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## NEW CHALLENGES FOR E-LEARNING POST-GRADUATION IN EXACT AND TECHNOLOGICAL SCIENCES

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### Introduction

Learning and teaching in an on-line environment are, in many ways, much like teaching and learning in any other formal education context. However, the pervasive effect of the on-line medium creates a unique environment for teaching and learning (Anderson, 2004). This century will see the emergence of a post-modern era of distance education characterized by increased diversity and choice (Garrison, 2000). Such development is made possible by new communication technologies, as exemplified by the evolution of the open universities in their adoption of new models to replace/complement the traditional self-paced, independent learning model of the industrial era (Davis, 1999). The implementation of these new models to formal master courses in specific areas of life sciences, mathematics and technology is a new challenge, where face to face field and laboratory activities are often compulsory.

This paper presents a preliminary reflection on the working experience of three masters courses taught at Portuguese distance learning university. In Portugal those courses are novel both in terms of the e- or b-learning regime, and in terms of curricular contents and professional competence outcomes.

### ***Masters Degrees in Exact and Technological Sciences Education***

The Department of Exact and Technological Sciences of *Universidade Aberta* (UAb) offers three e-learning MSc courses in the fields of mathematics/statistics and computation, environmental sciences and food consumption sciences (more information available on <http://www.univ-ab.pt/ensino/2ciclo.php>). These are formal courses, organized according to the European Credit Transfer and Accumulation System (ECTS), and in accord with the pedagogical model of UAb. This online model rests on four major principles: student-centred learning, flexibility, interaction and digital inclusion. For Master's degrees the model is based on a Learning Contract developed by the teacher of each curricular unit (CU). Each Learning Contract is structured into working topics, aims, competences to acquire or develop, learning methodology, list of e-activities, timetable for developing learning activities, and support materials (Pereira *et al.*, 2007). The semester is defined as a period of twenty weeks, where the five final weeks are dedicated to the final assessment. The continuous assessment component (obtained through the e-activities) weights a minimum of 60 % of the final mark.

The open source MOODLE ([www.moodle.univ-ab.pt/moodle](http://www.moodle.univ-ab.pt/moodle)) and ODISSEIA ([www.odisseia1.univ-ab.pt](http://www.odisseia1.univ-ab.pt)) are the course management systems (CMS) used in these MSc courses. A two week's online course is available to students, just before the beginning of the 1<sup>st</sup> semester, as an introduction to the CMS and UAb pedagogic model. All the courses have virtual class sites for each CU, a coordination site for student matters, a coordination site for the teacher's team, and a virtual *café*.

### ***MSc in Environmental Citizenship and Participation***

The MSc in Environmental Citizenship and Participation offered at the UAb intends to prepare for acting in environmental policies making and environmental citizenship, participation and planning. The course addresses governmental, public and private environmental advisors, members of Environmental NGOs, teachers, researchers and others involved in environmental practices, policies, planning, teaching, participation and citizenship. Subjects,

methodologies and case studies arise from the Environmental Sciences, Sustainability and Social Sciences.

This course has begun in the year 2006-2007 and is taught in b-learning system. Most of the CU are taught in e-learning except one CU that is partially taught in face-to-face lectures concentrated in one Friday ("Participation and Interactive Methods in the Environmental Decision" CU). The beginning of the first and second semesters is also marked by a face-to-face session. The minimum and maximum number of students is fixed, respectively on 8 and 30. The MSc has the duration of three semesters, being the first two semesters dedicated to the course units (60 ECTS) and the third semester dedicated to the preparation, orientation and presentation of the thesis (40 ECTS).

Each semester of first year of this master's course correspond to 30 ECTS (sum of 60 ECTS) and is composed of 5 curricular units, (total of 10 course units). The first semester is composed of 8 optional curricular units from which the students choose only 6 (30 ECTS). The units of the first semester give the fundamental concepts in environmental sciences and social sciences, and the units of the second semester give the conceptual, practical methodologies and techniques for an environmental citizenship.

Curricular units are organised into topics, each topic being developed into two to four weeks, depending on the subject area. The Moodle activities used include lessons, mini-tests, glossaries, discussion *fora* and blogs. Each topic is generally associated with one learning activity. E-activities used are discussion *fora* (mostly involving group work), short written assignments and blogs. Communication is mostly asynchronous. Support materials include books, e-books, research papers, internet sites, power point presentations and short films. Instructor's feedbacks are done during the semester, after each e-activity. Final evaluations are individual assignments or tests conducted on the CMS.

For the academic year of 2007/2008, the MSc Environmental Citizenship and Participation course had 26 applications, 16 of which resulted in course enrolment. Of the enrolled students, 6,2 % live abroad, 12,5 % live outside Continental Portugal, 12,5 % live in northern Portugal, 43,7 % live in central Portugal, and 25 % live in southern Portugal.

More information, description and course performance in terms of student motivation, student-content interaction, student-student interaction, student-teacher interaction, learning activities and type of evaluation are described in detail elsewhere (e.g. Bacelar-Nicolau et al., 2007).

#### ***MSc in Statistics, Mathematics and Computation***

The goal of this MSc degree is to provide its students with an in-depth knowledge of current methods and developments in computational statistics and mathematics, and, in particular, training them to use and/or develop methods of computational data analysis or automatic theorem proving. Its graduates are prepared to start working in public and private companies and institutions where data analysis, opinion studies, and computational mathematics skills are needed, as well as to develop teaching and research activities in these areas.

The MSc in Statistics, Mathematics and Computation is taught in a full e-learning environment, supported in the MOODLE and ODISSEIA e-learning platforms of the UAb. It has two areas of specialization, namely: Computational Statistics, and Computational Mathematics. It has the duration of four semesters, the first two corresponding to the activities of the curricular units (CU) that constitute the degree (60 ECTS), and the last two are dedicated to the preparation of the final dissertation. In the first two semesters, the students must complete 8 out of 9 CUs in order to proceed to the dissertation phase. In all these CUs, the coursework is organized in several topics, each of which being developed in a two to four weeks period. The e-learning activities used include lessons, quizzes, surveys, assignments, glossaries, and discussion *fora* (sometimes involving group work). Each topic is generally associated with one learning activity. Communication between instructor and students, and in-between students is mostly asynchronous. Support materials include books, e-books, research papers, and internet sites. For some CUs the use of software packages, such as SPSS, is mandatory. The instructor's feedback of each e-activities is done during the semester, usually a couple of weeks after the end of the activity. Final evaluation is done through written works.

In 2007/08 there were 13 applications, of which a total student population of 8 was enrolled in the course. Of the enrolled students, 37.5 % live outside Portugal (namely Brazil, Mozambique and Angola).

#### ***MSc in Food Consumption Sciences***

This course aims to provide knowledge and understanding of different aspects of food products and their intake. As a result, the course ranges across diverse food science areas, with particular emphasis upon the principles of food biochemistry, food preservation and consumers issues. By being designed to appeal to people from a wide range of areas of education, the course will give a comprehensive view of the food system and its dynamics. Thus, this course is intended to attract retailers, food managers, food manufactures, quality assurance consultants, governmental public advisors and members of NGOs who are involved in food consumption subjects, food media professionals, teachers,

researchers and others involved in food science and consumption issues.

This course is the result of the adaptation of the form MSc course taught at the North Delegation of Universidade Aberta (UAb – Portugal), at Oporto, since 2005. Currently, the MSc in Food Science and Consumption it is taught in b-learning environment, where most of the modules are taught in e-learning mode and supplemented by occasional face-to-face lectures for supporting practical activities (particularly for the units of: "Food Preservation Technology and Food Packaging" and "Sensory Analysis and Product Development") and for oral students' assessments. The course has the duration of four semesters, being the first two semesters dedicated to the modular units that constitute the curricular year (60 ECTS) and the last two dedicated to the preparation, orientation and presentation of an original dissertation which accounts for a further 60 ECTS. Each semester of the curricular year is composed of 5 modular units. The modules of the first semester are all compulsory; the second semester is composed by 3 compulsory modules and by 2 optional modules, which the students choose from a list of 4. In total, the optional units account for 10 ECTS. The main focus of the first semester units is on food proprieties and food preservation (supply approach), while the second semester units focus on consumer issues (demand approach).

Each module from the MSc in Food Science and Consumption is organised in a set of topics, each of them developed in two to four weeks period. Generally, each topic is associated to one learning activity. The teaching and learning method used for the e-learning regime, at the UAb, engage the student in active learning. This is achieved through the inclusion of a number of activities with accompanying teacher commentaries, such as: surveys, quiz, assignments and compulsory discussion groups (moderate by the module teacher), searching on the internet access on-line data-bases. Support materials include books, e-books, research papers, internet sites, slide presentations and original teachers' documents. Examples, case studies, news from media and original research are used to bring the subject to life and to help students to link theory to their practice. Final evaluation (corresponding to a maximum of 40 % of the module evaluation) is done on-line through individual assessments or tests presented at the platform and oral students' assessments (essay presentations, case study analysis, research poster presentation).

For the academic year of 2007/2008, the MSc course in Food Science and Consumption received 13 applications, of which a total of 11 had enrolled in the course. Of the enrolled students, 46 % were from Oporto District (North of Portugal), 27 % were from Coimbra District (Centre of Portugal), 18 % form Lisbon District (South of Portugal) and 9 % from outside Continental Portugal.

### Methodology and research instruments

A questionnaire survey was carried out with the teaching staff in order to characterise the three post-graduation teaching courses described above. The survey questions were prepared taking into account previous work (unpublished) and teacher's workshops. The goal was to identify the critical issues that underpin the learning processes, at a post-graduate level, in master degrees in Live Sciences, Mathematics and Technology, taught in an almost entirely virtual, and collaborative, environment. The use of the MOODLE and ODISSEIA e-learning platforms in online tuition and support was also assessed and some questions aimed to identify the specific needs for more complicated tools, techniques and creation of tutorial tools for e-learning.

### New challenges/difficulties of the MSc in exact and technological sciences education

The preliminary analyses of the questionnaire survey applied to the teaching staff involved in the three graduate courses allowed to highlight the main problems and challenges of the students and are summarized in Table 1.

Table 1: Main problems and possible solutions, pointed out by the teachers of the e-learning MSc courses in exact ant technological sciences education.

Problems	Comments	Possible solutions
Too much documents to read in each curricular unit	Most of our students have full time jobs while doing the course	Use of material of easy access and reading; clear division between essential and supplementary reading
Too much simultaneous e-activities in the same and in different curricular units		Flexibility on the e-activities deadlines  Reduce the number of e-activities during the semester in

		each c.u.  Coordination between the different c.u. activities
Language/communication – problems	This is the particular case of students from other countries speaking Portuguese (African countries and Brazil), where they have problems not only with Portuguese but with texts in English	Use of texts of easy reading and give help tools of online translation
Students with low income	This is the particular case of students from African countries; they hardly can have the computer requirements that are necessary to perform some activities of some courses. Some students gave up the course, namely because they need to come to Portugal for the public MSc final work defence.	Promote scholarships and private supports to students
Problems accessing the Internet	This is the particular case of students from African countries, where some times they even don't have energy on their homes.	Teacher should take this limitation into account on the final assessment
Face to face classes for practical and assessment activities	This is a critical issue only for students living outside continental Portuguese	Videconference for students that are outside Portugal  Reduce the classes to the acceptable minimum, by finding and developing other virtual tools that can replace face to face classes
Technical problems with software inside and outside CMS	Students have to work with different software like SPSS, Latex or ArcGis.  For example in Latex, expressions like $f(y)$ are automatically converted to "emoticons" in Moodle.	Create a online technical support service from the beginning of the semester  Upgrading to new versions; changing source code  Up-grade the CMS for better integration with different software, allowing for example, to use the software in synchronous sessions

The geographic distribution of the students of the three Master courses is very disperse, from outside Portugal (African countries and Brazil) to Portuguese Atlantic islands and the different regions of continental Portugal, which is a great advantage of this type of learning regime, but also an impressive challenge. As can be seen from Table 1, some of the course's problems are related with language, financial and technical problems of students population coming from African countries, (where Portuguese is the official language). For this reason the coordination team of each Master course must give special attention to these students, namely to help them finding financial support for their studies.

In addition, greater effort in motivating and general feedback and communication technologies support is necessary in the initial period of a course in e-learning regime, when the e-learning community bonds are still being formed, and some ICT-issues are still a problem. This support may decrease the drop-out rates which still characterise the courses on e-learning regime. The virtual *café* is an important place for student's socialization, companionship and isolation avoidance.

Part time courses that allow students to complete the curricular year in a longer period of time (e.g. two years) could also help students, most of which have are full-time employees, to overcome the simultaneous learning activities and study, thus increasing the success rate of the courses.

Some face to face practical activities are an important component in the MSc courses, particularly in the life science areas and should not be completely removed. Nevertheless, virtual tools can be developed to complement those

activities and reduced them to a minimum.

Even though some problems persist in distance learning novel regimes, students from the above mentioned MSc degrees have shown a very high level of satisfaction with their courses, has it allows them to carry out their studies without the need to be absent from the job, or to live near the university campus or even in the same country. The continuous assessment through the e-activities has the advantage of increasing student's learning aptitude and competences. The interaction among students and between students and teachers was highly rated by the students, and was considered a crucial factor for the success of the courses.

A number of forces are pushing for change in higher education, such as new information and communication technology, demand for new competencies, flexibility, increased competition and life-long learning. E-learning is both a result of and a response to these changes (Eneroth, 2000).

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