Analyzing lifelong learning student behavior in a progressive degree

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Abstract: The *Universitat Oberta de Catalunya* of offers official degrees and some courses in the same virtual environment for students or professionals who want to improve their knowledge and competences. The Computer Engineering degree is designed in several progressive degrees that offer an accreditation and a competency level. Some subjects are recommended as well as the other ones that are mandatory for obtaining a progressive degree. In this paper we analyze the curricula selection behavior of students enrolled into a Computer Engineering degree degree and we compare the two main available possibilities: one is following the preplanned "per semester" structure, and the other is following what is named "progressive degrees", which allow students to obtain certificates in several areas related to professional competences. Although this second strategy is supposed to provide a better lifelong learning experience, results show that students do not strictly follow it, mainly because of the difficulties of the proposed scheduling.

Introduction

With the creation of the Bologna process, distance and open education is changing the followed approaches until now. As the UNESCO enunciated, “Universities are important stakeholders in lifelong learning. Their role could evolve, and the link between the learner and the university could become a lifelong link, both to constantly disseminate the knowledge and to develop the networks and communities. E-learning should be encouraged and trained to acquire and further develop their e-competences”. Lifelong learning becomes a clear goal for any university, using a learning competency-based approach. It is well known that student formative needs are different for an official degree than for postgraduate students. Some students need to improve their knowledge in order to apply it immediately at work, and also most of them want to learn about specific topic without obtaining an official degree. The University offers several courses in a lifelong scenario called Ateneu. The particularity of these courses is that a great variety of students with different backgrounds are in the same virtual classroom. Other official degrees such as the Computer Engineering degree allow students (actually, professionals) to improve in their knowledge about specific areas, following a progressive degree which helps them to specialize in selected areas (software engineering, networking, and so).

We have a special interest to study and analyze student behavior. Different situations of such behavior are taken into account. A three-level framework for analyzing learner behavior has been identified and developed (Mor, 2004) and it can be analyzed at the lifelong learning level in our virtual environment. What is obtained as the result of such analysis can be used to improve the students’ lifelong learning, thus competence design for a lifelong learning scenario, improving progressive degrees and discovering whether the preplanned curricula is followed by most students or not. A competence design is strongly related to a learner profile. A learner profile is built taking into account students’ characteristics and information. This profile constitutes the basis of an accurate competence-based design. Later on when the competence design is running and students are enrolled to courses, their activities and behavior can be gathered and stored. This study can generate high valuable information for improving the teaching and learning process. This information can be integrated in the learner profile, in addition to other student information and characteristics.

This paper is organized as follows: Section 2 describes briefly the University and the virtual e-learning environment for Lifelong learning and official degrees. Section 3 describes the student behaviour during the learning process in the virtual campus. Section 4 describes the analysis done in the Computer Science degree. Finally, the conclusions of this paper and the current and future research lines are summarized in Section 5.

Professional development in a lifelong learning virtual environment

The University is an institution which has emerged from the knowledge society. Its mission is to provide people with education and training throughout their lives. The university's principal aim is to ensure that each student satisfies his or her learning needs in a virtual environment, gaining the maximum benefit from their own efforts. The growth of the Internet is bringing online education to people in corporations, institutes of higher education, the government and other sectors (Rosenberg, 2002), and both the growing need of continuous education and the inclusion of new multimedia technologies become crucial factors for the expansion of lifelong learning.

To this end, it offers intensive use of information and communication technologies (ICT), thereby enabling us to overcome the barriers imposed by time and space for offering an educational model based on personalized attention for each individual student. Students, professors and administrators interact and co-operate on our Virtual Campus, constituting a university community which uses the Internet to create, structure, share and disseminate knowledge. Within the university virtual campus, each subject has a virtual classroom for teaching and learning process and they are the virtual meeting point for learning activities.

Among many other courses, the university offers several official degrees and also the Ateneu courses. These courses selected from the subjects offered as part of the official degrees, are oriented to lifelong learning students who want to improve their knowledge and professional competences. Another example about our lifelong learning scenario could be the Computer Engineering degree as we will see. The virtual campus, resources and services involved in the learning process are the same to the learners of an official degree. Students with different knowledge, competences and background are studying together in the same virtual classroom and with the same tools such as the others. Students can be enrolled without any university access prerequisite, with the aim of developing and reinforcing (in certain areas) their competences and knowledge. The Computer Engineering degree has been chosen for studying if students can improve their professional and personal competences through the courses offered in a progressive degree in a lifelong learning scenario.

Computer Engineering professional development

The aim of Computer Engineering degree is to develop professionals and prepare them for acquiring a set of competences for covering several areas in the market job. This degree is addressed to people or professionals interested in:

- Planning, construction and maintenance of complex information systems.
- Management, install and set up of computers networks and the required basic software: operating systems and databases.
- Management of computer projects for different types of organization and several degrees of complexity.

According to the surveys, the university student has an average age of 35 years and an important percentage has a previous degree (around the 28%). On the one hand, they decided to enrol for improving their competences and skills, and on the other hand for advancing in their professional careers. Computer Engineering students could be considered such as lifelong learners because they are active professionals with a previous degree (it is a required requisite to have a Technical Computer Engineering degree).

The Computer Engineering degree is designed in form that a student involved full time will achieve it in four academic semesters, even though the flexibility of the university allows that each person can adjust it according to his or her availability and time. In this way, each student can decide every semester which subjects he or she wants to do, as all subjects are offered each semester with a few exceptions (optional courses with few students). This degree is organized in several progressive degrees, which try to improve the acquisition of some specific Computer Engineering competences. It also allows students to develop and apply these competences during the learning process.

The difference between a technical Computer Engineering degree (systems or management) and the classical Computer Science is not only related with the applying area or practical issues. Taking into account the pedagogical model of the university, the students are the learning centre and this fact improves the acquisition of any kind competences (general or specific). When learners graduate they have to be able to perform some advanced competences. When we define the competences that have been acquired by a learner, this is done by stating the objectives to be reached regarding the knowledge process (Paquette, 2004). This degree with different progressive levels of accreditation and with this kind of learner profile in the university learning environment can be seen as a clear example of lifelong learning scenario. At the same time, it constitutes an attractive and important focus for analyzing and studying user behavior by the professors involved in the degree, extracting useful knowledge about the reality, thus, the everyday facts of lifelong learning education.

Progressive degrees in Computer Engineering

Computer Engineering degree is structured in a two-year period (that is, four academic semesters), and it is the continuation of the Technical Computer Engineering degrees (which are three-year periods), according to the Spanish educational system. Only students with the proper accreditation for a Technical Computer Engineering degree can enrol into the Computer Engineering one. This degree pursues specialization in several areas such as Human-Computer Interaction or Networking, for example.

Several learning itineraries are offered to the students and it means that any of them can organize their learning process according to their interests. Each student can organize his or her degree by stages and each one has an academic recognition and a clear linking with the needs of the market. While students are taking the degree they can obtain a specialization degree which is recognized by an accreditation. These types of learning paths are also known as progressive degrees. Each specialization or learning path offers a set of subjects following the real needs of employers in the software and technology industry.

There are six progressive degrees or specialization itineraries in the Computer Engineering degree: Human Computer Interaction and Multimedia Interfaces; Design and Management of Computer Networks and Security; and Project Management and Information Systems. Each one can be obtained after studying a reduced set of subjects during some semesters. These subjects are part of the official degree as established by the Spanish government, and some are mandatory and other of them are optional. The university provides students with a recommended subset each semester. For example, in the first and second academic semester the following recommendations are given (mandatory courses are in bold):

FIRST SEMESTER	SECOND SEMESTER
- **Object Oriented Software Engineering** - Computer Graphics I - Database II - **Computer Network Design** - **Artificial Intelligence I** - **Computer Architecture** - Economics for Engineers	- **Distributed and Component-Based Software Engineering** - Human-Computer Interaction - Database Management Systems - **Wireless Communication** - Distributed Systems Architecture - **Artificial Intelligence II**

Table 1. Recommended subjects with mandatory in bold

Usually students choose two or three of them each academic semester, but for us is more important to know whether students chose the subjects according to the recommendations they are given or not. Students can choose the ones which they consider more interesting for their needs, instead of the recommendations of the institution,

making the progressive degrees an interesting offer much more than the classical learning path established by the official degree. In this case we are interested in study both students' behaviour during their learning process in the virtual environment and the subjects chosen for improving the progressive degrees offered.

Collecting and analyzing student behavior

In any virtual learning environment, such as the university virtual campus, the student behavior can be collected and analyzed. Depending on the environment the data collection and analysis can be very simple or very complex. The analysis is very useful for knowing the students real behavior and for adjusting the formative proposal to student real needs. In order to offer learning paths according to the student behavior this kind of studies are proposed as basic tools for capturing the real intentions of learners in the virtual campus. It is very important to know what is done by the student in the Computer Engineering degree for redesigning the recommendations given, if needed. It is also important to know how students use the virtual learning environments, how they use the services, how they reach the desired contents or services and how they access and use the learning resources. This is a very important component of student behavior and must be taken into account when constructing the student model. Dropout is also an important issue which may be better understood if relevant variables are identified, such as undesirable combinations of difficult subjects which may be the cause of frustration and dropout indeed.

Our analysis focuses on the learner's knowledge and how to model their navigation paths, and once obtained, on the construction of navigation behavior patterns. Three different user navigation and behavior patterns levels are usually distinguished, namely short term, medium term, and long term, but in a virtual environment these levels can be stated as session level, academic course level and lifelong learning level respectively. Each one of these levels of system navigation, usage and behavior provide relevant information for constructing a user model and will allow us to achieve different kind of goals at different stages of the learning process. These three levels arise in a natural and hierarchical way from the use that the students make of the virtual environment and the distinctive dynamics of their learning and training activities when carrying out online distance studies.

It is interesting to notice that knowing what users do and how they navigate in the virtual environment is as important as knowing how they should navigate and which actions should they perform. Therefore, at each level of study, user navigation and behavior must be regarded in relation with the navigation and behavior models used when the e-learning environment and the courses were designed. Thus, the virtual learning environment can be measured and unusual and unexpected facts can be discovered.

Session level

At the session level the short term navigation behavior is studied, that is, what each individual user does every time that she or he connects to the university virtual environment. This information is processed in order to build a navigational path. Different paths of the same user can be grouped to get the user navigational behavior. When learning outcomes and activities are designed, several hypotheses about student behavior are used, such as that the students connect to the virtual environment in sessions of twenty minutes, or that they first check their personal mailbox and afterwards they access to the virtual classrooms and courses they have enrolled to.

The information obtained at this level will allow us to validate these and other work hypotheses used for designing formative actions and learning plans. Furthermore, the information discovered at this level may be used as usability data, as stated in (Hilbert, 2000) about extracting usability information from user interface events. This information is used for evaluation purposes (Ivory, 2001), detecting whether the system was properly designed or not and where users get lost and where they find obstacles and difficulties to reach out their learning objectives. It can also be used to detect bottleneck problems or virtual environment services or areas that are not used by most users.

Academic course level

The navigation behavior at medium term is studied at the academic course level. In the case of a regular university course, an academic semester is analyzed, which include several subjects. Currently now, all the students follow a learning path designed by teachers and instructional designers, including both formative and evaluative

activities. Personalization can be introduced by adapting such learning path for each student, depending on his or her profile, previous knowledge and professional competences. This profile includes socio-demographical data, academic data, but also a navigation behavior pattern, which contains: connection pace to the virtual environment, the length of each connection or session, the virtual classroom elements usage and navigation (multimedia resources, learning materials, communication virtual spaces…), and other indicators extracted from the session level. Different paths of each user are processed to generate the medium term level model. This pattern shows the user behavior and navigation during the academic course.

The information obtained from the analysis at this level can be very useful to design and improve learning paths that fit student needs and allow personalization by means of adaptive itineraries, using SCORM or any other standard with sequencing capabilities. These adapted learning paths also take into account the possibilities offered by a progressive degrees that students can follow. For example, additional modules and exercises could be optional for some students and mandatory for others, depending on their profiles. It will also allow us to find out if there is any correlation between navigational behavior and the attainment of the learning goals and the academic performance. At this level, the usage patterns of the different virtual environment spaces and services will also provide relevant information that will be of special importance for obtaining specific metrics of such spaces and services, as well for identifying usage and usability issues that should be addressed. In relation to the learning process, this level is the most important, because it reveals useful information as shown in (Carbó, 2005). For example, students with more complex connection patterns (high interaction with the teacher, learning resources, and so) usually obtain better academic results and vice versa. This information can be used by teachers to adjust the learning process according to the student competence needs and to warn educators about students more likely to drop out.

Lifelong learning level

At this third level, that is, the lifelong learning level, the long term learner behavior is analyzed. The whole education lifecycle is considered, taken into account each course and subject followed by students. It means that different stages can be found; that are determined by the academic lifecycle of each student. The main stages are university access, first registration, further registrations, progressive degree completion and degree achievement or, unfortunately, dropout.

The study of these stages is useful to identify the aspects and features that will determine crucial points in the student's career. Progressive degrees can be redesigned with this study and mandatory subjects can also be improved. Preliminary experiments show that the navigational behavior extracted in the second level may be useful to detect (and even prevent) dropout during the first three semesters, and especially in the first one, although this is highly variable depending on each degree. The analysis also showed that recommended subjects are not always enrolled. We are also interested in discovering the combinations of subjects that favor the attainment of learning competencies, for example, according to each learner profile (Tattersall, 2004) and professional development such as the European Comission has also enunciated (European Comission, 2005).

Computer Engineering student behavior analysis

In order to analyze the students' behavior in the lifelong learning level, we have carried out a simple experiment which shows the reality regarding how students enroll into the offered subjects at each academic semester, showing the differences between the official and the real learning pace. Table 2 shows the number of students enrolled into mandatory subjects each semester according to the academic semester each subject is supposed to be done. This table has been generated using accumulated data from ten academic semesters, since Spring 2001 to Autumn 2005, both included.

In the first semester, students are supposed to enroll into four mandatory subjects (as shown in Table 1) and a few optional subjects. A simple statistical analysis reveals that most students only take one or two subjects each semester. Among the vast amount of available subjects (the four proposed but also other subjects which can be taken as credits needed to fulfill the degree requirements), most students chose them from a limited subset, the four supposed to be taken and a few courses very different in nature; for example, one optional course in Computer

Graphics and other optional Database course from the offer from the second semester. This fact reveals that some students have already acquired the basic competences in the technical degree and they can advance faster in the Information Systems progressive degree. Two subjects, one in Object Oriented Software Engineering (11) and other in Artificial Intelligence I (14) are the most popular, while other subject known to be difficult, Computer Architecture (13), is not likely to be chosen in the first semester.

	1st sem.				2nd sem.				3rd sem.			4th sem.		
Sem.	11	12	13	14	21	22	23	24	31	32	33	41	42	Total
1	**472**	**178**	77	**389**	7	31	8	5	0	2	61	1	0	785
2	**104**	**120**	**150**	**117**	**117**	**81**	33	64	10	10	**76**	12	0	576
3	25	**145**	59	37	**169**	67	**81**	49	31	11	**93**	10	1	396
4	14	50	35	22	**66**	**80**	**61**	**80**	**84**	40	**66**	29	3	300
5	4	31	21	10	39	36	35	**67**	43	**54**	45	**59**	15	241
6	0	17	8	8	19	**33**	26	31	19	**34**	**33**	**38**	23	170

Table 2. Enrolment by semester according to each academic semester.

Other interesting fact is that students do not follow exactly the given recommendations for taking the courses. For example, Artificial Intelligence II (24) is supposed to be done after Artificial Intelligence I (14), but only 64 out of 389 possible students do it during the first and second semesters, while Compilers I (33) has been done by 230 students by the third semester but only 52 have enrolled into Compilers II (41) by the fourth one. The main reason is that students prefer to finish complete semesters instead of following the proposed paths for specialization. Other important reason is that not all students pass the evaluation procedure and need to take the same course again. These results show that a redesign of the progressive degrees can be done. Recommended subjects should be revised for taking into consideration the real student learning process in the virtual environment. Therefore the learner's professional competences can be improved as well as they need.

Conclusions

In some professional fields it is very important to promote the formal acknowledgement of skills, knowledge and competences gained through work experience, informal training and life experience, for prior learning recognition purposes. Lifelong learners need to improve their knowledge and also to apply it immediately, as in the case of Computer Engineering students at the university. The learner profile in this degree is very similar to the common lifelong learner profile and a further research is needed to design the learning process according to their profile and formative needs, according to their real needs. Several progressive degrees have been designed with this goal. It is known that students choose progressive degrees for the accreditation they will obtain when they finished some subjects. A professional higher stage can be reached in their jobs with this accreditation.

As a fully virtual university, student behavior at different levels has been analyzed in order to improve the recommended learning process for a given degree. Usually, the proposed paths for specialization are not followed by the students as the professors designed them. Preliminary results show that students choose subjects according to the classical academic semester organization. Thus, the learning process and the subject organization in the Computer Engineering degree (and its progressive degrees) should be redesigned or modified if we want to adjust this degree to our real student behavior in the virtual environment and for taking into consideration their lifelong learning needs.

A personalization learning model could be designed for improving the teaching and learning process in the virtual environment. We could even design a teaching plan adjusted to the real student behavior. Finally, in order to design a competence-based degree such as the Bologna process has enunciated, students' navigational and behavioral patterns should be studied deeply.

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