HOW TO OFFER ALSO ONLINE
AN UNDERGRADUATE UNIVERSITY DEGREE

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Abstract: This paper describes the implementation of the online version of an undergraduate university degree in Security of Computer Systems and Networks, already activated at the University of Milan in traditional, classroom based fashion.

In particular, the paper focuses on the process followed to transform classroom lectures into online materials – preserving didactical contents while facilitating asynchronous fruition by remote students – and on the additional supports planned to help these students to keep the correct study pace.

Some results after ten years of online experience – both in terms of student characteristics and performance and in terms of economical revenues of the initiative – are also included.

Keywords: E-Learning, Online course, Undergraduate degree.

1. INTRODUCTION

The Department of Computer Science of the University of Milan (Italy) activated in academic year 2003/2004 – in a campus located in Crema (a small town 40 kilometers east of Milan) – an undergraduate degree in Security of Computer Systems and Networks (from year on called SSRI, acronym of the Italian name of the degree: *Sicurezza dei Sistemi e delle Reti Informatiche*).

Such a degree was – and still is – the unique Italian undergraduate offer explicitly devoted to ICT security; for this reason, the degree immediately appeared interesting especially for people already employed full time in ICT companies and willing to deepen their competences in a field of ever increasing importance. The possibility of attracting these professionals, spread over the whole country and not able to attend traditional classroom lectures (thus very different from the "usual" university students) suggested to exploit the feasibility of offering the whole degree also online, using suitable e-learning models and technologies: to this purpose, the Rector of the University charged the staff of teachers working in the Crema campus and CTU (the university interdepartmental center devoted to support teaching with technologies, with an already long experience in e-learning) with the task of implementing the first online version of a complete undergraduate degree of the University of Milan. To support the design of the didactical model and of the online material, the university team has been complemented by consultants from Isvor Knowledge System, a company specialized in the production of e-learning courses.

Next section of this paper reports the didactical model adopted for SSRI online, and details the design process required to each professor to produce the online version of her/his course. In section 3, the management structure of SSRI online is described, with particular attention to the supports that have been planned and offered to the community of online students to help them to keep the correct study pace. Section 4 gives some insights into the characteristics of population of online students, while section 5 summarizes the economical results of SSRI online after ten years of life. Some conclusions are drawn in section 6.

2. SSRI ONLINE DESIGN

As deeply discussed in [3] and [4] the first step required to implement SSRI online has been performed by a groups of instructional designers (coordinated by CTU) who concentrated on de-structuring each single course of SSRI (composed by classroom lectures as well as exercises and laboratory sessions) and recomposing it in a way suitable to online fruition.

The structure adopted for each online course has been a hierarchy of autonomous elements, constituted by:

1. **modules** – main topics treated during the course;

2. **didactical units** – various aspects required to fully understand each main topic of the course;

3. **activities** – steps required to online students to complete each didactical unit.

Each teacher of SSRI has been asked first to perform what we called ***macro-design*** of her/his course, i.e., decomposition of the course into a few modules, each composed by a few didactical units.

Main purpose of this macro-design was twofold:

- definition of a sort of "table of contents" of each course, useful to online students to orientate themselves during studies;

- clear identification of the learning objectives of each element of the course, necessary to help online

students to concentrate on the critical aspects to be grasped.

Once the macro-design was completed and agreed with the instructional designers, each teacher has been asked to work on the *micro-design* of her/his course, identifying the activities necessary to complete each didactical unit of the course.

The most important activity required to online students is obviously to follow an **online lecture**: among the various multimedia techniques allowing to create online lectures, we decided to adopt for SSRI online the following ones:

- sequences of slides synchronized with teacher's voice;

- desktop capturing, synchronized with teacher's voice;

- blackboard-like behavior, where the teacher records her/his voice and her/his handwriting on the screen.

All visual materials are prepared by teachers following some guidelines (e.g., slide templates), and lectures are recorded autonomously by teachers using programs (e.g., TechSmith's Camtasia Studio®, Adobe's Captivate®, etc.) that allow the synchronization of desktop activities and teacher's voice; recording is done on tablet PCs, allowing also blackboard-like behavior by teachers. Post-production is limited to a consistency check of the final lecture and to some aesthetical interventions (e.g., smooth transaction between slides).

It is worth noticing that the average duration of each lecture is around one fourth of the corresponding classroom lecture, since teachers are required to "distill" the most important aspects of their didactical message in order to limit the student fruition time and to avoid inattentions.

Video recording of the professor has been considered inadequate, since her/his gestures tend to distract the student from the didactical message to be passed: for this reason, videos have been used only for the initial message of each professor, showing her/himself to students and briefly telling the purpose of the course.

Besides multimedia lectures, some textual/graphical lecture notes (i.e., papers, book chapters, etc.) to integrate online learning with traditional offline reference tools have been allowed.

To allow online students to verify their level of learning, each online lecture is followed by practical activities:

- exercises, i.e., open-answer questions asking the student to discuss a topic, to design an element, to write a piece of code, etc. Correction of these exercises is in charge of the Course expert tutor, mentioned in Section 3;
- tests, i.e., closed-answer questions automatically corrected by the CTU platform where SSRI online is offered, which keeps track of the progresses of each student.

Meetings between students and professors are limited to course introduction, midterm tests and final exams.

It is worth mentioning an additional type of support – deeply described in [1] – allowing students to remotely and asynchronously perform practical lab activities: OVL (the Open Virtual Lab) designed and implemented for the courses dealing with computer networks configuration. Using virtualization, this support allows online students to practice with configuration and behavior of a large number of network devices (e.g., switches, routers, firewalls, servers, clients, etc.) remotely, with the same learning effectiveness of students accessing a real lab.

All the materials prepared for online students are hosted by an e-learning platform (Ariel.net) implemented from scratch by the technical staff of CTU. As discussed in [3], qualifying functionalities of such a platform are:

- the support of one-to-one as well as one-to-many communications, both asynchronous and synchronous. Besides traditional e-mail and forums, also a private messaging system among students and tutors integrated into each single didactical activity (instant messaging), a virtual bulletin board reserved to tutors to post general interest messages, a virtual classroom support for synchronous meetings among students and tutors/teachers;

- a controlled access to courses by students, forcing them to follow only courses planned in the current quarter period;

- self-planning of learning activities by each student, who has a suggested learning plan, but who can change this plan according to her/his own needs. The plan is accessible by tutors, who can then track student work and intervene in case of evident pace loss;

- both online streaming fruition of audio/video elements, as well as download for offline fruition;

- the support of the exercising phases of students, tracking their advance and their results;

- the ability to support the individual learning process of each student, through a tool allowing each student to annotate her/his own instance of the online material;

- handling of logistical aspects as subscription lists to intermediate tests and final exams, recording of obtained grades, etc.

3. SSRI ONLINE MANAGEMENT

SSRI online is formally an undergraduate university degree like the classroom ones, thus it is in charge of the usual management structure of all other Italian degrees, mainly based on the *didactical council* composed by all university professors teaching a course.

However, online students meet teachers only for final tests and exams, thus daily help for clarifying course contents must be supplied online.

To guarantee a prompt answer to students, SSRI online defined the role of **Course expert tutor**, a content facilitator for each course and for each group of 40/50 students, normally selected among young staff or prospective staff members. Main duties of Course expert tutors are:

- to clarify course key concepts;

- to evaluate student exercises or open tests;

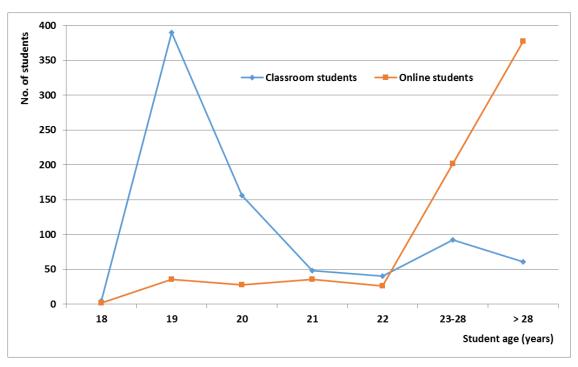- to answer any question useful to improve the student

Image 1: Number of SSRI students per student age

competences;

- to support teachers in developing the course contents, and in managing exams and face-to-face meetings with students.

Interaction channel used by Course expert tutors are:

- the **course forum** (one for each course) used to promote discussion about course topics and day-by-day peer tutorship;

- **e-mail** messages;

- an **instant messaging system** developed ad-hoc, used by students to pose questions directly related to a given learning step.

However, course content tutorship is not enough, as discussed e.g., in [2], [6] and [7]. Particular attention should be given to the community of online students as a group of people sharing tasks, problems and goals without physically meeting. To this purpose, a **Process tutor** has been defined in SSRI online, acting as e-moderator, process facilitator, adviser/counsellor. Main duties of the Process tutor are:

- to monitor all the relationship processes developing inside the online community;

- to support any logistic process involving interactions between students and SSRI secretarial/managerial staff;

- to manage a preferential channel of communication with students.

Interaction channel used by Course expert tutors are:

- the single **general forum** for the overall community of learners;

- **e-mail** messages.

4. ONLINE STUDENT CHARACTERISTICS

A first interesting picture about the characteristics of SSRI online students is given in Image 1, reporting the number and age of people enrolled to SSRI online over the first ten years of its life, compared with the people enrolling to the classroom version of SSRI.

It can be seen that the two populations have almost no overlapping, since classroom students are mainly young people entering the university immediately after terminating their high schools, while the large majority of online students is composed by pretty older people, coming back to studies after several years.

This means that the online version of a university degree does not "compete" with its traditional, classroom version in terms of enrolling students: on the contrary, it attracts a significant number of additional students that would never come to the university without the chance of distance learning. Thus, we can expect that the investment necessary to implement such a distance learning environment is likely to be rapidly compensated by the additional incomes deriving from tuition fees of online students.

Another interesting aspect of SSRI students is given in Image 2, showing the provenance (i.e., the home address) of both online and classroom people enrolled to SSRI:

- from the area surroundings the Crema campus, where the classroom lectures are offered;

- from the Italian region (Lombardia) where Crema is located: a 24 thousands square kilometers area with Milan as regional capital;

- from the rest of Italy.

It is easy to see that most of the classroom students come from the Crema area, while most of the online students live far away from Crema and decided to enroll thanks to the
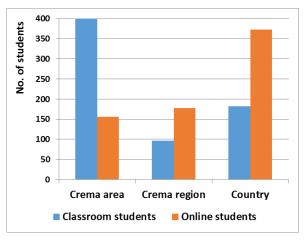
Image 2: Provenance of SSRI students

possibility of distance learning. Thus, there is no "competition" between the two versions of SSRI even in terms of geographical area the students come from.

A deeper analysis of online students, including their performances in terms of passed exams and degree completion is reported in [8]. It is here sufficient to show in Image 3 the behavior of students enrolled in the last few years as far as the attainment of the final degree is concerned: it is easy to see that the percentage of graduated online students is far lower than the one of classroom students, and this is justified by their condition of employed students stealing time to families and vacations to study. However, final grades of graduated online students are around 4.5 points higher than the grades of classroom students (99.04 vs. 94.62 on a 110th scale): in other words, online students capable of finishing their studies without delays even while working have to be particularly motivated, high-quality students, better than their classroom counterparts.

5. SSRI ONLINE ECONOMICAL RESULTS

As discussed in [5], the economical results of SSRI have been evaluated ten years after the activation of the online version of the degree.

Main costs required to setup the initiative were:

- an extra salary granted to all teachers producing the online lectures described in section 2; such extra salary was estimated, looking at the production costs of distance learning courses, as € 2,000 per course ECTS credit (thus, a teacher of a 6 ECTS credits course earned € 12,000 for the production of the online version of her/his course and its revision in the following three years);

- the consulting contract with the already mentioned Isvor Knowledge System, the company specialized in the production of e-learning courses (a total of € 348,000 for the support during the first three years of SSRI online design and activation).

Main yearly costs to manage the initiative consist in tutorship:

- each Course expert tutor (one tutor for each course and for each group of 40-50 students) is paid 2,000 to 3,000 euros per year, depending on the number of ECTS credits associated to her/his course;

- the single Process tutor is an administrative person hired full time for the job, costing € 36,000 per year.

Estimating costs, we did not take into account salaries of staff already employed by the university and partially involved in the implementation of SSRI online, since those salaries were already planned in the university budget far before designing SSRI online and because no extra staff has been hired for this purpose.

As far as incomes are considered, the two main sources are:

- student enrolment fees, varying on the basis of the economic situation of each student family; following the considerations made in previous section regarding the type of students enrolling to SSRI online (i.e., persons very different from "normal" university students, that would have never enrolled to a classroom degree) we considered as net income all those fees;

- extra fee for online services (lectures, tutorship, reserved exams during weekends to avoid to employed students the necessity of using holidays; such a fee has
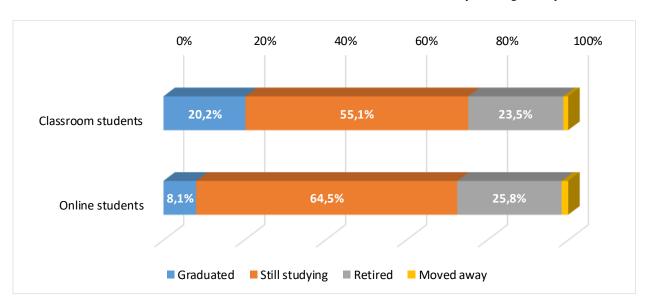

Image 3: Present situation of SSRI students enrolled in the last few years
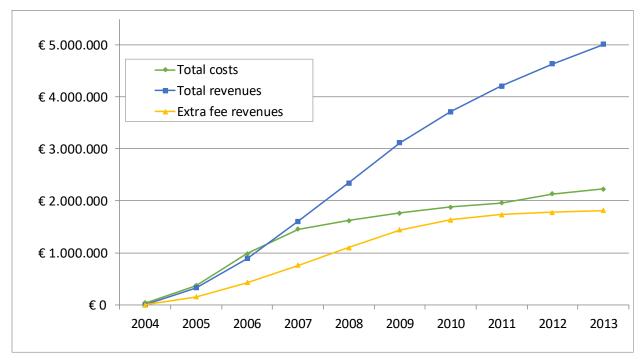
Image 4: Trend of SSRI online costs and revenues over the first ten years of activation

been established by the university management at € 1,500 per year, regardless of the economic situation of each student family.

The resulting trend is shown in Image 4. It is easy to note that:

- apart from setup, the yearly cost becomes stable and reasonably low;

- revenues from extra fees lower in the second part of the decade (but this is due to a reduction in the number of students due to contingencies already overcome, mainly thanks to an information campaign on social networks resulting in a sudden increase of students on the last few years);

- the breakeven has been reached very quickly (less than three years after SSRI online activation) and the net income after ten years is almost three million euros.

6. CONCLUDING REMARKS

The activation of the online version of an undergraduate university degree in Security of Computer Systems and Networks has been summarized in this paper. Main conclusions we may draw from this experience are the following.

For sure, the implementation of a complete three-years degree in e-learning is a complex process, involving several competencies (to be eventually found outside the university) and requiring clear commitment by the staff of teachers, asked to deeply revise their didactic material to be adapted to the different fruition environment. And of course ALL teachers involved in the degree must commit themselves to the online version, to guarantee a complete offer to students.

An aspect not to be underestimated is the web platform hosting all the materials produced by teachers and supporting interactions between students and institution:

regardless of the technological choice made (commercial product, customization of free software, implementation from scratch) it is mandatory to provide staff human resources guaranteeing its continuity of service and its updating during time.

Careful attention must be paid to human resources involved in supporting the community of online students. To this purpose, tutorship is the most important issue, not only in terms of technical aspects (i.e., help for students about the topics of every single course of the degree) but also in terms of relationship inside the community of online students and between them and the university organization.

Even from a purely budgetary point of view, the online implementation is a critical decision: the university has to plan for around half a million euros investment to guarantee high-quality production of the overall degree and to disseminate information about its existence to potential students.

It must however be noticed that these potential students practically do not overlap with the population of young people enrolling to classroom university degrees: the large majority of online students are in fact older people already employed. In other words, there is no risk for the university to pay for an initiative that will steal participants to its traditional degrees.

This means that if the topic of the degree is appealing enough for people already employed, the availability of an online version has an excellent chance of guaranteeing a significant return even in terms of incomes.

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