

New Challenges in e-Learning of Mathematics via EVLM and IDeLC projects

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Abstract: - We present the key problems, ideas, aims and results in introducing and developing new ICT for the education of mathematics in Plovdiv University (Bulgaria) within the frames of the Leonardo da Vinci pilot project EVLM (European Virtual Laboratory of Mathematics) and university scientific project IDeLC (Interfaculty Distributed e-Learning Center).

Key-Words: - E-learning, M-learning, Virtual Laboratory, Computer Algebra Systems (CAS), MathML, Xml, Jsp, Distributed E-learning Center, J2ee-based Environment.

1 Introduction

The total popularity of computers and ICT, combined with the power of mathematical software has provoked radical changes in methods of teaching and learning mathematics. This is pursued of some negative trends in higher education not only in Europe but all over the world. A declining level of mathematical knowledge among secondary school graduates and first years university students, more and more unattractive outdated traditional ways of teaching mathematics without ICT, a misuse of some new technologies by part of the university teachers, and others are all examples of this. These and other problems were first found in the education of mathematics in engineering [1], but they are also present in higher education of natural sciences and continue to be a spreading phenomenon. However, Bulgarian education of mathematics is not an exception to these trends.

The European mathematical community has to redouble its efforts to meet the general needs in the field in order to keep abreast with the advance of science, which is in direct conformity with the directives of the Lisbon (2000) and Barcelona (2002) meetings and the eLearning Action Plan 1, approved by the European Commission [2]. The general needs that can be found include: upgrading the overall level of mathematical knowledge; promoting innovative methods in teaching mathematics, as e-learning, m-learning, online tests, usage of interactive computer algebra systems, online consultancy and other blended solutions; improving the quality of teaching and training e-content of mathematics materials by applying the newest ICT.

In this paper we present the key ideas, aims and results of introducing and developing new ICT technologies in the education of mathematics within the frames of two projects: EVLM and IDeLC. The EVLM project afforded our faculty the opportunity to contribute to the development, storage and dissemination of large databases of e-learning materials by using the newest e-content technologies as MathML, xml, computer algebra systems, etc. On the other hand, the university funded research project IDeLC, is devoted to build new ICT tools for teaching and learning a specific type of knowledge (including mathematics) and also develop the tools provided easy and effective access to available materials for big groups of users. In this way the IDeLC project will enlarge the impact of the EVLM resources in favor of the content and methodology review that European society requires.

2 The EVLM project

The European Virtual Laboratory of Mathematics (EVLM) is a European pilot project in the Leonardo da Vinci program of the European Commission scheme for Education and Science, for the period 2006-2008 [3]. Nine institutions, predominantly in the engineering education, were involved in the project: Technical university in Bratislava, Slovak Republic (promoter), University of Plovdiv, Faculty of Mathematics and Informatics, Bulgaria, University of West Bohemia, Faculty of Applied Sciences, Plzeň, Czech Republic, Miskolc University in Hungary, University of Limerick, Ireland, University of Salamanca, Spain, Faculty of Informatics and Computing, Coventry University,

United Kingdom, Tullossilta, Finland and Slovak Society for Geometry and Graphics, Slovak Republic.

The main objectives of the project are the big amount of electronic materials in different mathematical subjects

and the use of innovative ICT, applicable in mathematical educational process.

Fig. 1. EVLM project: Central portal.

2.1 Aims of the project

The aim of EVLM is to promote better understanding and utilization of mathematical knowledge, to promote e-learning in all aspects of mathematics, to provide solutions for different target groups and help teachers and trainers enhance their skill in using the most advanced educational tools and environments. EVLM aims to provide a range of online resources to support and enhance the teaching of mathematics in secondary schools and higher education and to help the research needs of individuals in a number of areas including mathematics, statistics and mathematics education [3].

2.2 Project outline

The EVLM is comprised of a network of National Centers of Mathematics located at eight partner countries throughout Europe. Figures 1 and 2 show the homepages of the Central Portal, hosted by the Technical University in Bratislava, Slovak Republic (promoter) and Bulgarian Portal in Plovdiv University, respectively.

Each National Center hosts a portal in the respective national language providing a virtual database of

mathematical resources and e-learning materials available from the partner institutions. EVLM and each National Portal are freely accessible on the internet. In addition, the National Centers offer consultancy services to those wishing to learn about the latest results in mathematics and mathematics teaching. Communication between the project team ensure that any request for assistance and consultancy will be dealt with by the partner with the most relevant expertise. Feedback is enabled and welcomed from all users of ELVLM to assist in the quality control process.

2.3 Main results of the EVLM project

The mathematical e-content of the EVLM database was developed on the basis of the innovative ICT. It was built on the principle of diversity, in response to the partners with a higher competence in a given mathematical subject.

The EVLM Central Database provides free access to different e-learning educational material in mathematics covering the following subject areas: Fundamental Mathematics, Algebra, Calculus, Geometry,

Optimization, Numerical Analysis, Difference and Differential Equations, Multivariable Calculus, Probability and Statistics, History of Mathematics, Mathematical Games. Within each mathematical subject area a selection of frequently asked consultation topics (FACTs), reusable learning objects (RLOs), related

problems and modules are provided to facilitate easier navigation within the database. In addition, two didactic guides for teachers and students of mathematics are provided to act as standalone resources to aid in either the teaching or studying of mathematics.

ЕВРОПЕЙСКА ВИРТУАЛНА ЛАБОРАТОРИЯ ПО МАТЕМАТИКА
БЪЛГАРСКИ ПОРТАЛ

Връзки към националните портали

Проект № 2006-SK/06/B/F/PP-177436 [Българска стр. на проекта](#) [Пишете ни](#)

ЕВЛМ страниците, порталът и он-лайн базата данни бяха разработени като резултат от проекта, спонсориран от Европейската Комисия с цел:

- да развива он-лайн обучението по математика
- да предлага помощ на различни целеви групи, включително учители и преподаватели
- да спомога за подобряване на уменията при използване на най-съвременни образователни средства и среди
- да подпомага разработката на собствени материали за електронно обучение
- да осигурява консултации по използването на наличните материали
- да осигурява пространство за обмен на ресурси за електронно обучение чрез EVLM Портала
- да предлага консултационна служба по математика (по електронен начин или лично)
- да допринася за издигане нивото на математическите знания
- да засили компетентността по математика на избраните целеви групи потребители: студенти, учители, преподаватели, учени и изследователи.

ЕВЛМ БЪЛГАРСКИ НАЦИОНАЛЕН ПОРТАЛ, ПОДДЪРЖАН ОТ
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004596
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VIEW SITE STATS

Fig. 2. EVLM project: Bulgarian national portal.

The EVLM database provides e-content coded in XML, MathML, pdf, jsp, nb, html and other file formats. The Extensible Markup Language (XML) is a text-based general-purpose specification designed to transport and store structured data. It is used both to encode documents and to serialize data, and allows custom defined tags. MathML is an XML application especially aimed to encoding mathematics and its meaning. It enables mathematics to be served, received, and processed on the World Wide Web, just as HTML has enabled this functionality for text. Authors may use equation editors, conversion programs, and other specialized software tools to generate MathML, XML or other descriptive languages. Such editors, presented in EVLM are SciWriter, Publicon and others.

Special attention is given to the use of computer algebra systems (CAS) in mathematics education, not only in view of materials, but also by providing

introductory didactic chapters for engineering mathematics, examples and problems.

The following CAS are included: Mathematica, Maple, Matlab, SPSS, Derive, etc. The EVLM database provides also simple guides and examples to software tools for development of e-learning materials with online calculations and interactive demonstrations, created by the powerful environments as webMathematica and GeoGebra.

Figure 3 represents an illustration of an online consultation topic about surface patch modeling, coded as webMathematica applet – jsp file, enabling online calculations and manipulations. Users can type their own input data that will be inserted interactively, while all necessary calculations will be done, and the new graph will be plotted. Perspective view of the created surface patch is provided, which can be interactively rotated in the space by simple mouse movements.

2.4 The impact of the EVLM project

The on-going activities of the EVLM and National Centers of Mathematics show increasing interest among students, teachers and trainers at the partner universities. In a long term we are convinced that the project will

have an impact on mathematical competence in the new European research area. Especially, in Plovdiv University, the National Center and the built EVLM database of e-learning materials will play a basic role in the currently started scientific project IDELC.

Generalised Two-Axial Surfaces of Euler type - Microsoft Internet Explorer

Súbor Úpravy Zobrazit' Obľúbené položky Nástroje Pomocník

Dozadu

Hľadat' Obľúbené položky Médiá

Adresa <http://147.175.55.16:8080/webMathematica/daniela/eulercyclical1.jsp>

Google

Go Bookmarks 52 blocked ABC Check AutoLink AutoFill Send to

Surface parametric equations

$x(u, v) = -y[u]*\sin[k \text{ Pi } v]$

$y(u, v) = y[u]*\cos[k \text{ Pi } v]*\cos[l \text{ Pi } v] - z[u]*\sin[l \text{ Pi } v] + d*\cos[l \text{ Pi } v] - d$

$z(u, v) = y[u]*\cos[k \text{ Pi } v]*\sin[l \text{ Pi } v] + z[u]*\cos[l \text{ Pi } v] + d*\sin[l \text{ Pi } v]$

u [0 , 1]

v [0 , 1]

Number of points to plot 20 x 150

Evaluate

ParametricPlot3D

Fig 3. EVLM in action: Surface patch modeling.

3 The IDELC project

IDELC (Interfaculty Distributed e-Learning Center) is a new scientific project in Plovdiv University 'Paisii Hilendarski' for 2008-2009. It is planned to create and implement new ICT relevant to application in teaching and learning processes.

3.1 Ideas of DeLC and its enlargement in IDELC project

The Distributed e-Learning Center (DeLC) is an example of a Network-Based Education [4], which allows effective communication between cooperative physically dispersed programs, tools, students, educators, and administrators. The development of the first J2EE-based version of a DeLC is described in [5]. J2EE provides standard architecture for development, deployment and execution of applications in a distributed environment. Applications in J2EE may use a set of standard services such as: threads, distributed

resources, transaction, management, security, client and database access.

In Figure 4 the classification of different e-Services provided by the DeLC is given [5].

According to their content or nature, the eServices are classified in four classes (e-Learning, e-Educator, Administration and System). According to the type of mobility features there are three classes (Local, Remote, Back-End), and the grouping by the type of invocation is in two classes (Mobile, Stationary).

Each e-Service provided by the DeLC has a common unified structure that allows easy development of the system by adding new e-Services and integrating them with the existing eServices. The e-Services can be represented as containers, which consist of profile (meta-information) and functionality. The profiles give information about e-Service's content (semantics), user's group, interaction with other e-Services etc. The functionality can be presented as a set of rules specifying the actions to be realized [5].

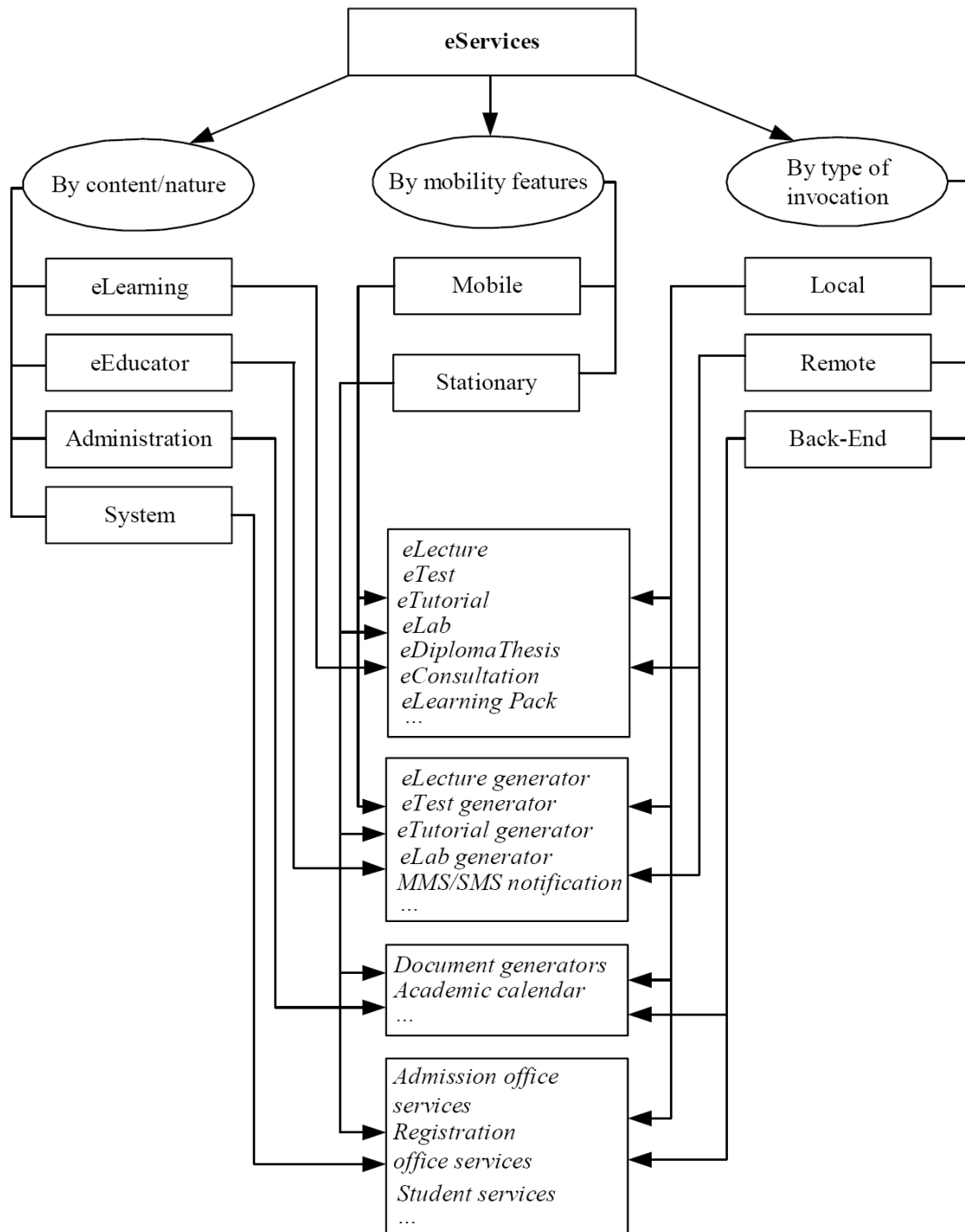


Fig. 4. The DeLC e-Services grouped by their content or nature, type of mobility features and type of invocation.

The provision of multi-agent systems, supporting intelligent mobile services and development of m-services is planned as further enhancement of DeLC to facilitate its e-learning capabilities [6-8]. It provides wireless services accessible via mobile devices (cellular phones, laptops, personal digital assistants-PDAs) through geographically intermittent high-speed connections. The following m-Learning services will be provided: m-Lecture, m-Tutorial, m-Test, etc. [7]. This type of service provisions allow students to gain access to a given service through their mobile devices. A crucial one in the entire e-learning process is the m-Test, which provides a flexible tool for evaluating the students' acquired knowledge and valuable feedback to students concerning their progress. The next enlargement is the development of electronic clusters, allowing hold the group examination [9]. All services require a creation of the appropriate e-content in specific areas of education in DeLC.

3.2 Aims of the IDeLC project

The basic aim of the project is the development and implementation of new models and tools in open virtual environment providing a large number of innovative educational services for e-learning, m-learning and distance learning in three faculties of Plovdiv University: Faculty of Mathematics and Informatics, Faculty of Laws and Faculty of Economics and Social Sciences. The specific research aims are: development of new e-learning and m-learning technologies on campus based intelligent and agent-oriented methods; development of hardware and software architecture of the IDeLC; creation and implementation of distributed electronic testing clusters for group testing, electronic clusters for e-content, consultancy cluster, etc.; providing innovative software security methods and database consistency.

4 Conclusion

In this article, we presented the main results achieved so far by the European pilot project EVLM and the ideas and aims forthcoming from the approved Bulgarian university project for radical innovation in e-teaching and e-learning. The discussed experience will undoubtedly be extremely useful in sharing basic problems, concepts and approaches in favor of the European society requirements. We are convinced that only the collaborative work between mathematical communities through Europe could raise the overall

level of mathematics education based on the current powerful ICT.

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References:

- [1] R. Sutherland, S. Pozzi, The changing Mathematical Background of Undergraduate Engineers, *The Engineering Council*, London, 1995.
- [2] http://europa.eu.int/eur-lex/en/com/cnc/2001/com2001_0172en01.pdf
- [3] <http://evlm.stuba.sk>
- [4] M. P. Singh, M.A. Vouk, Network Computing, In J. G. Webster, (ed.), *Encyclopedia of Electrical and Electronics Engineering*, 14 (Mu-Nu), John Wiley, 1999, pp. 114-142.
- [5] S. Stojanov, I. Ganchev, I. Popchev, M. O'Droma, R. Venkov, DeLC – Distributed eLearning Center, *Proc. of the 1st Balkan Conference in Informatics BCI'2003, 21-23 November, Thessaloniki, Greece, 2003*, pp. 327-336.
- [6] I. Ganchev, S. Stojanov, M. O'Droma, Mobile distributed e-learning center, *Proc. of the 5th IEEE International Conference on Advanced Learning Technologies (IEEE ICALT'05), 5-8 July, Kaohsiung, Taiwan, 2005*, pp. 593-594.
- [7] I. Ganchev, S. Stojanov, M. O'Droma, D. Meere, An InfoStation-based multi-agent system supporting intelligent mobile services across a university campus, *Journal of Computers*, Vol.2, No.3, 2007, pp. 21-33.
- [8] O'Droma M. I. Ganchev, Toward a ubiquitous consumer wireless world, *IEEE Wireless Communications*, Vol.14, No.1, 2007, pp. 52-63.
- [9] A. Rahnev, O. Raneva, N. Pavlov, Functional workflow and electronic services in a distributed electronic testing cluster – DeTC, *Proc. of the 2nd International Workshop on eServices and eLearning, Otto-von-Guericke Universitaet Magdeburd, 2004*, pp. 147-157.