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ScienceDirect

Procedia - Social and Behavioral Sciences 124 (2014) 210 – 218

Procedia
Social and Behavioral Sciences

SIM 2013

Research challenges for eLearning support in engineering and management training

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Abstract

This paper analyzes the need for advanced/innovative eLearning type of products intended for lifelong learning and teaching in the engineering and management field. This field is relatively new in Romania and needs modern educational techniques in order to improve the efficiency and quality of graduates for a fast integration in the labour market. The objective of eLearning is to train human resources for education and to raise the quality of student training which will lead to the rise of hiring potential and workplace integration. This raises many challenges and requires studies of national and international interest, training research methodology, and laboratory connections to research centres and networks.

Selection and peer-review under responsibility of SIM 2013 / 12th International Symposium in Management.

Keywords: eLearning; engineering and management; traning; research; challenges

1. Introduction

There is a need for advanced/innovative eLearning type of products intended for lifelong learning. This type of product needs parameterization in order to be use in Practice Enterprise and Enterprise Games types of laboratories in order to train students in the field of Engineering and Management. This filed is relatively new in Romania and requires modern educational techniques in order to improve the efficiency and quality of graduates for a fast integration in more and more challenging labour market.

The main advantages of the product can be: the support of educational process through modern information technology tools; the efficient use of educational resources; superior learning process facilitation; phenomena

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Selection and peer-review under responsibility of SIM 2013 / 12th International Symposium in Management.
doi:10.1016/j.sbspro.2014.02.479

simulation that otherwise will be impossible or highly costly to study in a laboratory; creativity and competition stimulation of individual and teamwork.

The aim is to sustain the development of abilities, competences and research potential of human resource dedicated to research, as well as of young researchers in the project, contributing to promote the national intellectual capital. The objective is to train human resource for education and to rise students training quality which will lead to the rise of hiring potential and workplace integration.

It needs studies and analyses of national and international interest, research methodology of training needs, laboratory connection to research centres and networks.

Possible use of the results can be: students use of the product for training in the domain (engineering and management), at all levels (licence, master, doctorate); the use of all that wants to perfect all lifelong (post and pre-university level); employees use from the enterprises for professional perfection; the use of potential employees and unemployed for professional perfection/reconversion.

The further research should be based on studies with the use of specific tools, benchmarking analysis to determine best practices/experiences/products which exist at the national and international level in the domain.

2. Relevance

The topic supposes the development for solutions (eLearning laboratory) to social and economical problems (education support tools). This contributes to promotion of modern and innovative tools use in teaching and learning, as well of to attract young and high quality researchers and specialists in research activity.

In the same time, this it's line up to research and actual preoccupation at European and global level in inter-disciplinary domains such as: engineering and management, practice enterprise, enterprise games, business and production simulations, games theory, information technology and communication (ITC, eLearning). It can be considered here the strengthening role of education in training especially among young people considering two of the Lisbon Key Competences: KC4 Digital Competences (the use of information technologies) and KC5 Learning to learn (the acquisition of competences through multiple learning ways) (Otten & Ohana, 2009).

In the context of knowledge-based society, the universities can and must play an important role in research-development-innovation activities, as stated in Global Entrepreneurship Monitor: 2012 Global Report, London Business School, published 2013 (Xavier, 2013).

An important contribution in Lisbon Strategy (Lisbon European Council, 2000) construction has the companies' requirements in the labour market which were more and more specific and complex regarding abilities of students/graduates that are preparing for employment. This strategy stated that each member state to concentrate on three things: to attract/maintain of more people on the labour market, to improve the employees' adaptability and to rise the investments in human capital through better education and training systems.

The success criteria of research results will be as follow:

- eLearning product for the laboratory will try satisfying the training needs of students;
- research methodology will help to analyse training needs and questionnaire collection; the success criterion of questionnaire collection can be the number of questionnaire according to established sample;
- scientific papers success can be measured through fulfilling the quantitative criterion (number of papers) and qualitative criterion (level of scientific conferences, indexing in quality and recognise/accepted databases);
- the success of connection to research centres and networks can be measure by the numbers of connection.

3. The research

The main advantages of this type of product will help to reduce and eliminate existing bottlenecks in university education. These will be: the support of educational process through modern information technology

tools; the efficient use of educational resources; superior learning process facilitation; phenomena simulation that otherwise will be impossible or highly costly to study in a laboratory; creativity and competition stimulation of individual and teamwork.

A very high impact on the educational programs has The Bologna Declaration of 1999 with the aim to create a European Higher Education Area (Bologna declaration, 2009), and the Lisbon Strategy of 2000 (Lisbon European Council, 2000) to create a European research and Innovation Area). The Lisbon Summit stated that, in order to make Europe the most competitive knowledge-based society in the world by the 2010, we need more and better trained researchers. By the end of 2010, most of the goals of Lisbon Strategy were not met.

Official appraisal of the Lisbon Strategy took place in 2010 at a European Summit, where the new “Europe 2020” strategy was also launched. It aims at "smart, sustainable, inclusive growth" with greater coordination of national and European policy (European Commission, 2010). The strategy promotes modernizing education and training. Quantitative targets are proposed, including increasing the employment rate to at least 75% from the current 69% and boosting spending on research and development to 3% of gross domestic product - it is currently only 2% of GDP, significantly less than in the US and Japan.

The results of a study regarding the lack of talents in Romania (ManpowerGroup Romania, 2013) show that 54% of Romanians employers have difficulties in finding employees with the right abilities, and that engineers and qualified workers jobs are the most difficult to fill for the 6th year consecutively. This problem is also a global phenomenon and it will limit the performances of business in the future. The lack of talents is very high in Japan (85%), Brazil (68%), India (61%), Turkey (58%) and Hong Kong (58%). On the other end, the lowest percentages are in Ireland (3%), Spain (3%), South Africa (6%), Holland (9%), and Czech Republic (9%). The companies’ leaders accepted that this is a big challenge for long term and needs to find solutions to the crisis.

The research is related to an innovative domain in Romania. This domain is “Engineering and Management” for which the research will develop, validate and implement a full set of tools and templates to support the vision of practice enterprise laboratory. The tools and templates will be based on an existing management model of enterprise and allowed the implementation of business idea or production enterprise from concept to implementing, functioning and developing of a practice enterprise.

The key characteristics of an engineering methodology are incorporated in product tools and modules accessible in practice enterprise functional model, with analysis techniques of economical indicators and enterprise design criteria for business objectives accomplishment at the higher level.

Today’s dynamic production environment is characterized by dramatic changes many times unanticipated. In this difficult and challenging environment, enterprises must develop and implement new and innovative strategies for success in the strong competitive market. Among competitive strategies which have an advantage, there are production systems which can be reproduced in a practice enterprise. These differ by existing inter-organisational model, by responsibility level and participants responsibilities, by the structure which contributes to enterprise competence.

The use of web-based applications is possible with the help of a standard web browser, without the need of installing other software. It is possible to add new technologies, like architectural middleware agents, applets, plug-ins and multi-user dialog systems. The function will include business needs requested by the project. By parameterization and personalisation of these functions, the system can be configured in a way that to implement and optimize necessary and existent information flows. There are subsystems which will realize the management of recorded information and auxiliary information, with the facility to execute established tasks for processes processing and supervising. Information presentation will be realised with an intuitive interface.

3.1. Engineering and Management Domain

The Engineering and Management domain ensure a double train, in engineering and in management, realizing the interface necessary for applying economical science in engineering. This domain is relatively new in

Romania, starting from 2005, but with a starting point from 1990 with different names and directions (industrial engineering, production system engineering, engineering economy from 1992). These specialisations were and are requested on the labour market of educational training, mainly considering the number of application in the admission process, considering the number of students that follow this domain (around 22000 per year), and considering the number of graduates employed. In 1996 was found up The Engineering Economy Consortium from Romania, which has today 33 universities with Engineering and Management domain.

Among competences and knowledge of graduates in this domain there are (RNCIS, 2013): computing/demonstration/application to develop tasks specific to engineering and management; roles and responsibilities identification in a multi-disciplinary team; elaboration and interpreting technical, economical and managerial specification; planning, programming and leading enterprises and production follow-up; identification of opportunity of continuous training and efficiently use of information resources, communication and assisted professional training resources (internet portals, software application, databases, on-line courses etc.). These competences can be achieved at a higher level in a laboratory of "Practice Enterprise and Enterprise Games". In this laboratory, students will achieve and train these competences in a complete and coherent way and in an inter-disciplinary approach.

3.2. eLearning

Information technology and communication ITC represent an ensemble of tools and technologies necessary to process information mainly through computers and the transmitting of information through electronics means (Lazarinis, Green & Pearson, 2010).

ITC role in university education require the assurance of tools and methods which facilitate passage from a professor centered learning environment, and based on physical educational materials, to a collaborative and interactive environment, centered on the student and learning process. To benefit from these opportunities, learning institutions must implement and use the new technologies in the leaning/teaching process and also to adopt a different learning/teaching concept from the traditional one.

In the last years, it appears a series of terms used to define and to name the on-line education: distance and or continuous learning, Web Based Training-WBT, Web Based Learning–WBL, eLearning, Learning Management System-LMS, Learning Content Management System-LCMS, virtual university, integrated learning system, Virtual Learning Environment-VLE, Managed Learning Environment-MLE), blended learning (BL) etc.

The newest and most efficient education form is considered blended learning (BL) based on new ITC. It represent a type of blended training in which the traditional ways of training (face-to-face) are combined with the ones that use new ITC (Garrison & Vaughan, 2008).

The advantages of new ITC used in education domain represent a strong argument to integrate them into a BL with the aim to highly improve educational process. The main disadvantages are: it requires ITC design and use experience, higher costs and time to design.

The research supposes a good knowledge of activities in the domain. This knowledge serve to efficiently design of the product, of the learning materials adapted to engineering and management domain.

At the present time we can talk about eLearning 2.0 / Social Learning, which suppose the integration of Web2.0 technologies / Social Media (RSS, blogs, microblogs, wikis, social networks, collaborative bookmarking tools, collaborative applications, OER, OCW) in learning (Campbell, 2013).

3.3. Practice Enterprise

The necessity of practice training of students in the same conditions as in future workplaces, with minimum costs, impose the founding of practice enterprises, in which we have identical activities as in the real enterprise, using the same procedures and benefit from the same structure (Taucean, 2006).

Trainers or tutors realise in the same time the theoretical training and the supervising of students in the simulated processes, and in the end they evaluate them. Each practice enterprise concentrates on real situation on a basis of entrepreneurial frame, in a specific domain.

The students activate in a productive and real environment and learn to accomplish the given tasks. In the end they will know the function of different department from the enterprise such as: production, commercial, finance and accounting, human resources, public relations, secretariat etc. They will have a global image regarding the activity of a real enterprise

The practice enterprise can affiliate to EUROPEN - European Practice Enterprises Network, founded in 1997, (Europen-Pen International, 2013) with 7500 members from 42 countries around the globe.

Practice enterprise contributes directly to reform in education through the closeness of the practical training system to the one that is use in developed countries. It essential contribute to solve the problems appeared on labour market by fast absorption of graduates trained in this way. Also practice enterprise is in the frame of university strategy to shorten the training period of graduate adaptation to the real production environment exigency.

Among other deficiencies existing here we can mention: the lack of adapted and specific software, to include all necessary modules of training (for each department of the enterprise), at the time it exist only "islands" of software with no integration and outdated technically/ scientifically/morally, lack or very low training materials, for production system we can't simulate the actual production processes, as in enterprise games.

Simulations of production systems are used mainly to examine the effect of improvements or investments in a production system. Most often this is done using a static spreadsheet with process times and transportation times. A production system is very much dynamic depending on variations in manufacturing processes, assembly times, machine set-ups, breaks, breakdowns and small stoppages.

Companies can benefit from production simulation by eliminating bottlenecks, enhance lean manufacturing, optimize capacity planning, and optimize production output. Simulation solutions are assisting companies across manufacturing sectors conduct more effective production scheduling, implement lean manufacturing, as well as carry out powerful process analysis: optimize and increase confidence in strategic capacity planning and lean manufacturing, integrate all aspects of operations into a single virtual operation with process analysis and what-if capabilities, gain insight into the effects of unknowns such as fluctuating demand and machine breakdowns, enhance production planning and scheduling, optimize production sequencing.

3.4. Enterprise games

One of the most efficient ways to learn by experience in management (in initial training of managers, in universities and business schools, as well in continuous training in enterprises where employee work) is the use of enterprise games.

Enterprise games where developed from the war game model of training, by simulating conflict situation and by applying efficiency war strategies. The fist one was realised by American Management Association in 1950 (Wells, 1990).

Later, many universities on business administration introduced games in university curricula, and some companies (IBM, General Electric) elaborate own games which were use in training managers or to support strategic decisions (especially investments decisions) (Iftimescu, 2012).

With games, an organization can shift from an outmoded top-down hierarchy to an agile network structure that promotes coordination over control.

Technical education and especially engineering education faces a number of challenges because of the recruitment situation in many countries within the engineering domain. According to the International Council of Academies of Engineering and Technological Sciences, Inc. with member academies in over 25 countries, including the major countries, attracting young students into careers as engineers, technologists, or technicians is

a serious problem (CAETS, 2003). Another citing describes the situation in the U.S. who has lost 25% of its undergraduate population in engineering between 1982 and 2000 (Orsak, 2003).

Today's students have knowledge and skills from extensive use of computer or video games, or more generally interactive game software (Prensky, 2001). Characteristics of games are a high degree of interactivity, advanced graphics, a highly dynamical virtual universe, and an incentive system to promote prolonged and more advanced use. Prensky (2001) provides an in-depth discussion of the fact that the students have radically changed in the sense that they think and process information differently from predecessors.

Games and simulations offer tremendous promise to help us cope with the current challenges in education and training (Balasubramanian, 2003). The current technology generations of students are cognitively more sophisticated and want learning to be fun, engaging, challenging, interactive, empowering, and provoking. However, many educators continue to think of knowledge and learning in terms of textbooks – sequential, fact-based, and immutable. Aldrich (2005) predicts that the development and adoption of games and simulations will have the greatest impact on teaching and learning in schools.

3.5. Originality of research

The research will contribute to the progress of the knowledge in the domain and will overpass the main bottlenecks, deficiencies, weaknesses and disadvantages mentioned through the proposed research and by expected results. This research outcome is an original/innovative eLearning type of product (a functional model) intended for lifelong learning. The domain of “Engineering and Management” is relatively new in Romania and which need modern educational systems to improve efficiency and quality of graduates for a fast integration in labour market.

The inter-disciplinary approach is in the same time a challenge which will contribute at the level of originality and innovation of the research. These research disciplinary components are revealed due to the realisation of an advanced/innovative eLearning type of product intended for lifelong learning. The research will aim to analyse and correlate scientific discipline like informatics (software), information technology and communication (eLearning), pedagogy/education (lifelong learning LLP, blended learning, eLearning), business simulation, game theory, engineering economy, and management. Between all these exist connections already known and accepted in university education (through the existing of “Engineering and Management” domain) and also on the labour market (through the request for domain graduates) (see figure 1).

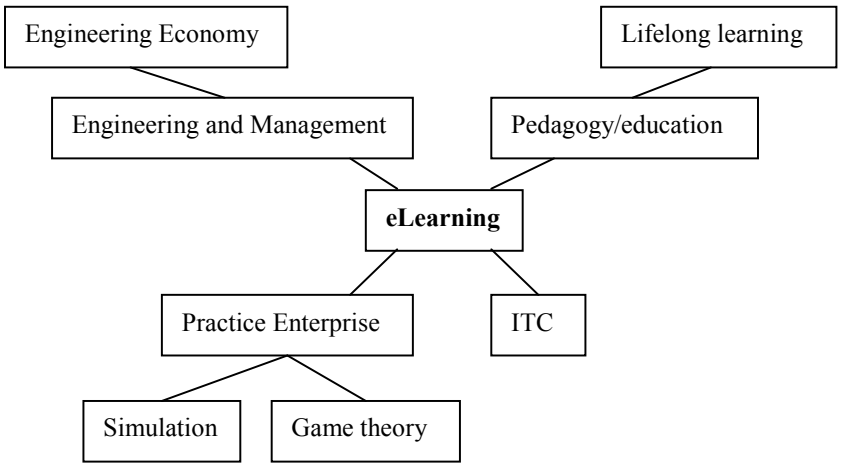

Fig. 1. Interdisciplinary approach to research

The integration of an enterprise games module will help the simulation of production processes which is a less common in the modules and function of practice enterprise (usually simulation is about information flows). Simulation of production processes is usually harder than other enterprise departments because of the differences in each type of production system (even in the same domain, with the same products) and the multitude of activities category and different procedures/algorithms.

The added value will come out also from the research cooperation, with the results of development new possibilities of research, scientific and educational, institutional and administrative, cooperation between interdisciplinary teams in this theme and in further themes. This cooperation permits realisation of studies and analysis from which each partner can learn, show strong point and try to minimise weak point in comparison with the other part.

The methodology of research in the first stage of the project will be original and based on questionnaires. These will be design and realise in the project frame, based on specific rules in concordance with what information it is wanted to be find. The data will be loaded in an original database ready to be use for statistical analysis with the use of software like SPSS (*Statistical Package for the Social Sciences*). The conclusions will be used in the second stage of the research and also can be disseminate toward decision factors form educational domain, labour market, with the respect of intellectual propriety rights.

Benchmarking analysis will lead to improve academic organisation structure, of educational option for students (new study plans for licence and master levels, new and direction of research at doctoral level, improvement of existing ones and correlation of them), will ensure a better students and graduates training to cope with labour market challenges, will lead to better trainers quality by using new/innovating training tools and methods.

4. Challenges and benefits

The research proposed raises many challenges.

Simulations and gaming environments can facilitate students' learning of both specific domain knowledge and concepts, and several cognitive skills like pattern recognition, decision-making and problem-solving (Balasubramanian, 2003). From their review of literature covering a period of 28 years, Randel et al. (1992) concluded that gaming could be used effectively to provoke interest, teach domain knowledge, and shore up retention. Funk (2002) cites studies which found that games strengthened students' engagement, information processing, problem-solving, social development, and academic abilities. Additionally:

- Students' dialogue and decision-making while engaged with multi-level games provokes experimentation, discovery learning, and perseverance as science, technology, engineering, mathematics (STEM) principles are distorted and explored in the games (Kirriemuir, 2002).
- Students develop expert behaviors such as pattern recognition, problem solving, qualitative thinking, and principled decision-making as their individual expertise with games increase (VanDeventer & White, 2002).
- Student effectiveness increases when they are afforded opportunities to contribute to the game design and create new games (Mitchell & Savill-Smith, 2004).
- With realistic games, students not only become smarter and intellectually engaged but also realize their desire for hard fun, delayed gratification, rewards, making right decisions, participation, depth of understanding, challenge, and using their pattern recognition and problem-solving skills (Johnson, 2005).

Aldrich (2004) discusses 17 challenges related to games and simulations, including cost, delivery, time constraints, evaluation, and extent of guidance in simulations. Other concerns with using computer games include: difficulty of integrating games with traditional instruction, mismatch between level of game and

students' abilities or needs, fear of some students not participating or cooperating, and exposing teacher vulnerabilities amidst technology-savvy students (Ellington, Gordon & Fowlie, 1998).

Well designed games and simulations can prepare students to learn critical problem-solving and decision-making skills necessary for the real world (Balasubramanian, 2003). When designed well, games can truly be an important teaching tool (Shreve, 2005). They promote numerous cognitive benefits in learners, including a facilitation of increased interactions, motivation for learning, experimentation, self-efficacy, self-monitoring, pattern recognition, problem-solving and critical thinking.

In conclusion, many agree that games, simulations, and social networking technologies have much to offer education. Educational benefits according to Dukes (1997) are:

- They increase student motivation.
- They facilitate the affective aspect of learning.
- They enhance interpersonal relations and promote interpersonal reward structures for learning.
- They do at least as well as conventional techniques in achieving cognitive outcomes.
- They tend to produce improved communication and discussion within the classroom.
- They tend to produce a more integrated view of the broader context within which sociological concepts fall.
- They promote individual discovery in learning from the learner's own perspective.

This plug many gaps which conventional methods of instruction are unlikely to fill; they round out the learning experience.

The scientific challenges to which the research will respond to are: inter-disciplinary character of the propose research and the correlation of the scientific discipline components like: informatics, information technology and communication, pedagogy, simulations, game theory, engineering economics, management; coordination of a multidisciplinary research team; young researchers implication in the research; realization/implementation of eLearning type educational tool which is new/innovative and which generally implies experience, longer design time and higher costs.

5. Conclusions

Possible applications of the research results are: the usage of the product by students for training in the mentioned field (engineering and management) with the possibility to expand to other connected fields, at all levels (licence, master, doctorate); the usage of the product by everyone willing to perfect all lifelong (post and pre-university level); the usage of the product by employees from enterprises for professional perfection; by potential employees and unemployed for professional perfection/reconversion; the usage in on-line education with the help of web-based applications.

The potential use in social and economical environment can be related to the possibility to exploit the intellectual property rights established in the frame of the project, especially for universities and other institutions and organisations/companies which offer training services.

Through the proposed objectives, the research helps develop knowledge-based economy/society by promoting research and innovation; also, it will help accelerate the development of information society, the development and efficiency of the usage of new learning techniques with ITC support (blended learning, eLearning).

The main outcomes of the research will help reduce/eliminate existing training deficiencies in university education. The advantages are: the support of the educational process through modern information technology tools; the efficient use of educational resources; superior learning process facilitation; phenomena simulation that otherwise will be impossible or highly costly to study in a laboratory; creativity and competition stimulation of individual and teamwork.

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