Extending educational web-based systems to meet new methodologies

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Abstract: - Interactions between technology, methodology and educational aims are explored in this paper towards building a technological platform to reinforce learning and improve teaching. We refer to *e-LKG Project* as a case study where learning customization plays a central role and technology is mainly inspired on educational methodology.

Key-Words: e-Learning, Groupware, Knowledge Management, Cognitive Competencies, Learning Diagnosis, Evaluation.

1 Introduction

One of the main principles in this paper is the statement "the essence of e-learning lies in the personalization of learning experiences", expressed by many authors [1]. This is the main reason why we focus our interest in the characteristics of technological systems as a support for the learning process.

On-line training is not enough without effective knowledge personalization, synthesis and transfer. Several proprietary platforms integrating basic functionalities for e-Learning, built-in Groupware and Knowledge Management [2] exist, but personalizing e-Learning when demands are massive, extensive and diversified, requires powerful management systems specifically designed to help the creation of qualified on-line courseware.

A personalized approach also requires an effective learner's orientation and individualized access support. At this point, generation of learning objectives is one of the crucial steps as proposed in [3], where cognitive competencies are categorized into levels according with Bloom's taxonomy.

In e-LKG project [4] (e-Learning + Knowledge Management + Groupware) we are building a framework to generate learning objectives for mathematics at engineering degrees. e-*LKG Platform* is aimed to allow the definition of itineraries and contents adaptation to each user, depending on his/her own characteristics, the accessed resources and the reported results from the tests. e-LKG platform is being tested on one of the multiple possible application fields at some Spanish Universities: Universidad de Zaragoza (UZ), Universidad Politécnica de Madrid (UPM) and Universitat Jaume I de Castellón (UJI).

The project includes the creation of tools to improve mathematical skills of first year university students. This application is really justified by the strong evidence that shows the low level in mathematical skills of students.

New environments integrating tools, methodologies, contents, managers and users with reasonable low development, implementation and maintenance costs are necessary.

The evaluation of e-LKG Platform will allow us to measure the effectiveness of the developed work during the project, as well as the definition, parametrization and costs of services to be offered via Internet after the final version of e-LKG Platform is launched.

2 Customizing learning

Any learning process is obviously personal and subjective. Namely, each person learns in a different way than the others and uses different strategies,

depending on the subject. Therefore, this fact should be taken into account when a new learning environment, supported by technology, is designed and built. In that way, methodology allows a personalization of the process.

The personalization of learning is specially necessary for e-Learning methodologies in hard subjects, urgent or prone-to-failure situations as, for example, the mathematical training in first year university courses [5].

Some researches about mathematical skills of students during Secondary School, made by official institutions [6], detect strong weaknesses in aspects like knowledge and use of mathematical contents and techniques, modeling of real situations, ability to solve problems with open answer, capacity of visualizing mathematics in daily life, etc. These reports also show the difficulties in reading comprehension, which influences the training process of any topic in a very relevant way. All of these facts justify the necessity of doing an individualized diagnostic of weaknesses for each new year student at the University [7].

Moreover, the use of new information and communication technologies has an enormous influence in the general training process and the educational systems of each country. Besides, the European Space of High Education (ESHE) focuses the interest in the learning process, more than in the teaching process itself. Therefore, the citizen should have enough competencies to learn by himself, work in group and manage the information.

Providing flexible education for everyone and everywhere, has been one of the fundamental goals of distance learning. The worldwide adoption of Internet as a new channel and the rapid evolution of web-based systems and tools, are providing new approaches towards solving some fundamental problems of traditional distance learning: mainly the isolation and the lack of knowledge construction in a social way as it occurs in the classroom. Among *e-LKG Platform* aims, the definition of itineraries to adapt the contents to each user, based in a cooperative methodology and the online tutorial tasks is a wanted approach. We find the necessity of adopting new distance-learning teaching methodologies, embracing technology and its benefits, but bringing back the importance of the community as the source and constructor of knowledge.

These are the premises with which third generation web-based learning systems are being designed and constructed, with the aid of Open Source tools and techniques [8].

3 Interaction between technology, methodology and educational aims

According to Saskia Sassen [9], the success of any innovation depends on the culture of people's usage and their social roots. There are two points of view to understand the creation of technology and its effects: engineering and usage logics. In general, systems are designed from the engineer's point of view but, only when their interactions with the society occur, the usefulness is really shown.

These two points of view should be taken into account from the beginning of the process, in order to avoid the risks of doing a technological design 'only for engineers', that is, focusing only on the functionalities instead of its later usage.

Platforms with Knowledge Management and Cooperative Work features guarantee full interaction between design and usage if the thought and action models go together. The concrete thought model is based on the software structure and the concrete action model is based on its usage. The success of the application will depend on the way these models are to interact, if the users have been listened during the planning, if their necessities have been dealt with, if the system is easy and powerful to use and if, in the end, the user perceives a useful and easy tool. In the future, the development of platforms will be oriented towards the user, in form of useful concrete services from an abstract tool.

Therefore, a recursive way to move forward is necessary by including new functions and contents in the system coming from the proposals of developers, the suggestions of managers, cooperative work and the experiences with final users. In this way the procedure to act in each project, by successive refinements, should be based in mutual interaction between technology (developers), methodology (managers) and objectives (users).

4 A case study: e-LKG Platform

e-LKG Project is based in the following objectives:

1. Creation of a new Open source module to include the definition of itineraries and the adaptation of contents to each user, as the main objective of e-LKG platform.
2. Development and evaluation of a cooperative methodology for e-learning and on-line tutorial

action which will be supported by e-LKG Platform.

3. Creation and evaluation of mathematical contents to improve the skills in the first year students at the University.
4. Experimentation of e-LKG Platform features and evaluation of mathematical contents, cooperative methodology and mathematical learning for students of Engineering degrees at the three universities involved in the project.
5. Design of web services supported by e-LKG Platform and evaluation costs. Tuning of access service via Internet to the platform for e-learning usage.

Moodle has been chosen for e-LKG Platform as the interface tool for the final user. The current modules in Moodle allow the inclusion of contents, tests and quizzes in a very different manner; as well as an extensive configuration to show and evaluate these tests. However, the adaptation of contents presentation to each user should be another facility of this platform, as well as the automatic generation of courses from a common repository of contents.

According to the objectives of e-LKG project, the creation of new modules in Moodle, with features for Cooperative Work and Knowledge Management, is necessary. In this way, the itineraries are defined for users and the management and presentation of contents are adapted to each student.

The development of the modules is based in an spiral evolution model which allows to build each subsystem with different depth levels, with the aid of user-developer interaction and permits a change of strategy in its production, depending on the circumstances. This model also allows to include the advantages of 'life cycle' based models and prototypes. It's also the only one including a risk analysis which takes into account the evolution of functional characteristics and system knowledge.

e-LKG Platform is evolving according to necessities and adapted to the users for different applications.

4.1 e-LKG Platform: technology inspired on methodology

The combination of flexibility and personalization is an important challenge in platforms for e-Learning. Offering the software as Open Source Software is a possible way to obtain more interaction between the engineering logic, the use logic and its integration with other systems. In this way, users feel as the owners of the code and they cooperate with each other, putting in common their necessities, improving the code and cooperating in its distribution.

The interesting fact about this emerging third generation of systems is that Open Source is not only contributing with its products but especially with its process: the process of being part of a community, where all members listen to each other and collaborate towards the construction of an abstraction [10].

Finally, each evolutionary step in the development of software requires measurement of obtained functionality and quality level, efficiency of use and design, development, implementation and tuning costs. Methodology plays a fundamental role and takes advantage of technological features to achieve previously fixed training objectives. Tuning is the final refinement to do, trying to follow the most efficient way, the conjunction of technology, usage's methodology and accessible objectives, in the new learning environment,

The experimental mapping of e-LKG Platform for mathematical learning in first year university courses tries to establish the initial link between the previous and the expected student's curriculum. Anyway, we bear in mind that each student has his/her own knowledge, skills, capacities and a personal attitude towards his/her own learning process.

Afterwards, the platform features will help the student and the teacher during the learning process. In particular, users will be more conscious of the following characteristics:

- Interdisciplinary treatment: technology, methodology and users.
- Cooperative work: sharing, acting as a team, building and improving.
- Applications of e-Learning: to learn to become a learner, to learn Maths but also some other topics.

The different methodologies to evaluate the learning [11], [12], [13] will provide alternative ways to address this issue adequately, depending on the specific learning setting and requirements. The effectiveness of an e-learning environment strongly depends on the proof that students actually learn what they are supposed to.

4.2 e-LKG Platform: methodology supported by technology

Among the most important reasons why Moodle has been chosen as the technological support are:

- It is Open Source Software, so it can be freely modified, redistributed and, if appropriate, the improvements can be incorporated into Moodle.
- It's the most spread Open Source Course Management System, probably because it has been created and developed by experts in education, focusing on usability and usefulness.
- It has a huge community which is constantly reviewing and seeking for bugs and security holes.
- Its architecture is modular, which offers great flexibility and easiness when developing.
- It has been installed in several institutions with great success.

The process described in e-LKG Project, including cooperative work between teachers from different Universities, tests and suggested learning activities is supported by the developed software.

We strongly believe that the development of a piece of software for training must include a methodology which guides the process of producing educative contents. Our proposal tries to be a step towards the necessary methodological adaptation of two powerful resources: computers and the Net.

Two of the main aspects that still need to be improved in Course Management Systems which are fundamental aims in e-LKG Platform are:

- *Content Repository*. e-LKG Platform developers are working together with people from the Open University (UK) towards the construction of a native repository for Moodle programmed in PHP and following the JSR-170 Standard for repositories.
- *Customized Learning Path.* e-LKG Platform developers are evaluating several existing proposals to improve Moodle to see if they match the desired goals.

4.3 e-LKG Platform: Measuring abilities and skills in mathematics

The student enters University with a given curriculum and the Project Team determines together what the desired curriculum for that student should have been.

The question that immediately arises is: "Do both curricula match?" or, in other terms, "Has the student met the curriculum set by the University?". We need a proof [14] in terms of a quiz or low-cost test which measures, with high reliability, if the answer to the question "Is the obtained curriculum the same as the desired curriculum?" is yes or no.

If we obtain an affirmative answer, we should say, with a high degree of reliability, that the student does possess a series of abilities and skills (knowledge, capacity, attitude...) that we describe as adequate to enter and further integrate into University and develop an efficient learning.

On the opposite, a negative answer shows that the student has not achieved the expected curriculum. It is then necessary to build the required connections that allow the student to reach knowledge and skills needed at the University.

Before following this process, we need to define a series of blocks which cover all common deficiencies in the learning process. In [7], some of these blocks are suggested as a starting point: personal attitude towards learning, language complexity and mathematical reasoning, difficulties with measures and quantities, complexity in variation and variation comparison, difficulties in open-response problems, etc.

Once these blocks are defined, tests are prepared to measure the situation of each student, as well as activities are prepared to try to fix the detected learning deficiency. It is at this point when the student must be guided by the teacher towards choosing the set of tests to do to determine the learning aspects that should be reinforced.

Once this deficiencies are detected, the teacher should suggest the most adequate learning activities and itineraries for the student to follow so those initial deficiencies are solved.

At this first stage, the role of a teacher as a tutor is essential for the proposed activities, student tracking and evaluation.

5 Reinforcing learning and improving teaching

The final aim of e-LKG Project is the creation of technologies and services for the Information Society, as well as mathematical contents to further improve the skills of students entering University.

In our case, these contents are being experimented in three universities, with the idea of

experimenting a systematical usage of e-LKG Platform.

When the project ends, the platform will remain installed on a dedicated server in the Internet, along with documentation about methodological aspects and contents for further re-use and experimentation, which is the first step towards offering web services supported by e-LKG Platform.

6 Conclusion

Creation of a new groupware Open Source software which allows cooperative working in a learning environment. This fits well with the idea of some learning theories (mainly constructivism) and has been reflected as such in the rapid success of some Open Source tools which open the path that distance learning methodologies had been waiting for [15]. Methodologies based on collaborative working and tutorial action are being experimented with good expectations [16]. Currently available platforms try to focus on one or other of the mentioned aspects and, in some cases, they offer marginal functionality of the other, not to mention that most of them are under expensive licenses.

This project, applied to learning under different contexts, is a great methodological adaptation of powerful resources as the Net and computers, an adaptation of the learning paradigms where individualized learning is important, an advance in defining the task of the tutor and highlight his importance in the learning process, an instrument that encourages team working of teachers and educators.

The project also pretends to be the beginning of a permanent coordination between Secondary School and University. We hope it helps to define the elaboration of new mathematical curricula in Secondary School and University so its organization becomes a shared responsibility with the aid of a commission which periodically evaluates didactic aims and keeps them updated and according to social demands.

In respect to mathematical education in Spanish University and due to the institutional collaboration between three Spanish Universities UPM, UJI and UZ in e-LKG Project, a standard mathematical curriculum is going to be defined and shared. This consensus is potentially extensible to ESHE by means of a *knowledge network* [17] in which several institutions are now or will soon participate, including several Universities, R&D Centers and Companies in Austria, Spain, Finland, France, Ireland, Italy, United Kingdom and Check Republic.

Once the proposed methodology is experimented and delivered as a service (e-LKG Platform), results from the project could be transferred to other fields [18] in which some team members have experience, as continuous training for the sanitary area, continuous training for human resources in companies, or even in activities such as cooperative working networks, information systems, virtual communities, etc.

7 Acknowledgments

The authors want to acknowledge Ministerio de Educación y Ciencia, Spain for grant TSI2005-04127 supporting their research.

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