *encompassing all learning activities which are engaged in throughout a person's lifespan and which facilitate the continuous development of the individual's quality of life*. The aim of lifelong learning is to enhance the learner's knowledge and competencies and thereby promote active citizenship, personal development and social inclusion.

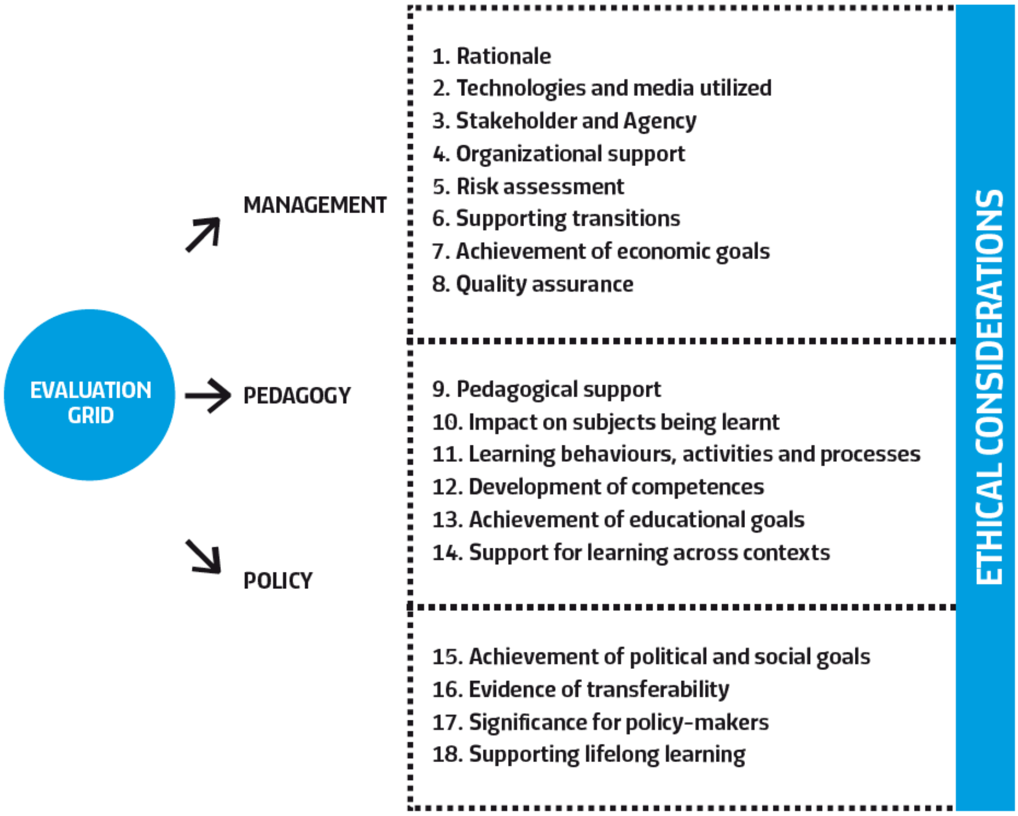



**Figure 13: The Evaluation Grid**

Lifelong learning involves experiences that are considered to be ‘transitions’. These are periods of changes, such as:

- moving from school to higher education;
- moving between formal and informal settings (e.g. classroom and home);
- reconciling academic skills and knowledge with requirements in the workplace;
- reconciling skills and knowledge gained in vocational education with requirements in the workplace;
- re-skilling and/or up-skilling the workforce through adult education.

Within the MOTILL project, transitions were interpreted as transformative experiences in both society and individual development; they may be horizontal, vertical, methodological, spatial and epistemological. The Evaluation Grid’s criteria interrogate how the project or initiative supports these various types of transitions.

### IMPLEMENTATION OF THE EVALUATION GRID

The aim of this phase of the project was to create the Best Practices Collection (BPC), a collection of case studies exemplifying best practices in the countries participating in the MOTILL project, as a way to share experiences and to demonstrate that mobile technologies had been used successfully to support lifelong learning. We wished to identify in each case study the elements that had worked particularly well, whilst also noting any difficulties or disappointments. It should be noted that 'best practice' is a debated term (Coffield & Edward 2009), although it is widely used in the field of learning technology, along with terms such as 'good practice' and 'effective practice'. It reflects the demand for succinct and useful information that can act as a guide. The case studies were carried out by conducting interviews with the lead person (such as a project manager or lead academic) for each case. In addition to studying specific cases, the work for the BPC included a meta-analysis of what could be concluded by looking across all the case studies to identify common issues and lessons learnt.

Although we were conscious that this collection would not necessarily capture best practices across the whole of Europe, the project remit and resourcing determined a focus on the four partner countries. However, we wish to stress that this apparent limitation also had a positive side to it. The team felt that local examples would be more meaningful and persuasive in terms of anticipated engagement of national policymakers and education practitioners in the partner countries. Our prior experience of these audiences suggested to us that frequently they may be interested in what happens elsewhere but feel that it is not directly relevant, as the circumstances are very different. Our primary audiences for the Best Practices Collection were national policymakers and education practitioners. Nevertheless we believe the collection will also be of benefit to researchers, since nowadays researchers need to rise above their sometimes narrow focus on a specific development or idea and cultivate greater awareness of the realities of management, pedagogical design, policy implications and ethics.

### Case study method

To identify a set of case studies, we began by using a collaborative online space to enable all project team members to share 'candidate' cases based on a general review of known and discoverable projects fitting two main criteria:

- The projects or initiatives were not only using mobile technologies in education but also it was clear that lifelong learning was being supported in some way;
- The projects or initiatives were sufficiently established to suggest that they would have substantial experience to share, as reflected for example in publications they had produced or information on their websites.

A 'long list' of 25 candidate cases was annotated according to these criteria, to facilitate final selection of up to a dozen case studies. We also strove to achieve an overall balance to include different levels of education, types of learners, and a range of ways in which technology had been used. For a while we retained the long list, knowing that in practice we would be constrained by whether projects or initiatives wanted to cooperate with us within our timescale and to be included in our BPC; therefore we had to remain flexible. Finally 11 case studies were completed and these are included in the BPC; they can be accessed freely on the MOTILL web portal[31] and slightly shorter versions have also been made available in a printed booklet.

In nearly all cases interviews were conducted by visiting the interviewees. The questions contained in the Evaluation Grid were used as an interview schedule to ensure consistency across all case studies. We recognize that the case studies are not comprehensive accounts of each project or initiative. Although this could be considered a limitation, the value of the case studies is enhanced by bringing together a set of experiences in a consistent way to interrogate certain key aspects of their practices. The Evaluation Grid format also enables a succinct form of communication of interview findings, with the various parts of the interview being visible, ensuring a good level of transparency. Any particular interest, for example an interest in 'organizational support', can be followed by reading what is reported in the relevant interview section across all of the case studies.

As shown in Table 3, the selected projects demonstrate that mobile technologies can be used to support lifelong learning in formal and informal contexts and at various stages of life. On the basis of our interpretation of the key aims of the case study projects, we can observe some recurring themes that relate to lifelong learning:

- opening up access to knowledge and resources
- establishing links between different places of learning
- supporting learners who may be excluded or at risk of dropping out
- facilitating location-based and outdoor learning
- enhancing creativity and collaboration

[31] http://www.motill.eu

| | Learners | Key aim |
|---|---|---|
| **MoULe** | Schoolchildren | To facilitate outdoor learning and collaboration |
| **FÓN** | Schoolchildren | To support language learning for life |
| **Federica** | Prospective students and others | To open up access to advanced knowledge |
| **LOGOS** | Students and adults | To enable flexible access to courseware and objects from repositories |
| **BathSMS** | Students | To support students entering university |
| **WoLF** | Students (trainee teachers) | To link college and work-based learning |
| **Bletchley Park Text** | Children and adults (museum visitors) | To personalize learning and link museum visit with school or home |
| **Contsens** | Students and adults | To enable context-sensitive and location-based learning |
| **Ensemble** | Young and adult migrants | To support integration and active citizenship by using everyday tools |
| **MobileDNA** | Young people | To support extracurricular or outreach activity and collaboration |
| **Mobile Mood Diary** | Young people | To support self-monitoring for long term health care |

**Table 6: Target learners and key aim of each project in the BPC**

## Meta-analysis of the case studies

A meta-analysis of the case studies was carried out collaboratively by MOTILL project partners with the objectives of drawing together the main points from the interviews and highlighting best practices. General considerations and suggestions on how mobile technologies can best support lifelong learning were proposed within the four categories of Management, Pedagogy, Policy and Ethical Considerations. These are briefly summarized here; full details can be obtained by referring to the downloadable PDF of the Best Practices Collection available from the MOTILL portal. In addition, we have reflected on how the case studies relate to the concept of 'transitions', since this is an important concept in the literature on lifelong learning.

### *Management*

The projects analyzed for this collection describe a complex scenario in which the use of mobile technologies in lifelong learning is very flexible. Schools, universities and education staff have been involved in the following activities:

- Creating contents specifically designed for mobile devices;
- Setting up new pedagogies and educational practices supported by mobile technologies;
- Designing tools and infrastructures to make contents available on new channels and devices.

Although many projects have focused on the integration and testing of mobile technologies in traditional educational institutions, some projects also introduce activities aimed at meeting social needs such as mental health treatment, immigrant integration or young people's participation in cultural events. The most interesting observation about technological aspects is the role of the device in each practice: these technologies are mostly used only as a gateway to access, create or download particular contents. Only a few projects propose a bidirectional way of communicating, allowing learners to interact with tutors, teachers or peers while using the device. This interactive approach seems to have a positive impact on both user motivation and the creation/reinforcement of social relationships, but it introduces some management problems. These kinds of mobile learning projects require strong support from both IT specialists and educational technologists, as well as from highly skilled educational staff who feel comfortable with the technologies being used. It is in fact the teachers and trainers who may jeopardize the success of a mobile learning project in lifelong learning.

Our analysis of the collection of projects raises a number of issues that need to be considered in order to maximize the effectiveness of the mobile learning experience from a management perspective:

- Hardware and internet connection are still onerous and devices rapidly become obsolete;
- Educational staff are often lacking in technological skills and it may be expensive to train them;
- Mobile learning activities are not effective if teachers are not comfortable with the technologies being used;
- Digital content rights, policies and privacy rules need to be defined.

It is also evident from the case studies that mobile learning projects require effective procedures for monitoring quality assurance. Strong measures and indicators are needed to guarantee the quality of both the outcomes and the implemented methodologies. Guidance is available in various scientific papers (Vavoula & Sharples 2008) in which methodologies and results have been analyzed in depth.

### *Pedagogy*

The projects in this collection have utilized the unique affordances of mobile technologies to construct learning approaches in support of educational and social goals which may be summarized as follows:

1) In relation to learners:
   a) Facilitating access and social inclusion;

   b) Responding to learners' needs (such as collaboration) and their technology use habits;
   c) Enabling students to manage and direct their own learning.
2) In relation to contexts of learning:
   a) Taking learning out of the classroom and into the real world;
   b) Enabling construction of learning in context;
   c) Providing learning content based on contextual information about the user.
3) In relation to curricula and learning content:
   a) Using ontologies to create multidimensional curricula that work at scale and cater to individual needs;
   b) Enabling mass-customized learning content delivery;
   c) Helping teachers and instructors to provide personalized content for students.

A range of familiar pedagogical approaches is evident across the case studies, including behaviourism, cognitivism and constructivism; but the projects have also led to the development of new models of instruction to fulfil specific educational aims. The new models attempt to describe the agency of the learners, the various settings where learning takes place, and how it is necessary to re-think the educational process, content and objectives. The need for those in post-compulsory education to manage and direct their own learning is widely recognised as essential to their success as lifelong learners. The case studies demonstrate how the use of mobile technologies has increased learners' level of engagement with the learning activities. There is also evidence of positive impacts on learners' self-perception.

Overall the case studies show learners' positive engagement with subject matter; furthermore, it may be said that the mobile technologies have a transformative effect upon the subject matters involved and the traditional boundaries between them. The LOGOS and Contsens projects have also considered pedagogy as a means to validate technological developments, but what is notable is that both projects have used ontologies in order to give a structural description of pilot courses. Ontologies have great benefits in education as descriptors, and with the help of ontologies it is possible to create a multidimensional curricula model which both enables mass-customized learning content delivery and helps teachers and instructors to provide highly personalized learning content for students.

### *Policy*

Policy related findings cover a wide range of economic and social problems, where mobile learning can make a positive contribution. However, policymakers should also keep in mind that, just like any other solution, mobile learning only works if there is sufficient financial backing. To sum up the most important policy related factors, the MOTILL project created the following list:

1) Educational challenges:
   a) national accreditation and acknowledgment of mobilized courses is still problematic;
   b) mobile learning addresses problems regarding the organization of educational curricula, which needs to be solved;
   c) open content initiatives proved to be viable.
2) Social challenges:
   a) m-learning initiatives are tackling horizontal lifelong learning policies, like discrimination based on race, religion, location, health or age;
   b) through lifelong learning processes m-learning applications can favour social groups which are at risk of being marginalized.
   c) m-learning may have a significant impact on social inclusion of immigrants across Europe;
   d) mobile technology in education works towards widening participation in educational activities.
3) Financial challenges:
   a) there are models and good examples for cheap mobile learning;
   b) however, new forms of funding are necessary, as institutions have great difficulties when integrating the latest technology into their administrative and educational processes.

### *Ethical considerations*

Ethical issues emerging from our analysis can be categorized under three main headings: Accessibility, Privacy and Security, and Copyright.

### *Accessibility*

Where lack of access to mobile technologies would lead to an inability to engage with the learning experience, mobile devices were provided to the learners. However, where the provision of a mobile device in order to facilitate engagement with the learning experience could be perceived as detrimental to the learners' perceptions of the experience, their own devices were used. Keeping the cost of using mobile technologies to a minimum was an ethical consideration for the projects. As the proliferation of mobile technologies was not considered universal, for some of the projects the learning activities formed a supplementary role and other means of access to the learning experience were provided. An alternate means of access to the experience was also an ethical consideration arising from concerns about the literacy of users in relation to using mobile technologies. Furthermore, care had to be taken not to undermine the ethos of the learning institutions' approach to mobile technologies. This was particularly evident in projects in schools and museums. Modifications to the learning experience in order to support access by learners with physical and cognitive disabilities were also undertaken to foster inclusion.

### *Privacy and Security*

The provision of private and secure learning environments for learners was a prevalent ethical concern. Many initiatives were undertaken to protect the privacy of all partners in the learning experiences. The limitation of the functions of the devices used, the anonymity of users, and adequate mentoring and monitoring of technology use were all employed to alleviate these concerns. The use of mobile technologies to communicate with learners can be perceived as an invasion of privacy and this concern was usually addressed through consultation with the learners. The ethical use of images, video and sound recordings obtained by learners using the mobile phone was another area that needed to be addressed.

### *Copyright*

The need to adhere to the relevant copyright and media ownership issues while incorporating mobile technologies for learning, raised ethical issues. These issues were addressed by obtaining permission to use the material from the owner, the development of unique material and the use of material available under creative commons licensing.

### *Transitions*

In addition to the above analysis, we were interested in how the case studies highlighted various ways in which projects had addressed the idea of 'transitions', given the importance of this concept in explorations of lifelong learning (Field et al. 2009; Ecclestone et al. 2010). The relevant literature deals largely with inter-institutional and intra-institutional transitions; inter-cultural transitions in learning; and transitions between non-formal/informal and formal contexts. We were able to see these classic themes reflected in our case studies, although inter-cultural transition was only discernable in the language learning case study. Lifelong learning for career change and in the third age are also increasingly on the research agenda in lifelong learning, however there is as yet little in the way of published or formal evidence that mobile technologies are being employed to support transitions relating to career change and late-life learning.

Within our set of case studies, the *MoULe* case study describes transitions between formal and informal learning, through experimental activities based on alternating onsite and classroom learning, and through the use of both mobile devices and computers. This is also a feature of the *Ensemble* case study, where mp3 devices allow young students to move from formal learning strategies in the classroom towards informal learning opportunities occurring outside of school; however it is noted that currently the informal learning occasions are strictly related to something occurring in a formal educational setting, and are sometimes dependent on an activity performed in the classroom. *Bletchley Park Text* focuses on the transition between the museum environment and learning opportunities in the classroom or home; this activity may be entirely controlled by the learner (e.g. on a casual visit) or it may be partly managed by a teacher (e.g. on a school visit). *Contsens* again promotes the transition between formal and informal contexts of learning. The students were free to discover content as they wished, without time constraints; this explorative learning method helped them to be more individual in their learning, which was deemed a great achievement compared to traditional education.

A second interpretation of transition focuses on moving between different levels of education. The *Bath SMS* case study is concerned with the transition students make from school or college to university, the latter having a different emphasis on self-motivation and self-organisation and often involving new subjects and new forms of study. The mobile SMS system in this case provides guidance, structure and motivation in the early phases of the first year of a degree course. Furthermore, the SMS system helps students to negotiate the division between the face-to-face parts of the course and interaction which takes place within the university's Virtual Learning Environment. Similarly in the *WoLF* case study, learners make a significant transition from foundation level to degree level study. By improving the quality of the portfolio and providing opportunities for formative and summative feedback, the PDAs used by student teachers gave them a better chance of making the transition to a full degree programme. By encouraging the students to share their experiences of different working contexts, the PDA also facilitated reflective and collaborative learning, giving students a better idea of what to expect in the workplace.

The MOTILL project also conceptualizes transition in terms of moving from knowledge acquisition to a situated learning experience, which serves to underline the common focus on situated learning as a transitional experience, even though the contexts of the case studies are very different. The appeal of real life learning is also exploited in the *Fón* project, which extends the context for increasing fluency in a spoken language out of the classroom and into real conversations supported by mobile technologies.

Finally, a theme closely related to transition is that of social inclusion. In the *Federica* case study, a project which targets prospective students amongst others, the intention is to introduce the use of mobile technologies in a progressive manner, allowing even those who are economically disadvantaged to be able to use low cost resources, but also catering for those who use high specification mobile devices, e.g. professionals. The *Mobile Mood Diary* supports a transition from illness to wellness which enables learners to fully participate in society while *mobileDNA* supports the core process and skills required to engage in collaborative creativity, supporting transitions from solo and uncreative work to collaborative creative interactions, and between extra-curricular activity and mainstream education, thereby helping towards inclusion.

## CONCLUSIONS

The MOTILL project enabled us to investigate the relationship between mobile technologies and lifelong learning in a European policy context, in a focused way that had not been attempted before. We developed a series of methodologically distinctive, highly collaborative research and analysis activities, resulting in quality-assessed resources that are now freely available to the international community of researchers, policy-makers and education practitioners. Mobile learning is a thriving field of research, and increasingly, a common way of learning, thanks to wide ownership of mobile phones and other portable technologies. Our critical reviews and case studies lead us to conclude that mobile technologies are an important, accessible means of supporting learning activities and interactions that are conducive to the long-term development of lifelong learning. At the same time, it is clear to us that a lifelong perspective could potentially enhance many projects and initiatives that currently focus firmly on just one learning stage or context. The increasing everyday use of mobile technologies will create its own momentum that will assist informal lifelong learning; however, a more sophisticated understanding of the interactions between formal and informal contexts, and continued identification of subtle points of transition, are necessary if we are to give learners the best chance of a supportive learning journey throughout their lives. Further refinement and elaboration of the evaluation grid and the SARD developed within the context of the MOTILL project would contribute towards the achievement of the previous objectives. In particular, the scope of the SARD should be extended to encompass the many mobile LLL initiatives not reported in scholarly literature. The Evaluation Grid, being a tool that enables the identification and assessment of mobile LLL good practice, can be used towards this end.

# PART III

# Impact of mobile technology on learning environments

# PART III - IMPACT OF MOBILE TECHNOLOGY ON LEARNING ENVIRONMENTS

## INTRODUCTION[32]

The Department of Information Systems at Corvinus University of Budapest has been actively researching and adopting mobile learning for many years (Kismihók & Vas 2009a; Kismihók & Andrejkovics 2008; Vas et al. 2009a). This work started with pilot content development in the early 2000s (Dye et al. 2007). Since then, mobile educational services have been incorporated into the mainstream educational activities of the Department, thus more and more attention has been focused on learners' perceptions of this novel technology. With funding from the European Commissions' Lifelong Learning Programme, a quantitative research study has been carried out in order to learn more about educators' and learners' perceptions of mobilized educational services.

### Structure of this chapter

First the framework of our empirical study is presented, regarding learners' attitudes towards using mobile technology in education. Then we describe of the research design and the various statistical analyses that were performed on the data collected. Finally we conclude with further challenges and research directions.

## LEARNERS' ATTITUDES TOWARDS MOBILE LEARNING

### Research context

IMPACT was an EU Lifelong Learning project ended in 2008, which aimed to discover empirically how technology enhanced learning changed the way we teach and learn (Agrusti et al. 2008; Krämer 2007). Within this study a complete work-package has been dedicated to mobile technology and mobile learning, questioning whether it is still in its infancy or has managed to make a step forward towards being an everyday routine. We were also interested in what learners think about mobile learning. Nevertheless the ultimate goal of the project was to provide a set of variables that help instructors to understand the implications of various technologies on their students and also to provide research-based principles for how instructors should use technology in their teaching. Furthermore, a more pragmatic outcome was to get information for planning a

[32] This section has been published in the International Journal of Mobile and Blended Learning (Kismihók & Réka Vas 2011)
Kismihók, G. & Vas, R., 2011. Empirical research on learners' thoughts about the impact of mobile technology on learning. *International Journal of Mobile and Blended Learning*, 3(1). 73-88

technology supported educational service portfolio at the Department of Information Systems at the Corvinus University of Budapest.

The idea of assessing learners' perspectives about educational technology being used in education is not novel. In the field of technology supported learning, comparing eLearning to face to face education has been done several times in the past. Researchers measured topics like student's satisfaction (Johnson et al. 2000), effectiveness of on-line education (Sargeant et al. 2004; Solimeno et al. 2008), investigated students' conceptions about learning through online discussions (Ellis et al. 2006) and also learning outcomes (Herman & Banister 2007). In general these studies concluded that there is no significant difference between on-line and face-to face studies, when it comes to learning outcomes (Solimeno et al. 2008).

Nevertheless, mobile learning is still rarely investigated from this comparative point of view. Some work has been done on examining the user acceptance of mobile devices in education (Huang et al. 2007), but most researchers have concentrated on trialling various mobile learning applications and collecting student feedback about them, for example a pilot study in Finland for supervising trainee teachers using mobile devices (Seppälä & Alamäki 2003). Collecting thoughts about mobile learning is also included in articles summarising various pilot researches, trying to give a perspective of the fields for other researchers and practitioners (Cobcroft et al. 2006; Corbeil & Valdes-Corbeil 2007; Sharples 2006). This practice was reflected by Traxler and Kukulska-Hulme (2005), suggesting the development of "good" mobile learning evaluation, which leaves the frames of single application validation processes behind. Later Traxler went further, to address the necessity of developing evaluation methods, which are also reliable on a bigger scale (Traxler 2007). He articulated that important features of mobile learning (that it is personal, contextual, and situated) make such evaluation very difficult.

It is clear that there is a lack of research on the actual general impact of mobile technology on learning. Therefore our research was attempting to target this issue and collect primary data about learners' general views on mobile learning in five European countries. The methodology employed in the IMPACT project was based on the "Identifying and implementing educational practices supported by rigorous evidence" framework (U.S. Department of Education, Institute of Education Sciences 2003). In this case the framework has been used for setting up a combination of blended quantitative techniques (questionnaire with general learning questions, in combination with specific questions and questions on educational background of respondents). This questionnaire was utilised by a quantitative analysis (in-depth statistical analyses) using inductive statistics and randomized controlled trials with survey sampling. The purpose of sampling is the accomplishment of efficiency, representation, and minimal disruption. Using inductive statistics was necessary as only weak agreements exist on the meaning of variables. The data was gathered and analysed throughout 2007-2008. The final data analysis was performed in late 2008. Descriptive statistical analyses presented in this article were produced with SPSS 15.0, for the cluster analysis we used SPSS 16.0.

### RESEARCH HYPOTHESES

As it was mentioned before, the main idea of this research was to investigate learners' thoughts towards mobile technology in education. In order to reach this goal the following domain specific hypothesis had been made:

- There is no significant difference in the judgement of people with or without experience in mobile learning that the use of mobile technology can enhance the general quality of learning.
- It is generally accepted that the use of mobile learning in education is beneficial for improving the communication between students and educators.
- Incorporating mobile learning into educational activities adds additional value for the learning programmes provided by higher educational institutions.

### QUESTIONNAIRE

The designed questionnaire consists of three sections:

- Section 1: Personal information including social indicators like gender, age, profession, or education as judgements depends on such indicators.
- Section 2: Experiences with technology enhanced learning, and
- Section 3: Questions related to mobile learning experiences.

For testing perceptions, thoughts and opinions about the impact of technology on learning, it was decided to use intensity questions in order to measure the strength of a respondent's feeling or attitude on questionnaire items in Sections 2 and 3. We allowed answers uniformly on five-part (Lickert – type) scale ranging from a high degree of agreement to complete disagreement. The "questions" were in the form of statements that were either definitely favourable or definitely unfavourable toward the matter under consideration. The answers were recorded as numerical values ranging from one to five. The highest value showed the most favourable attitude toward the subject of a particular question. The weights were not shown on the actual questionnaire and, therefore, were not seen by the respondents. The odd number of possible answers was chosen so that respondents who were neither pro nor contra could express their uncertainty about a particular item in the questionnaire.

## MAIN AND CONTROL GROUPS

The main (intervention) group, which was selected on the basis of their personal experience with mobile learning, comprised 150 respondents from the Department of Information Systems at the Corvinus University of Budapest, Hungary and from Ericsson Education, Ireland (These organisations have already incorporated mobile learning into their teaching portfolio).

The control group was also composed of about 150 respondents, from four of our project partners, namely Roma Tre University (Italy), Plovdiv University (PU, Bulgaria), Distance Education International (DEI, Ireland) and Fernuniversitat Hagen (FeU, Germany).

In both groups, experience with technology-enhanced learning was expected to vary.

### Main Group

At Corvinus University of Budapest learners involved in mobile learning related courses were asked to fill out an online questionnaire. The original questionnaire was translated into Hungarian in order to increase comprehension and avoid possible misinterpretations of items by non-native English learners. An informative message was sent via e-mail, which was designed to briefly inform the respondents on:

- Purpose of the project,
- Responsible organizer,
- Guaranteed anonymity,
- Link to the questionnaire.

Within Ericsson Education Ireland, questionnaires were distributed to groups who were engaged with mobile learning during their corporate training. The majority of the respondents were primarily from the categories of management and training consultants. All data was sent and responded to in electronic format.

### Control Groups

The control group was composed of 150 respondents from Roma Tre, DEI, FeU and PU. Before the submission, the questionnaire was translated into the appropriate language of each partner. Each partner chose the appropriate manner to submit the questionnaires to their respondents.

In Bulgaria the lecturers at University of Plovdiv handed out printed copies of the Bulgarian version of the questionnaire to randomly selected learners. After the students had completed their questionnaires, they were collected and the data was compiled in an Excel spreadsheet that was used to perform the data analysis.

The people who filled in the questionnaires under the direction of Distance Education International (DEI) were students at Dublin Institute of Arts and Digital Technology (IADT), Ireland. The questionnaires were administered to the respondents in a classroom situation in an evening course and filled out in the presence of the teacher.

In Italy the data was gathered among postgraduate students enrolled in Roma Tre University. The groups were chosen in order to represent this particular tier of learners. The questionnaires were administered before classes, giving the respondents sufficient time to answer. Data were then converted into electronic format.

## DESCRIPTIVE STATISTICS

### Differences between Main and Control groups

The total sample size of the study was 300 (N=300), which was equally distributed between two groups: the main (intervention) group with 150 and the control group also with 150 samples. This kind of sampling was made to meet the requirements of the United States Department of Education's 'Identifying and implementing educational practices supported by rigorous evidence'. Specifically, effort has been made to comply with one of the fundamental stipulations: "*A rough rule of thumb is that a sample size of at least 300 students (150 in the intervention group and 150 in the control group) is needed to obtain a finding of statistical significance for an intervention that is effective*". (U.S. Department of Education, Institute of Education Sciences 2003, p.15).

Cross-tabulation has been carried out in order to identify the main differences between the groups regarding the research questions. In the following section we describe the significant results of this comparison.

#### *Personal issues*

The main group contained 99 male and 51 female respondents, whereas the control group was comprised of 59 male and 89 female participants (2 respondents didn't answer this question). The difference is assumed to be a consequence of the different backgrounds of the various source groups in the study.

Regarding their occupations, the main group was more heterogeneous. Apart from the unemployed group, all other categories were represented with a significant number of replies. On the control group side the picture was simpler; most of the respondents were students (99 out of 149 (again, in this case 1 respondent didn't answer to this question)).

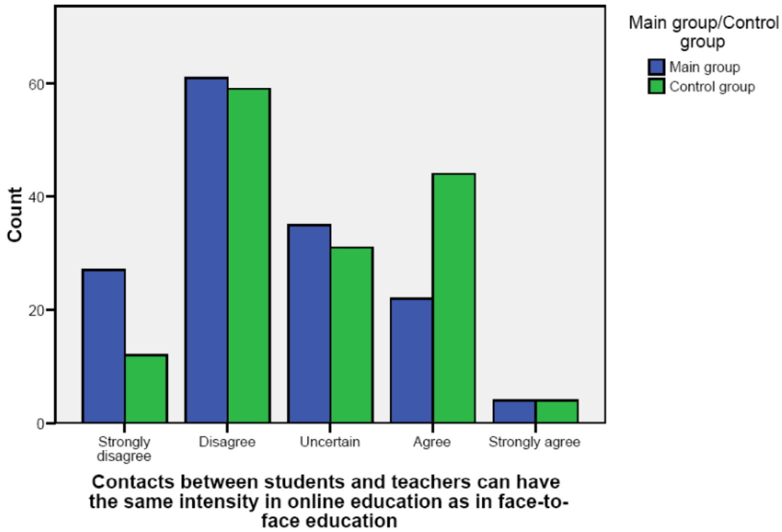



**Figure 14: Contacts between teachers and students**

The high proportion of student answers in the control group was visible by educational categories as well. The majority of people in the control group had only high school matriculation and most of them were still studying. The main group was more mature (105 respondents out of 150 had some kind of degree from a higher educational institution).

### *Impact of ICT on learning*

Regarding the Impact of ICT on learning the analysis was only significant in connection with a limited number of factors. We introduce here three questions, which best describe the contrast between the two groups.

An interesting and significant result of the comparison was that people who were engaged in mobile learning before were more negative regarding the intensity of communication in online education compared to traditional face-to-face education. However, while most of the respondents in both groups disagreed with the statement visible in Figure 14, there was a remarkable amount of positive answers in the control group (44 out of 150 agreed) and also relatively high, very negative feedback from the main group (27 out of 149 answers strongly disagreed).

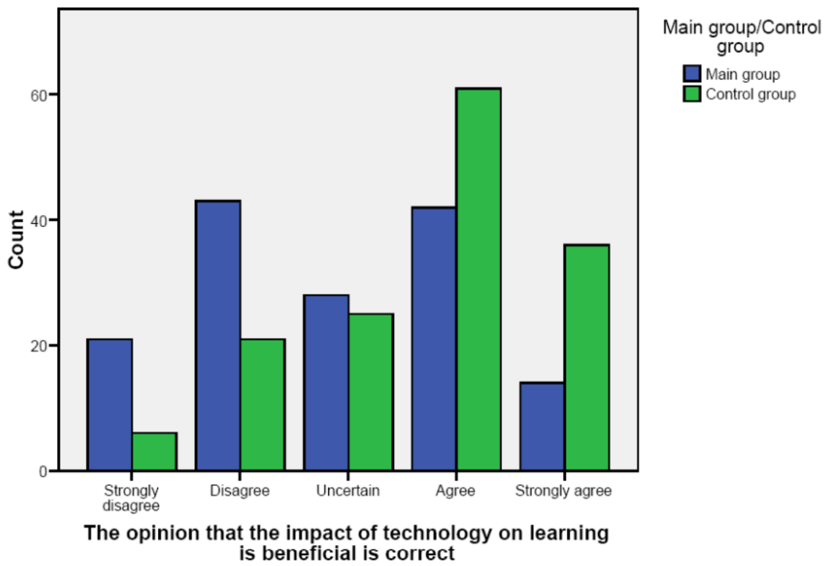



**Figure 15: Impact of technology on learning is beneficial**

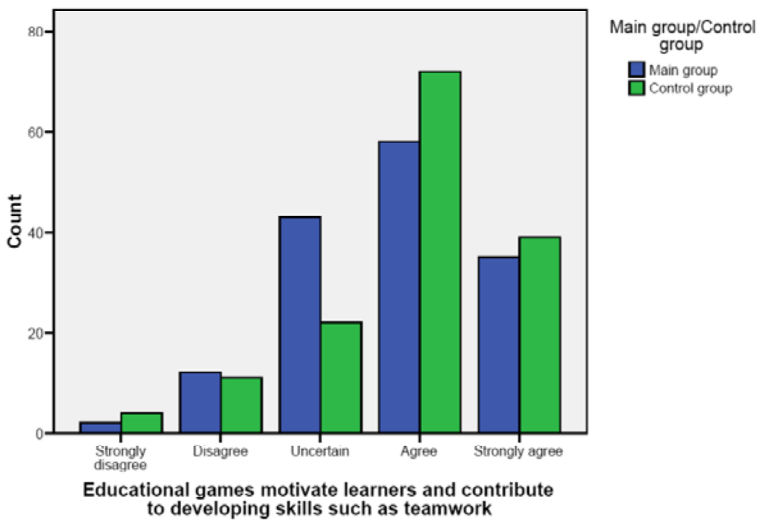



**Figure 16: Educational games**

The negativity of the main group was also visible in stating whether the impact of technology on learning is beneficial or not (Figure 15). Just like in the previous case, here the control group was more optimistic than the main group, with relatively low uncertainty in both groups. 64 respondents in the main group disagreed with this statement at some level, compared to 27 negative answers in the control group, while 56 agreed in the main group (against 97 in the control group).

A less critical response seems evident towards educational games. Nevertheless, there is still some uncertainty here. As Figure 16 below demonstrates, the majority of the individuals were positive in both groups with a small but notable positive bias in the control group (93 in the main and 111 in the control group respectively), but the number of uncertain answers were almost twice as many in the main group (43 in opposition to 22). It also has to be stated that the significance value of the Pearson Chi-square test was just above the 0,05 limit (0,056).

### *Mobile learning*

An interesting but not significant change in the judgment of the main group appears in the items connected to mobile learning. Here with a 0,072 significance level (with a 0,05 cut off value) the main group was more positive than the control group (Figure 17). 74 out of 142 of those, who already used a mobile learning related service, said that mobile learning is something that they could recommend to someone else (control group: 55/150). However the number of uncertain answers was also high in both groups: 44 in the main and 55 in the control group.

One possible reason for being positive about mobile learning is that the majority of the main group also thought that mobile devices in general increase access to education and training (Figure 18). 85 out of 150 gave positive answers to this question. It should also be mentioned that there is a certain relationship between this item and the previous one, as the Spearman – rho correlation coefficient shows a more than moderate connection with a value of 0,606.

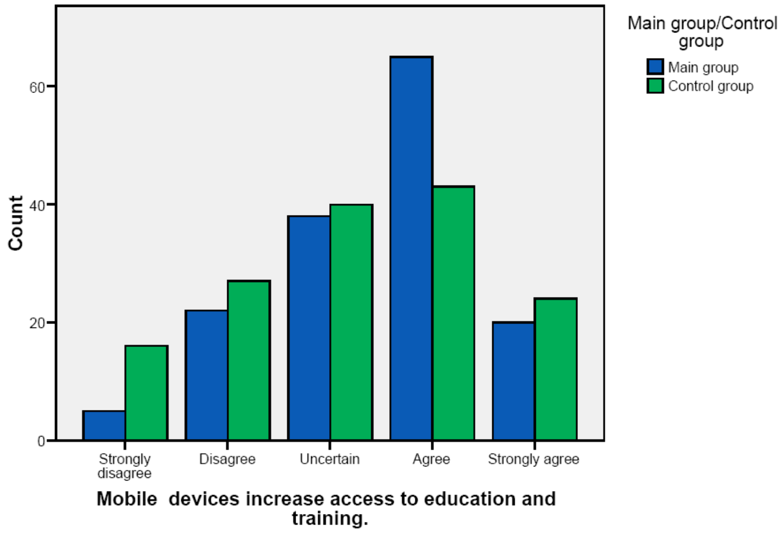



**Figure 17: Proposing mobile learning**

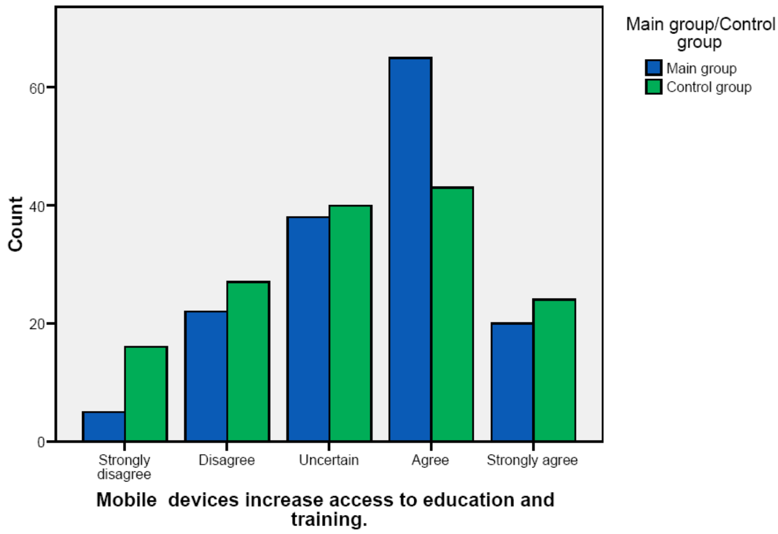



**Figure 18: Access to education**

This positive relationship did not appear for the statement associated with mobile communication (Figure 19). Here the critical tendency of the main group is quite strongly represented again. The same numbers of people (44) disagreed or were uncertain regarding the communicational benefits of mobile technology in education. This is a surprising result, as the main function of a mobile phone is the communication itself! However, from the questionnaire, researchers could not find out what kind of mobile services the respondents from the main group used, as there are several portable services available where the centre of attention is not communication, but on the mobility of learners.

The control group was also more positive regarding the importance of the general availability of mobile phones in education. As can be seen in Figure 20, respondents in the main group were more pessimistic (56/149) or uncertain (44/149), while 76 respondents in the control group were positive about this issue.

There was a general agreement about the statement regarding whether possessing a mobile phone is sufficient to undertake an academic or a professional educational program or not (Figure 21). Both groups rejected this idea (125/149 in the main group and 110/150 in the control group), but as with previous statements, the main group had a more negative attitude with a high number of 'strongly disagree' responses (89).

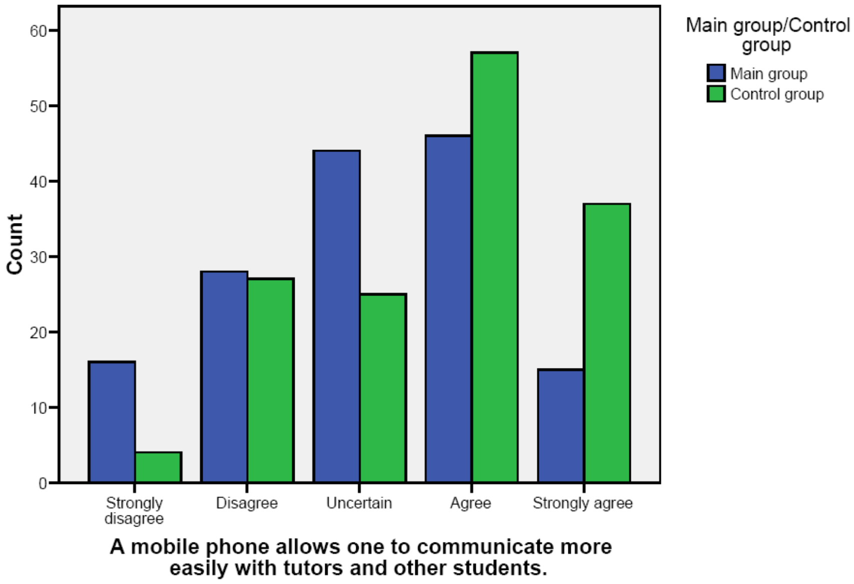



**Figure 19: Communication**

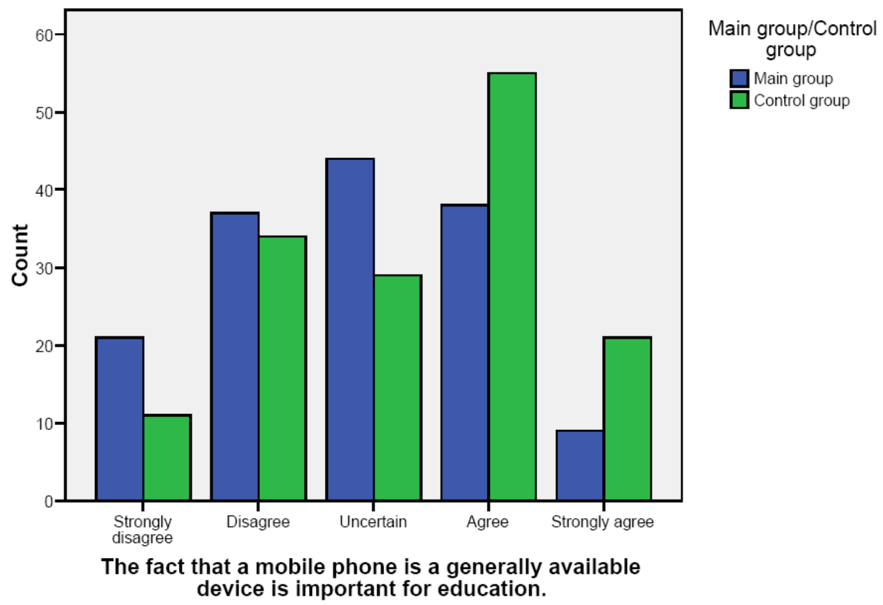



**Figure 20: Availability of mobile phones**

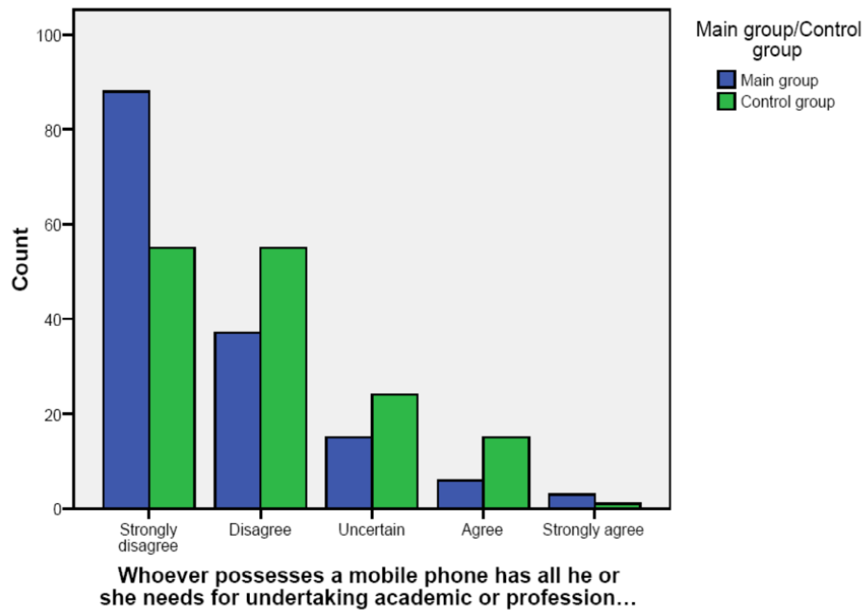



**Figure 21: Undertaking a professional study only with a mobile phone**

## Other influences: T-test

The t-test applied to our two sample groups allows us to compare the mean values within the outcomes of both groups. Table 7 presents these values. In general, there are no big differences in the mean values between the main and the control group, but some items still differ significantly. For the question '*The opinion that the impact of technology on learning is beneficial is correct*" the mean values were 2,9 in the main and 3,67 in the control group showing again the control group's positive attitude towards technology.

**Group Statistics**

| | Main group/Control group | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Thanks to technology, the problems of access to learning for students with disabilities have been resolved | Main group | 147 | 3,41 | ,866 | ,071 |
| | Control group | 150 | 3,61 | ,962 | ,079 |
| Contacts between students and teachers can have the same intensity in online education as in face-to-face education | Main group | 149 | 2,43 | 1,035 | ,085 |
| | Control group | 150 | 2,79 | 1,038 | ,085 |
| Online communication allows increased amounts of communication between teachers and students when compared with other forms of education | Main group | 150 | 3,15 | 1,019 | ,083 |
| | Control group | 150 | 3,44 | 1,020 | ,083 |
| The opinion that the impact of technology on learning is beneficial is correct | Main group | 148 | 2,90 | 1,233 | ,101 |
| | Control group | 149 | 3,67 | 1,112 | ,091 |
| From my personal study experience I find that the impact of technology on learning is valuable | Main group | 150 | 4,15 | ,862 | ,070 |
| | Control group | 150 | 4,05 | ,854 | ,070 |
| Information and communications technology has usually been used to encourage us to be active participants in learning | Main group | 149 | 3,40 | 1,013 | ,083 |
| | Control group | 149 | 3,71 | ,816 | ,067 |
| Information and communications technology has been used to support the development of higher level thinking skills such as synthesis and problem solving | Main group | 145 | 3,46 | ,928 | ,077 |
| | Control group | 149 | 3,63 | ,903 | ,074 |
| Information and communications technology has been used to support more individualized learning programmes tailored to our own individual needs | Main group | 147 | 3,56 | ,915 | ,075 |
| | Control group | 150 | 3,69 | ,898 | ,073 |
| Learning is enhanced when text and pictures are integrated in a multimedia environment | Main group | 150 | 4,19 | ,888 | ,072 |
| | Control group | 150 | 4,05 | ,947 | ,077 |
| Educational games motivate learners and contribute to developing skills such as teamwork | Main group | 150 | 3,75 | ,950 | ,078 |
| | Control group | 148 | 3,89 | ,973 | ,080 |
| I would propose mobile learning as a method of study to others. | Main group | 142 | 3,44 | 1,014 | ,085 |
| | Control group | 150 | 3,13 | 1,107 | ,090 |
| A mobile phone allows one to communicate more easily with tutors and other students. | Main group | 149 | 3,11 | 1,152 | ,094 |
| | Control group | 150 | 3,64 | 1,119 | ,091 |
| Mobile devices increase access to education and training. | Main group | 150 | 3,49 | 1,008 | ,082 |
| | Control group | 150 | 3,21 | 1,224 | ,100 |
| The fact that a mobile phone is a generally available device is important for education. | Main group | 149 | 2,85 | 1,137 | ,093 |
| | Control group | 150 | 3,27 | 1,175 | ,096 |
| Whoever possesses a mobile phone has all he or she needs for undertaking academic or professional study. | Main group | 149 | 1,65 | ,958 | ,078 |
| | Control group | 150 | 2,01 | ,997 | ,081 |

**Table 7: T-test results**

## CLUSTER ANALYSIS

In order to enhance our understanding of the responses, it is logical to create certain clusters within the focus and control group. K-Means Cluster analysis was selected for this purpose as this procedure tries to identify reasonably homogeneous groups based on our variables (Füstös et al. 2004). Distances between clusters were computed using simple Euclidean distance. There was no need for standardisation, as all items included in the cluster analysis were ordinal and Lickert-scale based variables. For this investigation we decided to create three clusters with iteration and repeated this analysis twice. We have verified the existence of these groups for the items measuring the impact of ICT in general (Item 7-16) and also for items related to mobile learning (Item 17-21). We anticipated seeing that the previous results and the described attitudes towards the various educational technologies were based on the heterogeneity of the groups. We also considered that the experience of several classification approaches in the field of technology enhanced learning and innovation adoption (Kozma 2003; Peng et al. 2006; Valenta et al. 2001) must be taken into consideration before the identification of our clusters.

Valenta and her colleagues (2001) examined the clusters of opinions held by students, with respect to technology and its application to education, across two populations: traditional college undergraduate students and adult learners (non-traditional graduate students). They identified 3 groups of students: (1) Most important to *Time and Structure in Learning group* was that web-based education provides flexible time management. (2) Among those in the *Social Interaction in Learning group* the primary objective was the potential for a discussion with as few participants as possible, which results in fewer subtleties in teaching with web-based education. Enrichment from other perspectives and potential interference with work were also ranked important in this group. (3) For the members of the *Convenience in Learning group* the emphasis was on the fact that web-based education lets them work at home and saves travel time. In this research the authors have not examined mobile technology aspects. It also has to be taken into consideration that none of the participants in this research had any experience with online coursework or had previously taken a web-based course. However in two of the identified clusters students are positive concerning the impact of technology on education and only the members of the Social Interaction in Learning group have reservations about the positive effects of technology on education.

The study of Kozma (2003) looks at how classrooms worldwide are using technology to change the practices of teachers and students. He examined the findings from 174 case studies of innovative pedagogical practices using technology from 28 participating countries. As part of the research, Kozma also performed a cluster analysis to examine how classroom practices were used together within cases and seven meaningful patterns of classroom practice were identified. In this research the authors have not examined the opinion of students and teachers about the impact of technology, but the cluster analysis clearly reveals that some groups are keen to use the latest technological innovations in education, while others are more careful and need a certain period of time to adopt new technology. In this research users that are sceptical concerning the impacts of technology on education were not identified.

Peng and his colleagues (2006) investigated university students' attitudes and self-efficacy and explored the role of their perceptions towards the Internet. They identified 4 clusters of university students. These are: (1) *Technology*, (2) *Tool*, (3) *Toy* and (4) *Tour*. They found that learners who perceived the Internet as a tour or a toy, in general, exhibited attitudes that were more positive (concerning technology supported learning) and their sense of communicative self-efficacy was better than learners who simply perceived the Internet as technology or tool.

It is also worth noting Rogers' categories of innovation adoption (Rogers 2003). Rogers suggests a total of five clusters of adopters in order to standardize the usage of adopter categories in diffusion research. The categories of adopters are: (1) *Innovators*, who are the first individuals to adopt an innovation and are willing to take risks. (2) The *Early adopters*, the second group of individuals who adopt an innovation. These individuals have the highest degree of opinion leadership among the other adopter categories. (3) Individuals in the *Early majority* category adopt an innovation after a varying degree of time. This time for adoption is significantly longer than the innovators or early adopters. (4) Members of the *Late majority* category will implement an innovation after the average members of the society. These individuals have a high degree of scepticism concerning innovations. (5) *Laggards* are the last to adopt an innovation and typically tend to be focused on "traditions". The initial assumption of our cluster analysis was that the interviewees should be grouped according to their attitude towards technology. Accordingly, Rogers' classification is a good starting point in identifying the clusters of active participants in virtual learning environments. At the same time our calculations did not underpin the definition of five clusters, only the formation of three groups was justified.

Considering the classification approaches described above (Kozma 2003; Peng et al. 2006; Valenta et al. 2001), also the cited innovation adoption model (Rogers 2003) and considering our own practices in the past (Vas et al. 2007), we decided to set up three technical categories for classifying active participants in virtual learning environments:

### Technology Pioneers,

These are the pioneers, who make use of the most recent technology in their studies. Among those people in this cluster, we found that the impact of technology on learning is quite valuable (at this question the final cluster center was 4 on a five point scale both in the main and control groups). Members of the Technology Pioneers cluster also strongly believe that contacts between students and teachers can have the same intensity in online education as in face-to-face education (here the final cluster centers were also 4 compared to only 2,43/2,79 in the main and control groups). These learners usually possess the latest technology in their palm, they are motivated to try and use new, innovative electronic services in education. ICT encourages the members of this cluster to actively participate in learning (with a value of 4 in both cluster centers compared to only 3,40/3,71 mean group values), supports the development of higher level thinking skills (also 4 in both groups, compared to 3,46/3,63) and of more individualized learning programmes (final cluster centers were 4 again, compared to 3,56/3,69 in the main and control groups). These learners are sometimes well ahead of their tutors, when it comes to knowing and handling technology. They believe that multimedia environments enhance learning experience and educational games motivate learners (4/4 compared to 3,75/3,89). However, when we take a look at the figures connected to mobile learning questions, the dividing line between the main and the control group appears. The members of the main group have reservations about the impact of mobile technology in education, therefore the cluster center of the main group underperforms the control group's values. For instance, members of this cluster agree that mobile devices increase the access to education, but this agreement is significantly stronger in the control group (the cluster center values are: 4 in the main and 5 in the control group). Pioneers in both groups do not agree with the statement that "*whoever possesses a mobile phone has all he or she needs for undertaking academic or professional study*" (The cluster center values are: 2 in the main group and 3 in the control group, compared to 1,65/2,01 group mean values).

### Technology Adopters

Members of this group have reasonable skills for adopting and incorporating information technology into their educational activities. Among those in this cluster ICT usually encourages them to actively participate in learning (at this question both cluster centers were 3 compared to 3,40/3,71 in the main and control groups). At the same time, this mean value is palpably lower than in the case of "Technology Pioneers" cluster (3 compared to 4). They are inclined to accept that ICT supports the development of higher level thinking skills (with a cluster center value 3 in the main group and 4 in the control group compared to 3,46/3,63) and of more individualized learning programmes (same cluster center values to the previous question, compared to 3,56/3,69), although this is not a strong belief. They usually follow the recommendations of the Pioneers and their tutors. They are confident in using technology, but technology is not their desire, they have - in general - a neutral approach. Just like the Pioneers, they also think that the impact of technology on learning is valuable (at this question both cluster centers were 4, compared to 4,15 and 4,05 mean values in the main and control groups). The members of this cluster are slightly positive concerning the role of technology in resolving the problems of access to learning for disabled students (3/4 cluster centers compared to 3,41/3,61). It must also be noted that the distance between the pioneers and the adopters in the control group is significantly lower than in the main group.

#### Technology Sceptics

People affiliated to this group pick up technology slower and articulate a critical voice towards technology supported learning. Participants of this cluster do not believe that learning is enhanced when text and pictures are integrated in a multimedia environment (at this question cluster center values were 2/1 compared to 4,19/4,05 in the main and control groups) or that educational games motivate learners and contribute to developing skills such as teamwork (with cluster center values 3/1 compared to 3,75/3,89). They see the importance of ICT in education, but they think this phenomenon is overvalued. The members of the "Technology Sceptics" cluster accept to a certain degree – at least in the main group – that impact of technology on learning is beneficial (with cluster center values 3/1 compared to 4,15/4,05), but they do not admit that ICT can support the development of higher level thinking skills (cluster center values were 2/1 compared to 3,46/3,63 in the main and control groups) or more individualized learning programmes (with cluster center values 2/1 compared to 3,56/3,69).

### Conclusions of Cluster Analysis

In this research we attempted to cluster participants in both the main and control groups. Nevertheless a possible bias of this approach is that the main group has already been engaged with mobile learning applications, suggesting that the number of technology pioneers is expected to be higher and the number technology sceptics is expected to be lower in that group respectively. We also separated the general ICT and the mobile learning sections for the investigation, in order to see whether group compositions are stable across different domains.

This analysis has been done with SPSS 16.0. After the cluster analysis has been performed we checked the cluster centers of each group and based on this analysis we assigned the relevant categories (pioneers, adopters, sceptics) to each group. For this reason the order of the different clusters in the main and control group differ, but it has no impact on the validity of the results.

### Main group

In the main group the identified classes are the following:

- Cluster 1. - Technology Pioneers,
- Cluster 2. - Technology Adopters
- Cluster 3. - Technology Sceptics

As is visible from Tables 8 and 9, there is a significant difference between the general ICT and the mobile learning related categorization. Regarding ICT, in general 80 respondents were classified as pioneer, 50 as adopter and only 10 as sceptical. This is not a surprise, as members of this group have enough experience in eLearning, they have been using and exploring the latest educational applications.

However it must also be emphasized that eLearning is not a new phenomenon. Web based learning and ICT usage on campus have been with us for the last 10-15 years, meaning that learners gained experience in computer based learning applications and developed substantial skills for computer literacy. But mobile learning is also new for this generation! Therefore it is striking to see how they approach this novel learning technology. Table 9 shows the main group clusters in mobile learning: 43 pioneers, 57 adopters and 40 scepticals. It is clear that the number of sceptics grew four times bigger among the technologically experienced respondents.

**Number of Cases in each Cluster**

| | | |
|---|---|---|
| Cluster | 1 | 80,000 |
| | 2 | 50,000 |
| | 3 | 10,000 |
| Valid | | 140,000 |
| Missing | | 10,000 |

**Table 8: Main group clusters regarding general ICT items**

**Number of Cases in each Cluster**

| | | |
|---|---|---|
| Cluster | 1 | 43,000 |
| | 2 | 57,000 |
| | 3 | 40,000 |
| Valid | | 140,000 |
| Missing | | 10,000 |

**Table 9: Main group clusters regarding mobile learning items**

## Control group

In the main group the identified classes are the following:

- Cluster 1. - Technology Sceptics,
- Cluster 2. - Technology Adopters
- Cluster 3. - Technology Pioneers

There is no wonder that the number of pioneers in this group is lacking behind the main group figures in the same domain. According to Table 10, it counts 39 members, which is less than half compared to the main group. The number of sceptics is also small (13). Our interpretation is that the majority of learners in our current educational systems are adopting necessary technology for their studies as it is requested by their supervisors.

Hence, when we investigate control group divisions in the mobile learning domain, we see that the disparity between the control and the main group is slowly diminishing (see Table 11. on the next page). 38 pioneers, 59 adopters and 53 sceptics were identified, which is not an immense difference, if we also consider that there were 10 respondents in the main group, which we could not assign to any of these three clusters. It seems the general perception of unknown technology – here mobile technology – is brighter than the technology which is already in use.

**Number of Cases in each Cluster**

| | | |
|---|---|---|
| Cluster | 1 | 13,000 |
| | 2 | 93,000 |
| | 3 | 39,000 |
| Valid | | 145,000 |
| Missing | | 5,000 |

**Table 10: Control group clusters general ICT items**

**Number of Cases in each Cluster**

| | | |
|---|---|---|
| Cluster | 1 | 53,000 |
| | 2 | 59,000 |
| | 3 | 38,000 |
| Valid | | 150,000 |
| Missing | | ,000 |

**Table 11: Control group clusters regarding mobile learning items**

In general we concluded that learners both in the main and control groups had a constructive attitude towards technology enhanced learning scenarios. Nevertheless, respondents were much more careful and critical with the new and emerging mobile learning, than with traditional eLearning. People already engaged with this technology became more vigilant with the adoption and became more critical as well. It is still a question though, whether this critical stance is due to the infancy or the limited suitability of mobile technology in education. This analysis can't answer this question.

### LESSONS LEARNT

Our analytical research in the field of mobile learning attempted to measure what learners think about this technology on a larger scale than many previous studies. A range of statistical analyses were applied on the collected data including descriptive statistics covering the whole population of respondents, t-tests comparing the main and control groups, non-parametric correlations, cross tabulation, variance analysis and K-means Cluster Analysis. The results of this analysis are two-folded. On the one hand a number of useful and significant data have been gathered and analysed, which describe the most important differences between traditional and mobile learners. As it is visible from the descriptive statistics and the cluster analysis there is a remarkable scepticism towards mobile technology in education from the main group, which is balanced by the positive expectations of the control group.

On the other hand some of the analysis did not provide statistically significant results, therefore based on our observations it is not possible to say unequivocally that our main research ideas are either completely justified or groundless.

Still, regarding the first hypothesis - *"There is no significant difference in the judgement of people with or without experience in mobile learning that the use of mobile technology can enhance the general quality of learning."* – there is significant data available in this research, which shows that this might not be true! The abovementioned scepticism shows that people who are engaged with technology based learning are a bit more careful about articulating their expectations, especially positive expectations towards technology in learning situations. This is also in line with previous research using a similar methodology in the field of eLearning (Johnson et al. 2000). There Johnson and his colleagues revealed that *"student satisfaction with their learning experience tends to be slightly more positive for students in a traditional course format although there is no difference in the quality of the learning that takes place"* (Johnson et al. 2000, p.44).

Concerning our next research statement, - *"It is generally accepted that the use of mobile learning in education is beneficial for improving the communication between students and educators."* – it was generally accepted that communication has great importance in education and using mobile devices might have a positive impact on educational communication between learners and educators. However mobile learning as a category is quite broad, and there is no evidence that those participants in the main group were articulating their views, based on practicing education related communication on mobile devices and applications. This was one of the weaknesses of the questionnaire, which should be handled in future research.

Regarding the third question – *"Incorporating mobile learning into educational activities adds additional value for the learning programmes provided by higher educational institutions."* – this research failed to gather significant evidence. No doubt, that mobilised educational services were treated positively in both groups and there is also an affirmative support from both groups towards technology in education. But no evidence from this study offered verification of added value in learning programmes when integrating mobile learning in academic processes.

Whilst we cannot draw too many conclusions from some aspects of our study, we should at least be aware that experience with technology enhanced learning does not always appear to lead to an increase in positive attitudes towards it. On the contrary, it seems to lead to an increase in scepticism. At the very least, as proponents of mobile and blended learning, we believe that addressing future investigations towards why this might be the case is essential. We think that mapping the thoughts and attitudes of mobile learners with the support of further quantitative studies may help to improve the general level of mobile learning services. Furthermore, researches like this help us, as education providers, to try to ensure that we are not going to disappoint learners in the future with systems that do not meet learner's expectations of what technology can deliver.

# MOBILISED, ONTOLOGY BASED LEARNING CONTENT MANAGEMENT

## INTRODUCTION[33]

On 1 February 2008 Carl-Henrich Sandberg, the CEO of Ericsson announced (Keegan 2008): *"There are now 3.3 billion mobile subscriptions in the world – and every month an additional 50 million people in the world start using their first mobile phone. Broadband is the next step with both mobile and fixed broadband growing rapidly. This figure of 3.3 billion mobile subscriptions far outstrips all previous forecasts."*

Competition between e-learning solutions is increasing at an alarming rate, while changes of the surrounding environment and the demands of both students and the labour market are frequent and substantial. As the announcement of Sandberg indicates the importance of mobile technology in mainstream education is inevitable. Vendors must meet these requirements in order to successfully compete both on national and international level. Moreover these factors put pressure on higher education institutions to turn towards the development and application of such innovative and modern technologies that enable students to easily access, understand and apply complex curricula and other teaching materials.

This chapter will discuss a comprehensive learning environment, putting emphasize on the mobile learning aspects and potentials of our approach. This platform independent learning environment enables the development of customized qualification programs, based on the individual's pervious qualifications, completed levels, corporate trainings and practical experiences. So the potential application areas of this approach are rather wide. Not only can higher education enjoy its benefits, but the public and business sector as well. The solution also provides support in improving students' mobility by enabling content transfer for individual learning scenarios through traditional Web browsers and mobile devices too.

In the first part a detailed problem analysis is given about motivating factors behind this project. As it will be visible, the Bologna-process indicated important challenges for the Hungarian higher education, which need to be dealt with. Innovation in education

[33] Parts of this chapter have been published in the following publications: (Kismihók, Kovacs, et al. 2009; Réka Vas, B. Kovács & Kismihók 2009a) Vas, R., Kovács, B. & Kismihók, G., 2009. Ontology-based mobile learning and knowledge testing. *International Journal of Mobile Learning and Organisation*, 3(2), pp.128-147.
Kismihók, G., Kovacs, B. & Vas, R., 2009. Integrating Ontology based content management into a mobilized Learning Environment. In S. Cabakke et al., eds. *Architectures for Distributed and Complex M-Learning Systems: Applying Intelligent Technologies*. 192-210. Hershey: IGI-Global.

provides competitive advantages for universities, therefore, – as we argue in this chapter – a combination of an ontology based learning content management with mobile devices enabled content delivery is certainly a solution..

The second part of the chapter is more technical oriented. It describes steps and important concepts of an ontology based content development system implementation. This system rests on two major pillars. One is a repository layer that has a key role in content development and management. The other one is an ontology layer that supports the creation of reusable learning objects (based on the Educational Ontology) and the promotion of reliable knowledge testing (Adaptive Knowledge Testing System). Mobile learning adds flexibility to this system, since individual learners are not bound to a certain location or time anymore, however the mobilized content is still connected to traditional lectures and seminars. Topics of educational ontology, Studio system architecture, content development and delivery are argued in separate sections. At the end we talk about the first user experiences and our future plans.

## PROBLEMS WITH BOLOGNA-SYSTEM

The Bologna Process is the most important higher educational reform created by European education ministers, inspired by the demand for suiting the requirements of labour markets. On June 19th 1999, 29 European Ministers responsible for higher education signed the Bologna Declaration that contains the aims of this process (European Commission 2005c). With their signature they declared the creation of the European Higher Education Area.

This European Higher Education Area is structured around three cycles where each level has the function of preparing students for the labour market, for further competence building and for active citizenship. This also requires formulation of such descriptors for bachelor and master programs that can be shared within Europe and be used for a variety of purposes, depending on particular national, regional or institutional contexts and requirements. Members of Joint Quality Initiative aimed at developing descriptors for bachelor’s and master’s that might be shared within Europe and made available for a variety of purposes, depending on particular national, regional or institutional contexts. This was one of the first initiatives, which provided support for facilitating comparison of degrees. The launch of these Dublin descriptors also indicates that competences should have a key role in providing transparent and comparable curricula and qualifications (Joint Quality Initiative 2004). At the same time, methods that enable comparison of curricula and qualifications in everyday practice are still missing.

The problem we investigate in this chapter has its roots in the intensification of student's mobilization between the various levels of the European education system, which puts the higher education sector under great pressure. Students, who want to join to a certain cycle (program), have different educational background. They possess diverse combinations of languages, prerequisite courses and learning experience. Due to these reasons, preparation for entrance requirements especially on bachelor and master level is a frequent, barely manageable problem, which may arise in a geographically distributed way – locally, nationwide or on European scale as well.

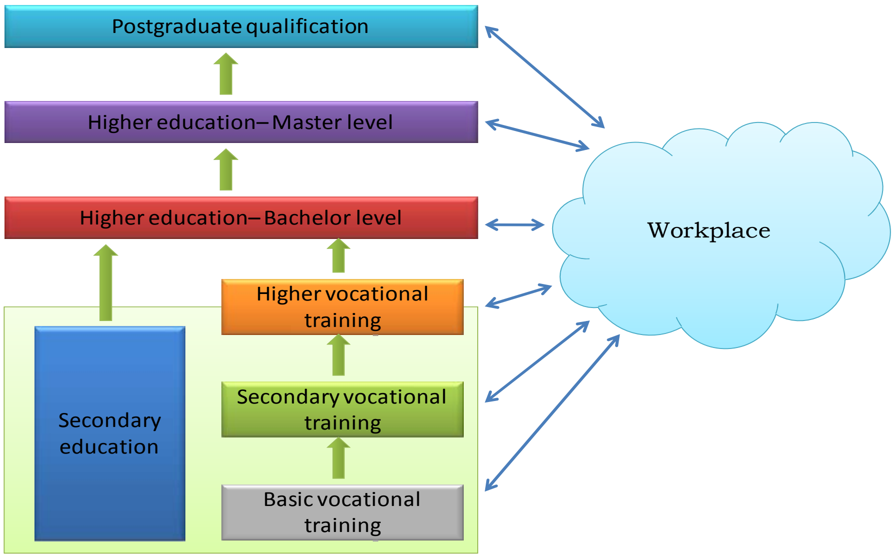



**Figure 22: The Bologna-system and the workplace**

Ideally, this Bologna – system enables an easy enrolment procedure for students, who completed the previous qualification level successfully, at all levels of the unified European qualification system. The BSc (Bachelor)-level cycle consist 180 ECTS[34] points (in minimum 3 years) and provides a degree with a certain profession with clearly defined competencies, as an output. It is possible for students to move horizontally from one educational institution to another within the same academic program, as students can reclaim their obtained ECTS points. A successful BSc degree is the prerequisite of an application to a Master (MSc/MA) program, where students have to collect 120 ECTS points (in maximum 2 years) on a BSc-level knowledge basis. (See Figure 22) The main difference between the enrolment procedure on master and bachelor cycle is that there is no national, standardized entrance exam on the master level, which may put the students into a ranking order. That's why institutions define and publish, two years in advance, the prerequisites for their master courses.

[34] European Credit Transfer and Accumulation System

Students, based on their interest, can decide on an institution freely. The only barrier of this choice is the abovementioned set of prerequisites, defined by the particular institutions. By vertical mobility students move on to a higher level program, if they fulfil its entry requirements (competences).

Therefore it is visible that students finishing their studies on a certain educational level have to face problems during the Prior Learning Assessment (PLA) of their future educational institution or workplace. The host organization has to convert the students' previous studies, on-campus or off-campus qualifications into valid skills and competencies, in order to check whether they fulfil the entrance requirements for a certain academic program or job-role or not. To be more specific, acceptance of students for a certain academic program requires the acknowledgement of their relevant, previously earned ECTS points. Generally 60-120 professional ECTS points are acknowledged from a BSc cycle, when entering to a MA/MSc program on the same educational field. If students can't meet these criteria – for instance points were collected in a different educational field or the receiving organization limits the acceptable ECTS points in the chosen MA cycle –, than they have to collect extra points for entering the desired program.

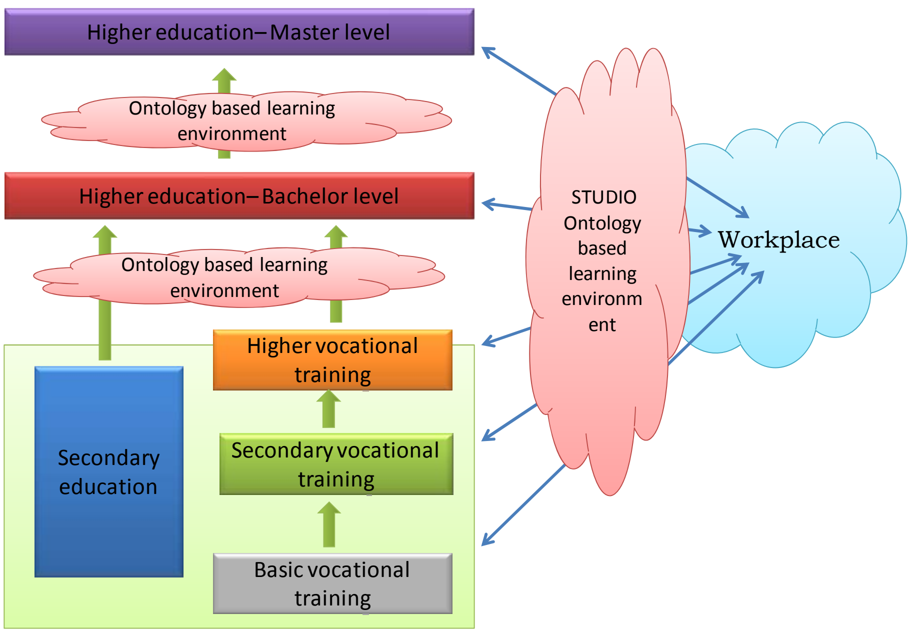



**Figure 23: Position of an eLearning interface (STUDIO) in the Bologna-system**

As it was mentioned above, institutions have the right to define the amount of ECTS points, what they can recognise in their master programs. However, they have to provide opportunities for applicants, who possess bachelor qualifications which are not completely acknowledged, to collect missing ECTS points needed for acceptance.

The domains of one important research question of this proposal, the ontology based selection and recruitment environment is emerging from this conversion problem of the European educational sector. As it is visible on Figure 23, our main idea is to introduce an interface between levels of higher education and workplace. This interface, based on the individual's pervious qualifications, completed levels, corporate trainings and practical experiences, should be capable to match students' existing competences with the desired academic programs' entry requirements. Candidates are selected for the particular academic program or job profile, and on the foundation of this assessment learning content will be provided to compensate their missing competences.

We believe that solving this acknowledgement problem of former experiences is to introduce an ontology based learning management system, which can

- successfully map qualifications within the educational sector and also with current and valid job roles,
- test and evaluate students to these valid, labour market driven competencies,
- highlight missing competencies and provide learning content to compensate them,
- be used for correcting failures of certain curricula, as an ad-hoc support of education,
- consider mobility (mobile learning) as a key factor of current education.

This system development started in 2003 under the frame of the "Development of Knowledge Balancing, Short Cycle eLearning Courses and Solutions" project[35], which aimed to handle the conversion problem between the different levels of Hungarian higher education system (BSc, MSc levels). More specific purpose of this project was to restructure the Business Informatics program's curricula offered by Corvinus University of Budapest (CUB) to facilitate compatibility with other educational programs in this domain, ensuring the above mentioned transparency and assisting student mobility (Gabor 2007).

### WHAT DOES MOBILE LEARNING MEAN FOR US?

Being mobile while studying is not a new idea. It has been incorporated into teaching activities and official curricula a long time ago in the form of field trips and on-spot trainings. Distance learning always carried features of mobility. According to Desmond Keegan (1990), distinguishing characteristics of distance education include the:

- Separation of the teacher from the learner(s)

[35] Project website: http://informatika.uni-corvinus.hu/root/web/web.nsf/do?open&lang=hu&page=proj-hefop331-elearning

- Use of technical media supporting communication and collaboration among students
- and their teachers;

The appearance of mobile technology in education in the mid 1990s has extended the scope of teaching and leaded us into a new world of education. Mobility in learning, supported by the latest information and communication technologies (ICT), has become an essential need for both the new generations of students and educational institutions (Naismith & Corlett 2006). In order to suit all requirements it is not enough to simply 'mobilize' the ordinary learning environments (Keegan 2005; Walker 2006), but conflicts of informal learning and Face-to-Face (F2F) education also have to be eliminated (Sharples 2006). Integration of mobile devices into education also fosters inclusion of innovative educational practices (Hoppe 2006; Milrad 2006).

At the same time the above mentioned transition has its institutional limitations. In traditional educational institutions, just like in the Corvinus University of Budapest, learning technology should be an integral part of knowledge transfer between students

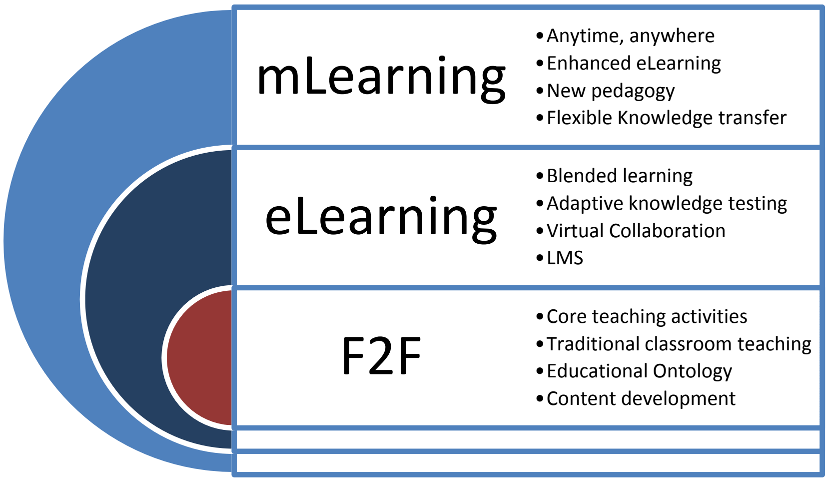



**Figure 24: Service Portfolio of Corvinus University**

and lecturers, but it cannot be the only platform of teaching. However it is essential to follow up students' demand – which forces institutions to involve technology more and more in their everyday teaching activities, enabling students to be flexible in their learning – and construct F2F based learning platforms, which provide elasticity in course content development and delivery. To meet challenges, emerging from combining ICT enhanced learning and traditional classroom education, a blended service framework has been elaborated. This service portfolio designed by the educators of Corvinus (Kismihók 2007) – see Figure 24 – also put an effort on incorporating theories of navigationism (Brown 2006) and connectivism (Siemens 2005).

The core element of the portfolio is the F2F education. The scope of curricula taught in our training programs is represented by the recently developed educational ontology ( Vas 2007), which is going to be the domain of future content development as well. On the top of traditional classroom teaching a Virtual Learning Environment (VLE) supports individual learning, enabling the use of even rather different independent learning styles. A Hungarian Learning Management System (LMS - CooSpace) provides authentication and other community services related to course organization. Further important service-modules, like adaptive testing, are connected to this platform as well. Mobile learning infrastructure, as an enhancement of the VLE, adds flexibility to the system, where individual learners are not bound to a certain location or time anymore, however the content is still connected to the traditional lectures and seminars.

To exploit the advances of mobile technology it is indispensable to transform the traditional learning environments into mobilized learning spaces otherwise users can't benefit from mobility. As Figure 25 indicates, there are three different aspects of mobility that is being covered at Corvinus University of Budapest.

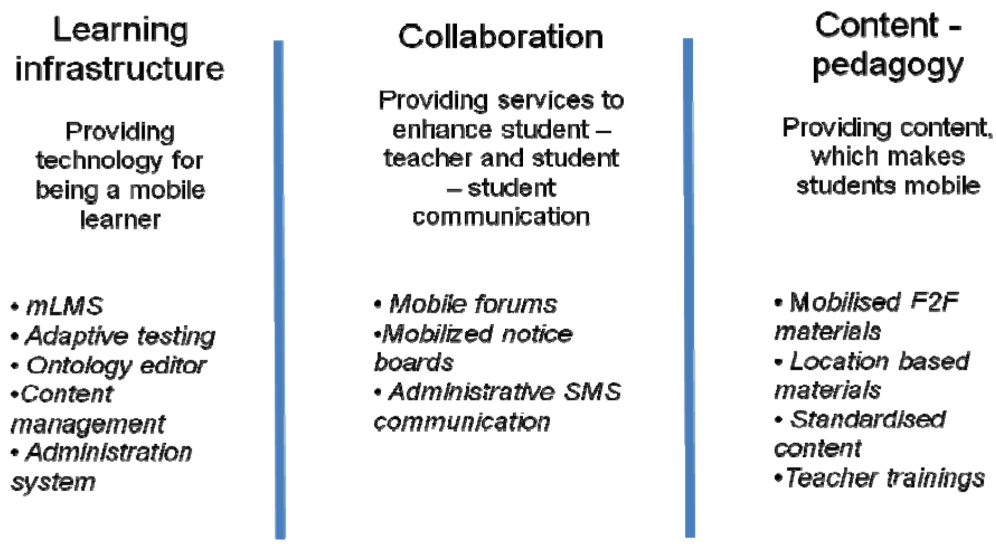



**Figure 25: Aspects of Mobile Learning at the Corvinus University of Budapest**

When it comes to Learning Infrastructure, challenges of limited resources of mobile devices have to be tackled and fitted to the long-established campus-workstation based services. In the Corvinus case, the mobilized infrastructure provides access point to selected services using a mobile phone

Regarding to collaboration, one of the main driving factors of mobility is collaboration. Fostering interaction between the stakeholders of learning processes is a key benefit that has to be supported with reliable services (Keegan 2005). Collaborative functions like forums, notice boards and messaging services are available in the Corvinus's system. When content is created for the mobile learner, the creator should establish learning scenarios that can be guidelines for content mobilization. On one hand lecturers want their lecture notes available for their students anytime, anywhere. On the other hand there are some applications (quizzes, games or evaluations), which are easy to use and fun to use on a mobile phone. At the same time being a mobile learner also means that the student uses content, transferred by the above mentioned means of educational infrastructure, in context. Getting learning content on the right spot at the right time makes formal and also informal learning mobile. On Figure 26 four examples are given for different types of content available in the system. From top-left to bottom-right the first two screens show a context sensitive course, called "Urban Architecture". The topic covers the history of door-making in Budapest. Students should walk around in a certain district of the city and investigate buildings themselves. On the third picture the outlook of a test module can be seen. The last one shows the general outlook of the mobile learning environment for a given course with the available learning content under "Mobil tananyag", the additional documents under "Dokumentumok" and the available course related forums under "Fórum neve".

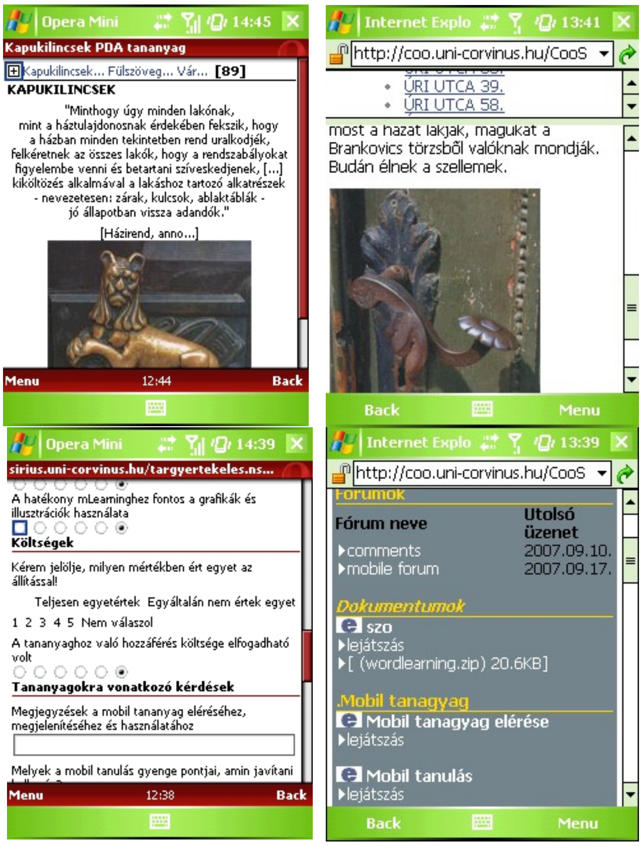


**Figure 26: Examples of available content in our mobile learning environment**

## THE EDUCATIONAL ONTOLOGY

Curriculum content may come in many forms and formats, from different departments, with different internal structures and even in different languages. Ontology-based approach provides support for capturing regularities in a single framework general enough to model the curriculum content management requirements of multiple institutions.

The wide spectrum of ontology applications also proves that both business and scientific world has acknowledged that the detailed exploration of semantic relations must stand in the middle of knowledge mapping and processes description – beside the precise definition of concepts (Corcho & Gómez-Pérez 2000; Gómez-Pérez & Corcho 2002).

Corcho and his colleagues – by taking into consideration several alternative aspects – constructed a rather precise and practical definition of ontology: *„…ontologies aim to capture consensual knowledge in a generic and formal way, so that they may be reused and shared across applications (software) and by groups of people. Ontologies are usually built cooperatively by a group of people in different locations."* (Corcho et al. 2003, p.44). Characteristics highlighted in this definition also have a key role concerning the Educational Ontology.

The scope of curricula taught in a certain training program can even be rather broad and curricula in general are substantively different in nature, which clearly poses a challenge on the ontology model building process. It should be also taken into consideration that the structure and content of a subject might be at least partly different in diverse institutions. Major classes of the ontology that were developed in the first cycle should meet these challenges. The following sections give a description of all of the classes in the ontology.

### *"Scope of Activities" Class*

The "Scope of Activities" class contains all of those professions, employments and activities that can be successfully performed with the acquisition of those competencies that are provided by the given training program.

### *"Task" and "Competence" Class*

A job consists of numerous tasks that should be executed in the course of everyday work. At the same time the employee must possess certain competences to be able to accomplish tasks relating to her position. So each task should be in "requires" relation with competences.

On the other hand one scope of activities should be in direct “specified by” – “served by” relation with tasks. This way the given scope of activities prescribes a number of concrete tasks that will define concretely required competences.

### *“Group of Task” and “Competence Module” Class*

By defining separate classes for tasks and competences, not sets (competence modules, group of tasks), but their elements are connected to each other. At the same time the “Group of Tasks” and the “Competence Module” classes should be entered to the model to enable the definition of sets of tasks and competences as well and ensure further ways of comparison.

### *“Knowledge Area” Class*

Knowledge areas and competences are connected directly with the “requires” and “ensures” connection. (A competence requires the knowledge of a given knowledge area and the good command of a knowledge area ensures the existence of certain competence(s).)

The class of “Knowledge Area” is an intersection of the ontology, where the model can be divided into two parts:

- One part of the model describes the relation of knowledge areas and labour market requirements with the help of the above-described elements.
- The other part will depict the internal structure of knowledge areas.

The internal structure of knowledge areas must be refined to allow of effective ontology construction and the efficient functioning of the adaptive knowledge testing system (detailed a bit later in this chapter).

“Knowledge Area” is at the very heart of the ontology, representing major parts of a given curriculum. Each “Knowledge Area” may have several Sub-Knowledge-Areas through the “is part of” relation. Not only internal relations, but relations connecting different knowledge areas are also important regarding knowledge testing. This is described by the “is part of” relation. At the same time another relation has to be introduced, namely the “requires knowledge of” relation. This relation will have an essential role in supporting adaptive testing. If in the course of testing it is revealed that the student has severe deficiencies on a given knowledge area, then it is possible to put questions on those areas that must have been learnt in advance.

For the sake of testing all of those elements of knowledge areas are also listed in the ontology about which questions could be put during testing. These objects are called knowledge elements and they have the following major types: “Basic concepts”, “Theorems” and “Examples”. In order to precisely define the internal structure of knowledge areas relations that represent the connection between different knowledge elements also must be described.

This way the ontology model that provides the base for the application (the adaptive testing system) is completed. The model of Educational Ontology is depicted by Figure 27 using the following notation:

- Rectangles sign classes.
- Arrows depict 0-N relations (so a competence may have several prerequisites, scope of activities may specify more tasks at the same time and it is also possible that a competence those not have any prerequisites).

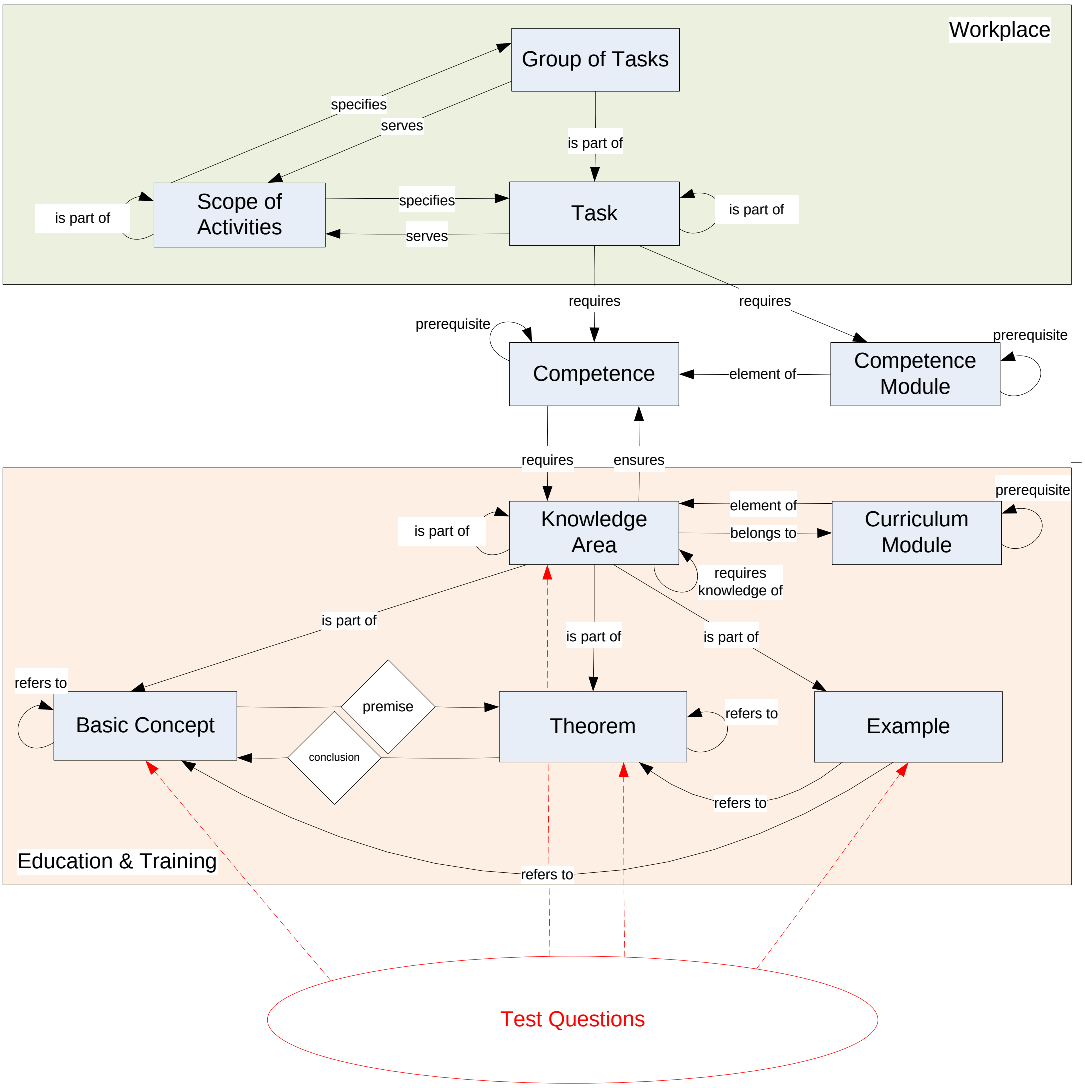



**Figure 27: Educational Ontology**

## SYSTEM ARCHITECTURE

A learning infrastructure should be developed in order to actively support the entire learning cycle, independently from its form (e.g. workstation- or mobile phone-based learning). This means that the system should contain a Learning Management System, which is capable to do transactions with clients using mobile devices as well as clients using desktop computers. This mobilized Learning Management System is responsible for user administration and authentication tasks. As it is visible on Figure 28, the mLMS is outside of our ontology-based authoring environment, similarly to the system responsible for institutional administration of student accounts.

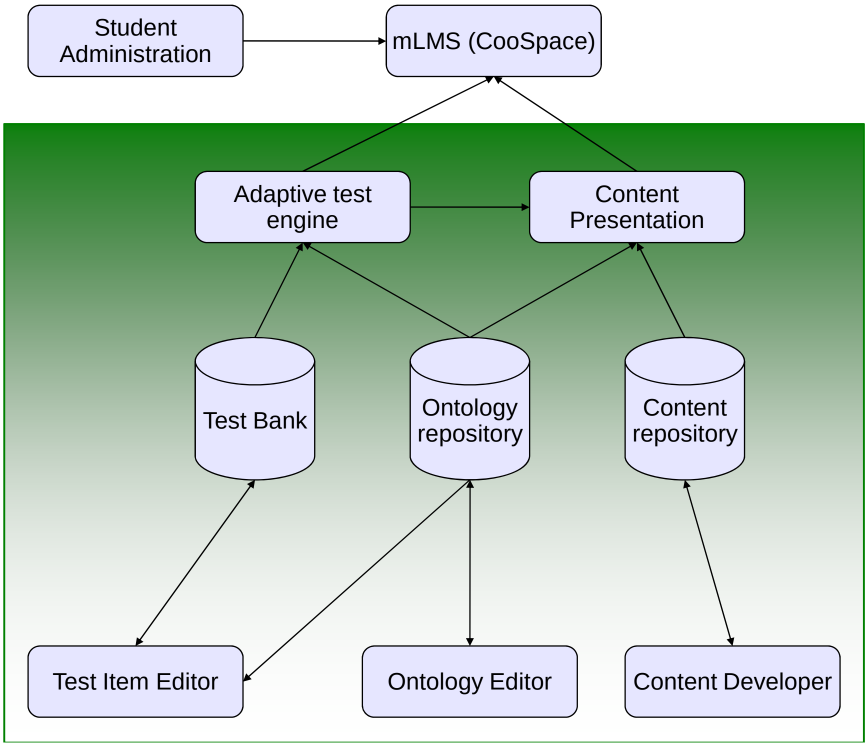



**Figure 28: The Corvinno Studio Architecture**

The mLMS is tied to the ontology-driven content authoring environment. This environment consists of a Content Repository, Ontology Repository and a Test Bank. Ontology Repository has a crucial role as ontologies are the central elements of the content authoring processes. Several ontologies are stored in this repository, all of which are using the structure of the above mentioned Educational Ontology, instantiating it for different domains. These ontologies constitute the central part of other components in this system. Creation and modification of ontologies are carried out by the Ontology Editor module, which guides instructional designers, when they edit ontologies according to the Educational Ontology model. This editor is not applicable as a general ontology editor, it is specifically tailored to support our Educational Ontology model, enabling users to create or edit ontologies, even if they have modest expertise in ontology building.

Students' knowledge is evaluated by using multiple-choice question tests. All questions and possible answers reside in the Test Bank and connected to a specific concept in the ontology. This way, learners' knowledge about a particular concept can be assessed. The Test Item Editor component is responsible for visualizing the ontology structure and allowing users to allocate questions to each node. Numerous questions can be assigned to any concepts in the ontology.

Learning objects are stored in the Content Repository. Additionally, a Content Developer application is also attached, offering content management functions for the authors. The repository has a Content Presentation component, which presents learning objects (LO) for the users. Content uploaded into the system is not format dependent, all extensively used text and multimedia file types are accepted, recognized and supported.

The above mentioned three components (Content Repository, Developer and Presentation) constitute a Content Management System (CMS) specialized for the needs of the ontology-driven environment. These elements enable structuring learning objects according to the ontologies, resulting that every concept in the ontology is connected to a particular piece of LO(s), describing the concept and its relations to other items in the same ontology.

For content management purposes an already existing system has been deployed. The key criterion was to be able to connect the content elements to ontology nodes. For this purpose, Semantic MediaWiki has been selected, as the most appropriate solution. It is an extension to the popular MediaWiki engine, which offers several tools and special wiki-notation in order to use or even construct ontologies to some extent. For instance this engine serves as background of Wikipedia, suggesting that it has the appropriate capabilities for managing large amount of content. One of the advantages of using MediaWiki is that it supports multiple types of contents, including text and various multimedia objects being used broadly in the learning objects of the Studio system.

For students the Adaptive Test Engine is the most essential application, which is also delivered through the mLMS. This component offers an adaptive knowledge evaluation and compiles customized learning materials. The component walks through the ontology structure and asks questions about concepts of the ontology, such as knowledge areas, basic concepts, theorems, examples and their relations. It evaluates the student's answers and decides on the following knowledge elements to be asked. At the end, the user's knowledge is mapped thoroughly and a tailored learning content is offered to be learned.

This customized material consists of pieces of learning objects, which are offered by the Content Presentation component.

### Ontology editor

In the next step an adequate ontology editor was selected, which meets all of the following requirements:

- Extensible – The training system has to meet the labour markets requirements, so it will require constant maintenance and development.
- Treatment of high volume data – Even one curriculum may consist of several hundred ontology elements, like knowledge areas, basic concepts, theorems etc. So the modelling of all the curricula of a given training program will require even greater capacity.
- Interoperability – This learning management solution includes several different systems and applications. So it must be ensured that all part, even including the ontology, can easily and efficiently communicate with each other.
- User friendly interface (Szabó & Vas 2006).

After an extensive search for a suitable ontology editor, Protégé has been selected for the construction of the Educational Ontology.

### Content Authoring

As it was described in the previous section, the ontology provides the underlying structure of the curriculum based learning materials. Every other content developed during the curriculum development process is attached to this structure. This way, all subsystems of the Ontology-based Authoring Environment should be integrated with the ontology layer.

The creation of a new curriculum begins with the selection of the relating domain ontology. Curriculum related learning content, created in the system, should follow the underlying ontology structure that defines the domain of discourse. Since the structure of the curriculum has already been defined, the only task of the content developer is to assign content elements to adequate nodes of the ontology.

Content elements can be found in the Repository or they can be created there while attaching them to the ontology. The central element of content development and management is the Repository. This component stores every content element that can be useful in composing a curriculum. Its content can be an image, an article, short texts like a useful paragraph or a famous quote or even audio and video materials. The role of the Content Repository is to store and manage these content elements while maintaining a rich set of metadata describing the contained elements. Each content element can be described with Dublin Core metadata (ISO 2003) and other useful descriptors, like tags or categories. This rich description enables that stored elements can be easily found and retrieved by curriculum developers.

### Test Bank

In order to provide adequate support for knowledge testing several theoretical foundations and conceptions must be laid down concerning the structure of test bank and test items as well. One pillar of the testing system is the set of test questions. Accordingly all test questions must have the following characteristics:

- All questions must be connected to one and to only one knowledge element or knowledge area in the ontology. On the other hand a knowledge element or knowledge area may have more than one relating test question. This way the Test Bank is structured by the Educational Ontology.
- All questions should be weighted according to their difficulty.
- Test questions will be provided in the form of multiple-choice questions. Therefore parts of a question are the following:
- Question
- Correct answer
- False answers

The Test Bank does not form an integral part of the ontology. This means that questions do not have to form a part of the ontology if we want to represent correctly a given curriculum. That is the very reason for connecting the Test Bank to the elements of the ontology only with dashed lines on Figure 27.

### Test Item Editor

As it was seen in the previous section and also in the case of the Content Authoring, Test Authoring is also based on the underlying ontology. The process of Test Development is also similar: questions have to be written and attached to various nodes of the ontology. Naturally, more questions can (and should) be attached to one node. The final phase of the test development process is test generation that means the setting of appropriate testing and evaluation algorithms for a test instance. Multiple tests can be generated using the same question set by setting the parameters differently.

### Packaging

The final step in the curriculum development process is packaging. During this step the curriculum material is packed in a SCORM-compatible package that can be deployed in a learning management system, like Coospace that will be described in the next section. The question set can also be packaged and deployed in the Adaptive Testing Engine that provides the necessary facilities to execute and evaluate the tests. The ontology itself is present in each package, however, in a different form. In the SCORM package, the structure is originated from the ontology; and it is an integral part of the test package, since execution of the tests heavily relies on the underlying ontology structure.

### Content Development Process

As it was described before, development of the curriculum content begins with the construction of the appropriate ontology. Ontology and domain experts determine the structure and concepts of the domain of the curriculum and with the chosen editor tool the ontology is built.

As the ontology is finalized, domain experts extend the bare structure with textual and multimedia content elements. Content elements reside in the Repository. Domain experts can search the repository for already existing content or create new elements if needed. Selected content elements are attached to the appropriate nodes of the ontology. This process is basically the establishment of assignments or relationships between ontology nodes and content elements.

Content developer has to design the curriculum material carefully to maintain a balance between the core and illustration material. Core material is related strongly to the ontology concepts, building the most important and basic elements of the curriculum, while the purpose of illustration elements is to help understanding the material. Core elements are usually textual ones, while illustration material can involve large variety of content elements, like pictures or video clips.

After finishing the content assignment, the Test Bank has to be filled. The domain expert can use the Test Item Editor to edit questions and assign them to the appropriate node of the ontology.

Result of this process is the finished ontology structure with attached content elements and questions. The last phase of content development is the packaging, meaning the creation of standard SCORM packages by extracting the structure of the ontology into a curriculum structure and storing the appropriate content elements together according to the standard. Another package is also created containing the Test Bank and the extracted ontology structure. The SCORM content package is deployed into the mLearning Management System and the test package is deployed in the Adaptive Testing Engine.

## ADAPTIVE TESTING ENGINE

The only task that must be accomplished before starting the construction of the adaptive testing system is to lay down the main principles of our own adaptive testing methodology and work out its process.

### Adaptive Knowledge Testing Approach

In contrast with traditional examination the number of test items and order of questions in an adaptive test is only determined during writing the test itself with the goal of determining the knowledge level of the test taker as precisely as possible with as low number of questions as possible (Linacre 2000a). Adaptive testing is not a new methodology and despite the fact that it has many advantages compared to traditional testing, its application is not widespread yet. This research has focused on the computerized form of adaptive testing; whose main characteristics – independently from the methodological approach – are the following:

- The test can be taken at the time convenient to the examinee; there is no need for mass or group-administered testing, thus saving on physical space.
- As each test is tailored to an examinee, no two tests need be identical for any two examinees, which minimizes the possibility of copying.
- Questions are presented on a computer screen one at a time.
- Once an examinee keys in and confirms his answer, he is not able to change it.
- The examinee is not allowed to skip questions nor is he allowed to return to a question which he has confirmed his answer to previously.
- The examinee must answer the current question in order to proceed onto the next one.
- The selection of each question and the decision to stop the test are dynamically controlled by the answers of the examinee (Thissen & Mislevy 1990a).

A methodology of adaptive testing has been elaborated that provides help in determining the knowledge level of the student with asking as few questions as possible. The main principles and steps of this methodology are discussed in the next sections.

### Principles of Adaptive Knowledge Testing

In the course of examination we select from a previously created set of questions. All test items are multiple-choice questions that have the following characteristics:

- One – exactly one – knowledge area is attached to one question.
- Text of the question.
- Set of answers in which the correct answer is indicated separately.
- Difficulty level of the test question (on a scale from 1 to 100).

The goal of knowledge evaluation and the ontology together determine the scope of questions that belongs to the given examination. The test taken by the student contains these questions. Based on the answers and their distribution on the ontology structure we are able to determine the knowledge level and the missing knowledge areas of the student. Accordingly the characteristics of the methodology are the following:

- If the candidate's performance exceeds a predefined pass level, meaning that she knows the given area on an adequate level, then she succeeded at the exam.
- If the candidate's performance is below the required level, meaning that she does not know the given area, then she failed.
- Finally, if the candidate is approaching the required knowledge level (from above or from below), then the final score can only determined after testing the sub-areas of the given knowledge area.

This means that even if the candidate knows the main knowledge area on a suitable level it must be assured that candidate's deficiencies on sub-areas can also be determined. In other words the methodology must ensure the possibility of examining the sub-areas of the given knowledge-area.

### The Adaptive Testing Algorithm

Before starting the exam several kick-off parameters must be provided. Beside the determination of these parameters the phases of the exam (the testing algorithm) is also discussed in this section.

#### *Start*

Before testing can be started the following parameters must be defined in the system:

- a 'T' knowledge area, that we want to test
- the $0 \leq low \leq pass \leq high \leq 100$ values, and
- a true/false value, that describes whether the sub-areas of the given 'T' knowledge area must be tested or not.

The role of *low*, *pass* and *high* values are the following: In each step of the test the actual knowledge level of the candidate must be estimated. Pass level is that level which must be achieved to pass the exam. If the candidate constantly remains under the low level, then the exam stops quickly and the candidate fails. In this case it is unnecessary to examine the sub-areas, since the candidate does not know anything about knowledge area 'T'. High level means the opposite. If the candidate permanently remains above the *high* level her knowledge concerning knowledge area 'T' is much more than enough, so we take as the candidate knows the hole area and she has know deficiencies.

#### *Phases of Testing*

Having defined the initial conditions the test can be started. The course of testing is based on the Rasch model (Rasch 1992) and has the following steps:

- The system asks some question whose difficulty levels are around the pass level.
- Based on the answers the knowledge level of the candidate is estimated, we call this value *D*.

- Further questions are asked; whose difficulty level is always above the actually estimated knowledge level and based on the last answer the value of *D* is corrected. We continue until one of the stop rules is met. (Further details concerning stop rules are provided in the next section.)
- If D < *low*, then the knowledge of the candidate is absolutely missing, so testing can be finished.
- If D > *high*, then the knowledge of the candidate completely, so testing can be finished again.
- If *low* < D < *high* then the knowledge of sub-knowledge areas must be tested too. All sub-knowledge areas are tested and results of each sub-area testing are summarized. If the summarized result is below the pass level then the candidate failed, otherwise succeeded.

### *Stop Rules*

Finally those rules have to be defined that determine when to terminate testing, ensuring that evaluation is accomplished by as few questions as possible. If there are no more questions attached to the knowledge area then obviously we do not ask more questions. Testing is also terminated if after a minimal number of questions (or after series of questions that have affected all sub-areas) D < low or D > high. At the same time if we ask 1,5 more than the minimal question number and low < D < high, then instead of knowledge area 'T' its sub-areas are examined more thoroughly. We use the same algorithm for each sub-area testing. If testing concerning all areas is accomplished, then the actual values of D is calculated based on questions and answers accomplished in the meanwhile. If D < low then the candidate failed, otherwise succeeded.

### Adaptive Testing in Practice

The user interface of the adaptive testing system is very simple and clear. After face validation the user has to start the test procedure. The system provides only one question and the possible answers for that question at once. After the student indicated his solution, the system following the above described algorithm puts the next question on the screen and so on. After the completion of the test the system provides a detailed evaluation of the student's performance. This evaluation includes the following:

- The number of questions, which have been answered
- The list of wrongly answered questions and why was the answer wrong
- A list of missing knowledge areas
- The grade of the exam (in percentage)
- Links to Learning content, based on missing knowledge areas – *customized learning material* is provided

- Detailed description about the reviewing process and complaining, in case the student doesn't want to accept the result.

## CONTENT DEVELOPMENT PROCESS

Content in the Studio system consists of the following elements:

- the ontology itself
- questions for the concepts in the ontology
- learning objects describing the concepts in the ontology

Content creation begins with the development of the ontology, as it was elucidated in the previous sections. This step provides the basis for all other content authoring activities. The created ontology has to be deployed into the Studio system in order to be able to associate questions and learning objects to its concepts.

The Test Item Editor is used to build up questions for appropriate concepts in a particular ontology. These questions are stored in the Test Bank and queried by the Adaptive Test Engine in order to generate tests. The system supports multiple choice questions with any number of possible replies and one correct answer. The author has to mark the right answer in order to allow the adaptive test system to evaluate the answers. It is advisable to associate several questions to an ontology concept, however the system only verifies the existence of at least one question per node. The Test Item Editor guides the author through the plot of ontology concepts by representing them in a tree-shape. This function also provides support for discovering conceptions without questions attached.

Developing and representing textual and multimedia content is enabled by the Semantic MediaWiki platform. The linkage to the educational ontology was described in the previous section. Following the ontology import, authors can insert learning objects in the system collaboratively by using MediaWiki features. These elements of content are stored in the repository, in conjunction with appropriate version information that enables authors to follow up and review all changes made in the content. There should be at least one person in the authoring team who has an overview of the status and readiness of the LO(s), since independent authors are responsible only for their own parts. For the Wiki page authors a detailed data formatting and inclusion guideline has been created, with prewritten html codes. Even though the content developer doesn't possess relevant html knowledge, with a simply copy-paste mechanism it is possible to embed rich media content.

Students, who log in the system from a mobile phone, using the mobile interface of our LMS, can access and read the content, which is either in the MediaWiki or in a course related Mobile Learning Space. These learning spaces contain face to face course lecture notes, presentations or other additional learning materials. For some courses location based content is also available. Neither the mLMS nor the MediaWiki are capable to communicate with positioning systems. In order to facilitate location based teaching a flash based application has been developed, which must be downloaded from the Mobile Learning Space and installed locally on the handheld device in order to benefit from location sensitive content delivery.

All materials are accessible via the normal desktop PC interface. PDAs, smartphones with Wireless LAN function are capable to enter the LMS this way as well. In case using a WAP browser of a mobile phone, it is possible that the browser won't be able to access our website. To avoid this problem we recommended students to use the Opera Mini, which is a free internet browser application for wide range of mobile devices. This Java based browser runs on almost all commonly used handhelds. Downloading instructions for the Opera Mini were provided through the mLMS as well.

### mLMS

To exploit the advances of mobile technology it is indispensable to transform traditional learning environments into mobilized learning spaces otherwise users can't benefit from mobility. Challenges of limited resources of mobile devices have to be tackled and fitted to the long-established campus-workstation based services. For the Corvinno Studio pilot a Hungarian Learning Management Platform (CooSpace) is being used, which has been deployed at the Department of Information Systems at the Corvinus University of Budapest for several years. CooSpace is a communication-centred solution, which takes place in scenes of this learning environment. A scene is a virtual space of an existing group. Students must join particular scenes through their studies, depending on the task or courses they are currently enrolled. These scenes are supporting co-operation between members of these groups by assuring numerous forms of communication channels and services. These cooperation scenes are treated as social networks, where participants can share their contact and personal information, or they can form study groups. A shared document composition tool supports students to work together on a common project.

### Interaction

One of the main driving factors of mobility is collaboration. Fostering interaction between stakeholders of learning processes is a key benefit that has to be supported with reliable services (Keegan 2005). Collaborative functions like forums, notice boards and messaging services are available within a selected scene. Students can set up conversations, discuss different topics in thematic forums or real-time chat rooms. It is possible to congregate virtual or personal meetings or follow up the learning program related academic or administrative events, with the help of an SMS messaging system.

Students can co-operate and publish their achievements for the closer and the wider circle of stakeholders who are connected to a particular scene. Besides these tasks, the distribution and division of assignments, the evaluation and traceability of distinct subtasks are also possible. It is also feasible to appoint tasks for the whole group or only for individual members of the group, who can submit their documents for evaluation according a predefinable time schedule of the scene.

#### Content management

When content is created for the mobile learner, the creator should establish learning scenarios that can be guidelines for content mobilization. On one hand lecturers want their lecture notes available for their students anytime, anywhere. On the other hand there are some applications (quizzes, games or evaluations), which are easy and fun to use on a mobile phone. At the same time being a mobile learner also means that students use content, transferred by the above mentioned means of educational infrastructure, in context. Getting learning content on the right spot at the right time makes formal and also informal learning mobile.

Still, educational documents are accessible in a unified way. Shared document storage provides a common repository of the achievements, templates and draft documents. Users can share documents, media files and with the compilation of bibliographies they can set out curricula, working papers.

#### User rights management

From the technology point of view, CooSpace is a web-based, multi-tier computer application. Regarding the platform, it works with a Microsoft 2003 server, with an MSSQL 2000 database server in .Net framework IIS6/aspx. The user rights management is being handled by a strict set of rules with the help of Microsoft Active Directory Services technology, providing a possibility of Single Sign In. On the web interface of CooSpace every important function (e.g. To Do List, Co-Operation Scenes, Messages, Forum, and Document Storage) is only 'one-click away'. This learning environment can be connected with other systems – including processes of data synchronization and single sign authentication.

### USER SCENARIO

In this section, user experience is demonstrated by a description a student case scenario.

The usage of the system begins at the CooSpace authentication screen. Entering the URL of our CooSpace server into a mobile browser takes students to the login page. There they log in with their login name and password (See Figure 29). As it was mentioned before, in CooSpace, educational cooperation takes place on scenes, which is a virtual space for an existing study group.

After signing in, students see all scenes which are associated to their profile. Opening a scene and clicking on the link of the appropriate test initialise an embedded module: the adaptive test engine. Adaptive tests can obviously be assigned to several scenes. This depends on the variety of courses and the policies of course organization in the particular educational institution.

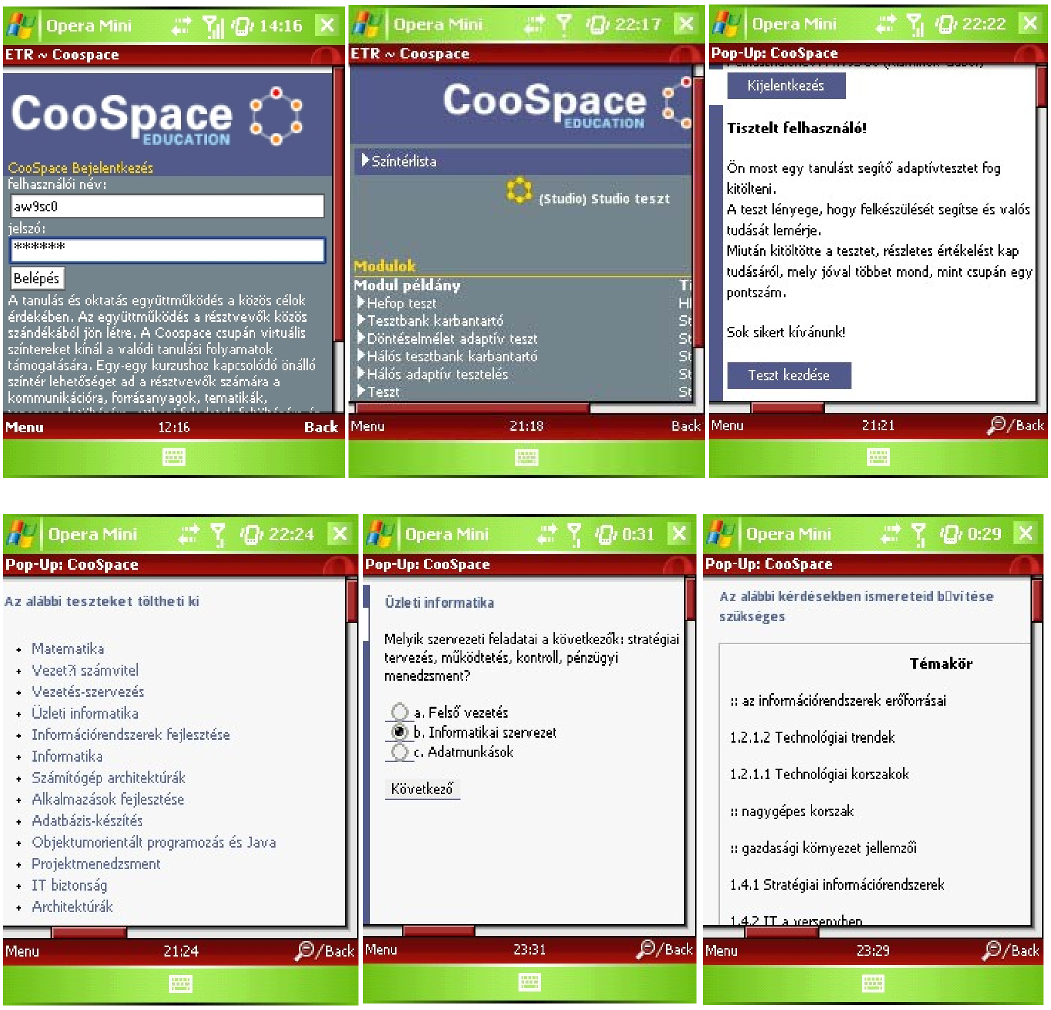



**Figure 29: CooSpace screenshots from a student perspective starting with the login screen (top, left) finishing with the list of missing knowledge areas (right, bottom).**

The following step is the face validation. Students receive a short message (top, right picture on Figure 29), informing them about the topic and the nature of the test, the regulation of this assessment and students' options during the test taking. This validation is essential to ensure that students are aware of the test's objectives. The test begins with the acknowledgement of this validation message. Students answer a series of multiple choice questions which are evaluated according the logic described above. At the end students receive their results and the apt explanation (bottom, right picture on Figure 29).

This list consists of incorrectly answered questions with links pointing to the corresponding learning materials, organized by the structure of the ontology. As a result, tailored learning units cover the missing elements of the test takers' knowledge. It is students' task and responsibility to visit the provided learning materials. To force continuous self assessment these tests can be repeated anytime. The system logs all attempts and results, which enable users to follow accurately their performance on that particular domain.

## EXPERIENCES

Although mobile learning still has technological limitations – like small screen or bandwidth problems, etc. – the most burning questions that require solution are mainly non-technological. The pace of life is accelerating and traditional processes are becoming more and more fragmented. In many cases there is no time for traditional, strictly scheduled education anymore, where it can easily happen that individuals do not get any feedback concerning their knowledge even for months. Today, employees are expected to be open to acquire new skills, attitudes and knowledge at any time that requires supporting technology. The above discussed learning infrastructure adapts to this changing environment by ensuring availability anywhere, at any time. Moreover feedback is provided immediately. After self-training, users can access the adaptive knowledge testing environment that provides instant evaluation of their present knowledge and suggestions concerning what to study again.

As a trial, the major parts of the above mentioned infrastructure and content delivery system was tested in 2007. Annually more than 650 business BSc students have to take ‘Introduction to Management Information Systems’ as a compulsory course at Corvinus University of Budapest. This course is part of the regular face-to-face training program, meaning that the knowledge transfer is initiated in classrooms. The background technology supports blended learning activities through the complete learning cycle:

- Learning content was accessible through mLMS
- Synthesized course summaries, lecture notes were provided for mobile devices
- Ontology based adaptive test supported self assessment

The course evaluation, which was filled out by 244 students, contained questions regarding the learning infrastructure they had to use.

### Place of learning

We wanted to know where our students used educational technology the most. Home and campus learning are still leading, but mobility is getting a key issue here.

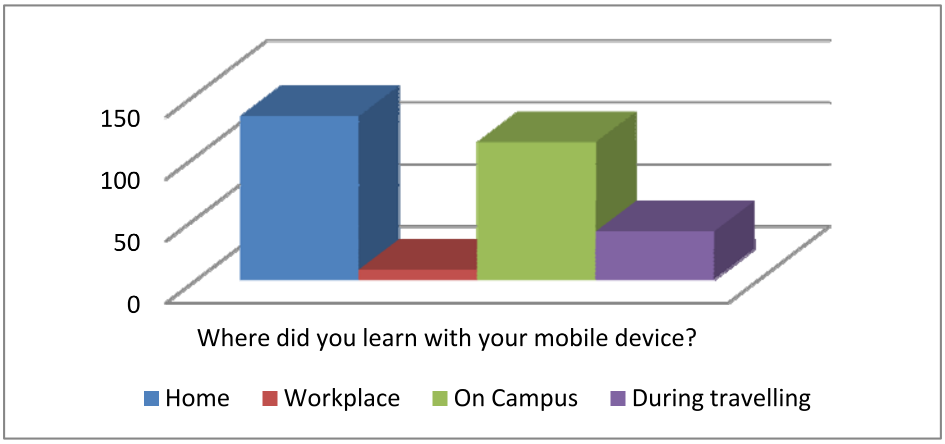



**Figure 30: Place of learning**

### Mobile learning increases the quality of e-learning

Also half of the students said that mobile learning increases the value of eLearning. However the majority of the respondents were convinced that mLearning could not be a standalone tool for education.

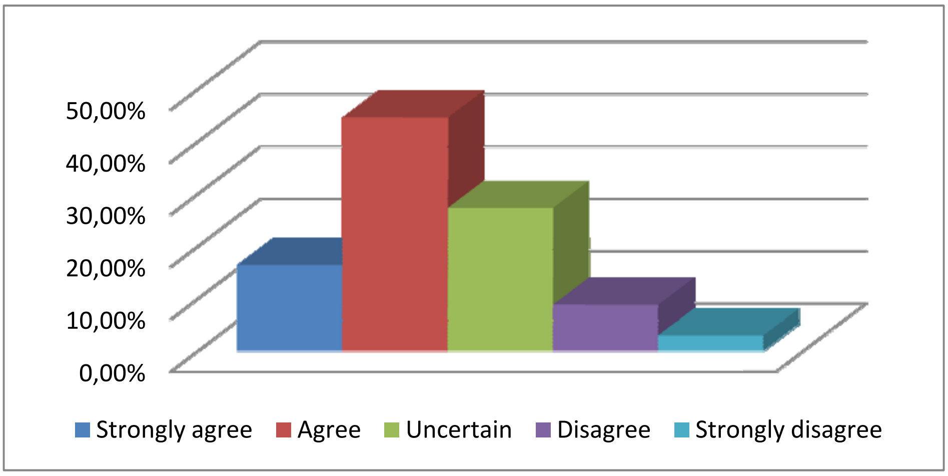



**Figure 31: Mobile learning increases the quality of e-learning**

### Course learning objectives can be met by mobile learning

Majority of the students replied negatively to this question. For more than half of them it's not acceptable to use mobile technology as a standalone channel in education.

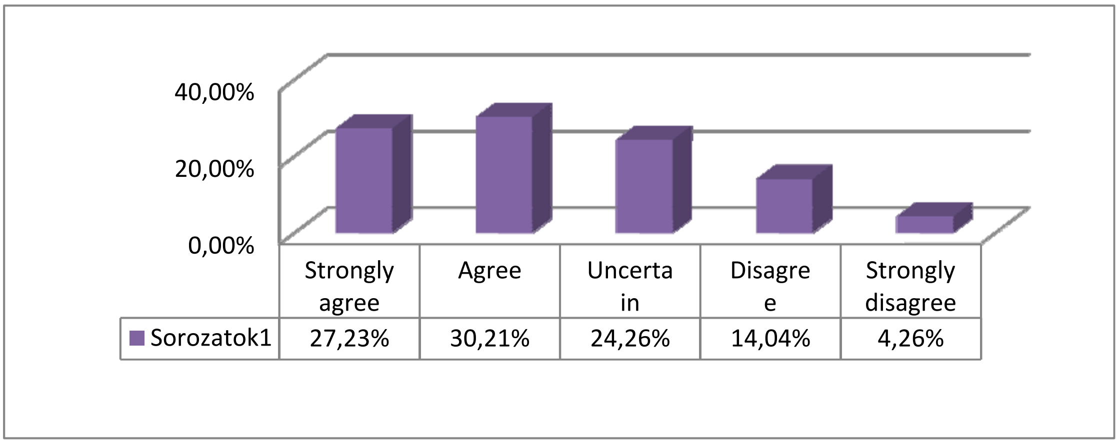



**Figure 32: Course learning objectives can be met by mobile learning**

### The learning content was accessible on the spot and at the time I wanted

The question reassures that students were happy about the reliability and usability of the technology, which worked well during the course.

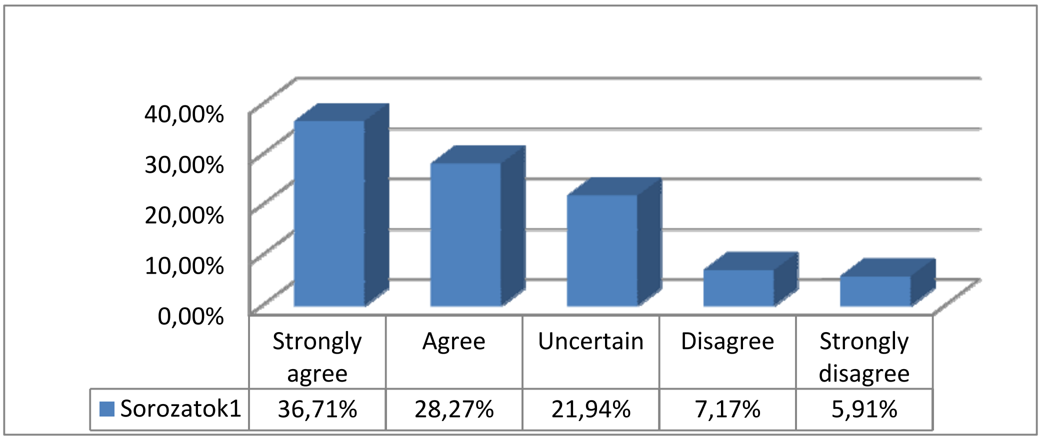



**Figure 33: The learning content was accessible on the spot and at the time I wanted**

### For mobile learning to be effective it is necessary to use graphics and illustrations

There were quite a few critics regarding this issue, but mostly about mobilized content. Students emphasized that they prefer text-based materials, which are not very long, as reading is quite exhausting on small screens. It was surprising that they also denied the idea of using more animations or more multimedia based content. The respondents stacked to the conventional learning materials consist of text and graphics. The reason behind this is that they find it awkward using "loud" multimedia content in public space, especially if they don't have a headset.

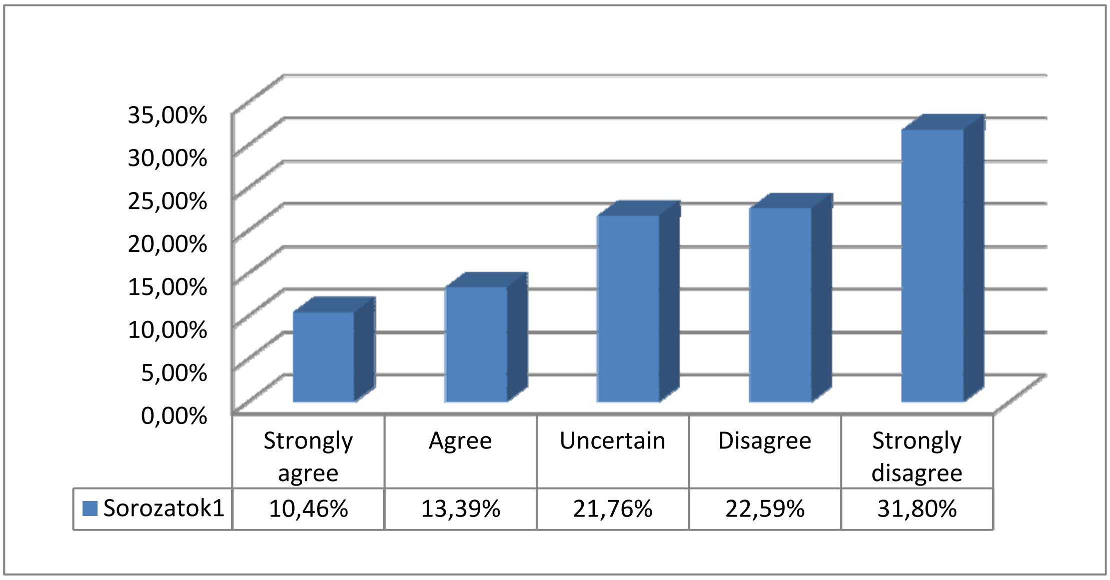



**Figure 34: It is necessary to use graphics and illustrations for mLearning**

### The cost of downloading the mobile course materials was acceptable

Majority of the students agreed that the cost of downloading the materials to their mobile devices was acceptable. One reason behind this is the following: the price of mobile internet is decreasing continuously. The downloading cost of an approximately 100Kb pack is not more than 40 Eurocents at the moment in Hungary (spring 2007). The other reason is that students were able to download the content to their personal computers and then upload it to their mobile phone. They could do this either on campus or at home, which were the most popular locations for this learning scenario.

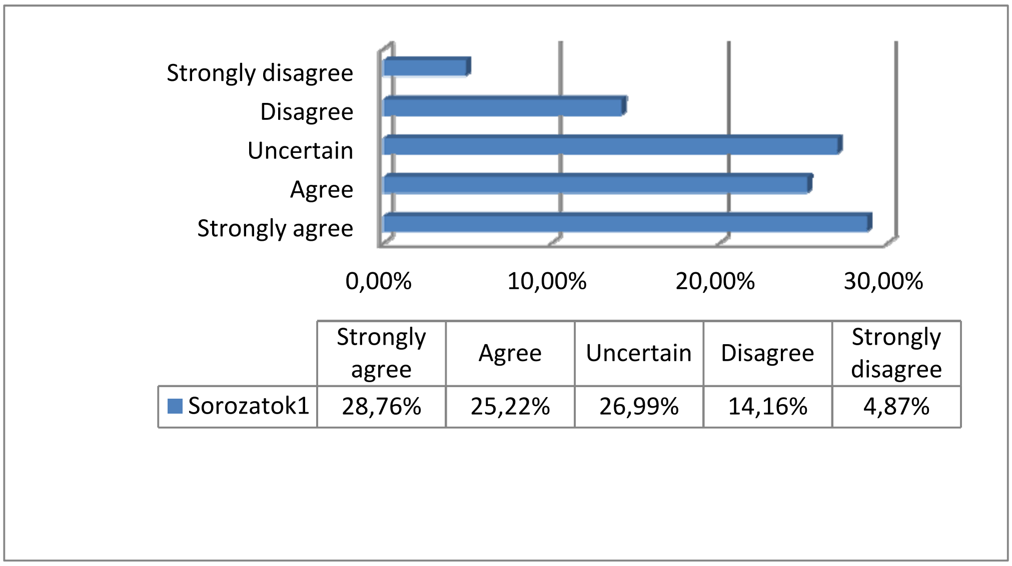



**Figure 35: The cost of downloading the mobile course materials was acceptable**

**Student comments about the access, visualization and the usage of learning content**

Students could put down their opinions in free text fields about the quality of the courses and about their feelings, opinions regarding mobile technology in education. This collection consists of the most typical answers.

Student reflections supporting mobile technology in F2F education

- „It was easy to access the materials”
- „It’s easier to use this, as I’m not bound to a computer.”
- „Who tried this way of learning, got expertise in using a mobile interenet browser (Opera Mini), which – I think – is a very useful Java application”

Student reflections against mobile technology in F2F education

- „The user guide for mLearning was not clear enough.”
- „It was easy to use, but the visualization and the readability of the graphs were sometimes poor.”
- „The installation and the customization of Opera Mini were difficult.”
- „My phone can’t handle Hungarian characters, which made the reading quite difficult”
- „Navigation is slow and complicated”

Student recommendations for the developers

- „It should be simple, easily accessible for everyone. The size should be as small as possible (skip illustrations) in order to decrease the cost of downloading.”
- „Provide more audio based content!”
- „Improve the design of the system!”
- „This way of learning is not very well known. You need to put more effort on promotion and dissemination.”
- „Implement more functions using communication features of mobile phones!”

In general this survey showed that more effort should be put on promotion, when introducing new technology in real teaching settings. Both students and teachers should have sufficient amount of information about user requirements, accessibility and the available features. A very interesting result was that the vast majority of students still couldn’t use the technology they possessed. They had troubles in using their mobile browsers, accessing the web from a mobile phone. Therefore they needed additional support from the instructors, which was not planned in their time schedule, causing delays in course schedules as well. In contrary, the results indicated that significant amount of students use mobile technology already in their studies (without any promotion).

## FUTURE PLANS

As our system consists of various components, moreover the majority of these components are already existing software in use, integration is a major issue. For this purpose, Service Oriented Architecture was selected as the state-of-the-art approach to application integration. (He 2003) Naturally, as SOA is only an approach, interface standards describing integration have to be declared. For this requirement, Web Services has been privileged.

This integration approach enables an enormous degree of freedom in deploying the system or replacing elements with already existing components. During the system development, designers have chosen an existing offline tool (a desktop application) for packaging, which can make use of the resources in the Repository to build content packages. Existing systems can also correspond by appropriate interfaces, which have been used to attach the Adaptive Testing Engine to the Learning Management System.

The SOA approach also enables the deployment of other existing educational environments, which might also be attached to an Enterprise Service Bus by using suitable adaptors. This provides flexibility and opportunities to extend our investigation from academic learning environments towards the needs of corporate training systems.

Another possible way of enriching this environment is introducing IMS capability. IMS stands for IP Multimedia Subsystem, which will be a standard and generic architecture for offering VoIP (Voice over IP) and multimedia services on mobile networks. This internationally recognized standard is expected to be rolled out worldwide from summer 2009. IMS supports all currently used mobile network types (GSM, WCDMA, CDMA2000), but also traditional cable based broadband internet services and WLAN technology. This technology may foster context and location sensitive learning, as it is capable to handle multiple access to services regardless of devices and geographical locations. This technology creates a new layer between content authoring and content delivery. Its main contribution might be to enrich customized learning material with multimedia elements that is presented to the student after completing a test. IMS is also suitable to improve current communication services of our Learning Environment. Audiovisual collaboration and enhanced data transfer between users add value to our system, incorporating several emerging technical platforms (mobile phones, computers, IPTVs, GPS services) into the learning process support. Students might also be able to synchronize their learning activities better.

The above discussed pilot research has focused on the application of electronic and mobile learning tools in the academic sector. The introduced approach concerned the deployment of a common framework of transparent and comparable degrees in the

Bologna system. As a result a competitive content authoring and knowledge evaluation system has been developed which serves the needs of mobile learners and also promotes the transition between the BSc and MSc levels of higher education. This platform independent learning environment enables the development of customized qualification programs, based on the individual's previous qualifications, completed levels, corporate trainings and practical experiences. Subsequently the potential application areas of this approach are rather wide. Higher education is not the only one, who can enjoy its benefits, public and business sector are also possible targets. This architecture also enables content transfer for individual learning scenarios through traditional Web environment and mobilized learning spaces.

Ontologies, as an abstract and precise way of knowledge description were used to describe the curricula and the needs of the labour market (competencies) in the project. The mobilized learning environment creates flexible learning spaces, which supports individual formal and informal learning either on campus or in individual settings. This approach proved to be fruitful and we are going to extend the scope of this research to the wider academic and business community.

# PART IV

# Extending and tailoring mobilised learning content management to the needs of HRM selection and recruitment

# PART IV - EXTENDING MOBILISED LEARNING CONTENT MANAGEMENT
# SIX SCENARIOS

## INTRODUCTION[36]

Representing content in an appropriate format, which is tailored down to the learner's context, is a great challenge of educators. As there are no identical learners with identical educational needs, the problem of providing uniquely composed and personalised learning material is an evergreen issue (Soloway et al. 1996; Watkins 2010). This chapter will describe a framework using ontologies for contextual learning content management, what also serves as a domain for research activities in the field of mobilised learning content management. The authors have been working on this issue in the past years (Kismihók et al. 2009; Kismihók & Vas 2009a; Vas 2007; Vas, Kovács & Kismihók 2009a) in order to establish a robust theoretical and empirical fundament for their research and teaching activities with the help of mobilised educational technology.

The structure of the chapter is the following: first some important theoretical issues regarding ontologies and adaptive learning content delivery is discussed. This part is followed by the plot of the research scene, which encompasses six main areas of research and practice: curricula development, adaptive testing, learning technology selection, selection and recruitment in Human Resource Management, competency matching and context based learning. The relevant technical and theoretical challenges that the authors had to face with by all these domains are also presented. At the end of this chapter conclusions are drawn for future research.

## ONTOLOGIES AND ADAPTIVE LEARNING CONTENT DELIVERY

Adaptivity and semantic technology is used in several ways in educational content delivery. These ways include interoperability, collaboration or context aware content management. Examples show that one way of using ontologies in a learning system is supporting interoperability between particular educational platforms and systems (Aroyo et al. 2006; Moreale & Vargas-Vera 2004). When it comes to collaboration the notions of ontology based applications in eLearning systems for learners' show that semantic enabled annotation and knowledge management systems provide flexible, real-time ammunition for collaborative learning tasks (Yang et al. 2004).

[36] Parts of this chapter is under publication in the Journal of Mobile and Blended Learning: Kismihók, G., Szabó, I. & Vas, R., 2011b. Six scenarios of exploiting an ontology based, mobilized learning environment. *International Journal of Mobile and Blended Learning*, accepted, to be published in 2011

Context awareness can be treated as a problem of processing sensory information coming from mobile devices and transform this information into a well defined context, which can be done in several ways: with ontologies or with clustering maps (Flanagan 2005). Furthermore, ontologies can also be useful for context identification and reasoning (Hu & Moore 2007), thus there are also attempts to use ontologies for modelling not only the learner's context but also the content's context in order to provide more user specific services in ubiquitous learning environments (Yang et al. 2006).

Based on the above mentioned topics, several ontology supported solutions are available for content representation. Emerging from traditional eLearning, the OntoEdu architecture was aiming to enhance content reusability together with device and user adaptability (Guangzuo et al. 2004). The SPIRIT project used ontologies for describing spatial structure of places, which structure was offered for information retrieval (C. B. Jones et al. 2002). The M-Loco project's contextual data representation considers the social connections of the user and the technology in use (Knight et al. 2005; Siadaty et al. 2010). The OntoMobiLe project uses SOA (Service Oriented Architecture) approach to represent data on mobile devices from various content providers tailored down to the user's – query based – context (Yee et al. 2009).

Yet another approach is when learning objects are organized by an ontology, resulting in a self tailored, query driven learning experience (Berri et al. 2006; Basaeed et al. 2007). Here a user query triggers an ontology based content delivery, which considers the context of the user with an intelligent user interface. Moreover, research shows that ontologies are also useful when tackling individual learner needs in adaptive learning systems (Ahmed et al. 2010).

A remarkable approach applied in a museum related educational setting also uses ontologies in order to establish a common understanding of concepts to be learned (Hsu et al. 2006). There the ontology 1) is a sharable content thesaurus, 2) maps the content onto standardised learning objects, 3) provides the foundation for the user interface (Hsu et al. 2006, p.640).

With the help of ontologies it is also possible to give a structured description of higher level concepts like competences. Draganidis and his colleagues (Draganidis & Mentzas 2006) from the National Technical University of Athens have worked out an ontology based competency management system, which also integrates eLearning functionality in order to map employees/organizational skill gaps with appropriate learning objects. Ng and her colleagues (Ng et al. 2006) developed an ontology-based competency formalization approach as a way of representing competency-related information together with other metadata in order to enhance machine automation in resources retrieval. In their approach, learning objects are annotated with instances of competences specified in a Competency Class.

### MOBILIZED LEARNING ENVIRONMENT

According to the literature and also our teaching experience at the Department of Information Systems in Corvinus University of Budapest, the mobilised learning environment should be developed with such an approach, which on one hand helps eliminating the scepticism of target users (see Part III) towards technology supported educational services (Kismihók & Vas 2011), can actively maintain communication between students and educators and also adds additional value to learning programmes. Therefore we decided to build on a stable foundation, which is coming from the field of knowledge management and called educational ontology (Vas 2007). This semantic application is used as a structural skeleton for our education related software and service portfolio.

In the following a detailed description of the mobilized learning environment is provided. This learning environment has a backbone (the ontology model) and six pillars. The backbone and three of the pillars (Ontology model, Curricula development, Adaptive testing, Learning Technology Selection) have been already elucidated, while the other three pillars (HRM selection and recruitment, Competency mapping, Context-based learning) are still under construction. This mobilized eLearning environment is depicted in Figure 36.

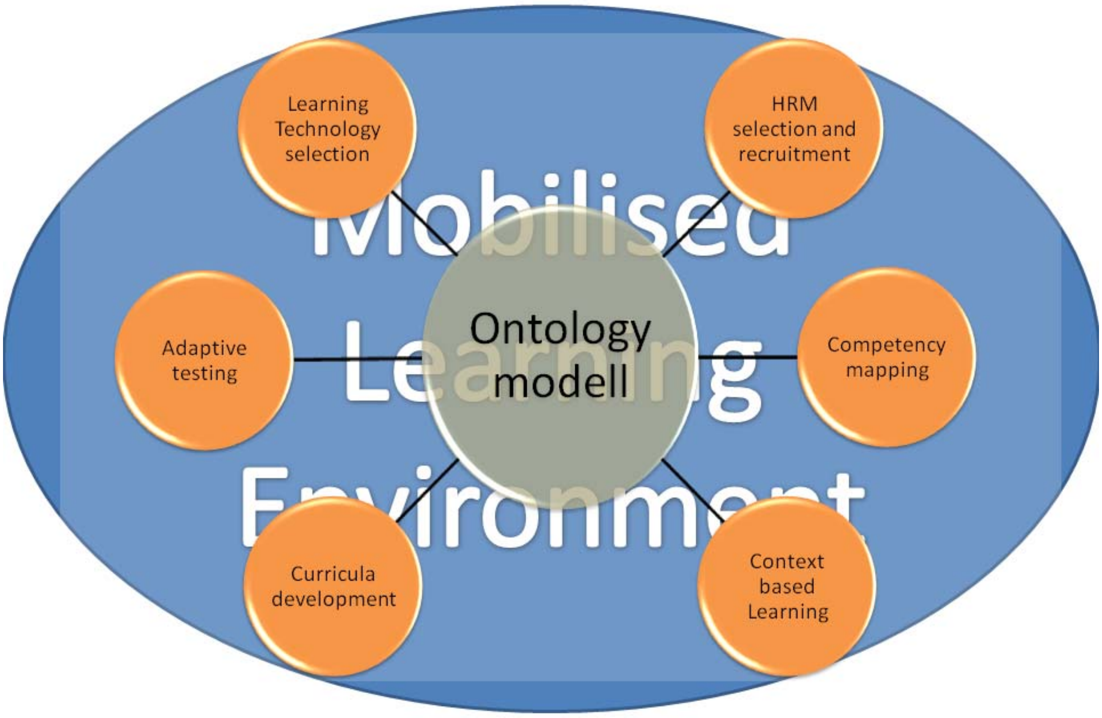



**Figure 36: Mobilised Learning Environment building blocks**

The mobility of this learning environment is ensured by providing time and space independent user access to the system on one hand and by developing mobilized curricula (which considers the mobility of the learner by providing learning content tailored down to mobile devices), on the other hand.

## Ontology model

The ontology model is the backbone of this system, since it provides foundation for the operation of the six different pillars by providing a formal description of the domain of interest. Ontology-based approach provides support for capturing regularities in a single framework general enough to model the curriculum content management requirements of multiple institutions or applications. A detailed description of the structure and major classes of the ontology model is provided previously (see Part III.) and also in Vas et al. (2009a) and Kismihók et al. (2009). The different domain ontologies are stored in an Ontology Repository. These ontologies constitute the core of every other component in the system. The basic model of Educational Ontology is depicted by Figure 37. (also Figure 27 previously)

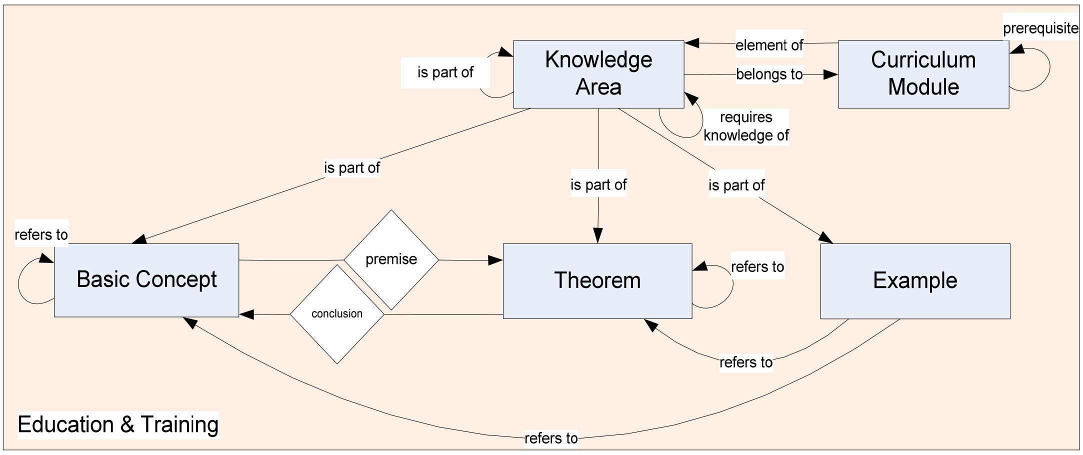



**Figure 37: Educational Ontology Model (Vas 2007)**

The selected ontology representation language is OWL DL, the description logic sublanguage of OWL Web Ontology Language (Antoniou & Harmelen 2009). The most important feature of OWL DL is that it combines the expressivity of OWL with the computational completeness and decidability of Description Logics.

In detail the most relevant features of OWL are the followings: 1. OWL DL data model consists of a subsumption hierarchy of classes; 2. In OWL classes represent concepts; 3. their instances (also called individuals) represent concrete manifestations of the concepts; 4. Classes and their instances can be constrained by stating assertions, e.g. a class can be defined as being disjoint with other classes, which means that instances of a certain class cannot at the same time be an instance of the disjoints of this particular class. For example if ‘Knowledge management strategy’ is an instance of Knowledge Area class in the Educational Ontology, than ‘Knowledge management strategy’ cannot be instance of the following classes: Competence, Curriculum, Basic Concept, Theorem and Example. Since all these classes are disjoint with the Knowledge Area class by definition.

Another significant feature of OWL DL is that classes are described by properties. Properties could be applied in two different ways: 1. properties can be used to specify datatype properties (so called XML Schema Datatypes) and 2. object properties (in this case instances of one class are related to instances of other classes). The domain and range of a property should be one of these classes. In other words a particular property may only relate instances of classes in its domain to instances of classes in its range. For example, in the Educational ontology *conclusion* property relates instances of Theorem class (which is the domain of the property) to instances of Basic Concept class (which is the range of this property).Properties may have some distinct formal attributes, such as symmetric, transitive or functional, and can also be defined as the inverse of another property. E.g.: in the Educational Ontology *partOf* property is the inverse of *hasKnowledgeArea* property. Just as in the case of classes, properties can be structured hierarchically as well.

With OWL DL it is also possible to infer explicit knowledge from implicit statements with the help of DL reasoners. Furthermore, DL reasoners can also be used to check the consistency of an OWL DL model. This way it could be checked whether the assertions made about classes and their instances are logically consistent without contradictions present in the structure.

Protégé-OWL was taken as the ontology editor in our project. Protégé OWL-DL has several advantages: reasoning facilities, support, documentation and samples are available. The Protégé-OWL editor enables users to: load and save OWL/RDF ontologies, edit and visualize classes, properties, define logical class characteristics as OWL expressions and execute reasoners such as description logic classifiers.

### Curricula development

Ontologies – that are stored in the Ontology Repository – are the central elements of the content authoring processes. The electronic learning objects are stored in the Content Repository in this system. Additionally, there is also a Content Developer application, which offers content management functions to the content authors; and a Content Presentation component, which is entitled to present the stored content pieces to the users. Content submitted to the system is not format dependent, all widely used text and multimedia file formats are accepted, recognized and supported.

The above mentioned three components (Content Repository, Developer and Presentation) constitute a Content Management System (CMS) specialized for the needs of the ontology-driven environment (Vas et al. 2009). With this approach content is also structured according to the ontologies, meaning that every concept in the ontology is connected to a specific piece of content, describing details or relations of the concept with other items in the same ontology.

### Adaptive Testing

Measuring knowledge in a reliable way has always been a great challenge of education. From the 1970s the emerging field of Computerized Adaptive Testing (CAT) (Linacre 2000b) provided important results about adaptive systems that can be combined with semantic technologies (ontologies). The principles of adaptive testing were laid down by Thiessen and Mislevy (1990b), which in Kő et al. (2008) were used and described in detail, how these principles were applied in our own adaptive testing solution. Our objective was to work out such knowledge testing methodology that enables the exploration of learners' knowledge gaps in order to help them complementing their educational deficiencies.

Accordingly, the Adaptive Test Engine is a key application for learners, which is embedded into our learning management system. In Kő et al. (2008) a short introduction of our adaptive testing algorithm is also provided, while in Szabó (Szabó 2006) a detailed description of the algorithm is presented. Students' knowledge is evaluated with the use of multiple choice questions. All questions and possible answers reside in the Test Bank and are connected to one specific concept in the ontology. In the course of testing the Adaptive Testing Engine walks through the ontology structure and asks questions about concepts of the ontology. This way, the learners' knowledge about a certain concept can be evaluated. The test engine evaluates the student's answers and decides on the following knowledge elements to be tested. At the end, the user's knowledge is thoroughly assessed and a tailored learning content is offered to be learned. This customized learning material consists of pieces of learning objects, which are offered by the Content Presentation component. Based on the first exhaustive trials – more than 600 Bsc students use this service on an annual basis – the authors saw growing confidence towards their mobilised learning management system (Kismihók & Vas 2009).

### Learning Technology Selection

An immense advantage of building such ontology is not only that stakeholders of our educational processes now share a common understanding about the structural composition of a particular domain, but this educational ontology also enables further analysis and reuse of the knowledge represented by those domains. Figure 38 represents eLearning technology related concepts in one of the domains which was reused for the analysis, evaluation and benchmarking of different synchronous eLearning technologies.

This eLearning ontology comprises all the relevant concepts of the domain providing a solid basis for comparison. For instance in a trial experiment we aimed at preparing a comparative assessment of several virtual classroom software. First the elements of 'synchronous eLearning technology' class of the ontology were used in this trial, in order to define the major selection criteria. Then, based on these criteria, a benchmarking process was run in order to select the most suitable software to our needs. Here the ontology provided a solid and reliable basis for a comprehensive comparison (Tóth 2009).

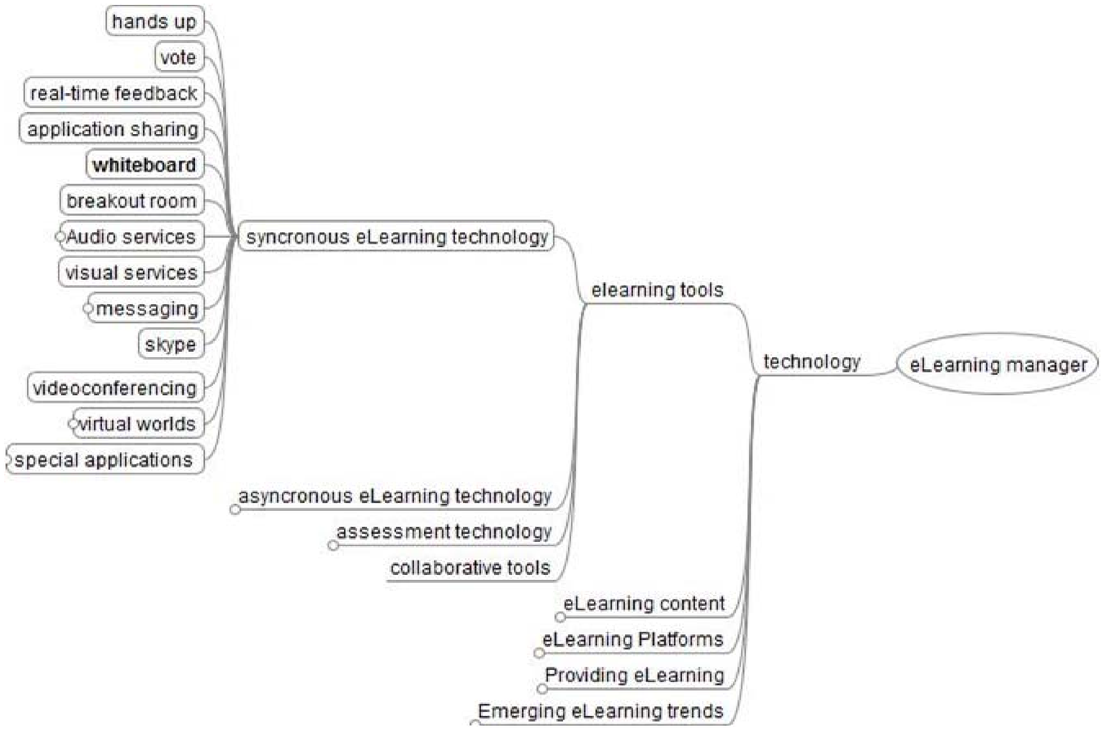



**Figure 38: Example of a concept description**

## HRM selection and recruitment

The field of personnel selection has its roots in the notion that a candidates' future job performance in a particular position may be predicted at the time of selection on the basis of relatively enduring and stable characteristics of that candidate. Therefore students, finishing their studies at various levels of education (higher or vocational education) and applying for a job, have to go through a Prior Learning Assessment, in which their previous experiences and qualifications are evaluated against entry requirements (skills and competences) for a particular job role.

Broad educational qualifications are too crude for purposes of personnel selection. With the help of another European Commission Project: OntoHR[37] (Ontology Based Competency Matching) the authors create a more specific qualification to job matching, with the overriding purpose of tackling the conversion of education qualifications into job related competences (Kismihók et al. 2010; Kismihók & Mol 2009). To facilitate this, their ontology supported training system is extended with a personnel selection module built in line with relevant HRM and Knowledge Management (KM) theories, employing existing (above described) educational technology. The elements of this solution are demonstrated on Figure 39. This extended Learning Management System is be able to

[37] http://www.ontohr.eu

- Test and evaluate students on the basis of valid, labour market driven competences
- Identify missing competences and provide learning content needed to acquire them
- Map an organization’s human capital in light of strategic workforce planning considerations.

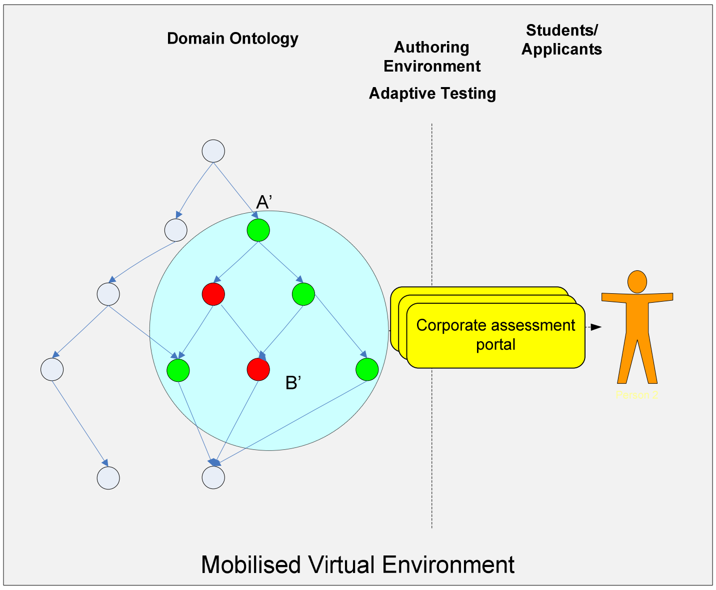



**Figure 39: Ontology based selection and recruitment**

The domain ontology here contains a competence oriented description of a particular job-role (Information System Analyst). For this purpose the underlying educational ontology model had to be altered and new classes have been introduced. Figure 40 shows these modifications.

The established model is aiming to set up structural connection between the workplace and the world of education. The “Competence” class calls into being this connection. According to the definitions of the OntoHR consortium (Kismihók et al. 2010) based on the applicant’s competence assessment a valid future performance estimation is possible. On one hand this assessment includes an exhaustive knowledge test, which follows the algorithm described previously in this article, with the help of “Knowledge Area”, “Basic Concept”, “Theorem” and “Example” classes.

On the other hand the new element for this assessment is the assessment of the candidate’s mental ability. As it is well known from the literature in Human Resource Management – Organisational Behaviour, general mental ability has one of the strongest predictor values of future job performance (F. L. Schmidt & Hunter 2004). Therefore the “Mental Ability” class was introduced, which is intended to structure those particular intelligence facets which are necessary for fulfilling tasks in a given job.

Elements of the “Competence” class are not measured directly. The OntoHR system evaluates the facets defined by the “Mental Ability” class and knowledge elements structured by the educational side of the ontology. These two measurements predefine the results of the “Competence” class elements.

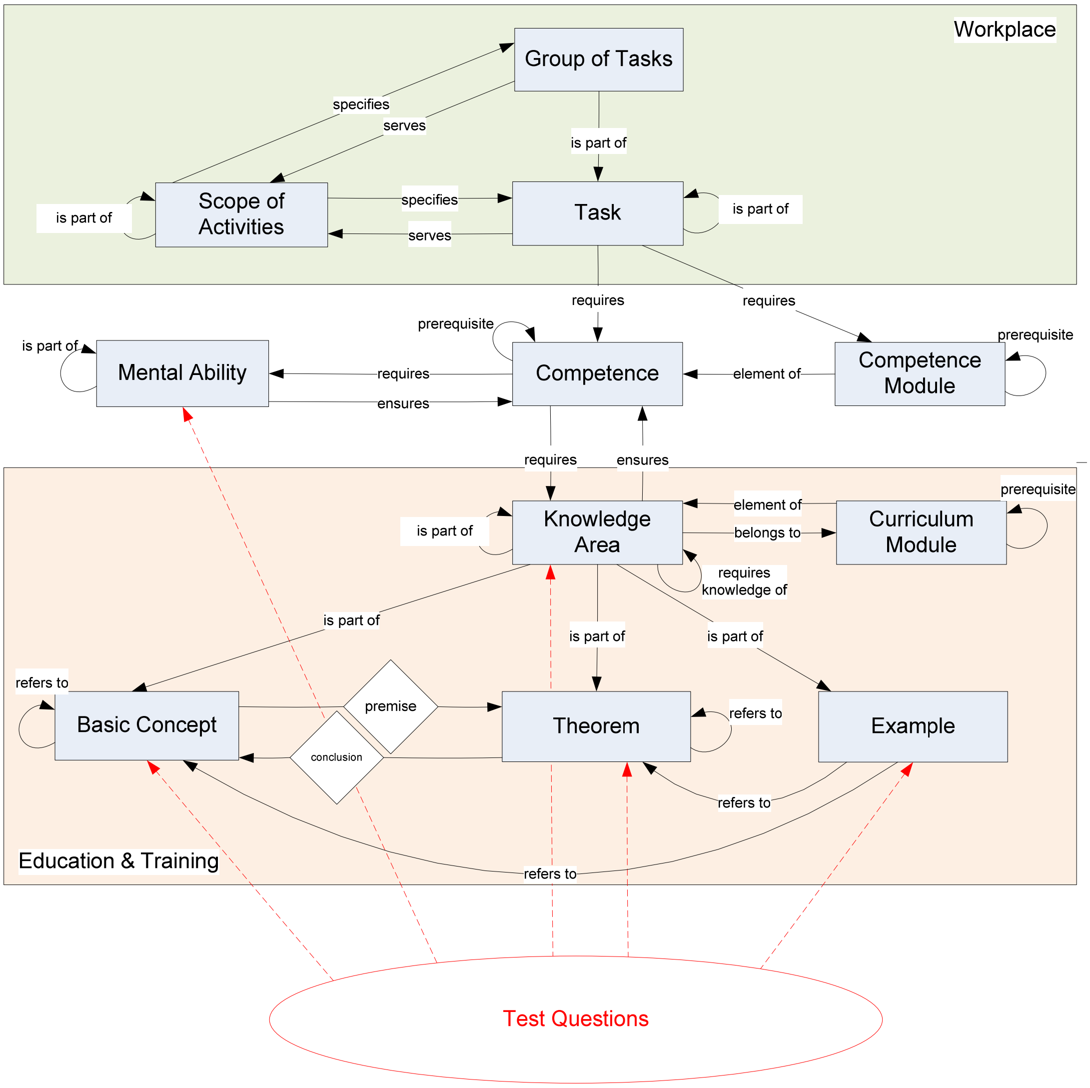



**Figure 40: Extended educational ontology for employee selection and recruitment**

## Competency matching

The above described ontology-based selection and training system is able to identify and address shortcomings of individual students, who apply for a particular job role. With an extension, this system is also capable of identifying the shortcomings of higher education or vocational education learning outcomes and producing continuous feedback to educational institutions recommending updates to their training programs. In 2008, Futó et al. (2008) has already showed that competences provide an appropriate foundation for comparing the supply and demand sides of labour market.

Learning from this trial, the OntoHR consortium regards the “Competence” class of the extended educational ontology model as the heart of the matching process. This class establishes ontological relation between the requirements of labour market and the learning outcomes of certain relevant educational qualifications. This project is focusing on the Information System Analyst job role and its associated qualifications, which serve as a domain for the job-role ontology. Based on competences retrieved from this job-role ontology (competence based job role description) and a learning outcome ontology based on competences extracted from details of certain training programmes, a competency matching algorithm is under development.

In both ontologies these competences are the instances of the “Competence” class of the extended educational ontology model (Figure 41.) and on the job side they are linked to the above mentioned selection and training systems’ instances of “Knowledge Area” class. In order to evaluate the quality of a higher or vocational educational learning programme, the job role ontology and the learning outcome ontology were matched. This matching reveals what is missing from a particular training programme (in other words what are those elements of the job role ontology that are not part of the learning outcome ontology).

Alasoud at al. (2008) define the ontology matching problem as follows: “*given ontologies O1 and O2, each describing a collection of discrete entities such as classes, properties, individuals, etc., we want to identify semantic correspondences between the components of these entities.”* In this work the semantic correspondences between individuals is concerned because the same meta-ontology constitutes the base of either job role ontology or learning outcome ontology. To find the appropriate matching algorithm authors consider an algorithm using logical constraints like in SAKE project Futó et al. (2008), algorithms based on linguistic similarity (Alasoud et al. 2008), or a general algorithm like finding morphism between two ontologies (Kalfoglou & Schorlemmer 2003). After creating and applying the appropriate algorithm for finding similar nodes (e.g. Design implementation plan is equal to Draw up an implementation plan) or recognizing a subsumption between the instances (e.g. competence “Provide information, instructions, and demonstrations with the aim of transferring built-up and available relevant knowledge to others, with a pre-defined learning objective” on education side is a sub-competence of competence “Present implementation plan to users and management” on job side) in the respective ontologies, matching results have to be validated manually. As a result, this extended selection and training system is capable of identifying the shortcomings of higher or vocational education learning outcomes and curricula through this competency matching and evaluates the compliance of a potential employee with the given job profiles.

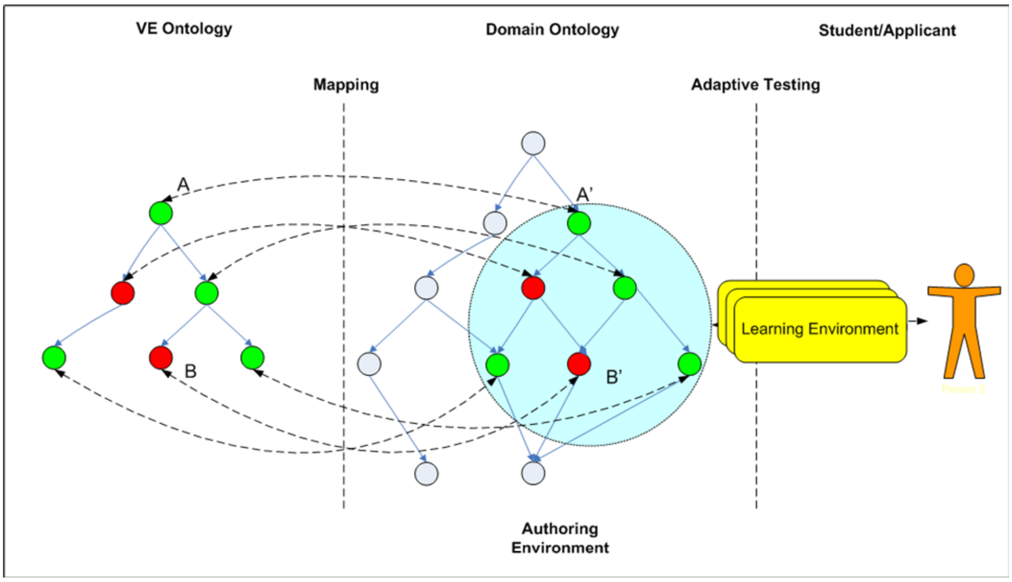



**Figure 41: Competency matching between education and world of labour**

## CONTEXT-BASED LEARNING[38]

An important feature of mobilized learning management systems is the capability of following the mobile learner and, based on measurements like sensory data, learning content is offered (Krause et al. 2006). Through the European Commission funded Contsens project, work has been done to implement this initiative to our ontology based system.

In the General System Design, the Contsens project partnership came up with several technologies and scenarios for context and location based learning content delivery. For the pilot at the Corvinus University of Budapest scenario number five has been selected and adapted to the educational context of our university:

"*Cormac is a telecommunications field engineer. He is out in the field fixing a particular node. When he arrives on site, the system knows where he is and recognizes the correct revision of the node. Cormac can pull or the system will push the necessary information to fix the node recognizing the device Cormac has with him. Cormac finds a smarter way to fix the node so be pushes that information back to the server which stores it until the next time that node needs to be fixed, thereby adding to the original information.*" (Contsens Project 2009b, p.33)

The plan was to organise the content development and delivery around our learning management system and based on the location and contextual information the mobile

[38] Parts of this section has been published by the Contsens project and received an ECLO Practitioner award in 2008. Kismihók, G. & Andrejkovics, Z., 2008. MLearning @ Corvinus University of Budapest. In *ECLO 15th International Confenece Proceedings*. ECLO 2008. Budapest, Hungary: ECLO.

device provides us, content is automatically pushed towards the learner. The abovementioned learning scenario was modified, using curricula connected to the art and information management learning programmes. Figure 42 demonstrates our general learning scenario:

- The user has to log on to the Corvinus' mLMS using wireless infrastructure (mobile networks, Campus (or any available) wireless network, GPS, QR tags, etc...) with a handheld device, using the previously installed application or (depending on the learning situation) a mobile web browser.
- After logging in, the application attempts to localize the user. At the moment this is only possible if the student possesses the appropriate (GPS enabled) device.
- Based on the location of the user, selected learning content and/or learning services will be provided to utilize the learning.
- The system is tracking continuously the location of the student. In case the location changes, different learning units will be available for the user.
- The user always has the freedom of changing the content or denying the location related content and study other learning units according to her needs.

The location and context based information is connected to the learning objects. These learning objects with the help of the educational ontology model can describe the learning subjects as domain ontologies. As learning objects are connected to the ontology nodes, the contextual information is represented in that segment as well.

### Context and location sensitivity

Our system is capable to handle various location and context aware educational situations. Figure 43 shows the general contextual learning scenario. The user has to log on to the Corvinus' mobile Learning Management System (mLMS) first, using the previously installed application or (depending on the learning situation) a mobile web browser on a handheld device. After logging in, the application attempts to localize the user. At the moment this is only possible if the student possesses an appropriate (GPS enabled) device. Based on the location of the user, selected learning content and/or learning services will be provided to utilize the learning. The system follows the movement of the student. In case the location changes, different learning units will be available for the user.  The user always has the freedom of changing the content or denying the location related content and study something else according to her needs.

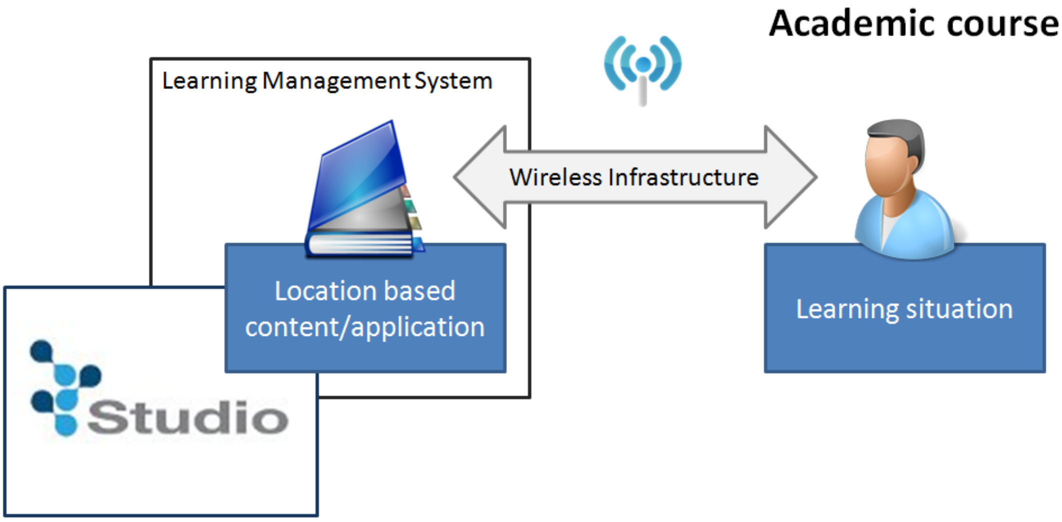



**Figure 42: Context aware content distribution**

It is important to emphasize that the ontology based system, which enables the content creators to consider various location and context sensitive issues when putting together the learning content. Basically, as it is also visible on the figure above, with little effort from the user, broad amount of services from different layers of the learning management system will be available automatically.

The final version of the application is capable to determine the user location and combine this information with the user's learning profile, stored in our learning management system. The content is pushed to the students based on both of these inputs. Figure 43 below describes the procedure.

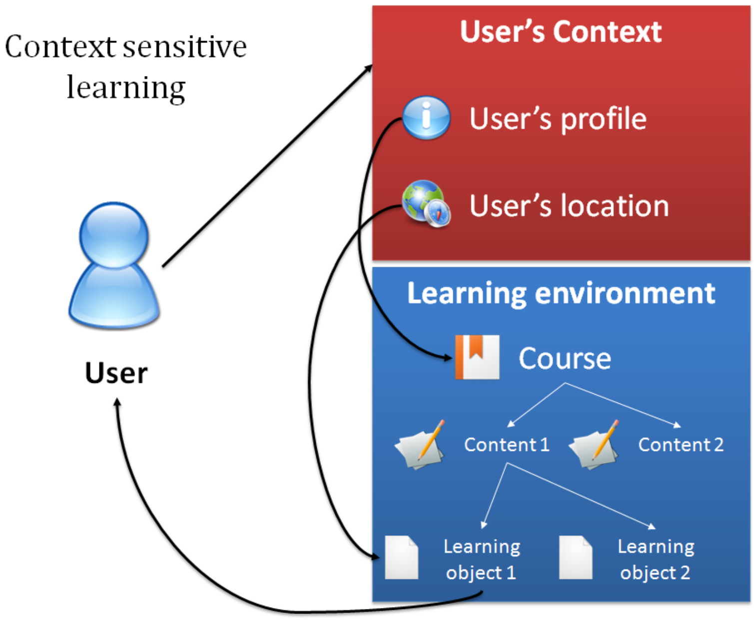



**Figure 43: Context sensitive mobile learning scenario for the Contsens project.**

## About the mobile application

Our context sensitive content management requires the user to install our flash based mobile application on her mobile device. The main advantage of flash framework is that it supports multi-platform usage (Adobe Systems Inc. 2010a). When developing a mobile application our prerequisite was an as wide cross-platform usability as possible. Statistics show that most of mobile devices use different operating systems and frameworks (see on Figure 44).

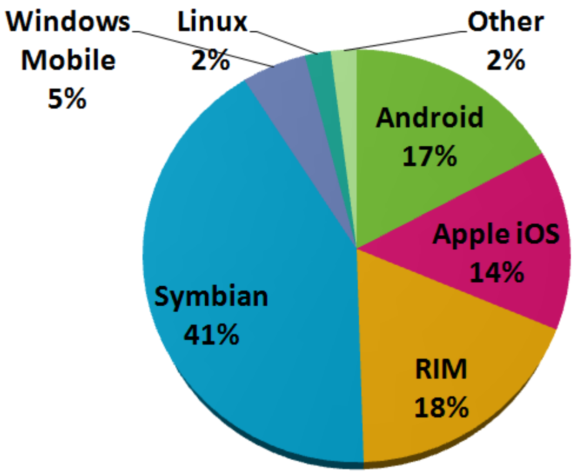



**Figure 44: Global market share of mobile devices in 2010 (Goasduff & Pettey 2010)**

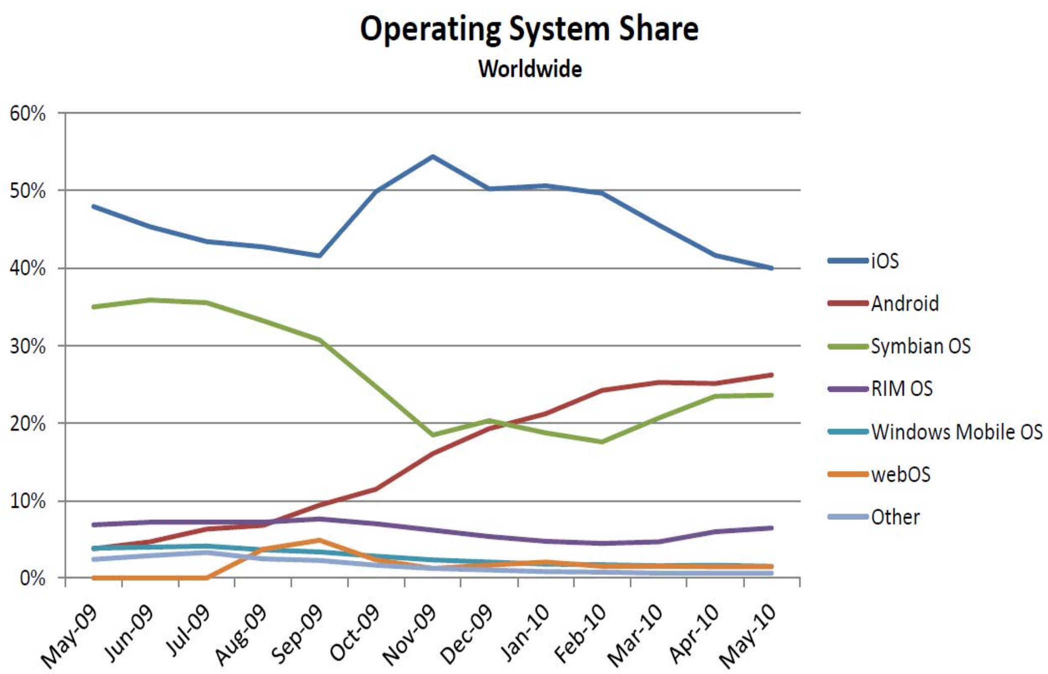



**Figure 45: Operating System Market Share by Internet usage (Foresman 2010)**

Statistics also show that most people use some sort of device for communication (call and text messages), but only limited number of them uses mobile internet (Only the 31.1% of the US households uses their device as browser (mobiThinking 2010)). As we select an appropriate mobile platform for software development, we should consider and focus on users, who already enjoy the benefits of mobile internet, also because innovators are more likely to pilot out new opportunities like mLearning. If we compare the two figures above we can recognize that Symbian OS users use less internet on their devices as the iPhone OS or Android OS users. This suggests us to find a platform that handles these three major OS systems. Nowadays only the flash platform allows deploying mobile applications to three different OS (including Windows Mobile).

**Flash mobile application development**

Flash platform enables developers to create rich media interface and content (Lawton 2008), which is essential for creating learning content. These interfaces could provide not only images, but interactive animations and even 3D videos (Ortiz 2010).

Flash uses Adobe's flash framework, which consists of three different deployment opportunity (Adobe Systems Inc. 2010a) on the client side, see on the next illustration (Figure 46)

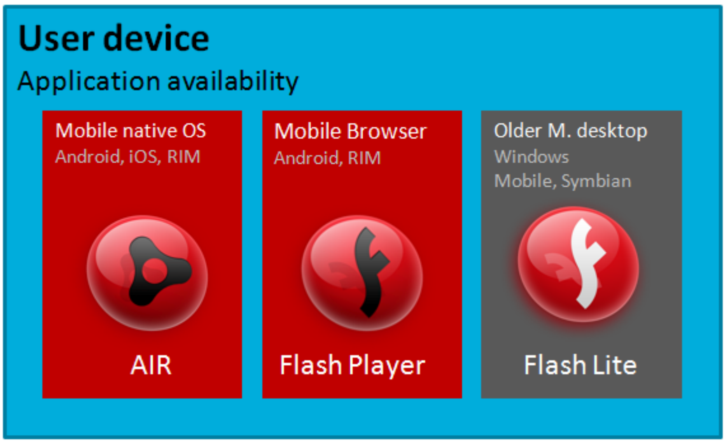



**Figure 46: Application Availability (Adobe Systems Inc. 2010a)**

(1) AIR platform is an operating system dependent running framework, which is capable to run the same flash application across the different operating systems (Adobe Systems Inc. 2010b).
(2) Flash player is a built-in browser plug-in, which is capable to run flash applications available on the web.
(3) Flash Lite is an older mobile deployment platform, which was supported also by Windows Mobile OS and Symbian.

Among the mobile devices some, like Android, support both newer opportunities (1 and 2) (Perkins 2010) offering opportunities to deploy our application on web and also on desktop based environments. There are also examples like Apple's iOS (Brimelow 2010), which supports only the native air deployment.

For our application we used the Flash Lite platform, which provided wide range accessibility to ordinary mobile devices (Anderson 2010). We used objected orientated programming approach for the software development, and action script as programming language. The software development phases were the following: (1) controller code design, (2) data processing and save initial data states design, (3) MLS integration, (4) content management system integration and the (5) interface design.

### Pilot testing

The Pilot test took place in November 2009. 23 undergraduate students from the Corvinus University of Budapest were participating in this proof of concept experiment and filled out the evaluation questionnaire. Students administered the questionnaires online (for the questionnaire, please consult Appendix 3.), after testing the application.

The application was available in two different versions:

(1) Contsens basic m-learning application showcase, that contains four context sensitive learning materials and a language learning game
(2) Contsens location sensitive m-learning application, that is also receptive to the location of the user

During the test the following learning materials have been implemented and used:

- WP4 – Urban architecture
- WP5 – Historical Fountains
- WP6 – Artificial Intelligence in Urban environments
- WP7 – Language Game connected to WP6's content, in English

The data collected during the test has been analysed by SPSS 16.

#### *Descriptive statistics*

Altogether 23 people filled out the questionnaire, which has been put together with a blended approach, including both qualitative and quantitative elements. On the sample descriptive statistical methods have been applied. Frequencies have been established and taking sex, age, GPS and mobile technology experience items as independent variables cross tabulation has been processed. The complete statistical analysis is presented online[39]. Here we only talk about the most important and relevant findings. The dataset is not designed for and the sample size was also too small for applying more complex statistical methods. Therefore besides the descriptive statistics, I relied on expert evaluations. This means that me and another experiment designer pooled and analysed the open questions in the questionnaire. The answers were synthesised and grouped according to the script of the experiment.

The general descriptors of the population show that this group of learners equally consisted of males and females, their respective age group was 21-25. Half of them has GPS device in their mobile phone (which is a surprisingly high number). They indicated themselves as either very experienced or experienced mobile phone users (see Table 12).

[39] The Contsens project website, http://www.ericsson.com/contsens, contains all data gathered and analysed.

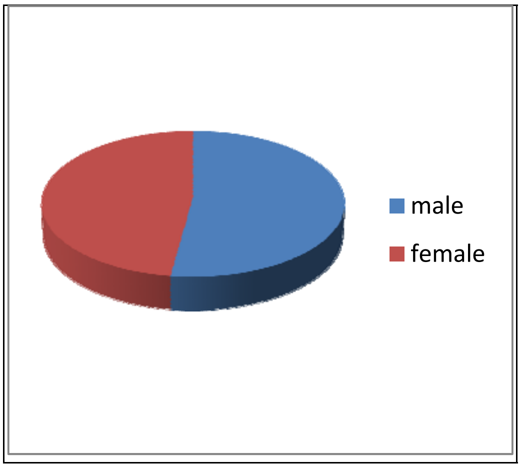
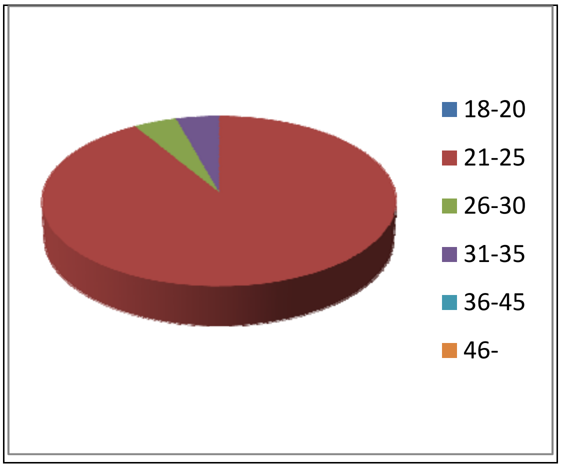
| Sex distribution | Age distribution |
|---|---|
| male 12<br>female 11 | 18-20 0<br>21-25 21<br>26-30 1<br>31-35 1<br>36-45 0<br>46- 0 |
|  |  |

**Table 12: Sex and age distribution**

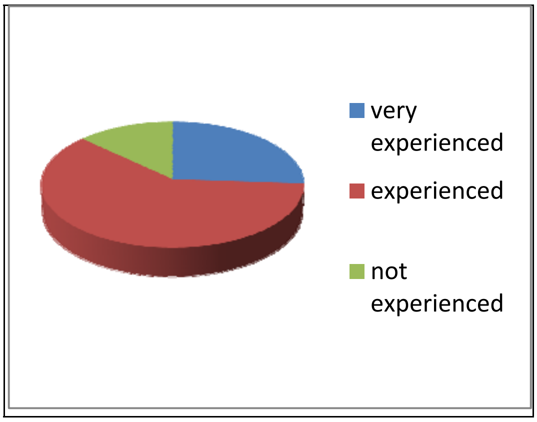
| Does your mobile have GPS (Global Positioning System)? | How would you rate your experience in using mobile phones? |
|---|---|
| yes 11<br>no 11<br>don't know 1 | very experienced 6<br>experienced 14<br>not experienced 3 |
|  |  |

**Table 13: GPS availability and user experience self-ratings**

For the question *“What did you think of the mobile learning course you have just experienced?”* a positive general attitude could be described. Week critics were articulated towards the quality of GPS signals (see Table 13), but besides that the testing crowd was satisfied. Some typical comments from students:

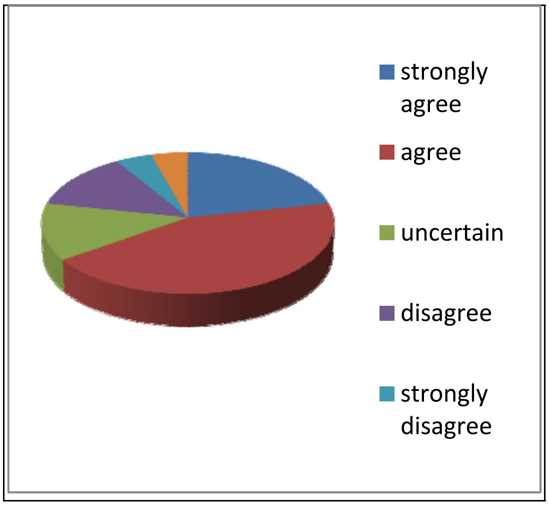
- „I think it is an extremely good idea.”
- „It seems very useful, and interesting.”
- „It is very useful, more interactive, and gives a better impression of the things we are learning about.”

Students had no real difficulties when using our flash application on their phones. According to the questions related to usefulness, 15 of them treated our concept as useful (5 of them completely agreed with this statement). Using the equipment was also not a problem, only 4 people reported difficulties (see Table 14).

When it comes to the quality of mobile learning experience the answers remained positive, but there is a remarkable amount of uncertainty emerging among the responders. (see Table 15) The uncertainty rate by both important items *“I would recommend mobile learning as a method of study to others”* and *“Using the mobile device enhanced the learning experience”* were at 26,1%, meaning the despite the general positive approach there is a significant number of students, who are at least not convinced about this form of location and context sensitive learning (Table 16).

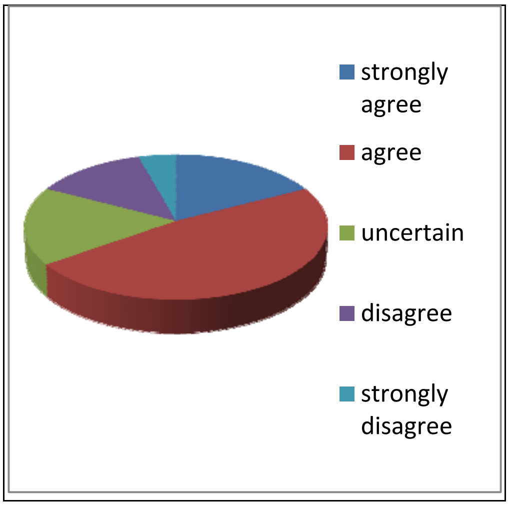
**How would you rate its usefulness in learning the subject?**

| | |
|---|---|
| strongly agree | 5 |
| agree | 10 |
| uncertain | 3 |
| disagree | 3 |
| strongly disagree | 1 |
| no answer | 1 |




**It was easy to use the equipment.**

| | |
|---|---|
| strongly agree | 4 |
| agree | 11 |
| uncertain | 4 |
| disagree | 3 |
| strongly disagree | 1 |
| no answer | 0 |




**It was easy to navigate through the content.**

| | |
|---|---|
| strongly agree | 2 |
| agree | 13 |
| uncertain | 4 |
| disagree | 3 |
| strongly disagree | 1 |
| no answer | 0 |

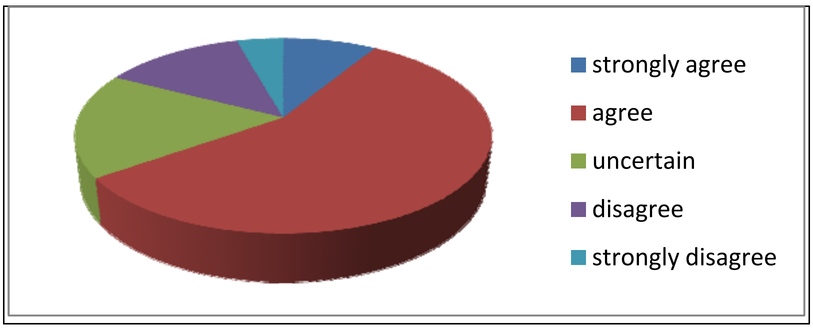
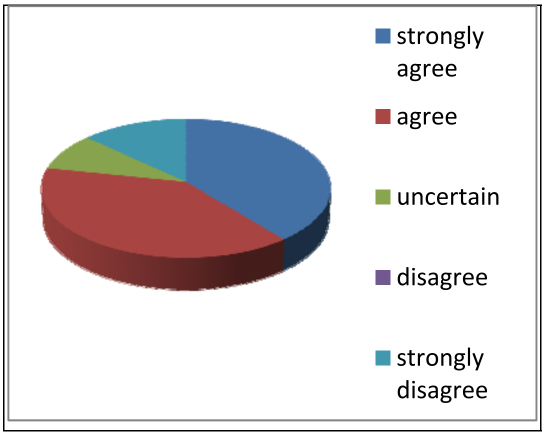



**Table 14: Usefulness of content, usefulness of equipment and navigation**

**The mobile learning experience was fun.**

| | |
|---|---|
| strongly agree | 9 |
| agree | 9 |
| uncertain | 2 |
| disagree | 0 |
| strongly disagree | 3 |
| no answer | 0 |




**I would take another mobile learning course if it was relevant to my learning needs.**

| | |
|---|---|
| strongly agree | 8 |
| agree | 6 |
| uncertain | 5 |
| disagree | 4 |
| strongly disagree | 0 |
| no answer | 0 |

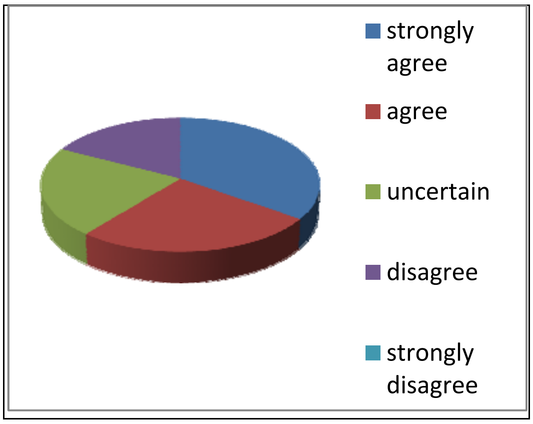
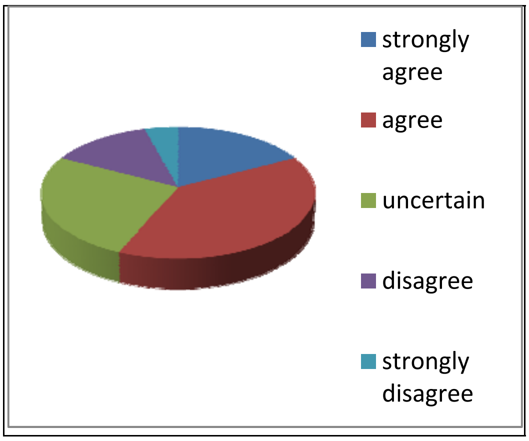



**Table 15: mLearning is fun and taking another mLearning course**

**I would recommend mobile learning as a method of study to others.**

| | |
|---|---|
| strongly agree | 4 |
| agree | 9 |
| uncertain | 6 |
| disagree | 3 |
| strongly disagree | 1 |
| no answer | 0 |




**Using the mobile device enhanced the learning experience.**

| | |
|---|---|
| strongly agree | 5 |
| agree | 7 |
| uncertain | 6 |
| disagree | 4 |
| strongly disagree | 0 |
| no answer | 1 |

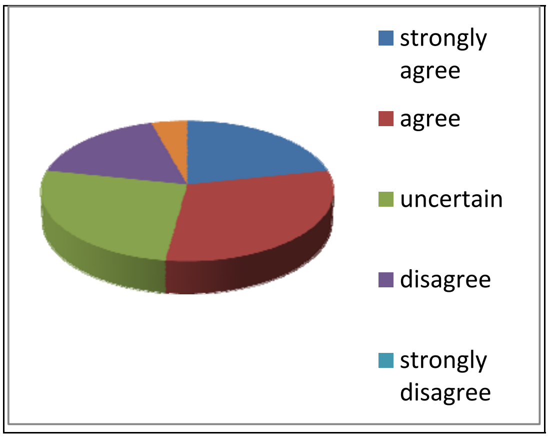



**Table 16: Recommendation of mLearning and the learning experience**

### *Cross tabulation*

The results of cross tabulation also brought up some interesting and remarkable aspects of this pilot test. Despite the small sample size, what reduces the validity of this dataset, there are some interesting phenomenon in this cohort, which worth mentioning. The bars indicate the number of answers in each segment. The answers (bars) were ranging from 1 – totally agree to 5 totally disagree. Empty columns imply that there was no such answer in the group.

Figure 47 shows the willingness of taking another mLearning course, across sexes. In this population female (2,00) respondents were slightly more positive than males (1,00). Females also gave less uncertain answers.

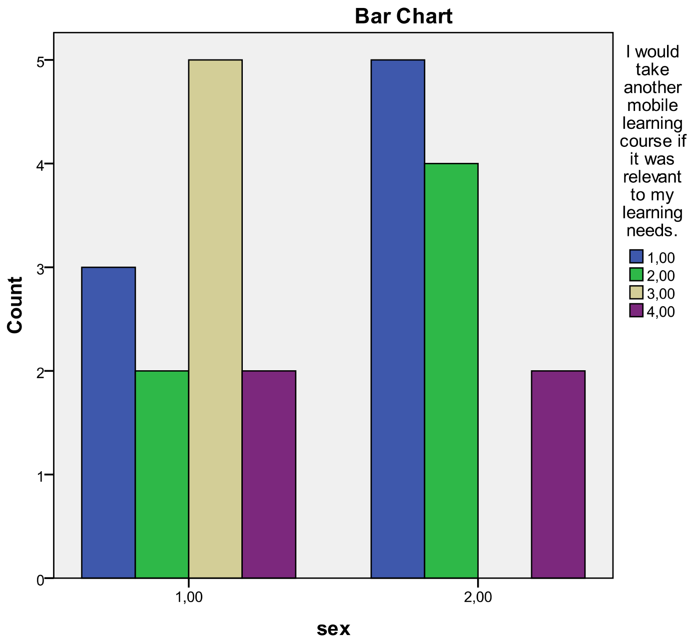



**Figure 47: I would take another mobile learning course**

When it comes to the learning experience using a mobile device, female students still show more satisfaction, however here the differences between the two groups are very little (see Figure 48).

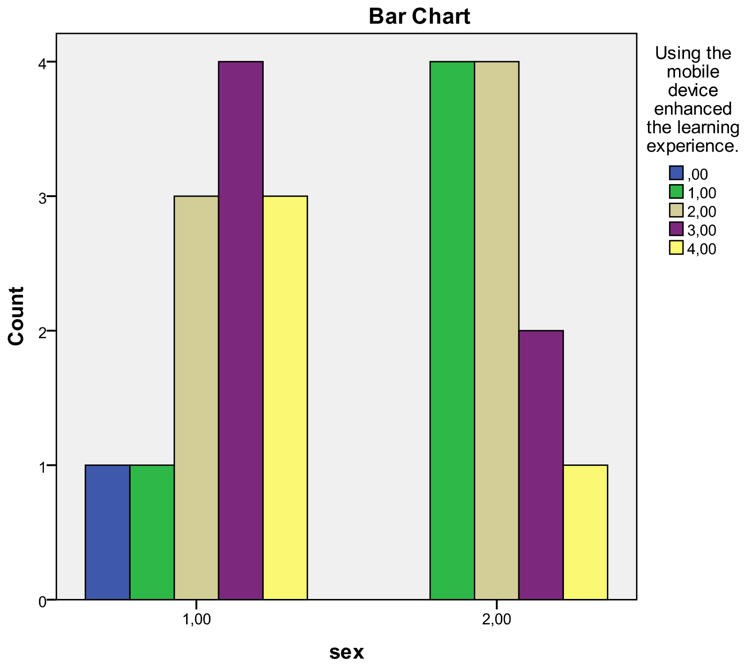



**Figure 48: Using the mobile device enhanced the learning experience**

As it was visible before, regarding to the prior GPS usage, two groups were visible, with 11 students each. This gave us a good opportunity to check, the role of GPS usage experience, when it comes to learning practice. The results were interesting. People using GPS enabled mobile phones (1,00) in their everyday life, showed more scepticism towards mobile learning. Also more uncertainty and disagreement was visible in their answers compared to the other group (2,00). They also experienced less fun during the test then people not having an everyday connection to GPS devices (see Figure 49). The person, who didn't know whether her or his device contains GPS, was very happy about the fun factor of this learning experiment.

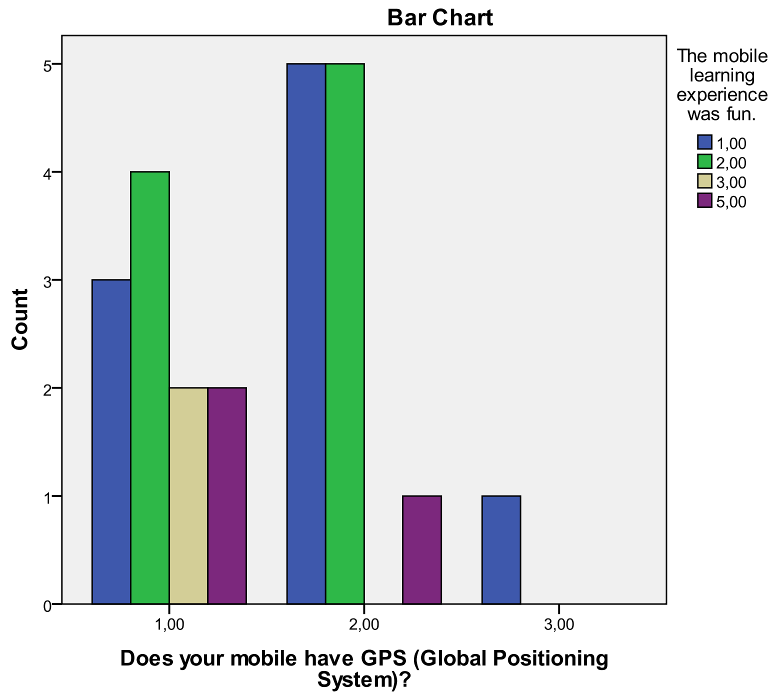



**Figure 49: The mobile learning experience was fun**

The most remarkable difference between the two groups can be found by the item of measuring the willingness of taking another mobile learning course. Those people, who took location aware technology as novelty, were much more motivated to try out a mobilized course again than people in the other group (Figure 50). This suggests that technology showed its pulling power here. Learners like to trial new, novel tools in their educational processes, but as this experience shows as well, this motivation significantly lower once users know and use that particular technology on a daily basis.

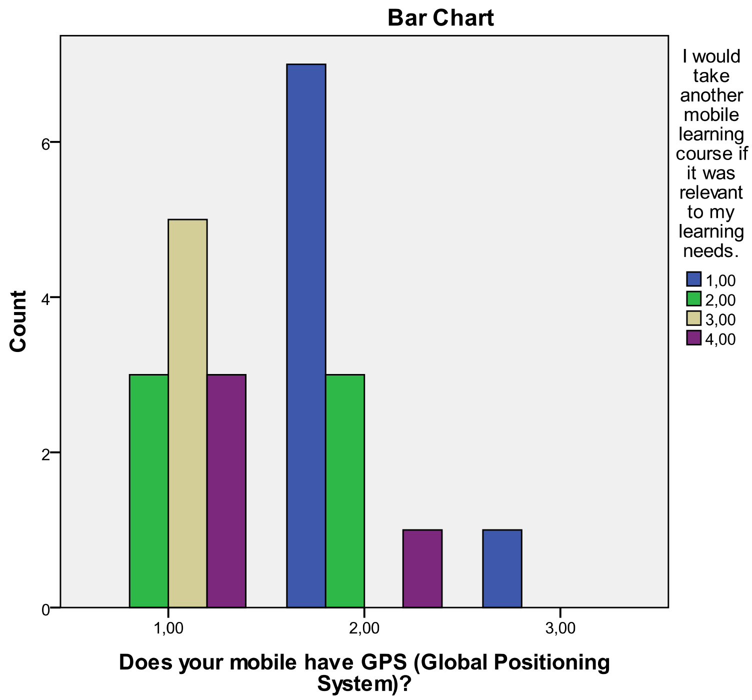



**Figure 50: I would take another mobile learning course if it was relevant for my course**

### *General comments*

The answers for the item "In what ways did it (or did not) enhance the learning experience?" emphasized mostly the fun factor mobile learning. Students enjoyed not being in the classroom, but being confronted with a learning activity, where the task was to explore their neighbourhood. Respondents also mentioned the simplicity as an advantage, but also the automatic location and context based learning content delivery got positive feedback. Some of the most typical feedbacks were:

- "It was fun like a game"
- "Speed and simplicity"
- "I don't have to find and download materials, it just gave me."
- "It is quite good that you can see the things around you that you can learn about, it makes learning more effective."

For the question *"Which functions of the device did you use most?"* The most common answer was: "*The map*." A few answers from this set follows:

- "Finding learning material on map"
- "Testing language knowledge"
- "Nearest interesting place"
- "Map navigation"

This GPS based service was critically in the center of attention. Therefore it is not surprising that this function received most of the positive but also most of the negative remarks. It was treated as an essential part of the application, but due to the unreliable GPS signal students failed to identify their location on the map quite a few times.

The look and visual design of the flash application was also a controversial topic. Answers like *"It was quite nice, but not the best"* or *"The visual experiment was clear and easy to understand"* indicated that in general the application design was acceptable for the students. However some problems have been identified, which need to be solved in the future: *"there was no touch screen support"* wrote one of the students, who wanted to use the application on a touch screen phone.

For the question *"The course used location-based technologies to provide relevant learning material to your phone. How did you find this (e.g. was the course material always relevant, did this work well, etc.)?"* students mostly criticized the quality of GPS connection. There was a general agreement about the usefulness and necessity of this issue, but just as one of the participants wrote: "*Not so accurate, but worked, sometimes it was useful"* Another problem was the information overflow: *"Sometimes I felt lost during scanning in the learning material. It provided too much information. In smaller portions in would be more useful."* As it seems some learners found the learning situation too complex. Using the device, finding the object and processing the learning content at the same time were exhausting, time and energy consuming activity.

Regarding to technical problems, besides the GPS signal the strength of the 3G network was problematic as well. In the downtown of Budapest, the signal was usually quite weak, which made downloading times too long. Waiting is something what mobile technology users don't like anymore, so there is no wonder why learners indicated this issue as poor. Besides this, the evergreen screen size problem has also been mentioned several times.

There were several ideas coming from the respondents about how to improve this application. The most important issue was about solving the compatibility problems, as flash with GPS only available on a limited amount of platforms at the moment. This fact – in short term – is a valid barrier in front of this educational service. Furthermore, learners demand improved content searching features, touch screen design, improved readability on small screens and build in interactive functions (like chatting and commenting the learning content) in order to leave personal narratives at learning objects.

According to our evaluation, the Pilot test results proved our concept of context and location sensitive mobile learning. Students were satisfied, they reported higher level learning experience compared to their regular courses. However the role of technology is clearly showed the risks as well! There is one thing incorporating the latest technology into educational processes, another thing is to maintain the learner's motivation caused by this novel technology!

Results also show that the weakest link in our learning scenario was the location based service. Even with the latest, GPS enabled mobile devices lost signal in the city center of Budapest, where the pilot study took place. For this reason occasionally the learning process also lost its contextual support (Contsens Project 2009a). The problem has an impact on the quality of learning service delivery, where the findings of this pilot have to be further analysed.

## CONCLUSIONS

Obviously the authors see high potential of incorporating semantic applications, like ontologies, into learning services. The above discussed research has focused on the application of ontology based electronic and mobile learning tools both in the academic and business sector.

First and foremost a competitive content representation and knowledge evaluation system has been developed which notably facilitates the work of teachers and/or tutors and serves the needs of mobile learners. This platform independent learning environment enables the development of customized qualification programmes, based on the individual's previous qualifications, completed levels, corporate trainings and practical experiences.

After several successful pilots, provisions of this ontology based, mobilized learning management system is being used on a regular basis and new modules are continuously implemented. One of these modules is focusing on exploring competency deficiencies between the world of education and the world of labour. The HRM selection and recruitment module establishes a stable solution to run competency gap analyses and match applicants to their desired jobs. With an extension, the system is also capable of identifying the shortcomings of higher or vocational training programs. In this module the different ontologies (namely the job role and learning outcome ontology) are matched, which reveals what is missing from the training program concerning labour market requirements. Last but not least such module was developed that promotes the delivery of context and location based learning content for mobile learners.

The mobilized learning environment creates flexible learning spaces, which supports individual formal and informal learning either on business, campus or in individual settings. Nevertheless there is still an immense call for exploring the nature of mobilization needs of learners and for providing possible solutions for these needs. The presented approach proved to be fruitful and the authors are going to focus on exploring further exciting research possibilities in this field. Here on one hand the nature of content processed with our ontologies has to be broadened (deploying more jobs with competency descriptions and knowledge requirements), and on the other hand there are further technical issues to be implemented, like intelligent reasoning, automated matching result validation and sensory information processing.

# AN ONTOLOGY BASED PROCESS MODEL FOR SELECTION AND RECRUITMENT

## INTRODUCTION[40]

Organizations with a strategic perspective on Human Resource Management (HRM) will want to know which competencies they require of their workforce today and into the future. It goes without saying that in the knowledge based economy such competencies are going to be evermore strongly based on individual employees' job knowledge. It is interesting to note however that typically, when educational qualifications are assessed in the selection process, organizations rely on crude measures, such as highest degree obtained, or worse yet, years of education. The latter has been shown to have a particularly low validity as compared with other selection methods (Schmidt & Hunter 1998), and this can be attributed to the fact that years of education is not always indicative of success in education. With job related competencies being more knowledge based nowadays, it is likely that organizations can achieve a competitive advantage by more carefully scrutinizing the intellectual capital they acquire through their selection policies. In light of these developments, it is surprising that job knowledge is actually a relatively seldom studied construct in the personnel selection context. This lack of research on job knowledge is especially remarkable when one considers that it is the most obvious bridge between vocational educational training (VET) and concomitant jobs in the workplace.

The aim of this chapter is to describe how ontologies may be used to assess applicants' job knowledge for purposes of i) personnel selection, ii) personal development, and iii) VET curriculum development. In the following we report on the initial development of a specific qualification to job matching system, the overriding purpose of which is to tackle the conversion of vocational education qualifications into job related competencies.

First, we discuss some of the key issues in defining the (knowledge based) competency concept and provide a tentative working definition. Such definition is critical, because the competency concept is fundamental to bridging the education-workplace divide, yet has taken on different meanings within these contexts. Second, we propose a methodology for the development of an ontology based selection and training system that is based on knowledge based competencies. Finally, we describe some of the

---

[40] Parts of this chapter are currently under publication:
Kismihók, G., Vas, R., & Mol, S. (2011a). An Innovative Ontology-Driven System Supporting Personnel Selection: The OntoHR Case. *International Journal of Knowledge and Learning*, *Accepted, to be published in 2011*.

challenges encountered in piloting a system based on this methodology in two cultures, namely Italy and the Netherlands. The specific aims of this chapter are to:

- Discuss some of the key issues in defining the competency concept
    - Bandwidth-fidelity dilemma
    - Temporal stability and latency
    - Discriminant validity (vis-a-vis job performance, ability, personality, knowledge)
- Provide an operational working definition of the competency concept for the current project.
- Demonstrate the relevant processes to be supported by the means of the proposed ontology based selection and training system
- Illustrate the difficulty of selecting and validating a job-role – Information System Analyst (ISA) –, which is general enough to be suitable for cross-national and cross-cultural applicant assessment.

## THEORETICAL FOUNDATIONS

### Key issues in defining the competency concept

In thinking about competences, it is tempting to simply define the concept as an individual's ability to do something desirable successfully. Yet, as soon as we define the object of the competency, it quickly becomes apparent that we can vary the specificity with which we define an individual's ability to do something desirable successfully. For instance, in the context of driving a car with manual transmission, the ability to change gears could be construed as a competency under the above definition. Yet, the ability to drive the car from point A to point B, which includes changing gears, amongst many other 'lower level' competences, could also be considered a competency. Thus, from a measurement perspective, for example when we want to ascertain a person's driving ability for licensing purposes, we are confronted with the choice to either assess "overall driving ability" or to assess driving ability on a larger set of lower level competences. Although conceptually there is nothing wrong with such multilevel constructs, and approaches are being developed to validate them (G. Chen et al. 2004), from a measurement perspective such constructs pose a thorny choice, as we will outline below.

### The Bandwidth Fidelity Dilemma

Originally stemming from the field of communication (Shannon & Weaver 1949), the application of the Bandwidth-Fidelity dilemma to the field of Industrial and Organizational Psychology is typically attributed to Cronbach and Gleser (1965). In psychological measurement, it is well known that the more indicators (test question or items) one employs in measuring a particular construct (e.g., a competency), the more reliable or consistent the assessment of this construct will be. Since there is a limit on the number of test questions a respondent is willing to answer, this implies that in psychological research one can either measure a few competencies with a great number of questions per competency, and thereby very reliably, or many competencies with few questions per competency. Thus, in assessing multilevel constructs, the number of lower level constructs (i.e., measurement specificity or bandwidth) is thought to be negatively related to the precision with which each of these constructs can be assessed (i.e. fidelity). Within the field of industrial and organizational psychology and personnel selection in particular, the bandwidth fidelity debate has mainly centred on the adequate and accurate assessment of personality and job performance (Hogan & Roberts 1996; Ones & Viswesvaran 1996; Schneider et al. 1996; Ashton 1998), although Tett Guterman, Bleier and Murphy (2000) discuss the dilemma as it pertained to the development and validation of their 53 competency hyperdimensional taxonomy of managerial competence.

In summarizing their discussion on the topic, Tett et al., (2000) contend that increased specificity will result in a more refined person-situation fit, a more complete understanding of causes, effects and measurement, and greater construct specificity than what the generalist performance models have to offer. Tett et al., (2000) specifically argue that: a) Predictive accuracy may be improved with the use of more specific and articulate performance measures; b) Complexity with respect to content must be matched between the criterion and predictor spaces; c) Specific measures, even if they are relatively short, are not by definition less reliable; and finally, d) Distinct measures of specific relevant constructs are likely to be more efficient because less time is spent measuring superfluous content.

It is readily apparent that the aforementioned advantages of specificity also apply to the current research. Specifically, since it is our overriding objective to match vocational educational qualifications to job related competencies, it is our contention that whether or not someone has acquired a VET diploma as a main ingredient of the hiring decision constitutes too broad an approach to yield the degree of insight that is necessary to fulfil our aforementioned aims, namely, i) to optimally predict job performance for selection purposes; ii) to provide remedial training in case of below standard performance; iii) provide feedback to educational institutions regarding specific deficiencies of graduates as compared to graduates of other educational institutions, and iv) to gain a thorough understanding of the theory based relationship between VET outcomes and workplace requirements.

## Temporal stability and latency

Returning to our earlier working definition of the competency construct as an individual's ability to do something successfully, a second question that comes into play is whether a competency is a trait or a state. That is, should competencies be conceived of as individual differences variables that are stable over time or as a temporally variable state? Proponents of both extremes would by definition be denying the possibility that competencies can be acquired, since the trait advocates would deny that a person who lacks a certain competency could ever acquire that competency, whereas the state advocates would expect that whether or not someone demonstrates mastery of a certain competency is contingent upon context. For the purposes of this research we will assume that a specific competency, once acquired, is a relatively stable and enduring quality of individuals and that students who have mastered a competency will *"... exemplify the dictum, once competent always competent*" (Shaw & Dobson 1988, p.667). Interestingly this position is only tenable for competencies that are assessed at a highly specific level of measurement. To return to our driving ability example: If we say that someone who is only experienced in driving a car with automatic transmission can drive, we would quickly become aware of our misjudgement the moment he or she got into a car with manual transmission; whereas if we say that someone is able to steer, or to shift gears or to operate the gas pedal, such generalizations are much less likely to occur. To summarize, jobs may change in content, but specifically defined competencies are more likely than general competencies to generalize from one job to another, and indeed to remain valid prerequisites for performance over time. This brings us to the question of what *mastery* of a particular competency entails. For now we will suffice to say that a competency is a latent quality of an individual to successfully express a particular and specific skill, and that competencies can be acquired. As such competence may be equated with skilfulness.

## Discriminant validity

Having discussed some of the defining characteristics of competences, we will now examine how competences may be compared and contrasted with a number of related terms that are also highly relevant to this research. These are job performance, cognitive ability, personality, and knowledge and will be discussed below. In order to frame and further clarify the main issues in this discussion, we will first present Binning and Barrett's (1989) framework for validating selection context predictors.

The field of personnel selection has its roots in the notion that a candidates' future job performance in a particular position may be predicted at the time of selection on the basis of relatively enduring and stable characteristics of that candidate. In their seminal article, Binning and Barrett (1989) shed light on the inferences that are made in personnel selection research (see Figure 51.) by providing three approaches to establishing the validity of a predictor measures, namely 1) the content- related approach; 2) the criterion-related approach; and 3) the construct-related approach. Rather than attempting to assess the job performance domain in its entirety, either a predictor or a criterion measure is used to sample the performance domain. Binning and Barrett have named the first approach, where a predictor measure such as the work sample test that is common to the assessment center directly taps into the performance domain, the content-related approach to establishing validity. This approach is represented by inference 9 (see Figure 51).

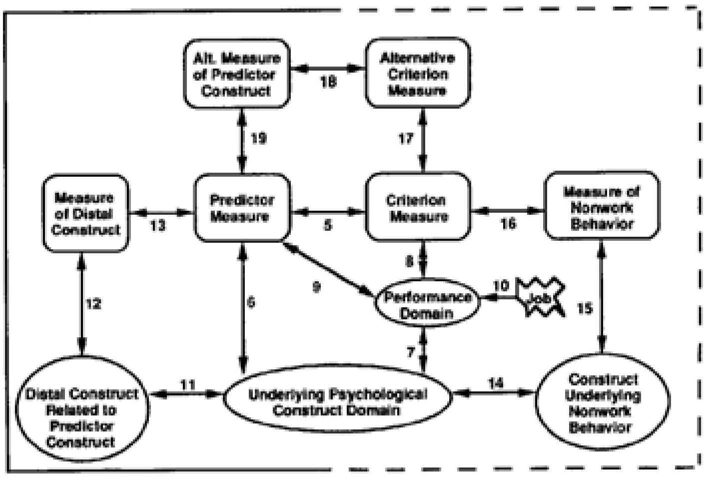



**Figure 51: Binning and Barrett's (1989) elaborated model for personnel decision research.**

They have labelled the second approach, where a predictor measure (such as a conscientiousness measure) is used to predict a criterion that samples the performance domain, the criterion-related approach to establishing validity. Within the criterion-related approach, the researcher needs to provide support for two inferences (namely 5 and 8) rather than just inference 9. Thus the researcher needs not only to demonstrate predictive validity of the predictor measure onto the criterion measure (inference 5), but also needs to demonstrate that the criterion measure adequately samples the job performance domain (inference 8). The criterion-related approach to validation is empirical in nature in that it hinges upon the demonstration of an empirical relationship between some predictor and a measure that has been designed to adequately and accurately sample the performance domain.

The third and final approach to establishing validity is called the construct-related approach. The construct-related approach involves the identification of psychological construct domains that overlap with the performance domain (inference 7), and then developing predictors that tap into this domain (inference 6). This is an alternative and a more theoretical approach to providing support for inference 9 than either the content-related or the criterion-related approaches.

### *Job performance*

Job performance is typically defined in terms of behaviour and or the outcomes of such behaviour (cf. Binning & Barrett, 1989). In addition, definitions of performance typically include a value component, in the sense that the behaviour and or outcome must contribute to the goals of the organization in one way or another. For example, Motowidlo (2003, p.39) has defined job performance "*as the total expected value to the organization of the discrete behavioural episodes that an individual carries out over a standard period of time"*. Therefore, although job performance and competencies can both be considered to be valuable to the organization or its constituencies, the two concepts are different in the sense that specific competencies can be construed as the propensity to behave in a way that is valued by the organization, whereas job performance constitutes the actual behaviour that is valued. In this sense, a competency can be considered to be a necessary, albeit perhaps not sufficient, antecedent of a particular behavioural episode that is valued by the organization.

### *Personality*

According to Saucier, personality is typically defined broadly but operationalized narrowly. That is, researchers will proffer a definition such as "*all of the relatively stable attributes, qualities, or characteristics that distinguish the behaviour, thoughts, and feelings of individuals"* (Saucier 2008, p.30), before using exclusion rules or yet more ambiguous subject matter expert evaluations to eliminate everything that is not considered to be personality. Since personality seems to have become equated with everything that might conceivably distinguish one person from another (i.e., even gender could be considered to be a personality variable under the above definition), it is difficult to differentiate competency from personality. Our take on this is that competencies are more likely than personality variables to i) be acquired and in that sense less stable over time, ii) be firmly rooted in knowledge, iii) have a clear value component, iv) be more specific, and v) be more salient (i.e. more familiar and acceptable as a decision making instrument) than personality within the educational and organizational context.

### *Cognitive ability*

On the basis of a meta-analysis of meta-analyses conducted until 2004, Ones, Viswesvaran & Dilchert (2005) concluded that cognitive ability predicts learning, acquisition of job knowledge, and job training performance with outstanding validities and job performance with a high validity. It is thus clear that cognitive ability should play a central role in any investigation attempting to link educational outcomes to the personnel selection context. Yet, there are also limitations to solely relying on cognitive ability in selecting personnel, and it is here that evoking competencies can and should complement what is now considered to be the most powerful predictor of job performance. That is, the fact that cognitive ability is generally perceived to be a trait as opposed to a state poses clear constraints as to what any particular individual may achieve in the course of his or her lifetime. For example, although cognitive ability predicts job training performance very well, as mentioned earlier, researchers are typically not privy to the idea that training might yield a higher cognitive ability, and indeed due to the trait like nature of cognitive ability, this is unlikely to be the case. Thus competencies although partially contingent on cognitive ability, also allow for the possibility that individuals may get ahead despite limitations on the part of their general mental ability, and the mechanism by which is described next.

### *Job knowledge*

In a previous paragraph it was stated that competence is more likely than personality to be firmly rooted in knowledge. With this we mean that the ability to do something desirable successfully, particularly within the educational and organizational contexts on which our research focused is likely to be highly contingent upon knowledge. Recently in the field of education Vas, Kovács & Kismihók (2009) have all but equated knowledge and competency. Within their educational ontology, Vas et al. (2009, p.134), state that "*Knowledge areas and competences are connected directly with the 'requires' and 'ensures' connection (A competence requires the knowledge of a given knowledge area and the good command of a knowledge area ensures the existence of certain competence(s)).*"

From a measurement perspective, there are many advantages associated with equating knowledge with competence in this way since by implication one need only measure knowledge to assess competence. The main issue with assessing competences lies in their latent nature. For instance, Tett et al (2000, p.215) define competency as follows: *"A competency is an identifiable aspect of prospective work behaviour attributable to the individual that is expected to contribute positively and/or negatively to organizational effectiveness"*. Although this definition comes close to the heart of the concept of competence as we have attempted to define it so far, operationally this definition yields the question of how to assess something that is *prospective* and *expected*. That is, assuming that one could assess such as work behaviour, what is the guarantee of it actually occurring in the future? Furthermore, how likely are job applicants to accept a rejection for the job they applied for on the basis of a behaviour that they have not even exhibited? Knowledge, on the other hand is i) readily assessable without the need to sample on the job performance or behaviour, and ii) likely to be a face valid selection context individual differences variable, especially to those applicants who have just graduated from a vocational educational program, where assessment of knowledge, in the form of exams, is extremely common.

It has been suggested that job knowledge cannot be used to evaluate and hire an inexperienced worker, because he or she *"cannot be expected to have mastered the job knowledge required to perform a particular job unless he or she has previously performed that job or has received schooling, education, or training for that job"* (F. L. Schmidt & Hunter 1998, p.267). Yet, in the current knowledge intensive economic climate, we cannot think of a situation where an employer would want to hire an employee with a 'blank slate' over an employee with at least the vaguest knowledge of the job. Furthermore, and in light of other predictors commonly used in personnel selection, it is hard to think of a selection context predictor that has higher face validity (i.e., the perceived job-relatedness of a selection context predictor (Smither et al. 1993) than job knowledge.

On the basis of the above it is proposed that competences should be defined as follows for the purposes of this research:

> *A competency is an unlikely to be forgotten (i.e. temporally stable once acquired), narrowly defined, and trainable latent ability to complete an organizationally valued prospective job task successfully. Competencies are contingent upon both specific cognitive ability facets and identifiable, specific, and distinct educational knowledge domains.*

In sum, we propose that VET programs teach knowledge that interacts with students' cognitive ability to produce the competence that they are expected to demonstrate on the workfloor.

## IT PRACTICES IN COMPETENCE-BASED SELECTION AND RECRUITMENT

### Proving selection validity with traditional learning environments

As it was mentioned in the beginning of this chapter, few attempts have been made to educational and job-specific competences using IT. Principally, this competency assessment is initiated by private companies and the main idea behind this approach is to identify and describe accurately different job-roles in a particular corporate architecture. In the PLATO[41] (Coughlan 2007) project, consortium members used this skill-card approach to build up a system, which covers a complete learning cycle: self assessment, learning content delivery, expert assessment and evaluation. The system consists of two main parts:

[41] http://deis.ie/previous/plato

(1) Capability Adviser module, which deploys job-role specific skill-cards and assesses the participants.
(2) Moodle, open source Learning Management System, which is used to deliver learning objects to the participants, based on their assessment.

The complete assessment includes the following steps (see Figure 52):

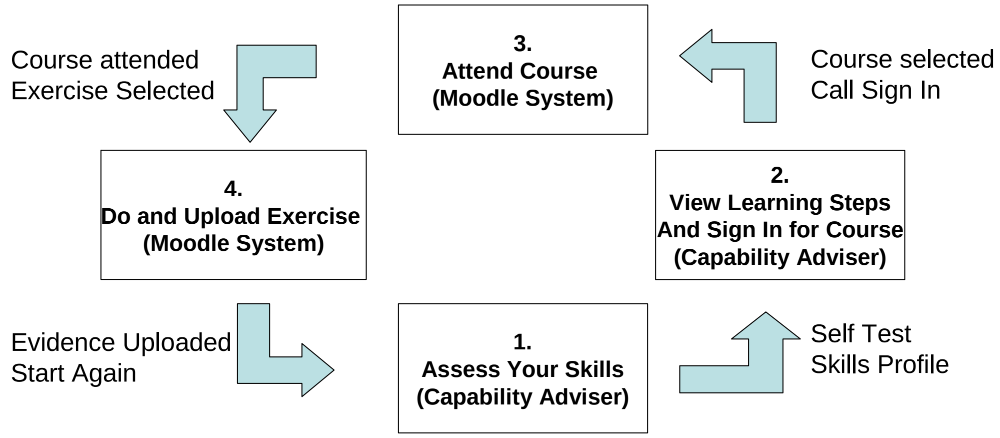



**Figure 52: The Plato learning cycle**

Participants log into the Capability Adviser first. They have to browse the skills tree, and commit a self assessment against performance criteria. If they have other evidences, which may demonstrate their expertise, they have to upload them as well. The "Learning Steps" option in the Capability Adviser offers courses, learning materials like books, articles, websites and references, based on the result of the self assessment. E-Learning courses are accessible directly with a single sign on procedure due to the integration of the Capability Advisor and Moodle.

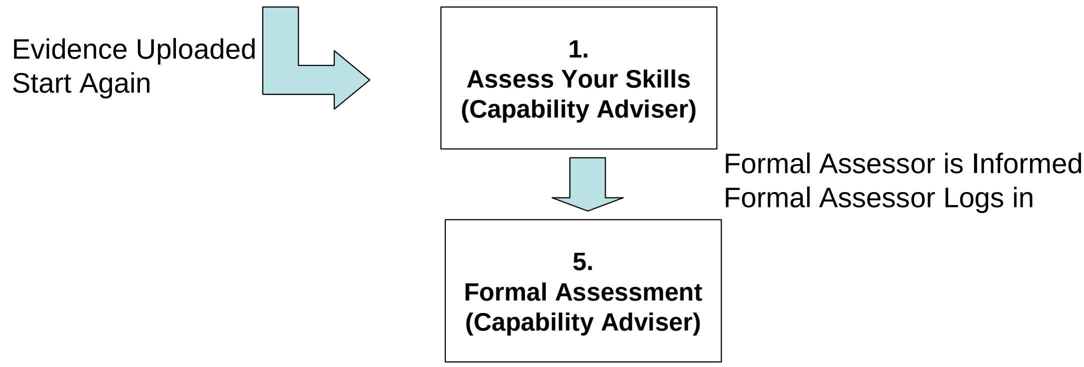



**Figure 53: The Plato formal assessment extension**

The actual learning takes place in the 3rd step. In Moodle, participants follow courses, completing the course requirements and getting a certificate about the completion, what they can use as evidence in the Capability Adviser. After the completed learning process participants switch to the Capability Adviser again and upload their course results as evidence into the system to verify their competence.

To ensure the validity and the reliability of the assessment external assessors are also connected to the assessment cycle (See Figure 53). When users complete their self assessment sequence, assessors will be informed about a completed assessment profile. The formal assessors log into the Capability Adviser, consider evidences, evaluate performance criteria and produce a formal skill profile of the user. Evaluations of the formal assessor are displayed together with self evaluations of users.

The Plato skill-card consists of the following units:

- Description of the position
- List of skills related to the position
- List of elements, related to the skills
- Skill element tests

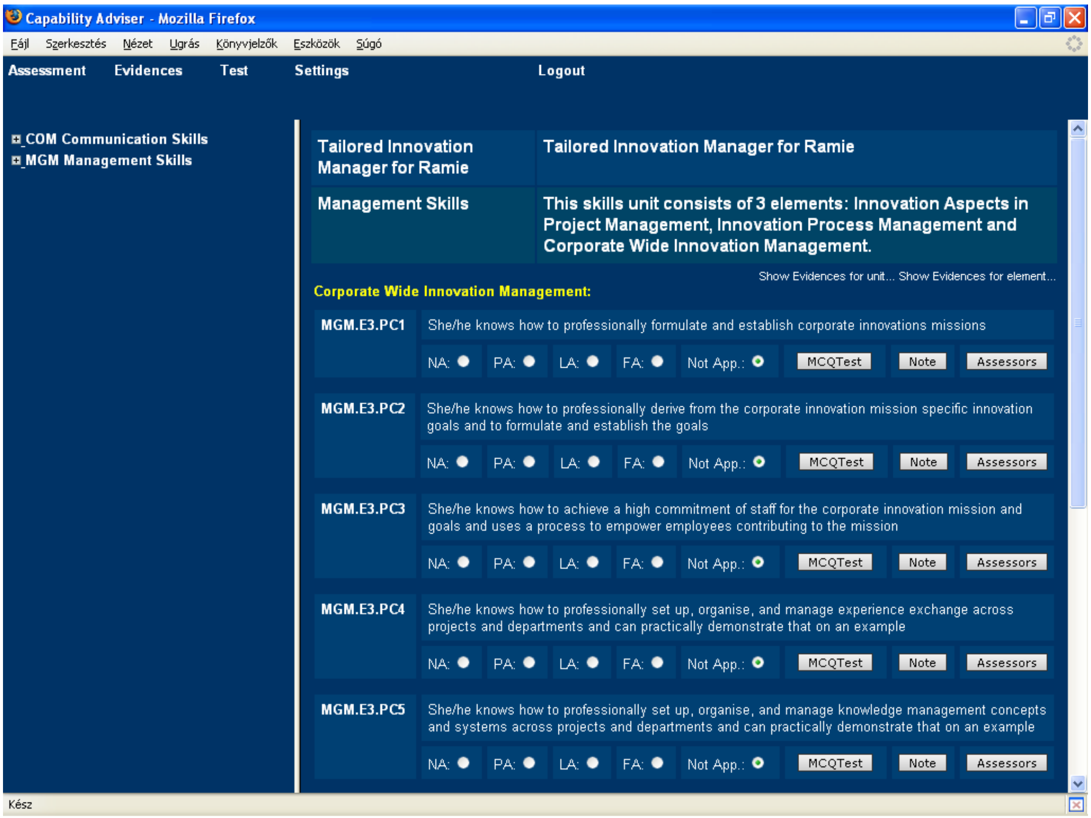



**Figure 54: The PLATO skill-card**

The combination of the various skill elements specifies the role of the employee. As it is visible on Figure 54, a role of innovation manager in this special case is composed by various management and communication skills. Here management skills have three sub elements: project management, innovation process management and corporate wide innovation management. All these elements are measurable with several performance criteria. A Multiple Choice Test is assigned to each and every step, which measures the awareness of the participants in the particular criterion.

### Ontology based approaches

The application of semantic technologies in competency-based recruitment and skill development is an ever increasingly explored research area. The current section provides an overview of the competency-based selection and recruitment practices that use ontology supported information systems for this purpose. One way of using ontologies in recruitment and skill development is to integrate ontology-based competency management solutions with eLearning systems with the specific aim of exploring knowledge and/or skill gaps of employees or candidates.

Draganidis and colleagues (2006) have worked out an ontology based competency management system, which integrates eLearning functionality to map employee and/or organizational skills gaps and to address these with appropriate learning objects. Their proposed ontology-based system provides a report in which the skills gaps of a particular employee are identified. Upon having completed the assessment, an employee report is produced through the comparison of the competencies possessed by the employee with organizational requirements. In case of a discrepancy, the competency management system provides the employee with a personalized learning path so that he or she may improve his/her proficiency level. Another example is the research of Ng, Hatala, and Gasevic (2006) who developed an ontology-based competency formalization approach as a way of representing competency-related information together with other metadata in an ontology, in order to enhance machine automation in resources retrieval. In their approach, learning objects are annotated with instances of competency specified in a Competency Class. The Competency Class is represented in three major classes: competency definition, proficiency level, and knowledge reference.

In other cases the ontology-based and competency driven solutions aim at supporting comprehensive human resource management functions. A remarkable example is the Professional Learning project of the FZI in Karlsruhe, Germany, which aimed to elaborate an ontology based reference model for HRM (Schmidt & Kunzmann 2007). In proposing this model, these authors set out to connect the operational and strategic level of HR development and also to ensure the continuous updating of an organisation's competency catalogue. The aggregation of individual competencies into organisational competencies became possible and with the help of ontology, their model was sharable and reusable across various IT (Service Oriented Architecture) platforms, offering the possibility of integrating competency models into business processes. On the basis of the above depicted model learning services have been offered, based on competency gaps of employees. Based on a competency gap analysis competencies are mapped against the profile of the employee. Based on this analysis relevant learning opportunities are offered. In the SAKE project an ontology based job-competency matching algorithm was developed (Kő 2010). The idea here was to match individual competencies with the needs of the labour market. For this purpose ontological description of educational outputs and job profiles were provided. The educational output contains the details of degree programs. In other words it contains all of those individual competencies that students may have at the end of their studies. Job profiles descriptions include the educational demand of the labour market. Additional demand was identified on the basis of job offers which were collected from several sources, such as recruitment databases and subsequently conceptualized in the ontology. In this solution, the job profiles (offer and demand) are compared with educational output in terms of competencies. In contrast with the SAKE approach, in OntoHR job profiles are described with tasks and competencies required in the given job role, and this description is more complete and exhaustive then the educational demand/job offer based description. Another difference is that in the SAKE approach competencies are not measured, the competencies of the offer and demand side are simply compared with one another. Mochol and her colleagues (Mochol et al. 2004) also investigated a recruitment process, which used ontologies to classify available human resources. They created an HR ontology with several sub ontologies based on the HR-XML standard. Competencies were represented in the SKILLS sub-ontology. These competencies provided the basis of the job-requirement descriptions and employee skills. Levels of particular competencies were also handled within this sub-ontology. PERSON and ORGANISATION sub-ontologies described the relevant information about employees and the recruiting organisations. A Matching algorithm was used to sample similarities between applicants' profiles and job requirements providing a ranking of the suitable candidates for a particular job.

Biesalski presented a solution for the automotive industry (Biesalski & Abecker 2005). They applied an ontology based framework for Human Resource and Skill Management at DaimlerChrysler Wörth. They established similarity measures in order to compare the 700+ skill profiles in their system. Similarity measures are treated as cornerstones in this project. In specifying competencies needed for a particular position the demand was to reach the best position–applicant match at a required competency level. Stakeholders specified several "knock-out" competency criteria as well using similarity values. Four types of similarity measures were introduced. A further ontology-based intelligent system for recruitment – disseminated by Spanish researchers (Garcia-Sanchez et al. 2006) supported job-seekers of the Murcia region in Spain with an ontology based, collaborative recruitment website. These developers used ontologies to describe and categorise job offers in order to obtain a faster matching between job seekers and job offers relevant to their profiles. However there is no further built-in support for the application process in that only offers and possible candidates were sampled. Therefore, the ontology model is designed to enhance the efficiency of the web based search engine. The key concept of the ontology is the PROFILE, which connects job-applicants with offers. ABILITIES are also attributed to the profiles and broken down to various subclasses. Reich, Brockhausen, Lau, and Reimer (2002) developed a Skills Management System for Swiss Life (SkiM), which can be used to expose skill gaps and competency levels, to enable the search for people with specific skills, and to influence the requirements for training, education and learning opportunities as part of team building and career planning processes. SkiM forces every skill, education or job description of employees to be formulated in terms that are selected from the corresponding ontology. Within SkiM, three ontologies are defined, namely for skills, education, and job function. The skills ontology consists of three rather independent branches which correspond to the three organisational units that were selected for the pilot phase, i.e. IT, Private Insurance, HR. The ontologies for education and job function are not divided into sub-domains as is the skills ontology. Currently, the skills ontology consists of 700 concepts, the education ontology consists of 180 concepts, and the job function ontology comprises 130 concepts.

With regard to the key theoretical foundations discussed earlier, both the current investigation and those just discussed, all seem to agree that greater specificity in competency description will result in a more refined person-situation fit and that ontological description of competencies can ensure the required level of specificity. Another common theoretical element is that competencies should be described and compared with a set of related terms. In the current research these terms are the following: knowledge, cognitive ability, personality and job performance. At the same time in the approach of Draganidis, Ng and Biesalski and also in the SkiM solution simplified competency descriptions are applied since not all of the above mentioned terms were taken into consideration (e.g.: according to Draganidis et al. (2006) a competency is a combination of knowledge, behaviour (job performance) and skills (abilities), that is in this approach personality is not examined).

While competency measurement is a key element of our research, neither of the above described approaches deals with this aspect and its theoretical foundations. No tests or other evaluation tools are used for this purpose. In all of the above described solutions it is the user (e.g.: HR manager) who defines or assesses what competencies the employee in question possesses.

Evidently, there is a gap in integrating in-house ontology-based competency and human resource management solutions with (e-) learning systems of higher or vocational education, in which competency measurement plays a key role. OntoHR aims to develop such an ontology-based selection and recruitment system which besides providing competence gap analysis for applicants and/or employees, also enables mapping qualifications in vocational education to current and valid job roles. The OntoHR system tests and evaluates the applicants, identifies their missing competencies, and provides individually customized learning content (a shortcoming of the above-described practices).

### THE ONTOHR PROCESS

The domain of the OntoHR selection process is the modified educational ontology (Vas 2007; Vas et al. 2009; Kismihók et al. 2009). According to the conceptual model of this ontology the class of MENTAL ABILITY and KNOWLEDGE AREA is connected to the COMPETENCE class with the 'ensures' and 'requires' relationships (See Figure 55 and also Figure 40 on page 125). That implies that in the OntoHR system competences are measured only indirectly, throughout mental ability and knowledge.

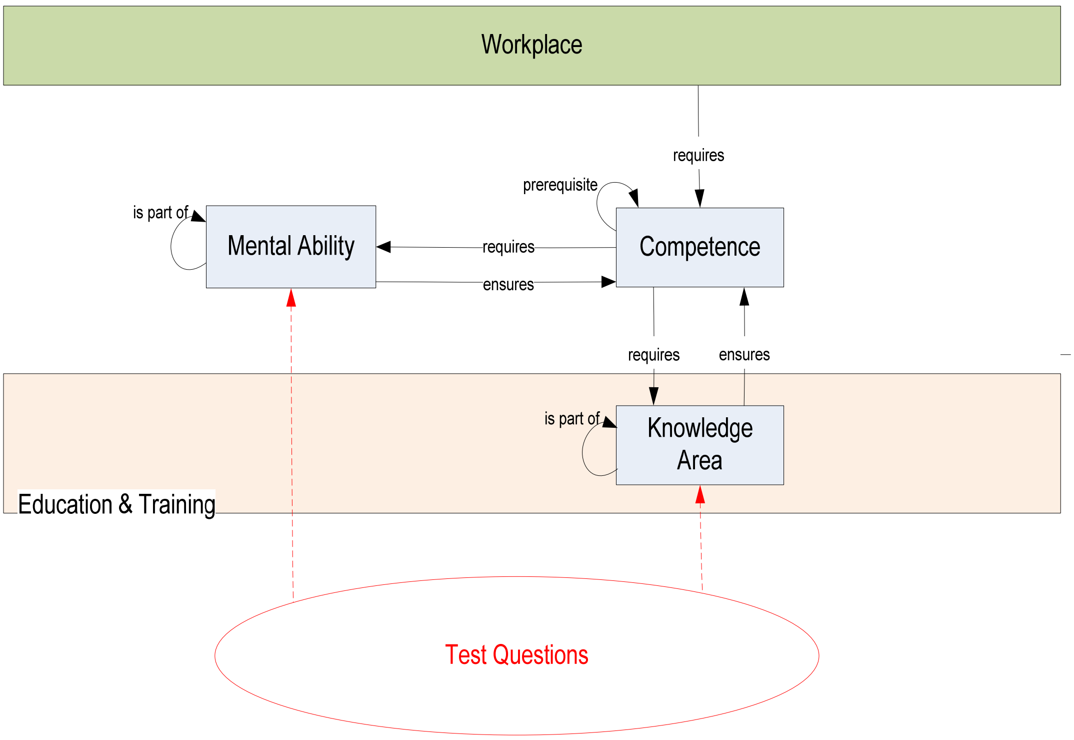



**Figure 55: Simplified view of the OntoHR conceptual model**

This idea is also reflected in the OntoHR process model, which plots:

- the stakeholder involvements,
- the OntoHR process flow from the perspectives of the stakeholders and

- the input/output information of process (see Figure 56).

Three different types of stakeholders are engaged: the recruiting organisation, the applicant and the educational institution. The recruiting organisation uses the modified educational ontology for describing competencies required for a job. Applicants are those people, who are actively applying for this particular job at the recruiting organisation. Based on their educational background, the relevant educational institution(s) are clearly identified. The required sets of competencies are broken down into knowledge elements and mental ability facets. Currently 78 IT related competencies are deployed in the system, which is broad enough and sufficient for modelling the competency requirement of an 'Information System Analyst (ISA)' job role by any organisation. This competency set has been sampled and constructed based on international job-description databases[42]. The selection of competencies was conducted by domain experts.

The competency set was validated on the basis of interviews with real companies employing ISA (see next section). The knowledge elements of these competencies are represented by 200+ knowledge areas and basic concepts, which are measured with an adaptive knowledge test (Vas et al. 2009; Kismihók et al. 2009). A knowledge area is accepted if the answer is correct for the question that belongs to that particular knowledge area within the ontology and also for the questions of its sub knowledge areas. In case a test taker answered a particular question correctly, the system will start investigating the sub knowledge areas of that particular node, in order to examine if the test taker has mastered the underlying knowledge elements or not.

[42] 13 major international databeases have been selected and investigated in order to sample the competecy profile of the Information System Analyst job. The complete list of databases is available here: http://www.ontohr.eu

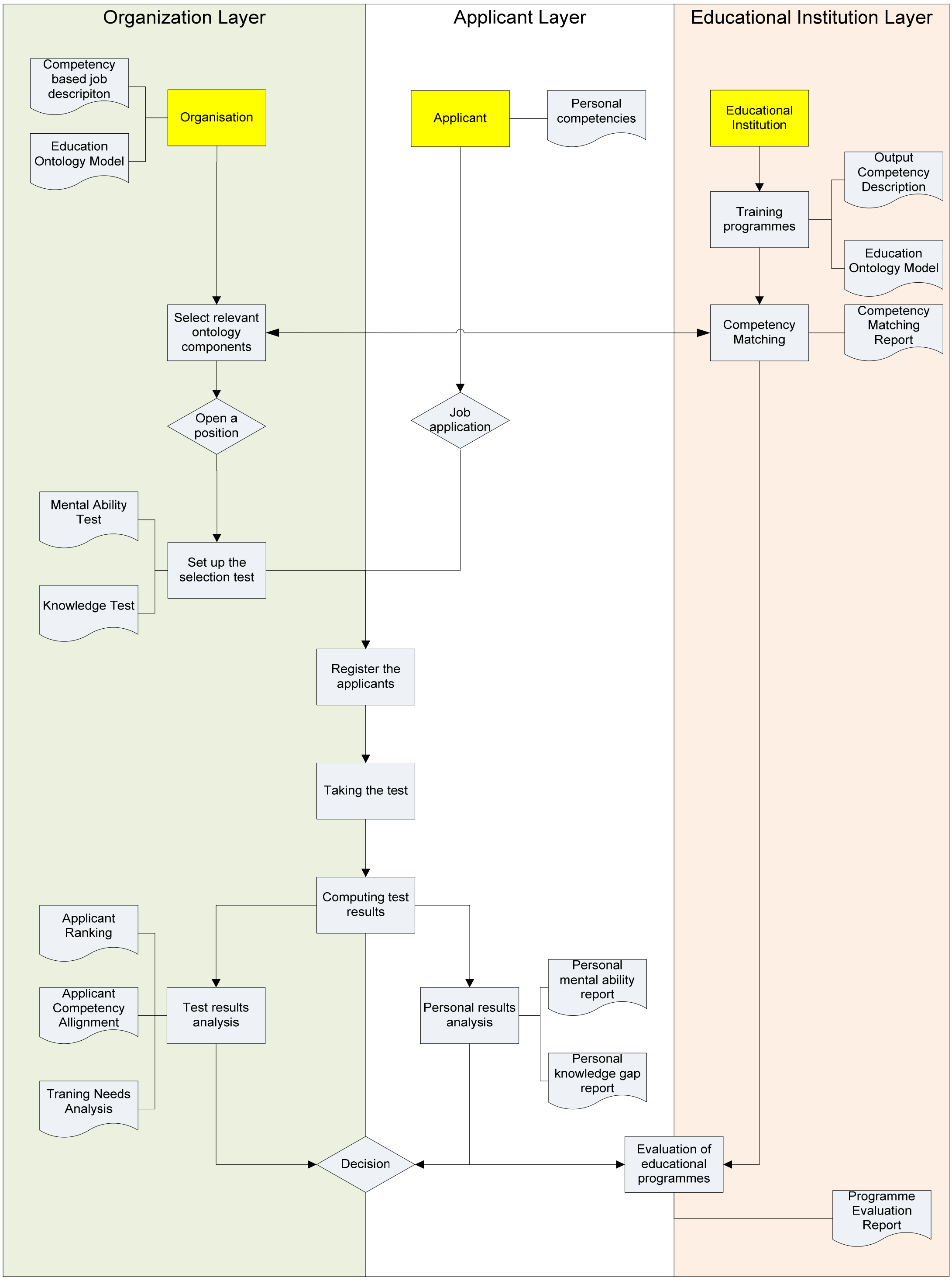



**Figure 56: The OntoHR process model**

Furthermore, six abilities are measured in a separate mental ability test: Verbal Ability, Arithmetic Reasoning, Computation, Spatial Ability, Form Perception and Clerical Perception. Although the measurement of cognitive ability at a more specific level than the general is somewhat at odds with the finding that all specific abilities load on a single general factor and that this general factor is the best predictor of job performance (Ones, Viswesvaran, & Dilchert, 2005), it is our contention that similar to the arguments that were advanced in favour of measuring specific competencies, the measurement of specific abilities will facilitate an increased theoretical understanding in terms of construct related validity evidence (cf. Binning & Barrett, 1989) of how specific knowledge and specific abilities interact to produce performance on a specific competency. Therefore, competencies are accepted based on these two assessments that all applicants have to go through. These abilities are sufficient to measure general mental ability for employment. For this measurement a well-established, widely used tool was adopted: the O*Net Ability Profiler[43].

The number of competencies to be tested is based on the actual needs of the recruiting organisation. It is possible – but not necessary – to make a selection from the available 78 competencies and to perform the test based on this selection only. This option tailors down the general ISA job-role into an organisation or culture specific ISA job-role. For instance, it is not unthinkable that the ISA job-role in the Netherlands requires a different subset of competencies than the ISA job-role in Italy. By getting local stakeholder to select those competencies that in their expert opinion best represents the ISA job-role in their location, the general ONTO-HR framework can be tailored down not only to specific organizations, but also to specific cultures.

The perspective of an educational institution differs from the recruiting organisation. Here the educational ontology describes the output competencies of the ISA (IT) relevant vocational educational programmes. These output competencies are compared to the input competencies of the particular (here: ISA) job role. This comparison is done by a matching algorithm, which enables us to compare similar objects in different ontologies based on keywords (Kismihók et al. 2011; Szabó & Vas 2006). This matching results in a report providing a detailed list of existing and missing job-role competencies on the vocational education side (see Figure 57).

[43] More information about the ability profiler is available on its official website http://www.onetcenter.org/AP.html

OntoHR ONTOLOGY BASED COMPETENCY MATCHING
Bridging the gap between vocational education and the workplace

| | | | | |
|---|---|---|---|---|
| | | Information System Analyst | 2011.06.14. 12:53 | |
| | ISA Competence | Keyword | VET Competence | Confirm |
| 1. Conduct needs analysis | 1.1 Define business problem to be solved by the application (e.g., through interview process) | knows&business process | knows about business process management | √ |
| | | has knowledge of&business process | has knowledge of Business activity and business process models | x |
| | | business problem | is able to come up with creative and innovative solutions to business problems | √ |
| | | solution&business | is able to come up with creative and innovative solutions to business problems | √ |
| | | business environment | has knowledge of Information systems in business environment | √ |

**Figure 57: The OntoHR job-education competency matching result**

The abovementioned report is an influential feedback for the educational institution about current competencies needed in the actual labour market. However at a later stage of the OntoHR process this feedback can be further customized. As applicants enter the assessment stage, they fill out the knowledge and mental ability tests. They are evaluated based on these tests and their existing ISA related competencies will be transparent. At this stage the recruiting organisation will have a clear view of the applicant’s general suitability to its ISA job. Also the recruiting organisation will have a personalized training needs analysis of the applicants, clearly pointing out the missing knowledge areas and potential deficiencies in mental ability. Based on the missing knowledge areas learning content is provided, which is automatically customized to the actual personal training needs.

This evaluation contains also useful information for the educational institution. Considering the competencies of their graduates, the OntoHR assessment shows the strengths and weaknesses vis-à-vis the graduates of other educational institutions. Their actual competencies therefore do not merely serve as a basis for a selection decision on the side of the recruiting organisation, but also allow for a critical evaluation of their previously completed educational programme.

## JOB ROLE SELECTION FOR THE ONTOHR PROCESS

### Process of Job role Selection, Competence Description and Validation

Information and communication technologies (ICT) are in constant change and evolution. Indeed, the ICT related professions are also subject to frequent changes, especially when considered across cultures. They therefore require systematic updating of underlying knowledge and the ability to use such knowledge in different contexts. In order to efficiently handle this diversity a common system of ICT skills (such as the European Qualification Framework (EQF) (European Parliament 2008) or the International Standard Classification of Education (ISCED) (United Nations, 1997)) must be used for the description of job roles. ISCED and EQF are two different approaches to setting standards for the categorisation of competencies and qualifications. The ISCED framework focuses only on formal educational activities designed to meet learning needs. In contrast, EQF defines learning as taking place in formal as well as informal settings. The focus of the framework is the learning outcome which defines the competencies of an individual at 8 different levels of reference. Since this research aims at matching vocational educational qualifications (in other words learning outcomes) to job related competencies, EQF was selected as the reference system of ICT skills. Beside the application of such standards it is also crucial to develop a clear and comprehensive system of criteria for the job role selection.

The progressive process of job role selection and definition has been strongly challenged by diverse difficulties in identifying a common profile among the different national scenarios of partners (OntoHR pilots are organised in the Netherlands and in Italy) and are related both to the classification systems and to the dynamic dialogue among educational and VET systems, the job market and companies. Thus, according to the CEDEFOP country reports the VET system of the Netherlands and Italy show remarkable differences (Visser 2009, ReferNet Italy 2009).

The critical dimensions of the Job role definition process are reported in the following chart (see Table 17), also highlighting OntoHR foci and choices. Job role descriptions may come in many forms and formats, with different internal structures and even with different conceptualizations. The application of certifications and standards for job role description play a key role in handling such diversity. Applying the elements EQF in job role description can ensure that the definition will be widely accepted and reusable both by VET institutions and the industry. A further problem that “entry level” of job role may have different meanings for VET institutions, companies or for the job market in general. This issue must be clarified, in which a bridging institution (such as Adecco) can provide the required help. Finally, it also has to be taken into consideration that every company may have a different practice of selection and recruitment. Concerning the aims of OntoHR such companies should be selected for piloting where the HR department actively participates in selection procedures in each of the departments of the company. This can ensure that people development and HR policies offered by OntoHR solution can be successfully integrated into the everyday operation of the company.

| **Drivers** | **Critical dimensions** | **OntoHR Focus** | **Pilot** |
|---|---|---|---|
| Diversity of Job role description | Certifications – Reference standard: EQF | Selection criteria | VET institutions |
| Diversity of Entry levels | Levels<br>Low level;<br>High level;<br>Experience;<br>Specific competences. | Relations between VET systems companies and job market | Institution working as interface with the companies context |
| Diversity of companies as learning places | HR systems integration degree | Selection/recruitment Integration within people development and HR policies | Companies |

**Table 17: Critical dimensions of job role definition**

### Criteria System of Job Role Selection

The job role selection procedure is guided by three main criteria, and their sub-criteria in the OntoHR project. These are the following:

#### *Definition Criterion*

In order for the pilot and the OntoHR project to succeed a job needs to be targeted that is relatively well defined and in which knowledge is the primary determinant of whether someone performs well in that job now and in the future. The following issue must be considered:

- Is the job performance domain clearly delineated?
    - Job title: Is the job title well known and agreed upon?
    - Role ambiguity: Is it clear which tasks the employee is expected to perform and which not?
    - Knowledge component: Does the job include a significant knowledge component as opposed to soft skills?
    - Documentation: Is there abundant documentation (technical manuals, internal training documents, web materials, etc) about the knowledge required to perform in this job?
    - Generalizability:

  - Is the performance domain the same between the Netherlands and Italy?
  - Are all employees in this job performing the same tasks?
- Comparability: Can the job be found in well-known and widely accepted classification systems or models? The relevant job profiles must be validated by means of independent and certified job classification systems. Altogether 12 significant international occupation databases were compared (e.g. O-NET, EUCIP, ESCO).
- Defensibility: Is it possible to define and defend the importance of this job in the greater European context?

### *Linkage Criterion*

The second step was to examine whether the job in question is potentially linkable to a nationally recognized vocational education programme. In order for the pilot and the OntoHR project to succeed the previously defined job role needed to be linked to a certain vocational educational program. The *Linkage* criterion has the following sub-criteria:

- Entry level: Is this an entry level job in the Netherlands and Italy (i.e. is previous work experience required for this job in the Netherlands or in Italy)?
- Vocational education: Is there a vocational education training program offered by a national educational institution that targets this specific job in the Netherlands and Italy? If so, what is it?
- Dropouts: What percentage of students drops out from the vocational education program in the Netherlands and Italy?
- Attractiveness: Is the job considered to be sufficiently attractive in the eyes of students in the selected vocational educational training programs?

### *Feasibility Criterion*

The third step is to evaluate whether the job is researchable in terms of the core objectives of the OntoHR project. In order for the pilot and the OntoHR project to succeed a job needs to be targeted that is sufficiently researchable. This criterion is the so called *Feasibility* criterion that has the following sub-criteria:

- Tenure: How long does an employee typically stay in this job before moving on?
- Population: Is there a sizeable number of employees performing this job in Italy (N > 5000) and the Netherlands (N> 5000)?

- Sample size: Are there sizeable numbers of applicants applying for this job in the Netherlands who would agree to participate in our pilot (n > 50) and Italy (n > 50)?
- Selection ratio:
    - What percentage of applicants gets hired?
    - Is there sufficient variability in qualifications?
- Structured selection:
    - To what extent to applicants undergo a structured selection process and are data from this process available?
    - Is this data dichotomous (hired vs. not hired) or are more specific scores available?
- Knowledge focus: Does the current selection system focus on knowledge?

### Vocational Education System and Job Market

One of the selection criteria is the linkage between the job role and a certain vocational education programme (within the field of ICT) both in the Netherlands and Italy. In both countries students are trained in three different educational levels for entering the labour market: lower vocational-, higher vocational- and academic education. The comparable European Qualification Framework (EQF) levels are level 4-5 for lower vocational education, level 6 for higher vocational education and level 7 for university graduates (European Parliament 2008). One of the selection criteria is the linkage between the job role and a certain vocational education programme (within the field of ICT) both in the Netherlands and Italy. In both countries students are trained in three different educational levels for entering the labour market: lower vocational-, higher vocational- and academic education. The comparable European Qualification Framework (EQF) levels are level 4-5 for lower vocational education, level 6 for higher vocational education and level 7 for university graduates. Since 2009 the national lower vocation counsel of the Netherlands (MBO Raad) is aiming to implement the EQF to allow for more international comparison. Similar efforts are observable on Italy.

A second initiative in the Netherlands, relevant to the scope of the ONTOHR project, is the federation of 17 knowledge centres (COLO). Each knowledge centre functions as a bridge between social partners, labour market, education institutes and central government. The aim of COLO is to contribute to high quality and attractive lower vocational education. In 2010 competency-based learning was introduced in the lower vocational study programmes in the Netherlands. The knowledge centres work together with the stakeholders to develop qualification dossiers that describe the professional skills and competencies that are needed to be successful at the labour market. The educational institutes will use these qualification dossiers as input in the development of lower vocational study programmes.

The Netherlands was one of the first countries to introduce the Bachelor-Master structure as agreed on in the Bologna treaty (and this structure is also in force in Italy). The binary structure is implemented in both the higher vocational education as well as in the academic field. The difference between higher vocational education and the academic university level despite some overlap is best described in that, academic students are stronger in analysing (knowing why) and developing new knowledge (research), while higher vocational students are stronger in applying existing knowledge (knowing how). This differentiation is again also noticeable in the Italian education system.

There are further relevant initiatives and researches in the Netherlands. The first of these is the contribution of the higher education counsel (HBO-Raad) to adhere to the standards of the EQF. Secondly, research (November 2008-april 2009) commissioned by the conglomerate of SME's in Netherlands (MKB-Nederland) and the Confederation of Netherlands Industry and Employers (VNO-NCW) showed that two-third of participating companies were dissatisfied by their participation in higher vocational internships. Within the top-5 of most heard complaints is mentioned the disappointment in expertise and competencies of the students and the difference in quality between educational institutes. Based on the analysis of the vocational education systems of the two countries and the above described initiatives it was decided that such a job profile should be selected for the pilot that requires higher vocational training.

## Process of Job Role Selection

### *Step I.: the IT administrators*

The first suggestion of the project group was to focus on the job role of IT administrator. The term "IT Administrator" appears to be very ambiguous. The appropriate educational entry level is dependent on the interpretation of the job role. A system administration position that mainly requires reactive maintenance or stability of the network environment is expected to be more appropriate for lower vocational students. A position with a more dynamic, changing environment or (multiple) system integration challenges is expected to set higher vocational education as an entry level. Comparable function names for higher vocational positions are "network manager", "system analyst" or "network architect". The selected job role of IT administrator is part of the operating group in the EUCIP model. Secondly, the American job profile database O*Net was used as a comparative framework. The function description of Network and Computer System Administrator appears for a large part to be operational. Combining this overview with the opinion of Dutch experts on the appropriate education level, it seems that the entry level for the selected job role adheres to the lower vocational education level in the Netherlands. A selected job role with a higher vocational education entry level might require more competence development of the applicant. Analytic, managerial competencies and other soft skills might be a contributor to the success of the employee within the job role.

### *Step II.: the System Analyst*

Comparing Italy and the Netherlands with reference to the labour market and their respective VET system, it is clear that the profile of System Analyst presents pros and cons with reference to the above described job role selection criteria system. First of all, the positive factors of this profile are:

- CORE ICT - The essential component of the Competence for this profile is technical.
- EU / USA perfect alignment. The American job profile database O*Net is used as a comparative framework.

The negative aspects of this profile are related to the fact that the starting point (the level of entry into the labour market) is not a degree. It's an essential certification path, but also experience.

### *Step III.: the Information System Analyst (ISA)*

The selected job profile is: the Information System Analyst. The professional Information Systems Analyst does not require any previous work experience, and can be considered as an entry point for VET graduates into the world of work. The EUCIP standard is an important reference point both in Italy and the Netherlands and it contains the job profile that was selected.

### *Step IV.: Job profile validation*

Based on international occupational databases, the competency profile of the ISA job was set up. Eight major competency groups were identified which all have sub-competencies. On the whole the competency set of the ISA job profile consists of 78 different competency items. These items and the concomitant databases which were investigated are listed on the OntoHR website.

In order to validate the relevance and quality of the ISA competency model, interviews were organised with Italian stakeholder organisations. Experts at ADECCO (Unit of Benevento, IT) and both Human Resource Managers and practicing Information System Analysts at five different small and medium sized enterprises were asked about the construction of the OntoHR ISA profile (on the whole 12 people answered the questionnaire, two from each of the participating organizations). These interviews had three major parts: 1) Validating that competencies concerning the ISA job role (also activities linked to each competency) are suitable and useable for practice. 2) Requesting comments about the general quality and the reliability of the competency model. 3) Confirming Knowledge elements (both technical and transversal) considered essential for an Information System Analyst position.

In general interviewees agreed (11 out of 12 interviews) that the ISA competency model is a comprehensive and complete model that covers all competencies and activities that are necessary for the ISA job profile. They also pointed out, that organisations will hardly ever use the complete profile in their daily practice, and will rely instead only a selection of the competencies provided. This feature was treated positively, as all interviewed organisations successfully identified their own ISA job-profile within the general OntoHR ISA profile, providing flexibility in job configuration. This configuration includes selecting their ISA job competencies, matching that with relevant knowledge elements and forming a basis for mass-customized training programme for their ISA employees.

## CONCLUSIONS

Having discussed some of the defining characteristics of competencies, we also examined how competencies may be compared and contrasted with a number of related terms that are also highly relevant to the research. These are job performance, cognitive ability, personality, and knowledge. Furthermore a job-role has been selected and analysed both in the Netherlands and Italy; and the competency profile of this job-role has been set up, similarly to the model of job-role and VET ontologies.

As it is visible from the discussed ontology model and the detailed OntoHR process model, the proposed system has the potential to improve personnel selection practices, particular with regard to the expensive first selection (screening) round by measuring applicant's suitability in terms of technical competencies for a particular job-role. As the system analyses gaps in an applicant's knowledge and general mental ability it is capable of generating a personalised training curriculum. Therefore with longitudinal testing of employees, the OntoHR system can also be used to supporting personnel development at particular organisations. Last but not at least, based on these personal competency profiles and applicants' educational background, feedback may be provided to the precursory VET educational institutions. This feedback is based on applicant scores on the labour market driven competencies that are derived from the assessment profile of applicants from a given educational institution.

Although a handful of ontology based systems have been successfully implemented both within the fields of HRM and education, the readily apparent desirability of bridging the vocational education – workplace divide, by means of interconnected VET and domain ontologies as outlined here, is unique. Filling this increasingly conspicuous research gap may in due time put an end to the arduous process of first testing students to allow them to successfully exit vocational education, only to test them again upon organizational entry. Indeed in due time, we foresee that this technology might further facilitate the blurring of vocational education to workplace boundaries, by allowing the adequate and accurate measurement of time to proficiency in a particular occupation, while at the same time continuing the delivery of training content that is tailored to the needs of the individual student.

# PART V

# Lessons Learnt

# PART V – LESSONS LEARNT

## SUMMARY

In the last circa 170 pages I collected evidences of my research about the integration of personalised, ontology based learning content management into real educational practices, which resulted in a system capable to select and train applicants for a certain job-role.

At the beginning of the book I stressed the importance of this investigation and showed what the major driving factors of this research were. As it was visible from Part II, this is the right time and the right place for eLearning related research. The world of education is changing rapidly and behind these changes important factors are the advancing technology and the changing (digitalizing) society. I also showed that in the region of Central-Eastern Europe – including Hungary of course – is lagging behind Europe and the world, when it comes to eLearning developments. Therefore significant amount of research should be done in this field both on academic and on industry levels. There is an articulated policy movement in this area, aiming to support investments into eLearning research, which is a very promising fact for the future. However, these policy efforts are currently lacking coordination and common objectives. Also an emphasis has been given to the importance of informal learning, which is very technology driven and contributes significantly to reshaping today's education (and society) rapidly.

Education is only a follower of the advances of technology, especially mobile technology. Mobile technology as such is already grown out from its infancy many years ago, still, mobile technology in education is only getting into the mainstream nowadays. Evidences – as it is written also in Part II – show that incorporating mobile technology into educational practices demonstrate clear benefits for learners, educators and also for educational institutions. Nevertheless this incorporation should be planned very carefully as, despite many successful mLearning projects, failing to utilise mobile technology for education is not very difficult. In order to scaffold the inclusion of mobile technology in lifelong learning, an Evaluation Grid (EG) has been created. This Grid, on the basis of academic research, industry experiences and policy related works, aims to identify mLearning practices to be followed and implemented. The EG clearly articulates that any improvements in educational technology without putting it into a managerial (strategic), pedagogic, political and ethical context is not sustainable by any organizations organising formal educational programmes.

Besides the policy and organisation level issues of eLearning and mobile learning it is also inevitable to consider the perspective of individual learners. This viewpoint is crucial for educational information system developers, as it indicates user demands. As the results in Part III demonstrate an individual's approach towards technology enhanced learning is clearly influenced by former experiences with technology. In general there is a positive attitude towards technology enhanced learning both from the perspective of an experienced or non experienced users. Those people however, who have significant user experience, show more criticism towards novel learning technology. This finding has substantial influence on system development as reliability and robustness are clear user expectations from mobilised educational systems. It is not surprising that these issues already influenced the development of our mobilised ontology based learning content management system development. Reliability is definitely high on the agenda by a system of many components. The system we constructed has six main components, the ontology editor, testbank, test item editor, content authoring, content representation and user interface. The novelty of this mobilised learning content management system is that all content is structured according to an educational ontology model. The ontology scaffolds both the assessment procedure and the content authoring and representation. Learning objects and test questions are organised according to domain ontologies (created by subject matter experts), which results in a highly personalised assessment and training based on a robust, but granule learning object structure. This granularity and structure provides the possibility to create an infrastructure for mass-customized learning, which is a crucial step towards flexible learning systems.

Part IV demonstrated furthermore that the abovementioned flexibility can be further enhanced if we consider the context of the learner or if we extend the learning environment towards an industry related application for employee selection and recruitment. As we have seen the context of the learner is important in order to provide personalised learning content. Context on our case meant the user's geographical location in combination with prior and current learning experiences. However with the assistance of currently available mobile technology it is possible to add further factors, additional sensory information about the learner's and its environment's current condition. The plotted proof of concept study also supported the lessons learnt in the mStudio system development pilot, namely, that our ontology can successfully structure and scaffold learning content delivery and the connected assessment services.

The same applies for the third pilot, which attempted to trial our system in a corporate environment for selecting and recruiting employees for an organisation. However this is still an ongoing pilot at the time this work is written, preliminary results already indicate that the granularity of the data in the system provide HRM managers to constitute highly personalised jobs and job descriptions. These jobs are described with a certain set of technical competences, which are constituted by knowledge elements and general mental ability facets. The combination of these two adds up automatically to an employee training profile with the relevant learning materials. The advantage of this approach on one hand, is an improved employee – employer matching in the future, based on the real, valid competences of applicants, which on the other hand is also matched with the educational performance of relevant formal educational learning programmes (in this case VET programmes in Italian and Dutch educational institutions). This matching is capable to show the weaknesses of the educational programmes in the light of valid and current labour market expectations.

## HYPOTHESES

Previously, I formulised four main hypotheses (H1- H4). H4 is also supported by two sub hypotheses. Despite the fact that some of these hypotheses have already been discussed in the text, here I repeat and also extend the findings.

**Hypothesis 1 – H1:**

> *There is no significant difference in the judgement of people with or without experience in mobile learning that the use of mobile technology can enhance the general quality of learning.*

Our empirical study in Part III showed that there is significant data available to demonstrate that this might not be true! Results show that people, who are engaged with technology based learning, are a bit more careful about articulating their expectations, especially positive expectations towards technology in learning situations. This is also in line with previous research using a similar methodology in the field of eLearning (Johnson et al. 2000). There Johnson and his colleagues revealed that *"student satisfaction with their learning experience tends to be slightly more positive for students in a traditional course format although there is no difference in the quality of the learning that takes place"* (Johnson et al. 2000, p.44). There is an obvious hype around using the latest technology in education, mostly learners demand these services in connection with their studies. Here I'm not arguing that educators and their institutions shouldn't try to meet this demand. I consider this scepticism towards technology as a need for mature solutions in place. It is not enough to pick the latest and maybe the shiniest technology available. Reliability, scalability, robustness – basic information system development issues – should accompany such a decision.

**Hypothesis 2 – H2:**

> *It is generally accepted that the use of mobile learning in education is beneficial for improving the communication between students and educators.*

Communication has great importance in education and using mobile devices might have a positive impact on educational communication between learners and educators. However this research didn't show significant differences between mobile technology assisted learning environments and traditional learning environments. Again, instructional designers are highly dependent on the reliability of technology, furthermore communication services worth only as much as their integration into the curricula of that particular course. In general mobile technology and mobile communication services have the potential to improve the quality of educational services, but it must be planned and implemented carefully. The reliability of technology was an issue during the Contsens pilot, where location based technology failed to meet the requirements of the course. As the learning process and the learning experience was based on the geographical location of the user, the malfunction of this technology also caused major problems in learning content delivery and learning content based user interactions. The Impact study also showed that students having experience in mobile technology based educational activities also downgraded the importance of mobile communication related services. This is a truly surprising result, which also has some important implications for the future. There is definitely more research needed in this issue as communication in education is gaining more and more attention. Collaboration is seen as a great benefit of educational processes and several studies supported the positive outcomes of mobile communication in education. From student's responses one possible answer for this contradictory result can be connected to the implementation of collaborative services in the mobilised learning environment. Learners prefer their traditional networking channels, including traditional calling and messaging services (like SMS or MMS messages) or social software related communications (microblogging, following). These services operate also as a benchmark when it comes to judging communication related services in educational software. Users prefer keeping their own pathways of communication with each other, rather than exploring new opportunities.

**Hypothesis 3 – H3:**

> *Incorporating Mobile learning into educational activities adds additional value for the learning programmes provided by higher educational institutions.*

Flexibility in learning is a rapidly emerging issue of nowadays digital society. Studies in Part II in this book show, that this issue is emerging from a significant demand of digital native learners and put pressure on educational institutions and systems to transform their rigid, outdated and massive educational practices into personalised, mass-customized, open and reusable learning services. This is an enormous workload on the shoulders of institutions. Besides the studies, the previously detailed pilots are also supporting this movement. It is a clear result that a mobilised learning environment, which considers personal learning situations, which is sensitive to the learners' context, is providing extra value for the learning process and throughout this learning process to particular learning programmes. This flexible, highly personalised (mass-customized) learning however requires a different approach to teaching than the traditional face to face education. Teachers, educators should act more like a mentor of the student, facilitating the learner's own learning scenarios, as evidences show that tailoring down the learning content to the needs of individual learners benefits the learning process. Furthermore, mobilised learning content delivery also reflects the context of the user when offering the tailored learning content. This personalisation and contextualisation approach shows clear benefits for the educational institution, but of course it also has its price. Transforming traditional educational institutions into flexible education providers is a costly and timely effort.

**Hypothesis 4 – H4:**

> *Learner's context is a crucial constituent of education. Therefore the deployment of context aware services in a mobilised virtual learning environment is a valid approach, with quantifiable benefits for learners in a personalised learning environment*

As it was also mentioned above, the results of these studies clearly show the importance of context in personalised content delivery. Students using context aware services reported improved user experience, enhanced learning experience. Content delivery according to individual contexts fosters motivation and engagement in learning processes. Experiments showed that students were more interested, more connected and more enthusiastic in these mobilised systems than towards traditional learning methods.

**Hypothesis 4.1 – H4.1:**

> *It is possible to build up an ontology based personnel selection and training system, which can be employed to provide support for the inferences pertaining to the construct-, content- and criterion-related validity approaches that are described by Binning and Barrett (1989)*

As it was argued before, when it comes to employment, personal traits, features and prior learning are key concerns. Predicting potential job performance needs various – contextual – data in order to decide whether an applicant is capable to perform well in a particular job in the future or not. Literature showed that these predictions can be made throughout measuring construct, content and criterion related validity. Our experiments showed that these validity measurements can be assigned to our mobilised ontology based assessment system, when it was extended with measurement means for general mental ability. On the basis of the flexible enhanced educational ontology model, the combination of testing job knowledge and general mental ability adds up to a system, which fulfils the criteria of Binning and Barett (1989).

**Hypothesis 4.2 – H4.2:**

*It is possible to sample jobs based on a competency based logic, which is modelled by the enhanced educational ontology model.*

The challenge here was whether it is possible to construct competence based job descriptions, which are measureable over knowledge elements and general mental ability. It was proven that competency can be treated as a temporally stable, narrowly defined, and trainable latent ability to complete an organizationally valued prospective job task successfully. It was also visible that competences are contingent upon both specific cognitive ability facets and identifiable, specific, and distinct educational knowledge domains. In other words, with well articulated technical competencies it is possible to describe particular jobs – in this case the Information System Analyst job – and perform a competency assessment. One of the key issues here again is the granularity. Jobs differ across cultures and/or organisations. In order to handle these differences and provide a general description of a single job, it is necessary to create the widest possible competency set, what organisations can tailor down to their own needs. In our case that meant 72 different technical competences and more than 200 related learning objects. The ontology is used again to provide the structure for these elements, which also provides the domain of the assessment.

## EXPLOITATION

The work that has been done has various implications for other academic and industry related research and business activities. This research – as it has also been depicted previously – is part of a bigger research environment, having several various streams. The abovementioned results therefore form the basis of future research efforts in those areas.

### Academic perspectives

Form an academic perspective this research seamlessly in line with the controversial ‘flexible educational systems’ research agenda. The system, as showed here previously, has the abilities to support flexible learning and teaching. The concept proved to be successful in managing student’s individual learning activities, in assessing student’s knowledge in various knowledge and competence domains and also in bridging the fields of education and workplace with matching a valid job descriptions to students' and applicants' competence profiles.

One important factor of the success of these pilots was that these efforts were attempting to connect three different disciplines, namely HRM, eLearning and knowledge management. Domain experts, HRM practitioners and academics, educators, instructional designers, content developers, system developers, programmers, ontology engineers have been working together. This portfolio of different skills and knowledge added immense value to these experiments and it would be unwanted if the network of these professionals won't continue this sort of cooperation.

This research also shed a light on the importance of job knowledge in the recruitment process. In the field of HRM a great emphasis has been given to personality traits when selecting employees. The emergence of psychological tests in selection neglected job knowledge related discussions, as the common believes was that mental ability related assessment is significant enough to predict future job performance. However according to the current results there are signs which assume that such an ontology based approach can put job knowledge related HRM research again on the agenda. The granularity of knowledge related objects makes it possible to fine tune job requirement on a very specific organization or even on personal level. Therefore in theory it is possible to even create a job based on an applicant assessment – if this assessment also meets the requirements of the organization.

Another issue emerging from the results of this series of research is that flexibility of learning and working doesn't necessary mean that only the employee should be flexible and follow the demand of the labour market. Results suggest that this process may also work the other way round. It is imaginable that in the future not the organization will be the one, who picks employees, but employees will be able to pick organizations, based on their current competencies, skills, knowledge and personal traits. This means that after an assessment procedure the question will be – instead of comparing the results to the current organization's demand – whether it is possible to create a job, which suits the features of the test taker. This is something what definitely needs more consideration.

Running this ontology based learning content management system is an endless source of data to be analysed. It is possible to conduct cross-cultural analyses connected to a particular job or competence. It is also possible to conduct longitudinal studies and follow up personal profiles in the system. How do applicant profiles change after a selection decision? Tracking students as they are entering the labour market and then try to maintain their presence there is a possibility of fascinating study, what may have been designed on the basis of this system.

Furthermore more consideration should be given to the possible feedback channels towards the educational institutions. How shall these institutions handle and process the data, which is coming from a system like this? How to set up a competence matching system, which enables the comparison of labour market input competences with educational sector output competences. Work has been started on developing a matching interface, which matches job-role and vocational education competences on a keyword basis, but there should be more in-depth investigation an analysis on this issue.

Additionally there is an envisaged impact of artificial intelligence on educational software. There are several fascinating research ideas emerging from this perspective. How to set up an educational system where personal traits are treated as contextual data? How to include and maintain learner's personality in automated learning processes? As every learner is different in the system, how can we discover patterns in their education related activities (including assessment and learning) and how can we re-implement these patterns into those educational systems? One way might be implementing case based reasoning, but it is worthwhile to check the enhanced reasoning possibilities provided by AI applications. If context is an issue AI is something what educational systems have to absorb.

### Industry

From an industry perspective this research has also several practical future implementation possibilities. Firstly this application is definitely suitable for delivering adaptive, personalised education and training. It is also capable to be deployed as a complex selection and recruitment software, which also responsible for corporate training based on the applicant (employee) assessment profile. This function might be beneficial for a single organisation with knowledge intensive jobs, where the employee fluctuation is high (like call center positions, sales staff or technical support staff).

This solution might also be interesting for intermediary organisations – like headhunting organisations, student counselling organisations or labour renting organisations –, between education and workplaces. With the help of this software they can have a clearer view of the necessary competence allocation for the industry and also see the available competences on the market. This enables them to match demand and supply better.

Another emerging issue is the integration of this ontology based content management system into organisation's already implemented learning environments and ERPs (Enterprise Resource Planning). This step would enable on one hand the reuse of existing organisational learning content and on the other hand the financial planning of these personalised training activities would also be more efficient.

### Government

Potential demand in the governmental sector for such an application can also be envisaged. Labour market monitoring governmental institutions can use this software to monitor current trends and match that with also current output of educational institutions. That may help in employee re-distribution or re-skilling according to industry demands. Also, the means to challenge structural unemployment may encompass such a solution. It might also be an interesting application if the government continuously checks school or university graduates and match them according to their performance to particular occupations. This would support the carrier start of recent graduates with lowering the possibilities of a post-graduation unemployment status.

## SUSTAINABILITY OF THIS RESEARCH

At the time of writing this work, there is a growing interest from academic and industry stakeholders for further exploitation of this complex training system. Besides the discussed pilots further trials are being organised in Italy, Netherlands, Switzerland, Germany and Belgium.

In order to meet any of the above discussed exploitation scenarios, obviously more work needs to be done on this currently trialled product. The first issue here is the content. In order to leverage the result of this research, the system needs to embed more content. One way of broadening the scope of this system is implementing more ICT related jobs, including their underlying competence related content elements. This practically also means the enlargement of the ontology with further concepts about ICT.

Also the matching algorithm between the job-role and the educational ontologies has to be further elaborated and customized. It needs to be examined that besides keyword based ontology matching what other options can facilitate the comparison of job-role related and educational competences. It also needs to be investigated how to automatize the feedback towards the educational institutions in the light of their student's performance.

# RESOURCES

Adobe Systems Inc., 2010a. Adobe Flash Platform.

Adobe Systems Inc., 2010b. Desktop and Web applications.

Agrusti, F. et al., 2008. *The Impact of New Technologies on Distance Learning Students* D. Keegan, ed., Dublin: Ericsson.

Ahmed, S., Parsons, D. & Ryu, H., 2010. Supporting adaptive learning interactions with ontologies. In *Proceedings of the 11th International Conference of the NZ Chapter of the ACM Special Interest Group on Human-Computer Interaction*. Auckland, New Zealand: ACM, pp. 17-24.

Ala-Mutka, K. & Punie, Y., 2007. Future Learning Spaces: new ways of learning and new digital skills to learn. *Digital Kompetanse*, 2(4), pp.210 - 225.

Ala-Mutka, K. et al., 2009. *Learning2.0: The Impact of Web2.0 Innovation on Education and Training in Europe*, Seville: EU JRC IPTS.

Ala-Mutka, K. et al., 2008. *Active Ageing and the Potential of ICT for Learning*, Seville: EU JRC IPTS.

Ala-Mutka, K., Punie, Y. & Redecker, C., 2008. *Digital Competence for Lifelong Learning*, Luxembourg: European Communities.

Alasoud, A., Haarslev, V. & Shiri, N., 2008. An Effective Ontology Matching Technique. In *Foundations of Intelligent Systems*. Lecture Notes in Computer Science. Springer Berlin / Heidelberg, pp. 585-590-590.

Anderson, J.G., 2010. *Professional Flash Lite Mobile Development*, Wrox Press Ltd.

Antoniou, G. & Harmelen, F. van, 2009. Web Ontology Language: OWL. In *Handbook on Ontologies*. International Handbooks Information System. Springer Berlin Heidelberg, pp. 91-110-110. A

Arnedillo-Sánchez, I., 2008. The Mobile Digital Narrative Tool. In P. Isaías & I. Arnedillo Sánchez, eds. Lisbon: International Association for Development of the Information Society Press., pp. 77-83.

Aroyo, L. et al., 2006. Interoperability in Personalized Adaptive Learning. *Educational Technology & Society*, 9(2), pp.4-18.

Arrigo, M. et al., 2010. Mobile Technologies In Lifelong Learning: best practices. In *Proceedings of the 6th Hungarian National and International Lifelong Learning Conference*. 6th Hungarian National and International Lifelong Learning Conference. Pécs, pp. 419-435.

Ashton, M.C., 1998. Personality and job performance: The importance of narrow traits. *Journal of Organizational Behavior*, 19(3), pp.289-303.

Basaeed, E. et al., 2007. Learner-Centric Context-Aware Mobile Learning. *IEEE Multidisciplinary Engineering Education Magazine*, 2(2), pp.30-33.

Becker, G., 1993. *Human capital : a theoretical and empirical analysis, with special reference to education*, New York: National Bureau of Economic Research ; distributed by Columbia University Press.

Bentley, T., 2000. Learning Beyond the Classroom. *Educational Management Administration & Leadership*, 28(3), pp.353 -364.

Berri, J., Benlamri, R. & Atif, Y., 2006. Ontology-based framework for context-aware mobile learning. In *Proceedings of the 2006 international conference on Wireless communications and mobile computing*. Vancouver, British Columbia, Canada: ACM, pp. 1307-1310.

Biesalski, E. & Abecker, A., 2005. Integrated processes and tools for personnel development. In *1th International Conference on Concurrent Enterprising Proceedings*. 1th International Conference on Concurrent Enterprising.

Biesalski, E. & Abecker, A., 2008. Skill-Profile Matching with Similarity Measures. In *Enterprise Information Systems*. Lecture Notes in Business Information Processing.

Binning, J. & Barrett, G., 1989. Validity of Personnel Decisions: A Conceptual Analysis of the Inferential and Evidential Bases. *Journal of Applied Psychology*, 74(3), pp.478-494.

Brimelow, L., 2010. iOS Applications and Flash (Adobe Flash Platform Blog).

Brown, T.H., 2006. Beyond constructivism: navigationism in the knowledge era. *On the Horizon*, 14(3), pp.108-120.

Carril, I. et al., 2008. *The Role of Mobile Learning in Europe Today*, Dublin: Ericsson.

Carswell, L., 1998. The "Virtual University": toward an Internet paradigm? *SIGCSE Bull.*, 30(3), pp.46-50.

Chen, G., Mathieu, J.E. & Bliese, P.D., 2004. A framework for conducting multilevel construct validation. *Multi-level issues in organizational behavior and processes*, pp.273-304.

Christodoulou, E., Germanakos, P. & Samaras, G., 2008. *The Development of eServices in an Enlarged EU: eLearning in Cyprus*, Seville: European Commission Joint Research Centre Institute for Prospective Technological Studies.

Chytilová, J., 2008. *The Development of eServices in an Enlarged EU: eLearning in the Czech Republic*, Seville: European Commission Joint Research Centre Institute for Prospective Technological Studies.

Chytilová, J. et al., 2009. *The Development of eServices in an Enlarged EU: A Synthesis Report on eLearning*, Seville: European Commission Joint Research Centre Institute for Prospective Technological Studies.

Cobcroft, R.S. et al., 2006. Mobile learning in review: Opportunities and challenges for learners, teachers, and institutions. In *Online Learning and Teaching (OLT) Conference 2006*. OLT 2006. Brisbane.

Coffield, F. & Edward, S., 2009. Rolling out "good", "best" and "excellent" practice. What next? Perfect practice? *British Educational Research Journal*, 35, pp.371-390.

Contsens Project, 2009a. Using wireless technologies for context sensitive education and training - Corvinno evaluation report. Available at: http://www.ericsson.com/contsens.

Contsens Project, 2009b. Using wireless technologies for context sensitive education and training - General System Design.

Corbeil, J.R. & Valdes-Corbeil, M.E., 2007. Are You Ready for Mobile Learning? *EDUCAUSE Quarterly*, 30(2), pp.51-58.

Corcho, O. & Gómez-Pérez, A., 2000. Evaluating knowledge representation and reasoning capabilities of ontology specification languages. In *Proceedings of the ECAI 2000 Workshop on Applications of Ontologies and Problem-Solving Methods*. ECAI 2000 Workshop. Berlin.

Corcho, O., Fernández-López, M. & Gómez-Pérez, A., 2003. Methodologies, tools and languages for building ontologies. Where is their meeting point? *Data & Knowledge Engineering*, 46, pp.41-64.

Coughlan, R., 2007. Workpalce Learning and Accredited Programmes in Higher Education. In *Assessment and Qualification in a European Learning Community*. PLATO. Budapest, pp. 1-21.
Cox, M., Abott, C., Webb, M., Blakeley, B., Beauchamp, T. & Rhodes, V., 2003a. *ICT and attainment*, London: DfES.
Cox, M., Abott, C., Webb, M., Blakeley, B., Beauchamp, T. & Rhodes, V., 2003b. *ICT and pedagogy*, London: DfES.
Cronbach, L.J. & Gleser, G.C., 1965. Psychological tests and personnel decisions.
Day, C., 1999. *Developing teachers: the challenges of Lifelong Learning*, New York: Routledge-Falmer.
Downes, S., 2005. E-learning 2.0. *eLearn*, 2005(10), p.1–.
Draganidis, F. & Mentzas, G., 2006. Competency based management: a review of systems and approaches. *Information Management and Computer Security*, 14(1), p.51.
Druga, P., 2008. *The Development of eServices in an Enlarged EU: eLearning in Slovakia*, Seville: European Commission Joint Research Centre Institute for Prospective Technological Studies.
Dye, A., Jones, B. & Kismihók, G., 2007. Practical considerations when developing course materials for mobile learning. In D. Keegan, ed. *Mobile Learning A Practical Guide*. Dublin: Ericsson, pp. 111-119.
Ecclestone, K., Biesta, G.J.J. & Hughes, M. eds., 2010. *Transitions and learning through the lifecourse*, London: Routledge.
DG Education and Culture, Joint Research Centre, Centre for Research on Lifelong Learning & Eurostat, 2008. Progress Towards the Lisbon Objectives in Education and Training.
Ellis, R.A. et al., 2006. How and what university students learn through online and face-to-face discussion: conceptions, intentions and approaches. *Journal of Computer Assisted Learning*, 22(4), pp.244-256.
Empirica, 2006. *Benchmarking Access and Use of ICT in European Schools 2006: Final Report from Head Teacher and Classroom Teacher Surveys in 27 European Countries*, Brussels: European Commission.
Ericsson, 2008. The Impact of new technologies on distance learning students. *Ericsson Education*.
European Commission, 2005a. eAccessibility.
European Commission, 2007a. European i2010 initiative on e-Inclusion “To be part of the information society.”
European Commission, 2002. European Report on Quality Indicators of Lifelong Learning.
European Commission, 2005b. i2010 - A European Information Society for growth and employment.
European Commission, 2007b. *Key Competencies in Lifelong Learning*, Luxembourg: European Communities.
European Commission, 2008a. *Progress towards the Lisbon Objectives in Education and training. Indicators and benchmarks.*, Brussels: European Commission.
European Commission, 2005c. *The Bologna Declaration on the European space for higher education: an explanation*,
European Commission, 2008b. *The use of ICT to support innovation and lifelong learning for all - A report on progress*, Brussels: European Commission.

European Council, 2009. *Council conclusions of 12 May 2009 on a strategic framework for European cooperation in education and training ("ET 2020")*,

European ODL Liaison Committee, 2006. Learning Innovation for the Adapted Lisbon Agenda.

European ODL Liaison Committee, 2004. Review of Position and Future Functioning of the European ODL Liaison Committee.

European Parliament, 2003. *Adopting a multiannual programme (2004 to 2006) for the effective integration of information and communication technologies (ICT) in education and training systems in Europe (eLearning Programme)*,

European Parliament, 2006. *Establishing an action programme in the field of lifelong learning*,

European Parliament, 2005. *Mid-term review of the Lisbon strategy, European Parliament resolution on the mid-term review of the Lisbon Strategy*, Strasbourg: European Parliament.

European Parliament, 2008. *Recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning*,

Eurostat, 2006. Eurostat - Data Explorer. *Eurostat Database*.

Field, J., Gallacher, J. & Ingram, R., 2009. *Researching Transitions in Lifelong Learning*, New York: Routledge.

Fischer, Gerhard, 2001. Lifelong Learning And Its Support With New Media. In N. J. Smelser & P. B. Baltes, eds. *International encyclopedia of social and behavioural sciences*. Amsterdam: Elsevier, pp. 8836-8840.

Fischer, G. & Konomi, S., 2007. Innovative socio-technical environments in support of distributed intelligence and lifelong learning. *Journal of Computer Assisted Learning*, 23(4), pp.338-350.

Flanagan, J.A., 2005. Context Awareness in a mobile device: Ontologies versus unsupervised/ supervised learning.

Foresman, C., 2010. iPhone OS still dominates mobile web.

Futó, I. et al., 2008. Higher Education Portfolio Alignment With World of Labour Needs. In *Electronic Government: Proceedings of ongoing research and projects of EGOV 08*. EGOV 2008. Torino, Italy: Schriftenreihe Informatik, pp. 265-272.

Füstös, L. et al., 2004. *Alakfelismerés*, Budapest: Új Mandátum.

FVU, 2003. The Strategy of the Finnish Virtual University.

Gabor, A., 2006. Működéskorszerűsítés a felsőoktatásban. In *Felsőoktatás-fejlesztési és felsőfokú szakképzési konferencia*. Felsőoktatás-fejlesztési és felsőfokú szakképzési konferencia. Budapest.

Gabor, A., 2007. Tudásszintkiegyenlítő, rövidciklusú e-learning kurzusok kifejlesztése. In *HEFOP Workshop*. HEFOP Workshop. Budapest.

Garcia-Sanchez, F. et al., 2006. An ontology-based intelligent system for recruitment. *Expert Systems with Applications*, 31(2), pp.248-263.

Goasduff, L. & Pettey, C., 2010. Worldwide Mobile Device Sales Grew 13.8 Percent in Second Quarter of 2010.

Gokhale, A.A., 1995. Collaborative Learning Enhances Critical Thinking. *Journal of Technology Education*, 7(1), pp.22-30.

Gómez-Pérez, A. & Corcho, O., 2002. Ontology Languages for the Semantic Web. *IEEE Intelligent Systems*, 17(1), pp.54-60.

Gouthro, P.A., 2010. Well-being and happiness: critical, practical and philosophical considerations for policies and practices in lifelong learning. *International Journal of Lifelong Education*, 29(4), pp.461-474.

Guangzuo, C. et al., 2004. OntoEdu: a case study of ontology-based education grid system for e-learning.

Gudauskas, R. & Remigijus, S., 2008. *The Development of eServices in an Enlarged EU: eLearning in Lithuania*, Seville: European Commission Joint Research Centre Institute for Prospective Technological Studies.

He, H., 2003. What Is Service-Oriented Architecture. *webservices.xml.com*.

HEFOP FOI Project, 2006. Referencia-modell. *HEFOP FOI Website*. Available at: http://informatika.bkae.hu/hefop

Herman, T. & Banister, S., 2007. Face-to-Face versus Online Coursework: A Comparison of Learning Outcomes and Costs G. L. Bull & L. Bell, eds. *Contemporary Issues in Technology and Teacher Education*, 7(4), pp.318-326.

Hogan, J. & Roberts, B.W., 1996. Issues and Non-Issues in the Fidelity-Bandwidth Trade-Off. *Journal of Organizational Behavior*, 17(6), pp.627-637.

Hoppe, Ulrich, 2006. How can we integrate mobile devices with broader educational scenarios? In M. Sharples, ed. *Big Issues in Mobile Learning: Report of a workshop by the Kaleidoscope Network of Excellence Mobile Learning Initiative*. Nottingham: Learning Sciences Research Institute, University of Nottingham.

Hsu, T.-Y., Ke, H.-R. & Yang, W.-P., 2006. Knowledge-based mobile learning framework for museums. *Electronic Library, The*, 24(5), pp.635-648.

Hu, B. & Moore, P., 2007. “SmartContext”: An Ontology Based Context Model for Cooperative Mobile Learning. In *Computer Supported Cooperative Work in Design III*. Lecture Notes in Computer Science. Springer Berlin / Heidelberg, pp. 717-726-726.

Huang, J.-H., Lin, Y.-R. & Chuang, S.-T., 2007. Elucidating user behavior of mobile learning: A perspective of the extended technology acceptance model. *The Electronic Library*, 25(5), pp.586-599.

Hummel, K.A., Hlavacs, H. & Weissenböck, H., 2002. Web based online-learning in technically equipped and mobile student societies: a case study’, Paper presented. In *Proceedings of the 5th International Workshop on Interactive Computer Aided Learning*. Villach, Austria.

InfoDev, 2005. *Knowledge Map: Impact of ICTs on Learning & Achievement*, Washington: The World Bank.

IS unit website - IPTS - JRC - EC, 2008. Creative Learning & Innovative Teaching: A study on Creativity and Innovation in Education in EU Member States.

IS unit website - IPTS - JRC - EC, 2009. The Future of Learning: New Ways to Learn New Skills for Future Jobs.

IS unit website - IPTS - JRC - EC, 2010. The use and potential of ICT for learning, education and training.

ISO - International Organization for Standardization, 2003. ISO 15836 - The Dublin Core metadata element set.

Johnson, S.D. et al., 2000. Comparative analysis of learner satisfaction and learning outcomes in online and face-to-face learning environments. *J. Interact. Learn. Res.*, 11, pp.29–49.

Joint Quality Initiative, 2004. Shared “Dublin” Descriptors for the Bachelor’s and

Master's and Doctoral Awards.

Jones, C.B. et al., 2002. Spatial information retrieval and geographical ontologies an overview of the SPIRIT project. In *Proceedings of the 25th annual international ACM SIGIR conference on Research and development in information retrieval*. Tampere, Finland: ACM, pp. 387-388.

Kalfoglou, Y. & Schorlemmer, M., 2003. Ontology Mapping: The State of the Art. *The Knowledge Engineering Review*, 18(01), pp.1-31.

Kalis, M., 2008. *The Development of eServices in an Enlarged EU: eLearning in Latvia*, Seville: European Commission Joint Research Centre Institute for Prospective Technological Studies.

Kay, A.C., 1972. A Personal Computer for Children of All Ages. In *Proceedings of the ACM annual conference - Volume 1*. ACM '72. Boston, Massachusetts, United States: ACM.

Keegan, D., 2008. Exploiting New Technologies to Raise Young People's Achievement.

Keegan, D., 1990. *Foundations of distance education* First., London: Routledge.

Keegan, D., 2002. *The future of Learniing: From eLearning to mLearning*, Hagen: FernUniversitaet.

Keegan, D. ed., 2005. *Mobile Learning A Practical Guide*, Dublin: Ericsson.

Kismihók, G., 2007. Mobile Learning in the Higher Education: The Corvinus Case. In *Online Educa Berlin 2007 Proceedings*. Online Educa Berlin 2007. Berlin, Germany.

Kismihók, G. & Andrejkovics, Z., 2008. MLearning @ Corvinus University of Budapest. In *ECLO 15th International Confenece Proceedings*. ECLO 2008. Budapest, Hungary: ECLO.

Kismihók, G. & Mol, S., 2009. Ontology Driven Selection and Recruitment. In *Proceedings of EAWOP 2009*. EAWOP 2009. Santiago de Compostella.

Kismihók, G., & Vas, R. (2011). Empirical research on learners' thoughts about the impact of mobile technology on learning. *International Journal of Mobile and Blended Learning*, *3*(1), 73-88.

Kismihók, G. & Vas, R., 2009a. Mobile Learning Research at the Corvinus University of Budapest. In *the Corvinus University of Budapest, In: Szűcs A. (ed.): Book of Abstracts, LOGOS Conference on strengthening the integration of ICT research effort*. LOGOS Conference on strengthening the integration of ICT research effort. Budapest: EDEN.

Kismihók, G. & Vas, R., 2009b. Mobile Learning Research at the Corvinus University of Budapest. In *Book of Abstracts*. LOGOS Conference on on strengthening the integration of ICT research effort. Budapest: EDEN.

Kismihók, G., Kovacs, B. & Vas, R., 2009. Integrating Ontology based content management into a mobilized Learning Environment. In S. Cabakke et al., eds. *Architectures for Distributed and Complex M-Learning Systems: Applying Intelligent Technologies*. Hershey: IGI-Global.

Kismihók, G. et al., 2010. Ontology Based Competency Matching between the Vocational Education and the Workplace: The OntoHR project. In *AICA 2010 Proceedings*. AICA 2010. l'Aquila.

Kismihók, G. et al., 2011. Competency matching between vocational education and the workplace with the help of ontologies. In *Proceedings of WM2011*. WM2011. Innsbruck.

Knapper, K.C. & Cropley, J.A., 2000. *Lifelong learning in higher education* 3rd ed., London: Kogan Page.

Knight, C., Gašević, D. & Richards, G., 2005. Ontologies to integrate learning design and learning content. *Journal of Interactive Media in Education (Advances in Learning Design. Special Issue)*, 7, pp.1-24.

Kohn, A., 2000. *The Case against Standardized Testing: Raising the Scores, Ruining the Schools.*, Portsmouth: Heinemann.

Kozma, R.B., 2003. Technology and Classroom Practices: An International Study. *Journal of Research on Technology in Education*, 36(1), pp.1-14.

Kő, A. et al., 2008. Ontology-based Support of Knowledge Evaluation in Higher Education. In *Proceeding of the 2008 conference on Information Modelling and Knowledge Bases XIX*. Amsterdam, The Netherlands: IOS Press, pp. 306-313.

Kő, Andrea, 2010. Szervezeti memória és ontológiák.

Krämer, B.J., 2007. Data Analysis Report on the Impact of Technology on Learning in Open Universities and Distance Education.

Krause, A., Smailagic, A. & Siewiorek, D.P., 2006. Context-Aware Mobile Computing: Learning Context-Dependent Personal Preferences from a Wearable Sensor Array. *IEEE Transactions on Mobile Computing*, 5, pp.113-127.

Kukulska-Hulme, A. & Traxler, J., 2005. *Mobile Learning: A Handbook for Educators and Trainers*, London: Routledge.

Lawton, G., 2008. New Ways to Build Rich Internet Applications. *IEEE Computer Society*, 41(8), pp.10-12.

Learnovation Project, 2008. *Foresight Report*,

Linacre, J.M., 2000. Computer-adaptive testing: a methodology whose time has come. MESA Memorandum No. 69. In *Published in Sunhee Chae, Unson Kang, Eunhwa Jeon and J.M. Linacre. Development of Computerised Middle School Achievement Test (in Korean). Seoul, South Korea: Komesa*. Komesa Press.

Magai, Á. & Simonics, I., 2008. *The Development of eServices in an Enlarged EU: eLearning in Hungary*, Seville: European Commission Joint Research Centre Institute for Prospective Technological Studies.

Milrad, M., 2006. Media Migration and Contextual Services: Putting Content into Context to Support Nomadic Learners. In *ICALT 2006*. ICALT 2006. pp. 1178-1179.

mobiThinking, 2010. Global mobile stats: all latest quality research on mobile Web and marketing. *mobithinking.com*.

Mochol, M., Jentzsch, A. & Wache, H., 2007. Suitable employees wanted? Find them with semantic techniques. In *Making Semantics Work For Business, European Semantic Technology Conference 2007*. ESTC2007. Vienna.

Mochol, M., Oldakowski, R. & Heese, R., 2004. Ontology based Recruitment Process. In *Informatik verbindet, Band 2, Beiträge der 34. Jahrestagung der Gesellschaft für Informatik e.V. (GI)*. Ulm: Gesellschaft für Informatik e.V.

Moreale, E. & Vargas-Vera, M., 2004. Semantic Services in e-Learning: an Argumentation Case Study. *IEEE Journal of Educational Technology & Society*, 7(4), pp.112-128.

Motowidlo, S.J., 2003. Job performance. In W. C. Borman, D. R. Ilgen, & R. J. Klimoski, eds. *Handbook of Psychology*. Hoboken, N.J.: John Wiley & Sons, pp. 39-53.

Naismith, L. & Corlett, D., 2006. Reflections on Success: A Retrospective of the mLearn Conference Series 2002-2005. In *mLearn 2006 – Across generations and cultures Conference*. mLearn 2006. Banff.

Ng, A., Hatala, M. & Gasevic, D., 2006. Ontology-based Approach to Learning Objective Formalization..

Okada, M. et al., 2003. DigitalEE II: RV-augmented interface design for networked collaborative environmental learning. In B. Wasson, S. Ludvigsen, & U. Hoppe, eds. *International Conference on Computer Support for Collaborative Learning (CSCL2003)*. Dordrecht, The Netherlands: Kluwer Academic Publishers, pp. 265-274.

Ones, D.S. & Viswesvaran, C., 1996. Bandwidth-Fidelity Dilemma in Personality Measurement for Personnel Selection. *Journal of Organizational Behavior*, 17(6), pp.609-626.

Ones, D.S., Viswesvaran, C. & Dilchert, S., 2005. Cognitive ability in selection decisions. In O. Wilhelm & R. W. Engle, eds. *Handbook of understanding and measuring intelligence*. London: SAGE, pp. 431-468.

Ortiz, S., 2010. Is 3D Finally Ready for the Web? *IEEE Computer Society*, 43(1), pp.14-16.

Peng, H., Tsai, C.-C. & Wu, Y.-T., 2006. University students’ self-efficacy and their attitudes toward the Internet: the role of students’ perceptions of the Internet. *Educational Studies*, 32(1), pp.73-86.

Perkins, M., 2010. Flash Player 10.1: Live and Ready for Android (Adobe Flash Platform Blog).

PLS Rambol, 2004. *Studies in the Context of the E-learning Initiative: Virtual Models ofEuropean Universities*, Brussels.

Prensky, M., 2007. Changing Paradigms.

Quinn, C., 2000. m-learning: Mobile, wireless, in-your-pocket learning. *LineZine*, (Fall 2000).

Rasch, G., 1992. *Probabilistic Models for Some Intelligence and Attainment Tests*, Chicago: MESA Press.

ReferNet Italy. (2009). *Italy, VET in Europe – Country Report*. VET in Europe – Country Report. CEDEFOP, ReferNet.

Reich, J.R., Brockhausen, P., Lau, T. & Reimer, U., 2002. Ontology-Based Skills Management: Goals, Opportunities and Challenges. *Journal of Universal Computer Science*, 8(5), pp.506–515.

Restall, B., 2008. *The Development of eServices in an Enlarged EU: eLearning in Malta*, Seville: European Commission Joint Research Centre Institute for Prospective Technological Studies.

Robinson, K., Sir, 2008. Changing Paradigms.

Rogers, E., 2003. *Diffusion of Innovations, 5th Edition* Original., Free Press.

Romer, P., 1990. Endogenous Technological Change. *The Journal of Political Economy*, 98(5, Part 2), pp.71-102.

Runiewicz, M., 2008. *The Development of eServices in an Enlarged EU: eLearning in Poland*, Seville: European Commission Joint Research Centre Institute for Prospective Technological Studies.

Sargeant, J. et al., 2004. Interactive on-line continuing medical education: Physicians’ perceptions and experiences. *Journal of Continuing Education in the Health Professions*, 24(4), pp.227-236.

Saucier, G., 2008. Measures of the personality factors found recurrently in human lexicons. In G. J. Boyle, G. Matthews, & D. H. Saklofske, eds. *The Sage handbook of personality theory and assessment*. London: Sage publications, pp. 29-54.

Scanlon, E. et al., 2009. Support for evidence-based inquiry learning: teachers, tools and phases of inquiry. In *Proceedings of the 13th Biennial Conference of the European Association for Research on Learning and Instruction (EARLI)*. EARLI. Amsterdam.

Schmidt, A. & Kunzmann, C., 2007. Sustainable Competency-Oriented Human Resource Development with Ontology-Based Competency Catalogs. In *eChallenges 07*. Den Haag..

Schmidt, A. & Kunzmann, C., 2006. Towards a Human Resource Development Ontology for Combining Competence Management and Technology-Enhanced Workplace Learning. In *On the Move to Meaningful Internet Systems 2006: OTM 2006 Workshops*.

Schmidt, A. et al., 2009. Conceptual Foundations for a Service-oriented Knowledge and Learning Architecture: Supporting Content, Process and Ontology Maturing. In S. Schaffert, K. Tochtermann, & T. Pellegrini, eds. *Networked Knowledge - Networked Media: Integrating Knowledge Management, New Media Technologies and Semantic Systems*. Springer.

Schmidt, F.L. & Hunter, J.E., 2004. General Mental Ability in the World of Work: Occupational Attainment and Job Performance. *Journal of Personality & Social Psychology*, 86(1), pp.162-173.

Schmidt, F.L. & Hunter, J.E., 1998. The validity and utility of selection methods in personnel psychology: Practical and theoretical implications of 85 years of research findings. *Psychological Bulletin*, 124(2), pp.262-274.

Schneider, R.J., Hough, L.M. & Dunnette, M.. D., 1996. Broadsided by Broad Traits: How to Sink Science in Five Dimensions or Less. *Journal of Organizational Behavior*, 17(6), pp.639-655.

Seppälä, P. & Alamäki, H., 2003. Mobile learning in teacher training. *Journal of Computer Assisted Learning*, 19(3), pp.330-335.

Shannon, C. & Weaver, W., 1949. *The mathematical theory of communication*, Urbana: University of Illinois Press.

Sharples, M., 2009. Methods for Evaluating Mobile Learning. In G. Vavoula, N. Pachler, & A. Kukulska-Hulme, eds. *Researching Mobile Learning: Frameworks, Tools and Research Designs*. Oxford: Peter Lang, pp. 17-39.

Sharples, M., 2000. The design of personal mobile technologies for lifelong learning. *Computers & Education*, 34(3-4), pp.177-193.

Sharples, M. ed., 2006. *Issues in Mobile Learning: Report of a workshop by the Kaleidoscope Network of Excellence Mobile Learning Initiative*, Nottingham: Learning Sciences Research Institute, University of Nottingham.

Sharples, M. et al., 2009. Mobile Learning: Small devices, Big issues. In N. Balacheff et al., eds. *Technology-Enhanced Learning*. Dordrecht: Springer Netherlands, pp. 233-249.

Shaw, B.F. & Dobson, K.S., 1988. Competency Judgments in the Training and Evaluation of Psychotherapists. *Journal of Consulting & Clinical Psychology October*, 56(5), pp.666-672.

Siadaty, M. et al., 2010. m-LOCO: An Ontology-based Framework for Context-Aware Mobile Learning.

Siemens, G., 2005. Connectivsm: A Learning Theory for the Digital Age. *elearnspace.org*.

Smither, J.W. et al., 1993. Applicant reactions to selection procedures. *Personnel Pyschology*, 46(1), pp.49-76.

Solimeno, A. et al., 2008. The influence of students and teachers characteristics on the efficacy of face-to-face and computer supported collaborative learning. *Computers & Education*, 51(1), pp.109-128.

Soloway, E. et al., 1996. Learning theory in practice: case studies of learner-centered design. In *Proceedings of the SIGCHI conference on Human factors in computing systems: common ground*. CHI '96. New York, NY, USA: ACM, pp. 189–196.

Suurna, M. & Kattel, R., 2008. *The Development of eServices in an Enlarged EU: eLearning in Estonia*, Seville: European Commission Joint Research Centre Institute for Prospective Technological Studies.

Szabó, I., 2006. The implementation of the educational ontology. In *Proceedings of the 7th European Conference on Knowledge Management*. Academic Conferences Limited, p. 541.

Szabó, I & Vas, R, 2006. Educational Ontology and Adaptive Knowledge Testing. In *NITIM Ph.D. Consortium Proceedings*. NITIM Ph.D. Consortium. Piliscsaba.

Tangney, B. et al., 2010. MobiMaths: An approach to utilising smartphones in teaching mathematics. In *Mlearn2010 - 9th world conference on mobile and contextual learning.* Mlearn2010 - 9th world conference on mobile and contextual learning. Valetta, pp. 9-16.

Tett, R.P. et al., 2000. Development and content validation of a "hyperdimensional" taxonomy of managerial competence. *Human Performance*, 13(3), pp.205-251.

Thissen, D. & Mislevy, R.J., 1990. Testing algorithms. In H. Wainer, ed. *Computerized Adaptive Testing*. New Jersey: Lawrence Erlbaum Associates, pp. 103-135.

Thorpe, M., 2000. New Technology and Lifelong Learning.

Tóth, T.L., 2009. *Virtuális tantermek benchmarkingja*. Master Thesis. Budapest: Corvinus University of Budapest.

Traxler, J., 2007. Defining, Discussing, and Evaluating Mobile Learning: The moving finger writes and having writ…. *International Review of Research in Open and Distance Learning*, 8(2).

Traxler, J. & Kukulska-Hulme, A., 2005. Evaluating Mobile Learning: Reflections on Current Practice. In *mLearn 2005: Mobile technology: The future of learning in your hands*. mLearn2005.

United Nations, 1997. "International Standard Classification of Education ISCED 1997"

U.S. Department of Education, Institute of Education Sciences, 2003. *Identifying and implementing educational practices supported by rigorous evidence: A user friendly guide*, Washington: Institute of Education Sciences. Available at: www.excelgov.org/evidence.

Valenta, A. et al., 2001. Identifying Student Attitudes and Learning Styles in Distance Education. *JALN*, 5(2), pp.111-127.

Vas, R., 2006 Educational Ontology and Knowledge Testing. *The Electronic Journal of Knowledge Management of*, 5(1).

Vas, R, 2007. *The Role and Adaptability of Educational Ontology in Supporting Knowledge Testing*. Corvinus University of Budapest.

Vas, R et al., 2007. Hungarian Experiences of Using an Ontology-based Adaptive Knowledge Evaluation Approach in Teaching Business Informatics in a Mobile Learning Environment. In *Proceedings of the Workshop on Cross-Media and Personalized Learning Applications on top of Digital Libraries*. LADL 2007. Budapest, pp. 47-64.

Vas, R, Kovács, B. & Kismihók, G., 2009a. Ontology-based mobile learning and knowledge testing. *International Journal of Mobile Learning and Organisation*, 3(2), pp.128-147.

Vavoula, G. & Sharples, M., 2008. Challenges in Evaluating Mobile Learning. In *Proceedings of the mLearn 2008 Conference*. mLearn2008. Wolverhampton: University of Wolverhampton, pp. 296-303.

Vehovar, V., 2008. *The Development of eServices in an Enlarged EU: eLearning in Slovenia*, Seville: European Commission Joint Research Centre Institute for Prospective Technological Studies.

Visser, K. (2009). *Netherlands, VET in Europe – Country Report* ( No. 7). VET in Europe – Country Report (p. 52). ‘s-Hertogenbosch: CEDEFOP, ECBO.

Vygotskiĭ, L.S., 1978. *Mind in society: the development of higher psychological processes*, Harvard University Press.

Walker, K., 2006. Mapping the Landscape of Mobile Learning. In M. Sharples, ed. *Big Issues in Mobile Learning: Report of a workshop by the Kaleidoscope Network of Excellence Mobile Learning Initiative*. Nottingham: Learning Sciences Research Institute, University of Nottingham.

Watkins, R., 2010. *e-Learning*, John Wiley & Sons, Inc. Available at: http://dx.doi.org/10.1002/9780470587102.ch24.

World Economic Forum, 2004. *Networked Readiess Index*, WEF.

Yang, S.J.H., Chen, I.Y.-ling & Shao, N.W.Y., 2004. Ontological enabled annotations and knowledge management for collaborative learning in a virtual learning community. In *Proceedings of 1st International Workshop on Agents and Peer-to-Peer Computing (AP2PC)*. pp. 45-56.

Yang, S.J.H. et al., 2006. Context Model and Context Acquisition for Ubiquitous Content Access in ULearning Environments. In *IEEE International Conference on Sensor Networks, Ubiquitous, and Trustworthy Computing, 2006*. IEEE International Conference on Sensor Networks, Ubiquitous, and Trustworthy Computing, 2006. Taichung, pp. 78-83.

Yee, K.Y. et al., 2009. OntoMobiLe: A Generic Ontology-Centric Service-Oriented Architecture for Mobile Learning. In *Mobile Data Management: Systems, Services and Middleware, 2009. MDM ’09*. Mobile Data Management: Systems, Services and Middleware, 2009. MDM ’09. Taipei, pp. 631-636.

# APPENDIX

## Appendix 1. MOTILL Evaluation Grid

| | |
|---|---|
| **MANAGEMENT** | |
| 1. Rationale | |
| | What is the rationale for this new practice or innovation? Why was it introduced? |
| 2. Technologies and media utilized | |
| | Specifically which technologies and media are used, and how? |
| 3. Stakeholder & Agency | |
| | Who is involved in this practice? Who initiates the practice: the learner or another party? Who manages the practice: the learner or another party? |
| 4. Organizational support | |
| | Who provides support for this practice? What are their roles? What is required to conduct this practice? (e.g. Staff, equipment, expertise, venue, funding etc) Does this practice have a sponsor/funding? What are the costs of implementation (for the organization and the learners)? |
| 5. Risk Assessment | |
| | What are the main challenges faced by this practice? How have these been addressed? How could they be overcome more efficiently? |
| 6. Supporting transitions | |
| | Specifically how do mobile technologies support transitions at the level of educational practices? (e.g. between formal and informal learning, between one level of learning and the next) |
| 7. Achievement of economic goals | |
| | What economic challenges/issues does this practice address? What problems does it solve? Are these local or national? |
| 8. Quality Assurance | |
| | What is the value of this innovation? Has it been evaluated or researched? Has the evaluation or research been reported & how? What were the findings? Is there evidence of quality? What is the best of this innovation? What needs to be improved & how could it be improved? |
| **PEDAGOGY** | |
| 9. Pedagogical support | |

| |
|---|
| What pedagogical approach is used? What pedagogical resources? How does this practice support or enhance teaching and learning? |
| 10. Impact on subjects being learnt |
| How is the subject or discipline changed by the use of mobile technology? |
| 11. Learning behaviours, activities and processes |
| How does learning take place? What are the learners doing and why? To what extent do learners initiate and manage their learning? |
| 12. Development of competences |
| What skills and competences are learners acquiring through the use of mobile technology? |
| 13. Achievement of educational goals |
| What political educational challenges/issues does this practice address? What problems does it solve? Are these local or national? |
| 14. Support for learning across contexts |
| What are the physical and social contexts in which this practice takes place? (classroom, workplace, outdoors, virtual; individuals, groups, etc…) How are learners enabled to make connections and transitions between contexts? |
| **POLICY** |
| 15. Achievement of political and social goals |
| What political and social challenges/issues does this practice address? What problems does it solve? Are these local or national? |
| 16. Evidence of transferability |
| To what extent is this practice transferable to other contexts (local, national, international)? Is there evidence of transferability? Is there potential? |
| 17. Significance for policy-makers |
| What makes this practice important, i.e. what is its local, national or international significance? (for example in terms of its actual or potential impact) |
| 18. Supporting lifelong-learning |
| Specifically how do mobile technologies support social and cultural transitions? (e.g. social mobility, inclusion, lifelong learning) |
| **ETHICAL CONSIDERATIONS** |
| Were there any ethical considerations when planning, implementing and/or evaluating the project? (e.g. copyright, accessibility, privacy) |

**Table 18: The Evaluation Grid - Criteria for evaluation**

## APPENDIX 2. IMPACT QUESTIONNAIRE

# Impact of technology on learning in mobile learning

**Personal background**

1. What is your occupation?

- ☐ Manager
- ☐ Technical
- ☐ Teacher or trainer
- ☐ Student
- ☐ Self-employed
- ☐ Retired
- ☐ Unemployed

2. What is your age grouping?

- ☐ 24 or younger
- ☐ 25-29
- ☐ 30-40
- ☐ 41-50
- ☐ over 50

3. Gender?

- ☐ Male
- ☐ Female

4. What is your level of education?

- ☐ High school matriculation
- ☐ One to three years of post-secondary education
- ☐ Four or more years of post-secondary education

5. To what extent have you used advanced technological equipment in your professional life?

- ☐ A lot
- ☐ Quite a bit
- ☐ Little
- ☐ Very little
- ☐ Not at all

6. Have you had to change your way of working because of technological developments?

- ☐ Yes. More than once
- ☐ Yes. Once
- ☐ No

**Questions on the impact of information and communications technologies (ICT) on learning in general**

7. Thanks to technology, the problems of access to learning for students with disabilities have been resolved

- ☐ Strongly agree
- ☐ Agree
- ☐ Uncertain
- ☐ Disagree
- ☐ Strongly disagree

8. Contacts between students and teachers can have the same intensity in online education as in face-to-face education

- ☐ Strongly agree
- ☐ Agree
- ☐ Uncertain
- ☐ Disagree
- ☐ Strongly disagree

9. Online communication allows increased amounts of communication between teachers and students when compared with other forms of education

- ☐ Strongly agree
- ☐ Agree
- ☐ Uncertain
- ☐ Disagree
- ☐ Strongly disagree

10. The opinion that the impact of technology on learning is beneficial is correct

- ☐ Strongly agree
- ☐ Agree
- ☐ Uncertain
- ☐ Disagree
- ☐ Strongly disagree

11. From my personal study experience I find that the impact of technology on learning is valuable

- ☐ Strongly agree
- ☐ Agree
- ☐ Uncertain
- ☐ Disagree
- ☐ Strongly disagree

12. Information and communications technology has been used to encourage us to be active participants in our own learning and to learn by doing

- ☐ Strongly agree
- ☐ Agree
- ☐ Uncertain
- ☐ Disagree
- ☐ Strongly disagree

13. Information and communications technology has been used to support the development of higher level thinking skills such as application, analysis and synthesis

- ☐ Strongly agree
- ☐ Agree
- ☐ Uncertain
- ☐ Disagree
- ☐ Strongly disagree

14. Information and communications technology has been used to support more individualized learning programmes tailored to our own individual needs

- ☐ Strongly agree
- ☐ Agree
- ☐ Uncertain
- ☐ Disagree
- ☐ Strongly disagree

15. To what extent do you agree with the following: Learning is enhanced when text and pictures are integrated in a multimedia environment?

- ☐ Strongly agree
- ☐ Agree
- ☐ Uncertain
- ☐ Disagree

☐ Strongly disagree

16. To what extent do you agree with the following: Educational games motivate learners and contribute to developing skills such as teamwork?

☐ Strongly agree
☐ Agree
☐ Uncertain
☐ Disagree
☐ Strongly disagree

**Questions on the impact of information and communications technologies (ICT) on learning in mobile learning.**

17. I would propose mobile learning as a method of study to others.

☐ Strongly agree
☐ Agree
☐ Uncertain
☐ Disagree
☐ Strongly disagree

18. A mobile phone allows one to communicate more easily with tutors and other students.

☐ Strongly agree
☐ Agree
☐ Uncertain
☐ Disagree
☐ Strongly disagree

19. Mobile devices increase access to education and training.

☐ Strongly agree
☐ Agree
☐ Uncertain
☐ Disagree
☐ Strongly disagree

20. The fact that a mobile phone is a generally available device is important for education.

☐ Strongly agree
☐ Agree
☐ Uncertain
☐ Disagree

- Strongly disagree

21. Whoever possesses a mobile phone has all he or she needs for undertaking academic or professional study.

- Strongly agree
- Agree
- Uncertain
- Disagree
- Strongly disagree

## APPENDIX 3. CONTSENS QUESTIONNAIRE

### CONTSENS Mobile Learning Evaluation Questionnaire

Please complete this questionnaire. Your views are very important to us, so please do give your honest opinion. All your answers are confidential, and you will not be identified in any resulting work.

Name: ☐ Male: ☐ Female: ☐

Course or module: ☐

Age: 18-20 ☐ 21-25 ☐ 26-30 ☐ 31-35 ☐ 36-45 ☐ Over 40 ☐

1. Which mobile phone do you own? ☐

2. Does your mobile have GPS (Global Positioning System)? Yes ☐ No ☐ Don't know ☐

3. How would you rate your experience in using mobile phones?

   Very experienced ☐ Experienced ☐ Not experienced ☐

4. What did you think of the mobile learning course you have just experienced?

   ☐

5. How would you rate its usefulness in learning the subject?

   Extremely useful ☐ Useful ☐ Uncertain ☐ Not useful ☐ Extremely un-useful ☐

6. It was easy to use the equipment.

   Strongly agree ☐ Agree ☐ Uncertain ☐ Disagree ☐ Strongly disagree ☐

7. It was easy to navigate through the content.

| Strongly agree | Agree | Uncertain | Disagree | Strongly disagree |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

8. The mobile learning experience was fun.

| Strongly agree | Agree | Uncertain | Disagree | Strongly disagree |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

9. I would take another mobile learning course if it was relevant to my learning needs.

| Strongly agree | Agree | Uncertain | Disagree | Strongly disagree |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

10. I would recommend mobile learning as a method of study to others.

| Strongly agree | Agree | Uncertain | Disagree | Strongly disagree |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

11. Using the mobile device enhanced the learning experience.

| Strongly agree | Agree | Uncertain | Disagree | Strongly disagree |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

12. In what ways did it (or did not) enhance the learning experience?

13. Which functions of the device did you use most?

14. What did you think about the look and visual design of the course?

15. The course used location-based technologies to provide relevant learning material to your phone. How did you find this (e.g. was the course material always relevant, did this work well, etc.)?

16. Did you encounter any technical problems, e.g. in using the device and/or location-based technologies? If so, what problems did you have?

17. What did you like most about the mobile learning course?

18. What did you like least about the mobile learning course?

19. Do you have any suggestions for how we could improve the mobile learning course?

If you would be interested in being involved in further research with us into using mobile phones for learning, please give your details below:

Name: Email address:

Thank you for your help

## APPENDIX 4. LIST OF RELEVANT PUBLICATIONS


Agrusti, F., Keegan, Desmond, Kismihók, G., Krämer, B. J., Mileva, Nevena, Schulte, D., Thompson, J., et al. (2008). *The Impact of New Technologies on Distance Learning Students*. (Desmond Keegan, Ed.). Dublin: Ericsson.

Ala-Mutka, K., Gáspár, P., Kismihók, G., Suurna, M., & Vehovar, V. (2010). Status and Developments of eLearning in the EU10 Member States: the cases of Estonia, Hungary and Slovenia. *European Journal of Education*, *45*(3), 494-513.

Arnedillo Sánchez, I., Arrigo, M., Freida, C., Kismihók, G., Denaro, P., Di Giuseppe, O., Farrow, R., et al. (2010). *Motill - Mobile Technologies in Lifelong Learning / Best practicies*. Palermo: Italian National Research Council - Institute for Educational Technology.

Arrigo, M., Kismihók, G., Kukulska-Hulme, A., & Arnedillo Sánchez, I. (2009). Mobile Technologies in Lifelong Learning: Best Practices. *Proceedings of mLearn2009 International Conference*. Presented at the mLearn2009, Orlando, Florida.

Arrigo, M., Kukulska-Hulme, A., Arnedillo-Sánchez, I., & Kismihók, G. (2011). Meta-analyses from a collaborative project in mobile lifelong learning. *British Educational Research Journal*, (accepted, to be published in 2011).

Bíró, M., Fehér, P., Kismihók, G., & Gábor, A. (2005). Demands on e-Learning Development Raised by Offshoring Trends. *EPI - Working Places, Learning Spaces International Conference Proceedings 2005*. Presented at the EPI - Working Places, Learning Spaces International Conference 2005, Cork: CIT.

Bíró, M., Gábor, A., & Kismihók, G. (2007). Courses on Art Appreciation for Mobile Devices. In Desmond Keegan (Ed.), *Mobile Learning A Practical Guide* (pp. 137-141). Dublin: Ericsson.

Carril, I., Dias, A., Ispán, Z., Keegan, Desmond, Kismihók, G., Mileva, Nevena, Paulsen, M. F., et al. (2008). *The Role of Mobile Learning in Europe Today*. Dublin: Ericsson.

Chytilová, J., Dondi, C., del Rio, C., Gáspár, P., Jaksa, R. A., Kismihók, G., Vasja, V., et al. (2009). *The Development of eServices in an Enlarged EU: A Synthesis Report on eLearning* (Synthesis Report No. EUR 23831 EN). Seville: European Commission Joint Research Centre Institute for Prospective Technological Studies.

Dye, A., Jones, B., & Kismihók, G. (2007). Practical considerations when developing course materials for mobile learning. In Desmond Keegan (Ed.), *Mobile Learning A Practical Guide* (pp. 111-119). Dublin: Ericsson.

Jaksa, R. A., Kismihók, G., Kecskés, Z., & Lőrincz, L. (2005). *Nemzetközi „követendő gyakorlat" (best practice) a szélessávú fejlesztéspolitikában*. Budapest: IHM.

Keegan, D, Kismihok, G., Krämer, B., Mileva, N, & …B. (2008). *Bibliography: The Impact of new technologies on distance learning students*. deposit.fernuni-hagen.de. Retrieved from http://deposit.fernuni-hagen.de/1561/

Keegan, Desmond, Schwenke, E., Fritsch, H., Kenny, G., Kismihók, G., Biro, M., Gabor, A., et al. (2005). *Virtual Classrooms in Educational Provision: Synchronous eLearning Systems for European Institutions*. ZIFF Papiere. Hagen: FernUniversitaet.

Kismihók, G. (2006). Comparative Evaluation of Two Adaptive Knowledge and Skill Assessment Procedures. *NITIM – CEMS Ph.D. Workshop 2006 Proceedings*. Presented at the NITIM – CEMS Ph.D. Workshop 2006, Piliscsaba, Hungary.

Kismihók, G. (2007a). Mobile Learning in the Higher Education: The Corvinus Case. *Online Educa Berlin 2007 Proceedings*. Presented at the Online Educa Berlin 2007, Berlin, Germany.

Kismihók, G. (2007b). Adaptive technologies in competence based assessment within mobilized virtual learning environments. *Kaleidoscope mLearning PhD Workshop Proceedings*. Presented at the Kaleidoscope mLearning PhD Workshop, Waxjo, Sweden.

Kismihók, G. (2007c). SMS question-answer system. In Desmond Keegan (Ed.), *Mobile Learning A Practical Guide* (pp. 32-39). Dublin: Ericsson.

Kismihók, G. (2008a). Mobile Learning in Higher Education - An Empirical Study. *Impact International Conference*. Presented at the IMPACT 2008, Rome, Italy: Ericsson.

Kismihók, G. (2008b). mLearning in China. In A. Dias, Desmond Keegan, Nevena Mileva, & T. Rekkedal (Eds.), *Achievements of Mobile Learning Today* (pp. 35-58). Dublin: Ericsson.

Kismihók, G. (2008c). mLearning in Taiwan. In A. Dias, Desmond Keegan, Nevena Mileva, & T. Rekkedal (Eds.), *Achievements of Mobile Learning Today* (pp. 143-164). Dublin: Ericsson.

Kismihók, G. (2008d). An Ontology Based Learning Environment. *Proceedings of mLearn2008 International Conference*. Presented at the mLearn2008, Wolverhampton, UK: University of Wolverhampton.

Kismihók, G. (2009). Steps towards an ontology based learning environment. *ECLO 16th International Confenece Proceedings*. Presented at the ECLO 2009, 's Hertogenbosch, The Netherlands: ECLO.

Kismihók, G. (2010). Content development considerations for task based mobile learning. In Desmond Keegan & Nevena Mileva (Eds.), *Mobile learning performance support systems for vocational education and training* (p. 175). Plovdiv: Plovdiv University.

Kismihók, G., & Andrejkovics, Z. (2008). MLearning @ Corvinus University of Budapest. *ECLO 15th International Confenece Proceedings*. Presented at the ECLO 2008, Budapest, Hungary: ECLO.

Kismihók, G., & Gábor, A. (2005). The Art of m-Learning. *„m-Learning - The future of mobile?" conference proceedings*. Presented at the „m-Learning - The future of mobile?" conference, Dublin: Ericsson.

Kismihók, G., & Gábor, A. (2007a). Introducing mLearning into the mainstream education at the Corvinus University of Budapest. *Taking Learning Mobile Conference Proceedings*. Presented at the Taking Learning Mobile, Dublin: Ericsson.

Kismihók, G., & Gábor, A. (2007b). Introducing m-learning into the mainstream education at the Corvinus University of Budapest. *Proceedings of IADIS International Conference Mobile Learning*. Presented at the IADIS 2007, Lisbon.

Kismihók, G., & Mol, S. (2008). HR Meets e-Learning: An Ontology Based, Adaptive Selection and Recruitment Process Support. *Proceedings of 16th Annual EDEN Conference*. Presented at the 16th Annual EDEN Conference, Lisbon.

Kismihók, G., & Mol, S. (2009). Ontology Driven Selection and Recruitment. *Proceedings of EAWOP 2009*. Presented at the EAWOP 2009, Santiago de Compostella.

Kismihók, G., & Mol, S. (2011). The OntoHR project: Bridging the gap between vocational education and the workplace. *Book of Abstracts, EAWOP 2011* (pp. 194-195). Presented at the EAWOP 2011, University of Maastricht.

Kismihók, G., & Vas, R. (2006). Ontology based adaptive examination system in E-learning environment. *2006. 28th International Conference on Information*

*Technology Interfaces* (pp. 77-82). Presented at the 2006. 28th International Conference on Information Technology Interfaces, Cavtat/Dubrovnik: SRCE.

Kismihók, G., & Vas, R. (2009a). Mobile Learning Research at the Corvinus University of Budapest. *the Corvinus University of Budapest, In: Szűcs A. (ed.): Book of Abstracts, LOGOS Conference on strengthening the integration of ICT research effort*. Presented at the LOGOS Conference on strengthening the integration of ICT research effort, Budapest: EDEN.

Kismihók, G., & Vas, R. (2009b). Ontology based content management in a mobilized Learning Environment. *Proceedings of mLearn2009 International Conference*. Presented at the mLearn2009, Orlando, Florida.

Kismihók, G., & Vas, R. (2011). Empirical research on learners' thoughts about the impact of mobile technology on learning. *International Journal of Mobile and Blended Learning*, *3*(1). 73-88.

Kismihók, G., Dye, A., & Jones, B. (2006). Mobile Learning: The Next Generation of Learning: Exploring Online Services in a Mobile Environment. *EDEN 2006 International Conference Proceedings*. Presented at the EDEN 2006 International Conference, Vienna: EDEN.

Kismihók, G., Kovacs, B., & Vas, R. (2009). Integrating Ontology based content management into a mobilized Learning Environment. In S. Cabakke, F. Xhafa, T. Daradoumis, & A. A. Juan (Eds.), *Architectures for Distributed and Complex M-Learning Systems: Applying Intelligent Technologies*. 192 – 210. Hershey: IGI-Global.

Kismihók, G., Mol, S., Sancin, C., Van der Voort, N., Costello, V., Sorrentino, G., & Zoino, F. (2010). Ontology Based Competency Matching between the Vocational Education and the Workplace: The OntoHR project. *AICA 2010 Proceedings*. Presented at the AICA 2010, l'Aquila.

Kismihók, G., Mol, S., Vas, R., Duijts, P., Costello, V., Sorrentino, G., Zoino, F., et al. (2011a). An Innovative e-Learning System for Competence Matching Between Vocational Education and the Workplace. *SKIMA 2011 Proceedings*. Presented at the SKIMA 2011, Benevento: University of Sannio.

Kismihók, G., Szabó, I., & Vas, R. (2011b). Six scenarios of exploiting an ontology based, mobilized learning environment. *International Journal of Mobile and Blended Learning*, *accepted, to be published in 2011*.

Kismihók, G., Vas, R., & Mol, S. (2011a). Identifying challenges and constraints for an ontology driven, competence based selection and recruitment system development. *International Journal of Knowledge and Learning*, *Accepted, to be published in 2011*.

Kismihók, G., Vas, R., & Mol, S. (2011b). Competency matching between vocational education and the workplace with the help of ontologies. *Proceedings of EDEN2011* (p. 112). Presented at the EDEN2011, Innsbruck: EDEN.

Kismihók, G., Vas, R., Mol, S., & Castello, V. (2011a). Competency Validation and Matching – The OntoHR Workshop. *Proceedings of EDEN2011* (p. 96). Presented at the EDEN2011, Dublin: EDEN.

Kismihók, G., Vas, R., Mol, S., & Szabó, I. (2011b). Competency matching between vocational education and the workplace with the help of ontologies. *Proceedings of WM2011*. Presented at the WM2011, Innsbruck.

Mol, S., Kismihók, G., & Keegan, A. (2011). The Cinderella Predictor: Taking job knowledge to the personnel selection ball. *Proceedings of Dutch HRM Network Conference 2011*. Presented at the Dutch HRM Network Conference 2011, Groningen.

Vas, R., Kismihók, G., Kő, A., Szabó, I., & Bíró, Mi. (2007). Hungarian Experiences of Using an Ontology-based Adaptive Knowledge Evaluation Approach in Teaching Business Informatics in a Mobile Learning Environment. *Proceedings of the Workshop on Cross-Media and Personalized Learning Applications on top of Digital Libraries* (pp. 47-64). Presented at the LADL 2007, Budapest.

Vas, R., Kovács, B., & Kismihók, G. (2009). Ontology-based mobile learning and knowledge testing. *International Journal of Mobile Learning and Organisation*, *3*(2), 128-147.