A Comparative Study of Teaching Practices in Electrical and Information Engineering in Europe – Recommendations and Best Practices

D. Popescu*, S. Nowakowski, N. Bernard-Issenmann**, H. Yahoui***, D. Selisteanu***

** University of Craiova, 107 Decebal Blvd, Craiova, ROMANIA.*
(phone: +40-251-436999; fax: +40-251-436999; e-mail: dorinp@robotics.ucv.ro).
*** PRES de l'Université de Lorraine, NUTICE, 34 cours Léopold, 54056 Nancy, FRANCE.*
**** Université Claude Bernard Lyon 1, 41, Boulevard Andre Latarjet, 69622 Villeurbanne, FRANCE.*

Abstract: In this paper we present the methodology that we have adopted in order to propose recommendations for e-learning related to the objectives of ELLEIEC project. First, we present the general context and then we expose the different steps of the study which lead to e-learning recommendations for the Virtual Entrepreneurship Center.

Keywords: lifelong learning, thematic network, e-learning.

1. INTRODUCTION

ELLEIEC (Enhancing Lifelong Learning for the Electrical and Information Engineering Community) is an ERASMUS thematic network which is funded by the European Commission for a three-year period (October 2008 - March 2012) through Lifelong Learning Programme.

The universal right to education for every child, youth and adult is the fundamental principle. The general objective of the Lifelong Learning Programme is to contribute through lifelong learning to the development of the European Community as an advanced knowledge-based society, with sustainable economic development, more and better jobs and greater social cohesion, while ensuring good protection of the environment for future generations. In particular, it aims to foster interchange, cooperation and mobility between education and training systems within the Community so that they become a world quality reference [1].

The new Community programme - Lifelong Learning Programme (LLP) – continues former Socrates and Leonardo da Vinci programmes. The period of deployment of the programme is from 2007 to 2013, and the total budget will be of 6,970 million euros.

Components of the LLP are the following [2]: i) 4 sectoral programmes: Comenius (secondary education), Erasmus (higher education), Leonardo da Vinci (vocational training), Grundtvig (adult education); ii) Transversal programme; iii) Jean Monnet programme.

The European Employment Strategy sets as target in European Union the average rate for participation in lifelong learning to be at least 12.5 % of the adult population in employment age (age 24-64 years).

Adult education plays an influential role in poverty reduction, improving health and nutrition, and promoting sustainable environmental practices [3]. Adult learning counts, more than ever, in the era of globalization characterised by rapid change, integration and technological advances. Learning not only empowers adults by giving them the knowledge and skills to improve their lives but also benefits their families, communities and societies.

Lifelong learning objectives are integrated in the most important European and national strategic documents. For example, in Romania, one of these documents is the National Development Plan 2007-2013 (NDP). Romanian operational programmes for human resources development and strategies for national employment and for continuing vocational education are informed by lifelong learning [4]. The new Romanian Law of Education (January 2011) presents the national strategy for long life learning and offers a view on the main issues of lifelong learning at the level of all components and educational sectors and vocational training by also considering the non-formal and informal context of education.

It's required a change of mentality in what concerns the vocational training, which means increasing the level of awareness with respect to the importance of lifelong learning, the degree of motivation for broadening knowledge and developing skills.

The paper is organized as follows. Section 2 deals with the presentation of the project ELLEIEC; the main output of this project – the Virtual Centre for the entrepreneurship education in Electrical and Information Engineering – is outlined in this section. Also, one of the most important workpackages of the project is presented, more precisely the development of a methodology for an assessment of e-learning courses. In Section 3, this methodology is widely analyzed; the paper focuses on the

state of the art concerning e-learning, state of the art in terms of good practices, guidelines and existing projects in the field of e-learning, and some experiments achieved in several universities. Finally, Section 4 presents recommendations concerning the key points to be considered for the design of the Virtual Centre for the entrepreneurship.

2. DESCRIPTION OF THE ELLEIEC PROJECT

ELLEIEC is an ERASMUS thematic network which comprises 60 partners who are involved in a range of different workpackages. Our project will establish, as main output, a Virtual Centre for the entrepreneurship (VCE) education in Electrical and Information Engineering (EIE) with an internal e-learning assessment offer which will be a reference point for any applicant in the Lifelong Learning framework.

The Virtual Centre will connect learners of any age to a network of educators within academic institutions, business training advisory bodies and business mentors across Europe. The Virtual Centre will provide for enterprises a facility through which any learner within Europe can develop their enterprise skills and hence the centre will contribute to the competitiveness of the population in new venture creation and the economic growth of the European Union. Engagement of staff and learners with the Centre will also contribute to the excellence of European education and research in the enterprise area.

The first main task is to develop a virtual European Centre for Entrepreneurship Education in Electrical and Information Engineering. The second task will provide a guideline for an internal e-learning assessment offer which will be a reference point for any applicant in the Lifelong learning framework. The last task is to test some mobility network to promote mobility through the studying of good practice in the design of International cooperation at PhD, master and bachelor levels with attractive application. During the life of the project some experiments on the following set of tools will be tested through the Gateway:

- A gateway for individuals who wish to develop their enterprise knowledge and skills in the Electrical and Information Engineering discipline area;
- E-learning gateway;
- A degree framework for emerging job market needs in some domain of the EIE field;
- A showcase for PhD student positions, startups and European Degrees;
- Experiment in joint mobility network design at Batchelor and master level through Erasmus Programme, possibility for students to perform a double-exchange with an ERASMUS grant (in a first university for one semester and in a second one for a second semester);
- An Observatory of good practice in standard recognition of study periods;
- A methodology for an assessment of e-learning enterprise courses compared to more classical delivery methods, to define valuable e-learning tools.

All these aims and objectives could be reached by providing some tools on a central Gateway based on a set of experiments for the following target groups:

- Partners of the consortium,
- Professional engineering associations and Life Long Learning institutions,
- People involved in the field of EIE teaching and research in European higher Education institutions,
- Students and learners in European universities,
- Doctoral school and/or PhD student,
- Associate partners from outside of Europe and new free member of the entrepreneurship centre,
- Individuals who wish to develop their enterprise knowledge and skills in the Electrical and Information Engineering area.

For example, in workpackage V, ELLEIEC project has the aim to develop a methodology for an assessment of e-learning enterprise courses compared to more classical delivery methods, as well as to participate in the quality assessment of e-learning tools and define some valuable e-learning tools for course delivery.

The objectives were to submit a common questionnaire to different groups of students to evaluate teaching/learning process. The evaluation will explore many cases as:

- assessment of knowledge, skills and competence obtained by student during the learning process;
- identification of differences while using traditional teaching methodology and using e-learning tools and appropriate methodology;
- evaluation of satisfaction, motivation, enjoyment, etc.;
- self-evaluation of achievements in learning process while using e-learning tools and appropriate methodology in comparison with traditional teaching.

Sub-objectives of the workpackage V were:

- to clarify whether new methods of delivery have comparable or even improved efficiency as compared to conventional methods (Are e-supported learning methods in a mathematics-based subject successful? Compare success/failure with e-supported learning in more essay-based subjects, e.g. entrepreneurship);
- to observe potential trends in different learning behaviour depending on different regional provenance;
- to test different methods of delivery in practical situations;
- to enrich methods for assessment of success of on-line learning;
- to compare differences in the learning behaviour of students and their reactions to different learning methodologies:
    - classical methods using blackboard and chalk vs. technology-enhanced learning (TEL),

- within TEL: When teaching complex equations, do students follow the projections of mathematical equations? Or do they wait for explanation and subsequent writing down in their own notes?
- presence learning vs. distance learning.

- Comparison of the influence that different cultural backgrounds have on learning behaviour and learning success:
  - in Europe: East vs. West, North vs. South,
  - Europeans vs. Asians presence learning vs. distance learning.

- to compare different methods of assessment: oral; written, problem-based; written, simple multiple-choice; written, sophisticated multiple-choice.
- to compare different testers: academic staff, peers (other students), industrial partners.

3 METHODOLOGY

To achieve the main objectives of workpackage V, we have established the following milestones (Fig. 1a):

- state of the art concerning e-learning and the existing comparisons between the delivery methods;
- state of the art in terms of good practices, guidelines and existing projects in the field of e-learning;
- design of the questionnaire taking into account constraints coming from the involved partners (from the technical and methodological points of view);
- online survey and analysis of the results;
- recommendations for the VCE.

Fig. 1a summarizes the main steps and their interactions to achieve the objectives of the task.

3.1 State of the art

Our state of the art (Fig. 1b) has to fulfil some specific constraints. Firstly, because of the baseline of the task (comparative study of learning delivery methods), we have identified the need to have a common literature review and a shared knowledge of the important actors and actions in the field of e-learning for each partner country.

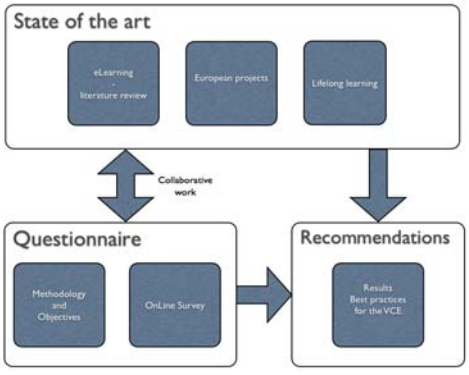


Fig. 1. a) Task V – Milestones.

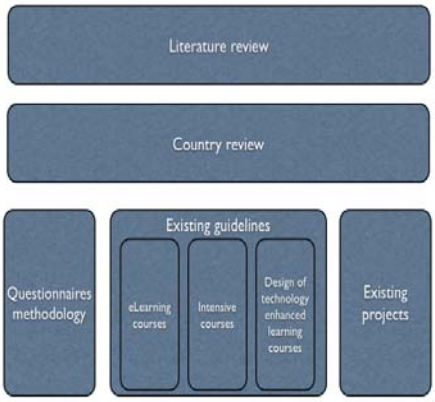


Fig. 1. b) State of the art – Structure.

Bibliography document of workpackage V presents the set of references which were investigated (more than 60). The references [5-27] are examples of papers used in the bibliography document for comparative study of learning delivery methods. E-learning, or more general virtual learning, is a well-introduced mean for supporting higher education. There is, however, a difference between e-learning in subjects that are more descriptive, and subjects that use mathematics as their language. This is why the adoption of e-learning tools in electrical and electronics engineering is not as rich as it could be. Another reason is the fact that there is not yet sufficient evidence of the usefulness of these means in course programs of electrical, electronics, and information engineering.

From a quality assurance point of view, there is still a statistically valid analysis missing that gives information about the comparability of a real-time face-to-face lecture and of a real-time virtual lecture using e-learning tools. For the same reasons, accreditation institutions have a very critical view to e-learning components in programs to be accredited.

On the other side, there is a growing demand for virtual courses in the context of lifelong learning, since these provide the necessary flexibility to potential learners to participate in learning programmes beside their work-life.

The aim of the proposed thematic network is thus to identify some types of e-learning that might be particularly useful in electrical, information and electronics engineering education, and to give evidence of it by testing and by statistical evaluation.

Secondly, we have to design a specific questionnaire with an adapted methodology which will give us the possibility to compare all types of experiments from e-learning to face-to-face instruction including specific tools (Tablet PC, ePortfolio, Users Response Systems) and blended learning. This questionnaire will be discussed in the next section. Thirdly, to be aware of the work done in others projects or studies, we need to have a common basis of references (bibliography, list of projects). These references will enrich the collaborative work which leads to the recommendations for the VCE.

Improving e-learning will create better access, quality, competitiveness and attractiveness to European higher education at all levels and in all domains, both in mainstream and in continuing education. Ultimately, this will support the Bologna objectives. It will ensure co-operation between European universities on one hand and raise competitiveness on the other [28].

By generating geographically borderless cooperation between universities and industry, the attractiveness and competitiveness of European higher education (HE) and European companies in the world is strengthened [29].

The result of accreditation on e-learning is an indication of the degree of excellence in Lifelong Open and Flexible (LOF) Learning in distance HE at the institutional or curriculum level, and not a Yes-No judgment. The assessment will be combined with a label of excellence for institutions, as far as the "E-" in e-learning is concerned. It will be a specific new scope, next to content, within the overall assessment process [28].

Most of the projects reviewed were or are financed totally or partly by the European Commission [30, 31] through some of its programmes: eLearning Programme, LifeLong Learning Programme (Comenius, Erasmus, Grundtvig, Leonardo da Vinci [32], Lingua, Minerva, Transversal Programme), Erasmus Mundus, and others.

The target groups comprise teachers and trainers, students from different levels from secondary schools, via undergraduate and postgraduate courses to continuing education and LLL (including employers, employees and unemployed). Nowadays digital students are defined as young adult students who have grown up with an everyday use of technology and who are accustomed to using technology. As the target groups are growing, the places where the learners can receive high quality education are widening: in school, at home, at work, in the hospital, while travelling and on holidays. Also the type of tools, which are used for the e-learning are increasing and improving: via Internet, PCs, tablet PCs, mobile phones, iPhones, radios, TV and interactive TV, iPods and so on. In the end, most of the EU projects aim, using the best practice in the traditional learning and the new technologies, to improve the quality of e-learning and to give opportunity to everyone for learning.

European research on technology-enhanced learning [33] investigates how information and communication technologies can be used to support learning and teaching, and competence development throughout life. Under FP6 (2002-2006), 32 technology-enhanced learning research projects have been co-funded with a total budget of € 125 million. The projects started between January 2004 and March 2006, and some will be running up to 2010. Under the ICT programme in FP7, there were three calls for proposals and 25 technology-enhanced learning research projects have been co-funded.

The work done in reviewed projects was compared through the following items: aims, target groups, learning style, achieved/expected results, skills and competences, active learning, course structure, assessment of the learners, evaluation of the course, tutoring, interactivity. Thus, using the results of the comparative analysis using the questionnaires and the best practices identified in the state of the art, workpackage V team will recommend some important features for the VCE.

3.2 Experiments

Each partner will contribute to the comparative study by bringing their own pedagogical experiences (see Table 1). The objective is to have a large variety of:

- pedagogical approaches (e-learning, blended learning, face to face, technology enhanced learning),
- technology used (Users Response Systems, Tablet PC, ePortfolio, LMS),
- students (different levels, different domains, different countries, ...).

Table 1. Experiments (selection)

Type of Experiments	**Universities**	**Domains**	**Number of involved students**	**% of e-learning**
A Practice in Using ePortfolio in a Higher Education Course Taught at Distance	Ege University, Izmir, Turkey	Object Oriented Programming	22 students: 7 undergrad., 15 grad.	50
Enhancing learning by using Tablet PCs in a networked classroom	Universidad Politécnica de Valencia, Spain	Electronic Algorithms and Data structure	20-20 / 30	50
CISCO Courses	University of Rousse, Bulgaria	Network	15	100
Medical Information Systems, Handbook for Laboratory Exercises and Self testing	University of Sofia, Bulgaria	Information Technology in Medicine	180/year	50
Blended Learning in Guided Propagation and Antennas	IST-UTL Lisbon, Portugal	Telecommunication	70	15
LMS	Kaunas University	Biomedical Digital Processing	20	60
eLearning versus classical one	J. Fourier University, Grenoble, France	Network and Telecommunications	5	50

Table 2. Structure of the questionnaire

Main categories	Details
Institutions	Country, town, university
Personal information	Gender, age, domain, level, year of study, BSc or MSc
Tools	***Evaluation of the usability (scale 1 to 5 from strongly disagree to strongly agree)***
	I think this tool is easy to use; I was able to learn this tool quickly; The tool operated correctly; The tool interface is attractive.
	Evaluation of the effectiveness (scale 1 to 5 from strongly disagree to strongly agree)
	The tool was helpful to achieve my learning goals This tool was useful enough to complete learning tasks
	Evaluation of the satisfaction (scale 1 to 5 from strongly disagree to strongly agree)
	I was satisfied with the tool
	Evaluation of the productivity (scale 1 to 5 from strongly disagree to strongly agree)
	The tool helps me to finish tasks in shorter time compared with other tools
Methods	***Evaluation (scale 1 to 5 from strongly disagree to strongly agree)***
	My proficiency in using this tool is good; I am satisfied with this methodology of learning; I learned the course material better with this approach; The pedagogical method helps me monitor my own learning; The pedagogical method engages me more in the course work; I needed instructor's help in following the course material; The pedagogical method helped me to improve creativity; The pedagogical method motivated me to interact more with my teacher and the other students; The pedagogical method enabled collaborative work with the other students; I put more time for learning the course material than in a traditional class.
Perspectives/Expectation	***Evaluation of the expectation (scale 1 to 5 from strongly disagree to strongly agree)***
	My expectations at the beginning of the course were very high
	Evaluation of the satisfaction (scale 1 to 5 from strongly disagree to strongly agree)
	The course approach has met my expectations; Overall, I was satisfied with this course approach; I would recommend this approach for other courses.
ECTS evaluation	***Evaluation***
	How many hours have you spent to complete this course (lecture, assignment, homework with other resources)? In order to complete the course, how much time have you spent using others resources (books, library, internet, ...) not included in the regular material ?
Experience in learning technology	***Evaluation***
	User Response Systems, ePortfolio, TabletPC, PPT, LMS, onLine tests, ...
Personal information	How frequently do you use computer? Do you own a personal computer? Do you have an internet connection? Since when do you have an internet connection?

These experiments were performed during the academic year 2010/2011. Other experiments were organized in the previous year (2009/2010) but the questionnaires were not adapted in that period.

Taking into account the feedback of the use of the first questionnaire, the current questionnaire is the result of a collaborative work between all the partners involved in workpackage V. The main constraint was that the questionnaire would be used for all the experiments. The questions had to be suitable both for e-learning experiments and for face-to-face or blended learning. The questionnaire is structured as in the Table 2.

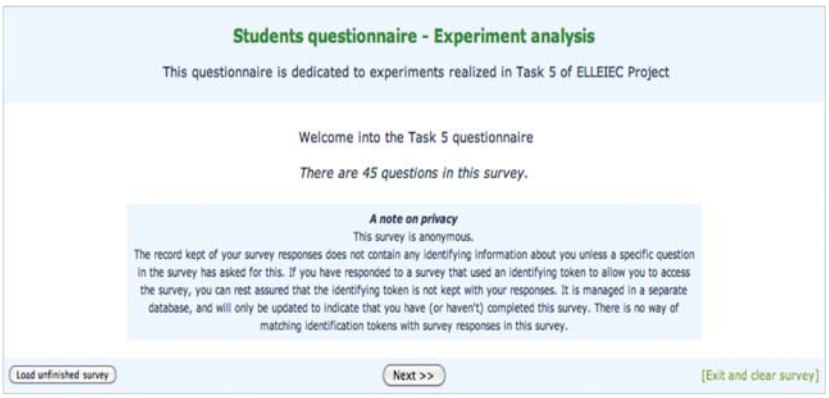
These main parts have been chosen to be filled in by all the students in every experiment. The questionnaire includes 45 questions and has been implemented in LimeSurvey (Fig. 2a) to benefit from various statistical functionalities (Fig. 2b, 3a and 3b). 73 students have answered the questionnaires from France, Spain, Portugal, Bulgaria, Turkey and Lithuania.

4 RECOMMENDATIONS

Following the results of the state of the art and the analysis made during the experiments, we have identified some key points to be considered for the design of the VCE (Fig. 4). These key points are the following: tutoring, delivery, design, assessment, and learning styles. Since it is the natural habit of students not to spend time and effort on assignments unless they are forced to, some ways of urging and guidance must be provided. The instructor should keep track of the developments and provide comments.

Such kind of learning systems and tools can be integrated into a broader course of study, such as degree programs in IT, engineering, math, or science.

In order to be actually successful in such technology-enhanced settings, it seems essential to address infrastructure issues, such as network connectivity and power management, in addition to instructional aspects.



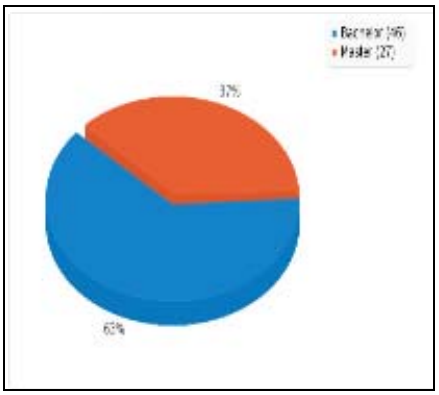
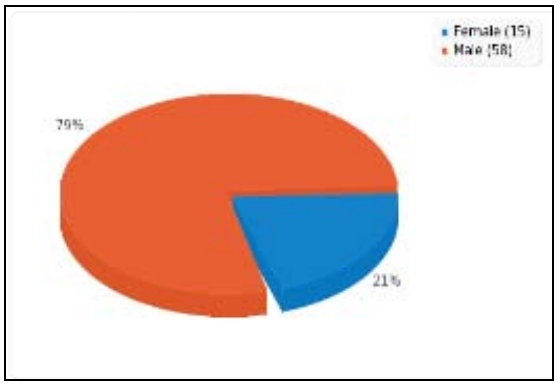


Fig. 2. a) online Survey homepage. b) online Survey – Levels.



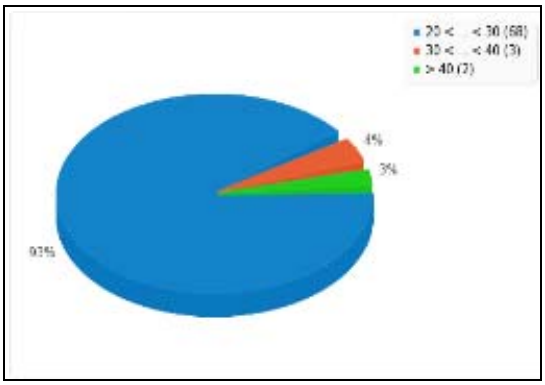


Fig. 3. a) online Survey – Genders. b) online Survey – Ages.

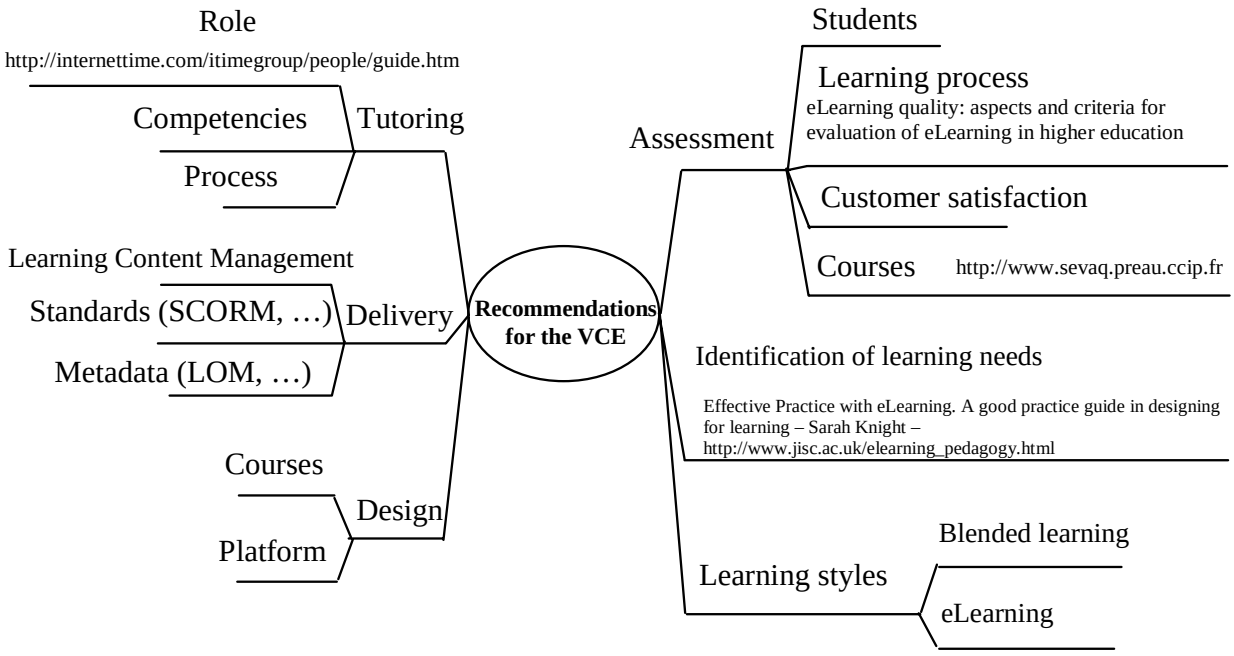


Fig. 4. Mindmap including main recommendations.

Tablet PCs could provide a good opportunity for integrating technology into learning environments because it is the closest parallel to pen and paper, which we know, as a modality, has been integrated into learning environments with success.

ACKNOWLEDGMENT

This work was supported by the European Commission in the Lifelong Learning Programme through the ELLEIEC project (142814–LLP–1–2008 – FR–ERASMUS–ENW, Instrument type: ERASMUS NETWORK).

REFERENCES

[1] http://eur-lex.europa.eu/ [Accessed March 2011]
[2] http://www.edu.ro [Accessed March 2011]
[3] http://www.cnfpa.ro [Accessed March 2011]
[4] http://www.llp-ro.ro [Accessed March 2011]
[5] Barrett, H. C. (2009). Electronic Portfolios – A chapter in Educational Technology: An Encyclopaedia to be published by ABC-CLIO 2001. (http://www.helenbarrett.com/portfolios/ encyclopediaentry.htm)
[6] Bilén S.G. et al. (2009). Tablet PC Use and Impact on Learning in Technology and Engineering Classrooms: A Preliminary Study. Workshop on the Impact of Pen-Based Technology on Education, pp. 11-19.
[7] Blackboard Learning System (www.blackboard. com).
[8] Bonk, C. J., and Graham, C. R. (2005). *Handbook of blended learning: Global Perspectives, local designs*. San Francisco, CA: Pfeiffer Publishing.
[9] Border, J., Stoudt, K. and Warnock, M. (2006). E-Learning Concepts and Techniques, (http:// iit.bloomu.edu/Spring2006_eBook_files/chapter4. htm#h4_2).
[10] Britain, S., and Liber, O. (2004). A Framework for the Pedagogical Evaluation of eLearning Environments. (http://www.cetis.ac.uk/members/ pedagogy/files/4thMeet_framework/VLEfullReport).
[11] Chen, C., and Jones, K. (2007). Blended Learning vs. Traditional Classroom Settings: Assessing Effectiveness and Student Perceptions in an MBA Accounting Course, *The Journal of Educators Online*, January 2007, Volume 4, Number 1.
[12] Drewitz, I. (2009). Evaluation of e-learning platforms, mSysTech, (http://www.eworks.de/ research/2009/03/Evaluierung-E-Learning-Plattformen/Evaluation_of_e-learning_ platforms.pdf)
[13] Gray Harriman Ltd. (2010). E-Learning Resources, (http://www.grayharriman.com/index.htm)
[14] Hristov, Ts. (2009).*Implementation and investigation of a WEB-Based eLearning Software Platform*, PhD thesis.
[15] Koile, K., and Singer, D. (2008). Assessing the Impact of a Tablet-PC-based Classroom Interaction System. Monograph of the 3rd Workshop on the Impact of Tablet PCs and Pen-based Technology on Education. Evidence and Outcomes, Purdue Univ., West Lafayette, Indiana, USA, pp. 73-80.
[16] Kolås, L., and Staupe, A. (2010). Implementing delivery methods by using pedagogical design patterns, (http://www2.tisip.no/E-LEN/papers/ EDMEDIA04/SymposiaNTNU.pdf).
[17] Maguire, C., and Zhang, J. Effective Blended Learning for Development, Tokyo Development Learning Centre, (http://www.jointokyo. org/en/).
[18] Microsoft® Class Server Solution Review, (http://www.microsoft.com/education/classserver. mspx).
[19] Mougalian, C. and Matesol, S. (2006). Moodle, the electronic syllabus, lends itself to PrOCALL, (http://faculty.miis.edu/~bcole/CALLme/page2/ page9/page9.html).
[20] Ng, E.M.W. (2010). Extending Learning to Interacting with Multiple Participants in Multiple Web 2.0 Learning Communities. (http://iisit.org/ Vol7/ IISITv7p011-023Ng769.pdf).
[21] O'Hear, S. e-learning 2.0 - how Web technologies are shaping education, (http://www.readwriteweb. com/archives/e-learning_20.php).
[22] Rashty, D. Traditional Learning vs. eLearning, Mount St. Mary's College. (http://www.msmc.la.edu/ include/learning_resources/).
[23] Richardson, W. (http://weblogg-ed.com/).
[24] Sneller, J. (2007). The Tablet PC classroom: Erasing borders, stimulating activity, enhancing communication. *Proceedings of the 37th ASEE/IEEE Frontiers in Education Conference*, 2007 © IEEE. doi: 10.1109/FIE.2007.4417929.
[25] T. J. Taylor Ltd. Corporate English Language Training, (http://www.tjtaylor.net/english/ elearning-online-and-blended.htm).
[26] Wall, J., Smith, et al. (2005). An International Comparison of eLearning in Action – An Interactive Graphical on Line Teaching Resources for Residential Construction in Australia and a Blended Programme to Support Irish Entrepreneurs in Ireland. In: *QUT Research Week 2005*, 4-5 July 2005, Brisbane.
[27] Zhang, D., et al. (2004). Can E-learning Replace Classroom Learning? Communications of the ACM May 2004, Volume 47, No. 5, pp. 74-79.
[28] Elearningeuropa. (2011). Creating a standard of excellence in e-learning, [On-line]. (URL http://www.elearningeuropa.info).
[29] e-Bologna. (2003). Progressing the European Learning Space, [On-line]. (URL http://www.eadtu.nl/ e-bologna/).
[30] EVE - electronic platform for the dissemination and exploitation of results of projects supported by programmes managed by the European Commission in the fields of Education, Training, Culture, Youth and Citizenship, [On-line]. (URL http://ec.europa. eu/dgs/education_culture/eve/) [Accessed February 2011]
[31] The Education, Audiovisual and Culture Executive Agency (EACEA), [On-line]. (URL http://eacea.ec. europa.eu/llp/index_en.php) [Accessed February 2011]
[32] ADAM - the project and product portal for Leonardo da Vinci, [On-line]. (URL http://www.adam-europe. eu/adam/) [Accessed February 2011]
[33] TeLearn - European research on technology-enhanced learning, [On-line]. (URL http://cordis. europa.eu/fp7/ict/telearn-digicult/telearn-projects-fp6_en.html) [Accessed February 2011]