NAQ PROJECT, A PRACTICAL APPROACH TO COMPUTER AIDED TEACHING AND LEARNING

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Abstract
The introduction and use of new technologies in the e-Learning field is not just about a structural process, scheduled and developed according to the right criteria. We must work on the educative contents, their creation process, features and objectives, because these are an essential part in the process that will lead us to increase the quality of learning. And, an important factor to consider is that these new technologies should be used for something else, like developing tools that help in the teaching-learning processes.

Nowadays student profiles are far from what could be found a few years ago in the classrooms. Currently digital natives come to universities. These are students born during or after the introduction of digital technologies, used to interacting with technological devices from an early age. These students show great abilities to handle any digital tool, keyboards devices, digital-electronic pens, or touchscreens.

For this reason, amongst others, the use of educative resources in the teaching-learning process can not be the same of past decades. Creation, distribution and use of educative content should make use of new technologies, digital format and internet.

Since 1999 through Bologna Accords, the EHEA (European Higher Education Area) was launched. This initiative has been undertaken on 2010, and means a convergence process in the education field in Europe, creating a new reform of European university systems for a total of forty six countries.

According to Encyclopedia Britannica, Computer Assisted Teaching is defined as a method of teaching using a personal computer to present material and guide a learner through a lesson, allowing freedom of navigation choice and providing the ability to bypass material already mastered.

NAQ (Numerical Analysis Quizzes) is a Computer Aided Teaching and Computer Aided Learning tool. NAQ Project was born with the view to adapting the learning -on the side of students- and the guide process -on the side of teachers-, of the subject Numerical Analysis to the objectives exposed in the EHEA proposal. This facilitates the monitoring of the teaching-learning process.

This paper exposes the experience acquired in the creation, distribution and use of these interactive educative learning objects: numerical analysis quizzes. They have been developed for subjects of Numerical Analysis of various official degrees from the University of Las Palmas de Gran Canaria.

Keywords: Computer aided teaching, computer aided learning, learning objects, creation engineering, learning methodologies, learning process, numerical analysis quizzes.

1. INTRODUCTION
Nowadays, the students’ profile is far from those we found in classrooms just a few years ago. Digital natives [1] have taken up the classrooms. These are students that belong to generations who has born and grown up with new technologies. They show high capacities when they have to manage digital tools, keyboards, digital pen or tactile screens. They can pay attention to different information sources at the same time: reading e-mails while listening to music, watching some video or surfing on the internet. Marc Prensky coined the term digital native in his work Digital Natives, Digital Immigrants published in 2001. In his seminal article, he assigns it to a new group of students enrolling in educational establishments [2]. The analogy of the digital native was also used by Josh Spear and Aaron Dignan who talked about people who were born digital, first appearing in a series of presentations given by Josh Spear in 2007 [3].
The use of educative resources in the teaching field, therefore, cannot be the same of past decades. The creation, delivery and use of teaching material should use new technologies, digital format and internet.

1.1 European Higher Education Area

Since 1999 with the signing of the Bologna Declaration it is created the European Higher Education Area. This initiative is launched in 2010, and means a convergence process in Europe Education Area, by making a reform of the University academic degree standards and from a total of 46 countries. [4] Its main objectives are:

1. To adapt higher education and research field to the demands and needs of European Society, as well as to advance in scientific knowledge.
2. To achieve a new system that allows both compatibility and transparency of higher education systems concerning to users.
3. To promote students mobility, new graduates, academic and administrative staff, as well as services in the European scope.
4. To open up the possibility of university graduates in the labour market
5. To facilitate to students both knowledge and needed strategies of lifelong learning.
6. To create shared standards of quality in higher education from a broader perspective: management, teaching, and research fields.

One of the educative factors of this proposal is the innovation in teaching-learning processes and the students' autonomy level in activities to be developed along the course. The four units of educational activities:

Directed activities.
Those made in the classroom. With a timetable previously established where the teacher manages the activities.

Supervised activities.
These activities can be developed in an autonomous way, anywhere but require the teachers’ supervision and monitoring.

Autonomous activities.
The students manage their schedule and dedication in an autonomous way, with independence. These activities could be developed both individually or in groups.

Assessment activities.
These are the activities made to know the level of objectives achievement on the part of the students. The results are evaluated and graded.

NAQ Project is launched with the objective of encouraging and facilitating the study of Numerical Analysis subject to the students of second years of degrees at faculties and university schools. It allows making an ongoing and assisted monitoring of the teaching learning process.

[5] This Project considers the approaches made in the EHEA proposal. These approaches are presented in the form of objectives.

1.2 Objectives

1.2.1 General objectives

To offer the students a more independent way of learning. The tools and LMS’s availability used in the project make it easier to manage the schedule according to the students’ needs.

To offer the teachers to participate in the teaching-learning process as its guide. Making a more detailed study of how the process is developed, according to the analysis of the students’ results on each stage.
1.2.2 Educational objectives

To offer the students resources in order to strengthen their knowledge, and to be able to monitor the process themselves, that later could analyze with the teacher.

To facilitate the proposal, by the teacher, of tools that fit with the educational outline they need for their subjects. Besides these resources allows a new way of communication with the students, as they take an active part in the process.

1.2.3 Quality objectives

Through students’ opinion polls about the quality of the forms, and the academic information gathered along the project, a new study is made to be considered in new releases.

1.2.4 Observability objectives

Different stages of the process and the information gathered allow monitoring the system functioning, the results prediction and the errors notification.

1.2.5 Structural objectives

The design and development of the resources used in this Project answers to the features of learning objects; in fact they have been planned and developed as these types of tools.

2 COMPUTER ASSISTED TEACHING

According to Encyclopedia Britannica (2004), [6] Computer Assisted Teaching is defined as a method of teaching using a personal computer to present material and guide a learner through a lesson, allowing freedom of navigation choice and providing the ability to bypass material already mastered.

There are much and varied, the different elements and resources used in this kind of teaching. It is the same for web based teaching, e-learning, blended learning or mobile learning among others. All these terms, each of them with its own characteristics, have in common the use of computers, internet and different technological resources to teach.

2.1 Learning objects.

Nowadays the learning objects are one of the most studied technological resources, which have a huge importance in the creation of educative contents.

There is not only one definition of Learning objects.

David Wiley, in his work: Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy, define them as: Any digital resource that could be reused to support learning [7]

According to the IEEE definition, the most quoted in the literature, learning objects are: Any entity, digital or non-digital, that may be used for learning, education or training. [8]

Learning objects developed and used in this Project answer to the exposed features by Afonso [9]. These features set software engineering and object oriented principles:

- Modularity. They are composed of independent pieces that interact with each other. The information inside these modules is strongly related. This is denominated high cohesion. And the degree to which each module relies on each other is low, which is called minimum coupling.

- Portability. They are independent from the runtime environment used. This way, the possibilities of broadcasting in different media is higher.

- Scalability. They have the possibility to increase or decrease its size or even its configuration in order to adapt to new requirements.

- Extensibility. Its amplitude could be increased, allowing the easy incorporation of new elements.

The modular design of these Learning objects allows them to be reused, easy to maintain and that they could be used in the scheduling of learning routes.

Learning routes are defined as the routes scheduled by lecturers according to a calendar with the aim that students will follow their own learning process. Using these routes, the monitoring of the teaching-
learning process could be much more effective, and the personalization of the process more accessible for the teacher.

2.2 Learning models

Schematically we could describe three different models:

Content centered model. The learning process is based in the communication and transmission of knowledge from teacher to student.

Student centered model. The learning process starts as an initiative of the student, who research, organize, study and learn always guided by the teacher.

Students’ knowledge construction centered model. The process starts with the teacher proposal, from existing models in the students, of new situations and changes in these models. The student must work and discuss with other students and teacher. This work is the one which build new models and modify the already existing.

NAQ Project is exposed as a Project that uses computer aided teaching tools. Using a web platform the students can access to different learning objects that facilitates the monitoring of the process. The framework use the content centered model for the theoretical part of the subject and the student centered model for the practical one.

On each stage of the project new functionalities has been added, the students’ opinion has been taken into consideration as well as the academic results gathered.

3 NAQ PROJECT

During/along the academic year 2009-2010 various tests, via web, were made for the subject Numerical Analysis. These tests were made using CAA system (Computer Aided Assessment system), widely used in high education. CAA system selected was AiM [10][11] because of its availability on internet, and after checking that the system had the appropriate features. Its base is Maple CAS (Computer Algebra System) to randomize and to mark mathematical problems.

We can find projects similar to AiM CAA, as CalMath [12] which uses Mathematica® as CAS as well as MapleTA, a Maple’s commercial product [13]. Recently STACK [14] which uses Maxima CAS as basis. Both STACK and Maxima projects are free open software. The main objective was to use a CAA system as teaching resource, instead of an assessment system. [15]

3.1 Implantation and practical experience

In previous academic years students of the subject Numerical Analysis, requested more exercises for the exams preparation. With time, we decided to tackle the development of these exercises during the academic year 2010-11.

At first, we made a research in the net of the packs that could randomly generate exercises. We decided to use AiM CAA. With two different versions: the first one, Belgium original; the second one, a new release that could be downloaded from the maths department of the University of York, in the United Kingdom. The quality has been evaluated installing both of them, checking their viability to be used in a Linux server, the difficulties of its use, and their strength. Finally we decided to use the second one because it provides more functionalities and a more usable interface.

One or two examples were developed, the first one, more simple, that deals with derivatives of functions of one variable; and the second one, a bit more complex, where given a value table, the interpolation polynomial should be calculated, using both methods Newton and Lagrange. In both case, once the questions are answered, the student had on real time the assessment for this work, and the detailed solution of each exercise. As we exposed above, the basic aim is that the system could support the learning process, instead of an evaluation system.

At the beginning of the second semester an e-mail is sent to the students that could be interested in the project. This e-mail invites them to check the questionnaire with the exercises and ask them to join to a test group, with a generous grade proposal. This proposal could be the use of questionnaires, being the assessment the 15% of the final grade.
Initially it accepts groups of 24 students. A total of 6 questionnaires with 21 different questions each, were developed. These questionnaires included more numerical methods than those of the subject’s content.

The development of each question means to write at least four different blocks of code. The first one deals with the random generation of the math objects needed to expose the question, and the verification of having an acceptable exercise. The second one would create the text of the question with its different sections. The next block is a Maple procedure that handles the marking once the answers of the students have been checked. Finally the last block deals with the complete solution of the exercise.

The development of questions involves an important length of time to prepare the procedures that performs specific task in the exercise. In some of them it is common to find code written in different programming languages, such as LaTeX, Maple, HTML and AlM’s own commands. This make difficult the questions arrangement, since the system do not inform, in many occasions, about the error’s source. Besides, it is convenient to take care of the generation of random parameters for the questions, they must have reasonable values, they must be both coherent and compatibles, and they could be able to generate a solvable exercise in a mathematical sense. The solutions should be also reasonable, easy to verify correctly in type and possible values. If the question has different sections the dependencies among them should be also checked.

The solution must have enough level of detail for the student to feel comfortable when studying. This means adding all the possible decisions to take, solving in detail each solution way. In practise all the intermediate values should be calculated. These values could appear according to the different parameters of the problem, and they could be: numerical, vectorial, matrix or functionals with different relations, restrictions and dependencies among them. Sometimes the exercise generated could not have a solution, this is why it has been necessary to develop in real time, while the exercise is generated, error handling and failover. This has meant an added difficulty, since the system itself assigns a time slot to “generate the exercise”. It is a fixed time slot (about two seconds), and gives an error message if this time is exceeded. The system lacks of resources to set-up the exercises when some error is found. For the developer, this could be an important reason to questioning the system.

If we develop questions with an average length for the solution, the system can be very reliable. Anyway, the advantages are worth the cost of development. Fig 1., shows one of the quizzes generated for the subject Numerical Analysis.
4 CONCLUSIONS AND CONTRIBUTION

The implementation of an innovative education Project, as the one presented in this work, can be tackled designing the different stages of the project and allowing changes on each stage. Definitely the more concern in the design the more easy will be the changes, if necessary. It is important to remark that the explanation of the material selection criteria, resources and methodologies to use, as well as the project’s objectives in the initial stages facilitate to know where we are and where we want to be.

The practical approach developed in NAQ Project enables the study for its adaptation to the students of the subjects of Numerical Analysis of the second year of technical degrees.

The polls made give information about the students’ acceptance during the pilot project and about the modifications that they should include in later releases of the project.

As regards to the academic information, although in the pilot project stage the results has been improved with regard to previous academic years, where this project still was not running, in the next release this result has increased.

For the next version, NAQ Project 2011-2012, will include the students’ current proposals (made in NAQ Project 2010-2011). Besides, it will include some more functionalities and technical requirements.
that the teachers consider important in order to increase the advantages and to improve the project’s objectives.

Functionalities:

The information will be saved with the number of tries and the results of each exercise with the aim to design rules that will use artificial intelligence to set learning routes.

Data mining techniques will be used to set students’ profile and to define with more accuracy the objectives they should achieve.

There will be statistical graphs automatically generated for teachers just having a quick look could obtain visual information.

Technical requirements:

The learning objects will make use of metadata to save enriched information in the database. This means changes in the database tables and in the relations between these tables.

More strict criteria to access the educative material and its use will be employed.

Once achieved the project stability and with the whole group of automated tasks this project will be extended to other subjects.

REFERENCES


