SSRI *online*
First experiences in a three-years course degree
offered in e-learning at the University of Milan (Italy)

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Abstract

This paper is aimed at presenting SSRI online: an e-learning initiative started at the University of Milan (Italy) for the academic year 2004/05. The initiative consisted in offering an already existing three-years academic degree course ("laurea in Sicurezza dei Sistemi e delle Reti Informatiche - SSRI": a post-bachelor course on security of computer systems and networks) not only in the "traditional" way (mainly based on classroom lectures and labs) but also online.
Main aspects discussed in the following sections are:
- *the players of the initiative and their roles;*
- *the adopted teaching model;*
- *the technological solutions identified and/or implemented to support the initiative;*
- *the characteristics of the student population choosing SSRI online;*
- *the first results obtained after almost one year.*

1. SSRI *online*: why and who

The University of Milan has a significant experience in the usage of technologies for supporting teaching.

Main player in this arena is an inter-departmental center (CTU) devoted to study and apply multimedia-based methodologies and technologies to teaching. During the last four years, CTU produced more than 300 e-learning modules complementing traditional lectures, and made available to students through a web platform (ARIEL) completely designed and implemented by CTU itself.

Previous experiences at the University of Milan had been carried out, mainly by the computer science and technology departments, using synchronous virtual classes to give lectures to remote students and making video recording of lectures to offer asynchronous support to students occasionally missing classroom activities.

However, all these previous experiences were designed to "support" traditional teaching, not intended as a "substitute" for it. Students working full time or living far away from Milan were supposed to integrate the e-learning material whit books, notes from colleagues, etc., without explicit help from the university.

Besides adopting a novel approach to e-learning, the SSRI course – launched in 2003 – is the first and unique three-years university course centered on ICT Security available in Italy. This uniqueness makes the course interesting for students spread over the overall country, and for this reason it became an ideal candidate for an e-learning version.

A further aspect making SSRI an ideal candidate for adopting e-learning was the fact that "traditional" version of it (i.e., the location were classes are given) is hosted at a campus located in Crema, a small town 40 km. South-east of Milan, where the Information Technology Department is situated. While the location provides a nice and quite environment for students going to the Campus, the geographical distance and limited public transportation make it not easily reachable. An online version of SSRI would have then be interesting also for students living in Milan but having difficulties in reaching Crema (no highway from Milan to Crema, time-consuming public transportations, traffic jam, …).

Based on the observation above, and willing to experience a initiative completely online, one year ago the University of Milan decided to activate SSRI *online*, involving in the initiative:
- the Department of Information Technologies in Crema, providing the courses and whose professors

agreed to:
- o re-design their lectures for the online version;
- o identify and train tutors for online interaction with students;
- o overview online learning and make examinations;

- the inter-departmental center CTU, devoted to:
  - o identify the best suited teaching model;
  - o identify the technological tools allowing the production of the online version of SSRI;
  - o drive the production of the online material, to ensure quality and homogeneity among the various courses;
  - o implement and manage the platform offering SSRI *online*;
  - o provide process tutoring (daily interaction with students, closely monitoring the student s' progresses, etc.);
  - o handle – in conjunction with the student secretariat in Crema – all the logistics aspects.

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.

2. SSRI *online*: how

The structure of SSRI *online* can be summarized as follows:

- each online course is structured in modules (each completing a given topic of the course). Each module is composed of didactical units, associated with the various aspects of the topic and constituted by different activities: lectures, exercises, tests;
- all teaching material is available to students on the CTU platform, which provides also forum discussions among students and tutors;
- students' progresses are monitored by tracking their activities and the results of the tests associated with each online lecture;
- online activities are coupled with face to face meetings between students and professors. For each courses there are three face to face meetings at course start (course introduction), halfway in the teaching period (mid term exam), and at course end (final exam).

To discuss in further details the didactical organization of SSRI online, we can first stress the fact that the course has neither been intended as a simple distribution – through Internet – of learning materials, nor as the simple online offering of the "traditional" classroom courses. SSRI online implied in fact the complete re-design of the full didactical and organizational environment related to the classroom version of SSRI. It is then more appropriate to refer to SSRI online as an "online laurea course" instead of "the online version of a laurea course".

2.1 The didactical environment

To support the re-design of the didactical contents, the teachers have been supported by a group of Instructional Designers, coordinated by CTU. Such a group focused first on de-structuring each single course, to identify its autonomous parts (**Modules**) and their components (**Didactical Units**). In turn, each Didactical Unit has been organized in several **Lectures**, each with associated a number of **Activities** to be performed by the students.

This process lead to the identification of the learning objectives of each Module and each Didactical Unit, their formulation in terms of "knowledge" and "practicalities", their articulation in terms of learning moments (where students are expected to learn concepts) and operating moments (where students are expected to apply the learned concepts).

This macro-design phase has been followed by a micro-design phase, aimed at identifying, for each activity, the multimedia element more suited, from a didactical-methodological point of view, for the presentation of the activity contents.

Among the various multimedia elements adopted, the most important ones have been the following:

- video recording of the teacher, mostly used to present – at the Module level – the contents and the objectives of the Module itself. Even if not used in this first academic year of SSRI online, the same technique could obviously be used also to support critical point inside single Lectures;
- sequences of slides synchronized with the teacher's voice, used – at Activity level – to focus the attention of the student on key elements of the Activity, to give deeper insight into Activity concepts, to support the concepts with examples. The reason for choosing to avoid video recording has been not only to guarantee delivery time, but especially to make students concentrate on graphical/textual material instead of teacher's behavior;
- desktop capturing, synchronized with teacher's voice, to allow the teacher to explain the behavior of particular programs, show interesting websites, and help the students to become independent in the usage of the desktop itself;

- blackboard-like elements, where the teacher can simultaneously record her voice and her handwriting activity on the screen: this can be done either with an empty screen (thus reproducing the classical blackboard lecture) or with a previously prepared background (e.g., a graphic or a drawing) where the teacher can add and/or emphasize parts;
- textual/graphical lecture notes (in form of book chapters) to integrate online learning with the traditional offline reference tools.

The design of these different multimedia elements had the objective of supplying the teacher with a set of tools in order to better adapt the online learning material to the nature and the complexity of the single teaching activity.

As a result of the adoption of the above multimedia elements, each SSRI online lecture is then constituted by a video recording (10 to 15 minutes long) presenting visual material (slides, PC desktop activities, etc.) accompanied by the teacher's voice. To ease production and revision of the lectures, the following approach has been adopted by CTU:

- visual material is prepared by teachers following some guidelines (e.g., slide templates);
- lectures are recorded autonomously by teachers (whenever and wherever they want) using programs (SofTV Presenter and Camtasia) that allow the synchronization of desktop activities and teacher's voice;
- recording is done on tablet PCs, allowing also

blackboard-like behavior by teachers (any handwritten note made by teachers on the tablet PC screen during recording becomes part of the lecture itself);
- post-production is limited to a consistency check of the final lecture and to some aesthetical interventions (e.g., smooth transaction between slides).

All the online learning material has been published on **Ariel.net**: the e-learning platform developed and implemented by CTU.

2.2 The Ariel.net platform

Ariel is the e-learning platform developed in the past few years by CTU to allocate the various e-learning materials developed by CTU itself to support web-enhanced university courses.

After a deep benchmarking activity, the main conception of Ariel proved to be suitable to support SSRI online, even if several additional functionalities were required to pass from web-enhanced to real online teaching. In particular, tutorship support and tracking of students learning were absolutely mandatory for a complete online platform, willing to support not only SSRI online, but also future similar courses at the Milan university (e.g., masters, specialization courses, etc.).

To this purpose CTU designed and implemented the **Ariel.net** platform, based on the Microsoft .net technology. In designing the platform, particular care has

Figure 1

been put in the integration of the various tools, to allow context-driven "navigation" among them: for instance, a student following a specific course can easily pass from lectures of that course, to the forum of the course, to interaction with tutors of the course, without leaving the specific course itself. As it can be seen in Figure 1, the right part of the screen shows (in Italian…) the direct links a student has when she is following a given course: forum of the course, annotating tool, tracking, communication tools with the tutor. Whenever the student switches to another course, all links adapt themselves to the new situation.

The qualifying functionalities of Ariel.net allow:
- the support of one-to-one as well as one-to-many communications, both asynchronous and synchronous. Besides traditional e-mail and forums, Ariel.net supplies also a private messaging system among students and tutors integrated into each single didactical activity (instant messaging), a virtual bulleting board reserved to tutors to post general interest messages, a virtual classroom support for synchronous meetings among students and tutors/teachers;
- handing the access to courses by students, forcing them to adopt the quarter period structure (courses are accessible only under platform control);
- self-planning of learning activities by each student,

who has a suggested learning plan, but who can change this plan according to her own needs. The plan is accessible by tutors, who can then track student work and intervene in case of evident pace loss. As in can be seen in Figure 2, for each Module of a given course, the temporal diagram shows three lines: the black, upper line is the study time proposed by the platform; the brown, intermediate line is the personal plan of the student; the blue, lower line is the actual progress of the student her/himself;
- 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. Exercises can be either multiple-choice, closed-answer tests (Ariel.net gives immediate feedback to the student), or tests whose correction is done by tutors (Ariel.net supports the sending of the student solution to the tutors) or tests whose correction is done by comparison with the solution proposed by the teacher;
- the ability to closely follow and support the individual learning process of each student, through a tool allowing each student to annotate her/his own instance of the online material (the annotation becomes a virtual sticker, "glued" to the material). For the tutor, this tool is used to make
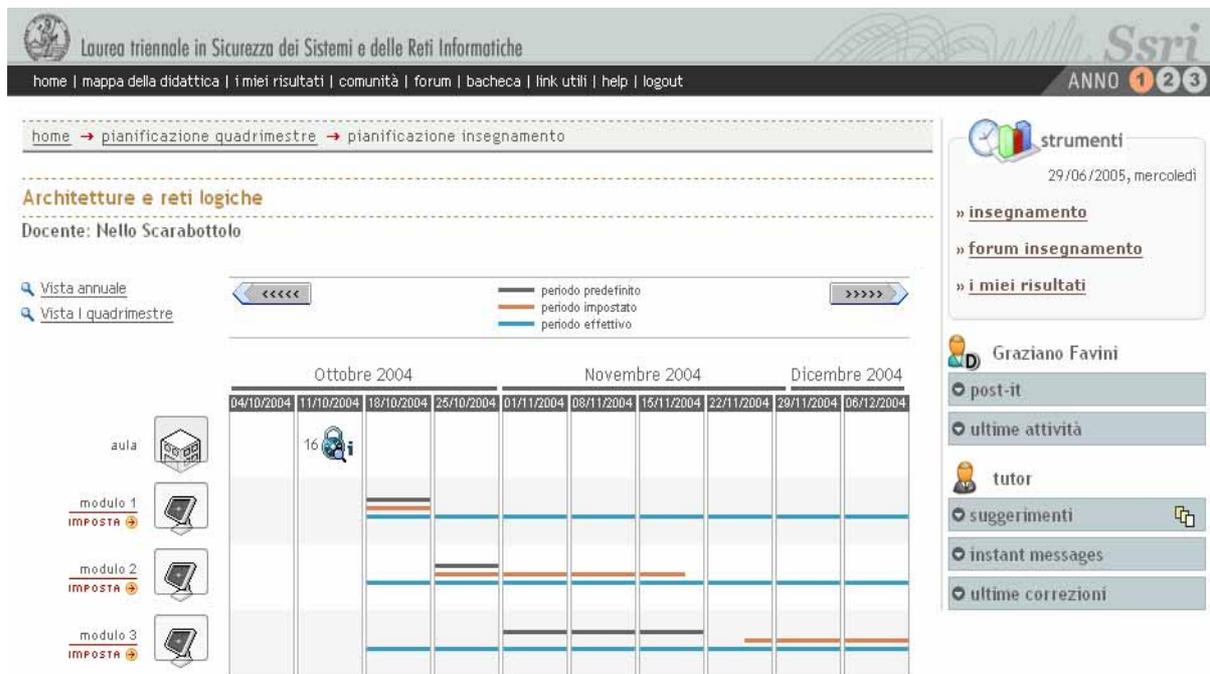

Figure 2

comments available to all students;

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

A pictorial representation of the architecture of Arial.net is represented in Figure 3.

(different study times) and for psychological attitudes;

- frequently is a worker, who stopped her/his studies several years before coming to SSRI online, thus encountering particular difficulties in re-defining her/his own study pace.
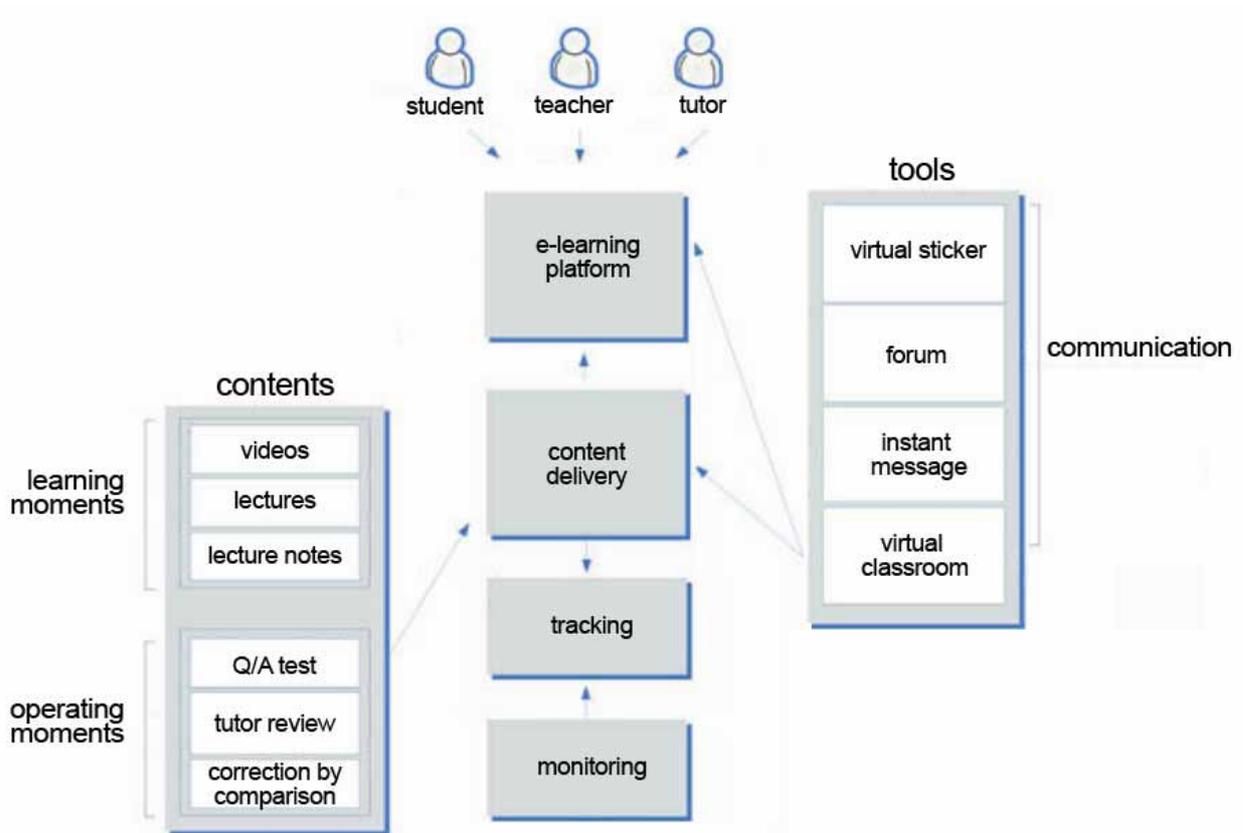

Figure 3

2.3 The organizational environment

Coming to the re-design of the organization of SSRI, the most critical aspect taken into account has been the peculiar target of potential users: in fact, the typical online student:

- is isolated both from the didactical context and from the colleagues following the same courses in the same period of time; the lack of interactions with teachers and colleagues makes particular important the possibility to immediately apply learned concepts to verify learning progresses;
- could have difficulties in being involved into collaborative works, both for logistical reasons

Taking into account the above aspects, SSRI online has been structured around a three four-month periods calendar, allowing the student to follow a reduced number of courses in each four-month period.

Each single course plans two intermediate evaluation tests, used not only for self-evaluation purposes, but also for integrating the final grade.

Reserved exams for online students have been planned at the end of each four-month period, before the starting of the next one, in order to clearly separate test times from learning times. Moreover, to help working students, tests and exams have been organized on Friday and Saturday.

3. SSRI *online*: to whom

SSRI *online* has been opened in the first year to a maximum number of 120 fresh students, on a first-come-first-accepted basis: the number has been saturated in just two weeks, and at least 100 more students have declared their interest in the online approach.

It is worth noting that this success of SSRI online did not affect the number of subscription to the traditional version of SSRI, which received 138 freshmen.

A deep analysis of the population of SSRI online students is beyond the scope of this paper: however, it is worth summarizing the most important outcomes:

- the large majority of the students is constituted by people older than traditional freshmen (67% of SSRI students are more than 28 years old, 23% are more than 35 years old) and already working (95% of them are full-time workers). This means that the online approach does not constitute a real alternative to the traditional one, since it definitely addresses a different student population;

- looking at the geographical distribution of SSRI students, it appears that 77% of them live and work in Northern Italy (where the University of Milan is located) 15% in Central Italy and only 8% in Southern Italy. This seems to drive to the consideration that physical distance is not as critical as time constraints in the decision of selecting an online course.

To further investigate into student motivations, two questionnaires have been distributed, one at the beginning of the first four-month period (to ask about expectations) and a second at the end of this period (to ask about fulfillments of the expectations). Main results are the following:

- the large majority of students (more than 90%) declared that, without the online opportunity, their would never have subscribed to a university course. This clearly shows that the online approach, far from being a fashion, satisfies a real need for people already working and willing to improve – at their own pace – their professional capabilities;

- among the main motivations for selecting an online course, the most frequent is the flexibility in study time organization, followed by the opportunity of a professional growth;

- even if the time flexibility is the main expectation, several students (26%) also expected the online approach to be more effective than the traditional one, 58% of them expected to reach the same level of competence of traditional students, and 17% of them expected an even deeper competence. This seems to indicate that the personalized interaction guaranteed by tutors is perceived as a significant improvement towards traditional classroom-based learning;

- the expected quality of the learning process is confirmed at the end of the first four-month period, when 59% of the students consider it very effective, 36% of them effective, and only 5% of them not effective enough;

- also the delivery platform Ariel.net is well perceived: most of the students declared to be able to easily access and download the online material, whose quality and clarity have been deeply appreciated.

Even the learning results of online students – compared with the results of the students following the traditional SSRI courses – reveal the correctness of the approach we adopted: both percentages of students passing the examinations and average grades obtained are aligned between the two populations.

4. Concluding remarks

The online course presented in this paper is presently entering the third and last four-month period of the first year, and a complete picture of its effectiveness has to be necessarily postponed to the end of such a first year.

Nevertheless, the preliminary results obtained from several information sources (personal data of SSRI online students, questionnaires, exam results) definitely show the fact that an online learning approach fills a real gap left by traditional classroom teaching, and that a course completely re-designed to be offered online is well appreciated by students and leads to learning results absolutely in line with traditional ones.

These preliminary results convinced the board of the Milan University to extend to 200 freshmen the access to SSRI online for next academic year, and to organize an admission test to select the most motivated and prepared students.

SSRI online: five-year experience on a bachelor degree offered in e-learning at the University of Milan (Italy)

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Abstract: This paper is aimed at presenting a review of the 'SSRI online' e-learning experience. Started in the academic year 2004/2005, the online bachelor degree in Computer Systems and Network Security is still the first online degree offered by the University of Milan and the unique degree centred on ICT Security available in Italy. At the moment, we are delivering the seventh edition of the degree and, after six years of experience with an audience of more than 300 students, we want to evaluate the project results, focusing our attention on the students experience: which results they have achieved, how much the degree has met their expectations, which placement opportunities they have achieved after the degree. In the following sections, first we briefly resume the main aspects of the SSRI online project, and then we show our evaluation results.

Keywords: e-learning; computer systems and network security; online degree; knowledge and learning; Italy.

Biographical notes: Fulvio Frati is an Assistant Researcher within the Department of Information Technology, Università degli Studi di Milano. He received his university degree in Computer Science from the University of Milan in 2004. From the academic year 2005/2006, he works as a Didactical Tutor for the Computer Networks and the Security and Privacy courses of the online degree on Information Systems and Network Security of University of Milan. He is the author of international scientific publications in the field of open source, software development process monitoring and modelling, and knowledge management. He is part of the research projects Secure Supply Chain Management (SecureSCM), ARISTOTELE (Personalised Learning & Collaborative Working Environments Fostering Social Creativity and Innovations Inside the Organisations) and Towards Evolving Knowledge-based interNetworKed Enterprise (TEKNE) funded by the European Commission and by the Italian Minister of Research and University (MIUR).

Sabrina Papini graduated in Humanities at University of Milan. In 2003, she attended a Postgraduate course in E-learning and then started working in this field. First, she worked as an Instructional Designer in elementary and high school online learning projects and as an Online Tutor in web-based support projects intercultural exchange and integration in schools. Then, she acquired experience working at private and public companies different in size and mission: cooperative companies who offered e-learning services for schools and retraining courses for workers, bigger public corporations – such as Milan Chamber of Commerce – which was developing corporate e-learning projects. In 2005, she started working at the University of Milan as a Master Tutor for SSRI online. Currently, she is working as a Tutor for the online degree and also as an Instructional Designer for online laboratories and websites to support traditional teachings at CTU, the interdepartmental Technology Center of University of Milan.

Nello Scarabottolo graduated 'summa cum laude' in Nuclear Engineering at the Politecnico di Milano in 1980. He is a Full Professor in Computer Engineering since 1994. He joined the Crema Campus of the 'Università degli Studi di Milano' in 1998, where he served as the Department Director and the President of the Didactic Coordination Council. His research activities refer to various aspects of computer architectures and information processing applications. In particular, he studied topics related to *microprocessor systems* (mainly system software for real time applications and hardware tools for performance monitoring), to *parallel and distributed systems* (parallel and distributed architectures, programming techniques for loosely coupled systems), to *dedicated architectures* (innovative architectures, mainly based on in-field programmable devices, for high-performance, high-reliability applications). He is the co-author of more than 100 papers. He has been involved in various EC projects. Since November 2003, he is a member of the Executive Committee of the Council of European Professional Informatics Societies (CEPIS).

1　Introduction

The University of Milan made its first experience in e-learning early in the nineties developing online and multimedia-based lecture courses and laboratories. In the past 15 years, CTU, the interdepartmental centre devoted to support teaching with technologies, developed almost 1,000 websites to support traditional teaching, visited by 5,000 distinct users each day, online laboratories, online lectures which substitute single modules of traditional teaching, students satisfaction evaluation projects on traditional teaching and on the effectiveness of multimedia and online instruments as a support to traditional teaching (CTU, 2010).

In the academic year 2002/2003 DTI, the Crema-located Department of Information Technologies of the Università degli Studi di Milano (DTI, 2010), started offering an undergraduate programme in Computer Systems and Network Security. It was (and it still is) the first Italian bachelor degree in this field and, from its beginning, it was of interest especially for full time ICT workers spread over the whole country, who could not attend traditional lectures. The activation of the online degree was described in Damiani et al. (2005).

The uniqueness of the degree programme within Italy and the possibility of reaching a new population of students were strengths that suggested investing in this degree and experimenting with new methods and models of teaching: so CTU and DTI experiences in ICT, e-learning and multimedia were joined to develop SSRI online, the first online degree of the University of Milan (SSRI, 2010).

2　Design guidelines for SSRI online

The SSRI online project required a complete re-design of the classroom version of the degree that deeply involved DTI and CTU, in order to provide contents and services able to fully satisfy the needs of remote students. In particular, DTI provided teachers, courses, teaching tutors, secretarial staff and developed ex-novo all the teaching materials, while CTU identified the best suited teaching models and the technological tools required to support these models, managed the production of the teaching materials, designed, implemented and operated the SSRI content management system and provided process tutoring.

In the past six years, 30 new online courses have been produced, with more than 3,600 different activities, such as video-lectures, lecture notes and exercises. Video-lectures are characterised by sequences of slides or desktop capturing, both synchronised with the teacher's audio explanation; exercises can be either online multiple choices, closed answer tests, more complex essays requiring tutor correction, programming, and networking exercises that students have to develop using a virtual lab. The first version of SSRI was delivered from 2004 to 2008, then in 2009 new university regulations about undergradute and postgraduate courses has been approved by the Italian Minister of University and Research and it became necessary to re-define the full degree programme, developing six new courses and updating the contents of the other courses.

All teaching materials are made available to students on the online platform dedicated to SSRI online, which provides asynchronous communication environments like forums and instant messaging tools, and tracking tools to support students, to promote discussions among students and tutors, to closely follow students learning improvements. A virtual lab implementation, the open virtual lab (OVL), whose architecture is explained in Section 2.1, was made available to students for practical exercises on network security and programming.

These different multimedia instruments and contents made possible to teachers to better render, in the online medium, the particular nature and complexity of each course, allowing students to better follow their learning process, understanding and experimenting step by step concepts and competences related to each course. During the learning process, students should work online for about 90% of their study time; they should come to Crema (the SSRI campus venue) only for the midterm exams and the final exams of each teaching (10% of their study time).

2.1   The open virtual lab

The OVL project started from the need of giving to students a complete training environment for distributed programming and network configuration (Anisetti et al., 2007). OVL is currently used to provide every student with a personal environment comprehensive of compilers, network configuration tools, firewalls, and so forth. The OVL grants the didactic continuity: since each student is entitled to full administrator privileges and has the right to modify its configuration, the same virtual machine must follow her/him during her career. However, there is also a need for diversity: the virtual machine is customised and upgraded, depending on the requirements of the courses the student chose to follow.

OVL's implementation supplies each online student with a Linux virtual machine accessible via secure SSH connections. Every student has complete and privileged access to her/his own personal environment; in particular, each user has full control of the virtual machine and can perform any type of system and network configuration on it. This way, OVL allows students to make real experiences on system configuration, system security, and network programming tasks.

Moreover, OVL is an open environment that can be operated at low cost and freely shared with partner institutions. In fact, DTI exploited the lab in the context of frequent collaboration with the *Institut de Mathématiques et de Sciences Physiques* of the University of Abomey-Calavi (Bénin – West Africa) where strict budget constraints make impossible for the local organisation to create and manage a laboratory for network administration exercises.

OVL is based on the open source Xen *para-virtualisation* framework and allows for setting up *virtual IP networks*, e.g., connecting the virtual machines of students belonging to the same class. This feature allows students to experiment with network programming (socket library, remote procedure calls and the like) and to set up their own client-server applications in a virtual network environment. OVL's full support for network programming and middleware is a distinctive feature with respect to commercial virtual labs, which focus more on network equipment configuration than on distributed application development.

3 The audience in the first five years

To define the typical audience of SSRI online, we can start looking at the population of SSRI online students by analysing demographic, educational, professional characteristics of the student cohorts in the past five years.

Online students are generally older than traditional students (i.e., students following traditional classroom lectures): SSRI online students age covers a range from 19 to 60, but the majority of online students are in a range between 30 and 39 years, while the majority of traditional students are 20 to 24 years old. In the last two years, also the SSRI online population is becoming younger: there are more students between 25 and 29, but online students are anyway older than traditional ones.

Most SSRI online students came back to university studies after some years of work: in average, ten to 15 years after their high school leaving qualifications. To start studying again is always a very carefully planned decision: very often it depends on students' professional goals and could be an exigency for their professional growth; sometimes they decide to start university studies again following only a personal desire: in this case often they want to complete a degree interrupted years before for many different personal problems (economic needs, family problems, etc.). More than 90% of our students declare that, without the online opportunity, they never would have restarted university, because they could not attend lectures and generally manage a traditional degree programme.

Online students' age and the goal of their studies seem to influence also their results. In the next paragraph, we are going to show a detailed comparison between online students and traditional face to face students marks, but here we can stress an interesting difference between younger and older online students: the older ones seem to be more determined to complete their degree programme in three years and so they make more exams in a year than the younger ones.

Obviously also the previous studies seem to influence the online students' results. The majority of SSRI online students (between 60% and 70%) followed technology-oriented high schools, but also their traditional counterparts made similar course programmes.

It is important to note how the time passed since high school leaving qualification can influence the online students result: we notice a negative effect on their competence in Mathematics and Physics (they do not use these basic competences during their work, so when they restart university they have to study from scratch and very carefully all the related concepts). Indeed, comparing the exams results, only 50% of the online students have passed these exams with respect to traditional face to face students, while SSRI online students have passed more ICT exams than traditional students.

Consequently, professional goals, needs, and competences influence SSRI online student progresses, but which kind of workers they are? The majority of them are full-time ICT workers: 50% computer programmers, 50% system and network managers; they are employed in a variety of factories and public corporations, such as software houses, telecommunication companies, banks and insurances, hospitals, public research centres, public bodies, the army, and commercial multinational companies of different fields (pharmacological and chemical companies for example), wherever an ICT security office or a general need of security of computer systems and networks are expected. Only 10% of our students work outside the ICT environment, like for instance teachers, who

choose SSRI online looking for a new and different job opportunity after the degree or wanted to complete the university studies interrupted years before.

On the contrary, it seems not significant the geographical distribution of SSRI online students: almost 70% of them come from Northern Italy, about 20% from Southern Italy, only a 10% from Central Italy; these percentages are quite similar to the ones of the traditional students. In other words, in the decision of selecting an online course, the physical distance seems to be a weaker constraint with respect to time saving and simpler study managing opportunities.

In addition, gender characteristics do not distinguish online students: 95% of them are men, and it is possible to find the same percentage also in face-to-face cohorts. It is in fact a characteristic common to all the Italian ICT university degree programmes, still engaging very few women: the general spread idea/perception in Italy is that ICT is only a men's job.

Table 1 Report on the number of successful exams for each course and the respective mean grade

Course	No. of exams		Mean grade	
	SSRI	SSRI online	SSRI	SSRI online
Algorithms and Data Structures	179	94	23.11	23.65
Computer Architectures and Logic Networks	284	192	25.14	26.16
Database Systems: Complements	231	140	22.82	23.86
Database Systems: Elements	240	146	22.11	22.82
Cryptography	188	99	23.01	23.87
Economics and Business Organisation	190	83	25.73	26.05
Elements of Security and Privacy	265	136	23.17	25.29
Physics	238	130	21.11	23.71
Introduction to Computer Security	394	255	25.07	25.98
Foundations of Continuous Mathematics	269	147	22.78	23.38
Foundations of Discrete Mathematics	255	147	23.18	23.88
English	400	198	22.82	25.45
Secure Programming Laboratory	340	236	24.42	25.33
Secure Programming	163	75	23.53	24.07
Computer Programming	313	172	22.83	23.78
Network Security	188	97	24.10	24.58
Information Processing Systems	238	135	25.32	25.55
Operating systems	184	138	24.00	26.17
TOTAL	*4,559*	*2,620*	*23.59*	*24.77*

4   Results comparison between online and traditional students

To evaluate the efficacy of the teaching model adopted for SSRI online and described above, first we compare the grades obtained by SSRI online students with the ones

obtained by students following the traditional version of SSRI (i.e., a graduation course based on classroom lectures requiring physical presence of students in the university campus) from the beginning of SSRI online life.

To guarantee the statistical significance of such a comparison, we restrict our analysis to the mandatory courses (i.e., courses that must be followed by all SSRI students) listed in Table 1, which summarises the number of successful exams for each course and their mean grade (please remember that Italian grades range from 18 – fairly pass – to 30 – pass with merit).

It is worth noticing that such a comparison is estimated to give very reliable results: in fact, not only teachers of SSRI online are the same of traditional SSRI, but also exams are carried on for both students together (except for one single dedicated exam session reserved to SSRI online students, at the end of each course, characterised by the same level of difficulty as the other ones). As it can be seen, SSRI online students show better performances in all the considered exams.

Even if it is important to take into account the motivation the SSRI online students, in particular a greater age than the ones following the traditional version of SSRI, a working career still in progress, the additional fee of 1.500 Euros per academic year to access online support by tutors, and the fewer time dedicated to their families in order to study during free hours and weekends, these results clearly indicate that the teaching model developed in collaboration with CTU give to online students a level of understanding of the various topics deep enough to undertake the final examination with a greater chance of success than the one given to traditional students. The above considerations emerge in an even sharper way if we analyse the marks obtained by SSRI students at their final, graduation examination (the so-called 'laurea').

Table 2   Report on final examination grade of online and traditional students

Degree	No. of graduated students			Average mark (max 110)
	Normal mark	*Cum laude*	*Total*	
SSRI	131	4	135	94.75
SSRI online	47	7	54	99.91

As shown in Table 2, the performance of SSRI students at this final step of their university careers is far better than the one of traditional students:

- the percentage of maximum grades (110 'cum laude') obtained by the 54 SSRI students graduated up to now is about 13% (vs. the far lower 3% of traditional students)

- the average mark – 99.91 over 110 – of online students is more than five points higher than the 94.75 of traditional ones.

Finally, a further statistical analysis has been applied to SSRI online grades to assess the level of confidence associated with the difference between the sample means. In particular, a two-tailed *student's t-test* was performed on the grades presented in Table 1, since the two samples do not overlap; the test results are shown in Table 3 and correspond to a level of confidence < 0.01.

Table 3   t-student test results

Parameter	Value
Degree of freedom	34
t-student	2.7892
P (confidence value)	0.0086

While, due to the case study context, these results remain anecdotal in nature, it is clear that SSRI online students' performance at the examinations are objectively better than traditional students' ones; moreover, it is possible to state, with a confidence greater than the 99%, that such better performance are not due to statistical fluctuations.

## 5   'Customer satisfaction': the opinions of the students

The evaluation of SSRI online is completed by subjective data coming from the 'customers' of the service – i.e., the students themselves – some surveys are performed by means of questionnaires submitted to SSRI online students in different times of the year:

- at the end of each term, when students are asked to fill in a satisfaction survey about the courses they have followed

- two times a year, their general satisfaction about the whole SSRI online course and also about the usability and effectiveness of the technological instruments that SSRI online platform provides is investigated

- after graduation, students are asked to complete a review survey about their whole educational experience.

The general picture coming out of all these surveys is definitely positive: SSRI online students declare to be quite satisfied with SSRI learning characteristics as well as its technological setting. Evaluations of the single courses – at the end of each term – emphasise as most positive aspects (see Figure 1):

- teaching materials clarity and comprehensibility, precision and completeness, exercises availability and usefulness

- teachers and tutors willingness and support

- information availability and clarity about the teaching organisation and the related exams.

For the majority of SSRI courses, evaluations of online students are aligned with – or even more positive than – the ones of traditional face-to-face students. Better results probably depend also on the particular SSRI online organisation: teaching materials have been specifically designed and developed for the online degree, and a dedicated tutoring staff is provided for each course.

Figure 1 Analysis of SSRI online students' satisfaction (see online version for colours)
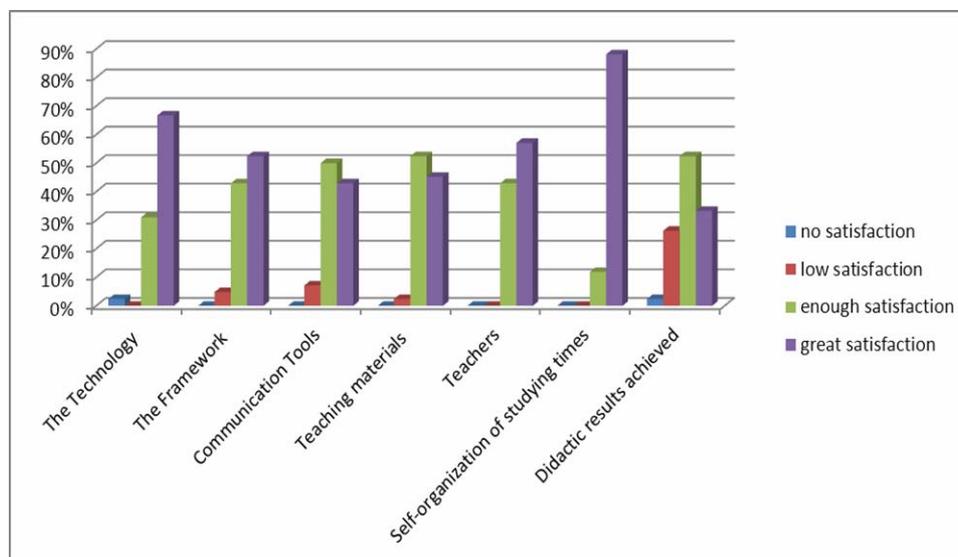
When online and traditional students' judgments differ, main reasons for negative online students' evaluations are the following:

- *Online students always declare to have more difficulties in managing study time and load.* They have to manage at the same time job responsibilities and deadlines, family needs, and study activities. As a consequence, their daily organisation changes very often and suddenly, and the study cannot be their only priority (as it happens for traditional, younger students, still not having a job).

- *Online students are more demanding about the quality of didactic materials and of exam procedures.* Didactic materials should be complete and should give a clear explanation of all the teaching key concepts, lectures and exercises should be useful instruments to study step by step and achieve a real knowledge. Examinations should not be multiple choice notional and rudimental tests: they should completely and practically evaluate the real student competences (as a matter of fact, online students do prefer to implement projects than simply answering tests).

- *Online students pay a greater attention to teachers and above all tutors behaviour.* In fact they should assure a constant presence and a high reliability, should be very accurate and have correct and friendly manners.

Other interesting indicators of student satisfaction come from the surveys about SSRI learning and technological organisation: more than 50% of SSRI online students consider to have reached a good level of satisfaction about these items, and about 35% of them declare an excellent level of satisfaction; also the correspondence between the real SSRI learning experience and their expectations about the quality of online learning they had before starting the degree looks very positive for online students.

In their opinion, SSRI educational model strengths are:

- the possibility of self managing the study time (and as a consequence the possibility of saving time)

- the kind and quality of didactical contents

- the kind and quality of staff support

- the quality of the technological solutions provided to support the learning process.

All these opinions confirm that:

- the educational goals we originally wanted to achieve starting SSRI online have been reached

- this success required to recognise the importance of designing very carefully all the organisational and didactic characteristics of an online course.

Considering in particular the online learning environment, students stress the importance of communication supports among themselves: one of the most important aspects of SSRI online is in fact the creation of the community of students, cooperating through forums and instant messaging to help each other.

Online students agree with the decision of developing didactic materials mainly as video-lectures with synchronised slides and teacher's audio explanation; they also appreciate the possibility of downloading and printing a copy of the slides to take some notes while listening to the lecture. Moreover, it seem to be very important for them the possibility of downloading teaching materials for off-line study; this is not due to interconnection band problems, since very often online students download lectures from their office with fast internet connection, but to increase usability of lectures even when not connected to internet. In particular, very frequently SSRI online students travel for work or live far away from their office, and then they try to capitalise every minute to study. Moreover, to use free time in the office for studying, it is necessary for them to access printed or offline didactic materials to bypass offices security internet policies and firewalls.

Sometimes online students stress the importance of defining and respecting a constraint about lectures length: the ideal length should be at most ten to 15 minutes to preserve high levels of concentration during the whole lecture listening and also to make possible a 'spot attendance of lectures' (i.e., repeated lectures listening for a few minutes in different moments of a day).

In addition, usability and interoperability are important constraints for SSRI online students: teaching materials should be developed and accessible using software packages simple to use and characterised by a high interoperability with different operating systems; lecture formats should always be compatible also with mobile learning and communication devices.

Furthermore, online students underline the importance of communication in their learning process: they recognise a need of support on different levels such as counselling, organisational/methodological support, content explanation; they appreciate its communication instruments and the possibility of getting teaching tutor and process tutor support as well as the possibility of developing peer review and fellow tutorship among themselves.

When – after their graduation – SSRI online students are asked to evaluate their whole learning experience, results are by far more positive than the ones of traditional students: all the online graduates declare that they would re-apply for the online course, coming back in time; moreover, this good learning experience pushes a significant percentage of them to prosecute their university career by applying for a postgraduate course, despite the fact that no online postgraduate courses are yet available at the University of Milan.

6   Graduated students placement inside the job market

As already said, the majority of SSRI online students started studying again to improve their job position, to retrain their professional competences, or to change their job position, and it is of course important to evaluate how far these expectations are met after graduation.

Actually, even the fact of being an online student seems to be a 'plus' in the job market; in fact, online students report that, when they apply for a new job position, people evaluating their curricula really appreciate their choice of investing on themselves and of making efforts to improve and renew their ICT knowledge and competences.

It is interesting to notice that a positive or negative evaluation of the degree title also depends on the kind and size of company considered: small ICT companies with a few employees and multinational companies have quite a different position on this subject.

If an employee, who works in a small company, wants to apply for SSRI online, her desire is not supported and sometimes it is clearly hampered (the employer thinks that study activities will steal hours and efforts from work and that a graduated employee will claim a better salary or try to change company organisation immediately after the degree). Very seldom, managers of small societies consider the possibility of exploiting the new skills their employers will obtain from the degree.

On the contrary, some multinational companies come to a particular agreement with their employee applying for SSRI online: if the student graduates in three years, the company will pay all the university taxes: a smart way to satisfy an employee desire and, at the same time, to improve the company professional skills without a significant economic effort.

By the way, since the majority of SSRI online students were already ICT workers when they started university studies again, the most frequent feedback they receive after graduation comes from their company; in fact, very often they become project managers, their job position improves, they can enter the senior staff or the management, and sometimes they become partners of their society.

Another rewarding confirmation comes from the fact that most of the SSRI online students received interesting job proposals from companies located in Northern Italy, accessing the database of graduated people managed by the University of Milan to facilitate placement.

Some SSRI online students have also been involved as consultants or co-workers from the University of Milan itself, cooperating in research projects inside the Crema Department or working as tutor for the online degree.

Some SSRI online graduated students had also the opportunity to set up their own company, usually consulting for larger companies. And in some cases, colleagues known during the study period decide to collaborate in starting a new company and entering the job market together.

And – last but not least – some graduations thesis of SSRI students prove to be innovative and good enough to obtain international research recognitions and awards, as it was the case with the Italian Chapter of Honeynet (2010) project.

A further proof of the different characteristics of SSRI online students with respect to 'normal' university students (following traditional classroom-based courses) comes from the results of the investigations some Italian universities performed on graduated people by interviewing them about 12 months after graduation (Scarabottolo, 2010).

We compare in the following tables the placement situation of people graduated in ICT between 2007 and 2009 in two Northern Italy universities (Insubria – near Varese – and the second Milan State University: Milano-Bicocca), one Central Italy University (Pisa), and one Southern Italy University (Palermo), with people graduated in the largest Milan State University (Università degli Studi di Milano), where people graduated in SSRI (both traditional and online) are separated from people graduated in all other ICT courses.

The different (older) age of SSRI students and the fact that usually they come to the university as 'working students' emerges immediately; as it can be seen from Figure 2, people graduated in all universities/courses are partly working, partly still looking for a job, partly following master courses, etc., while all SSRI online graduated people are all working. Asked about when they found their job, graduated people give the results shown in Figure 3. Differently from all the others, people graduated in SSRI online was already working before graduating, which means that most of them decided to follow SSRI online when they were already employed, very likely to improve their skills and their job position.

Figure 2   Students' working position after degree (see online version for colours)
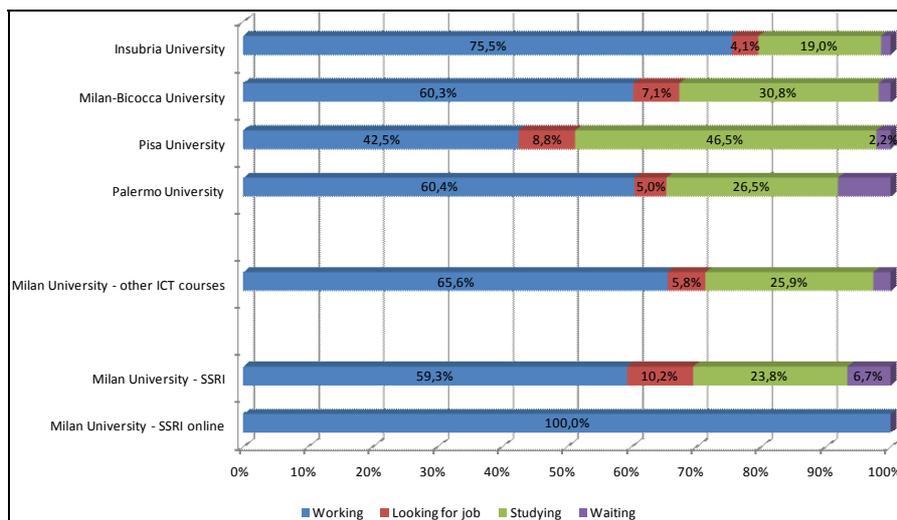
**Figure 3** Students' working situation before and after graduation (see online version for colours)
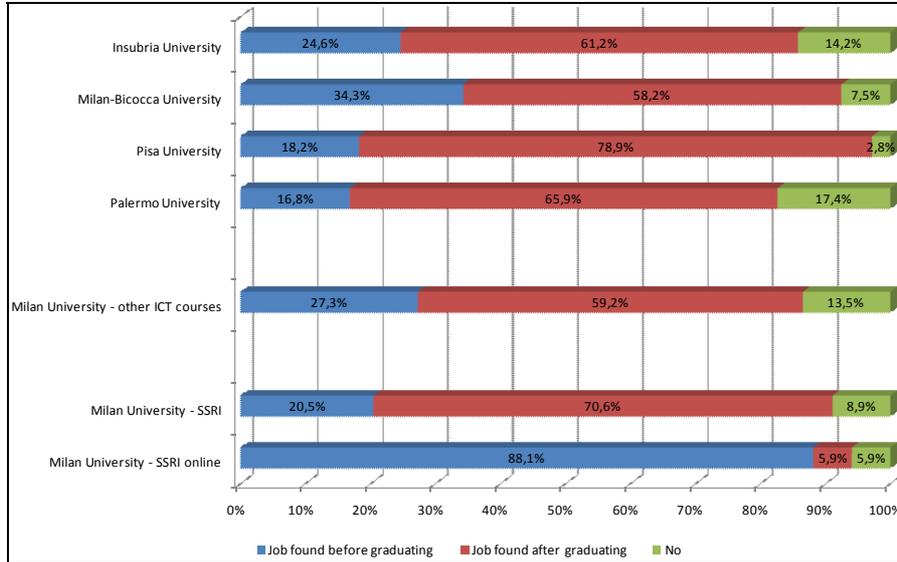
Even the type of employment contract (Figure 4) and the net monthly salary (Figure 5) are clear indicators of the different situation of SSRI online graduated people inside the job market: most of them (more than 80%) have permanent contracts, while only one third of the other graduated people obtained this type of contract in 12 months from the graduation. Furthermore, their salaries are mainly in the range of 1.500 to 2.250 Euros per month, while the other graduated people, just entering the job market, earn about 1.000 Euros per month.

Figure 4 Type of employment contract after graduation (see online version for colours)
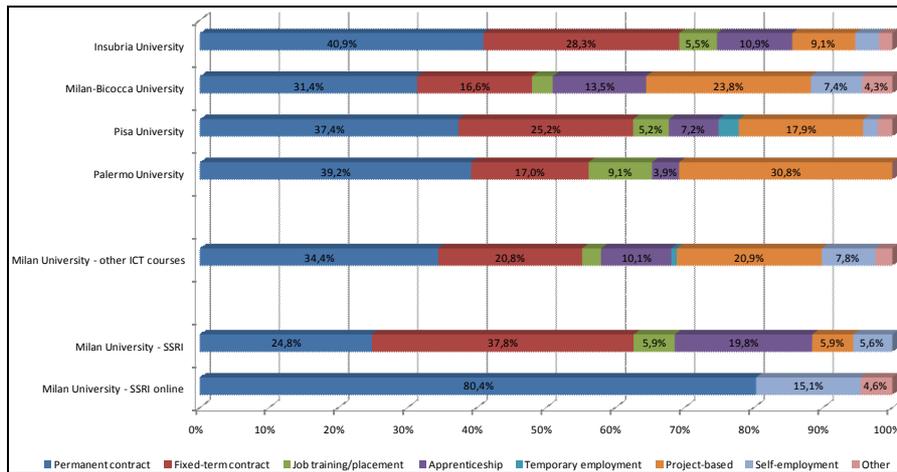
Figure 5   Net monthly salary after graduation (see online version for colours)
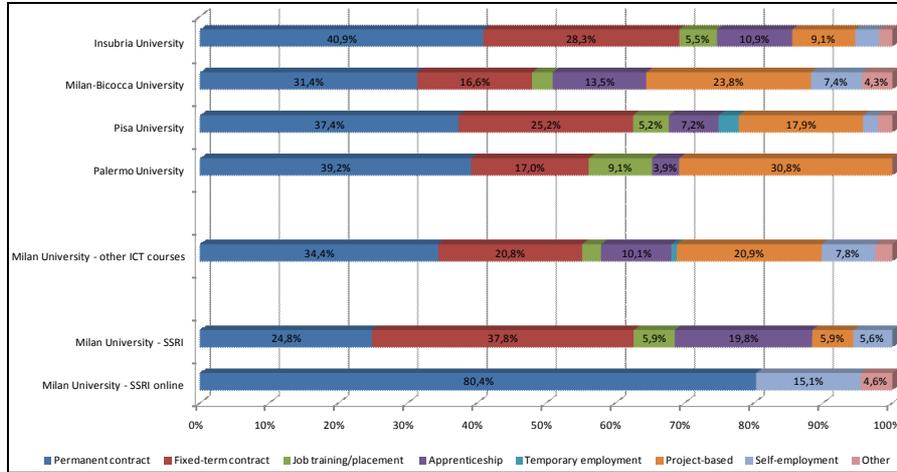
However, despite the fact that most of the SSRI online students already had job positions before entering the university again, and the fact that SSRI online asked them to invest personal effort and family time to graduate, the general perception of this course is definitely positive. Their answers to the question 'coming back in time, would you still apply for a university degree again?' are shown in Figure 6, clearly indicating a complete satisfaction, since all interviewed people likely will re-apply for the SSRI online course, while people graduated in other institution would prefer a different course or would not apply at all.

Figure 6   Report about answers to the question 'coming back in time, would you still apply for a university degree again?' (see online version for colours)
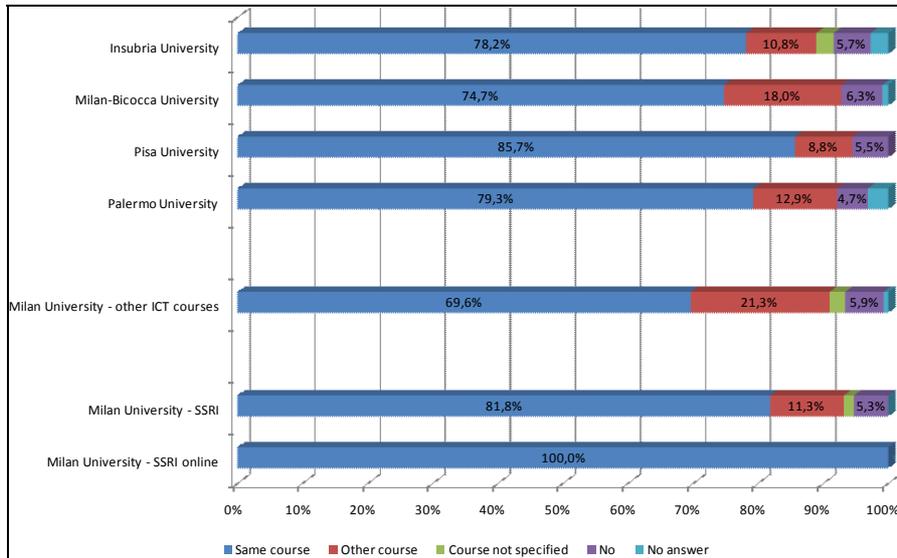
7 Concluding remarks

The evaluation of the first five years of SSRI online life – summarised above – allows to consider the experience of a complete bachelor degree offered online as definitely positive.

In particular, the following aspects of such experience deserve to be highlighted:

- SSRI online filled a didactical need not adequately covered by traditional university degrees, since the typical audience of SSRI online is constituted by older people, almost always employed, and willing to improve their skills and their job position without the possibility of frequenting a degree requiring physical presence in classrooms

- online teaching can be as effective as the traditional face-to-face relationship between teacher and students, provided that:

    1 the online teaching material is properly designed: to simply put on a website slides used in normal lectures, or even worse the video of the traditional lectures, does not fit the needs of a student learning alone, without immediate interactions with teacher and colleagues, thus requiring adequate support to help concentration and allow evaluation of personal progresses

    2 adequate supports in terms of tutoring are provided, both relating to the contents of each course and to the organisation and the logistics of the virtual community constituted by online students

    3 online students (and students' families …) are motivated enough to sacrifice to study a significant part of their free time, to compensate the difficulties related to the impossibility of following traditional lectures in normal working hours.

However, the SSRI online experience also revealed at least one critical aspect to be carefully considered when planning the implementation of a complete degree online: the significant demand in terms of availability of teachers to deeply revise their didactic material to supply it in the proper online format.

Besides any consideration on resources needed to implement the online degree – both in terms of money and of people (tutors, consultants, ICT technicians, etc.) involved – it is mandatory to trust on the enthusiasm of all the teachers themselves, as it luckily happened in the Crema Campus.

References

Anisetti, M., Bellandi, V., Cremonini, M., Damiani, E., Frati, F., Hounsou, J.T. and Rebeccani, D. (2007) 'Learning computer networking on open paravirtual laboratories', *IEEE Transactions on Education*, Vol. 54, No. 4, pp.302–311.

CTU (2010) Università degli Studi di Milano, Center for e-Learning and Multimedia Production, available at http://www.ctu.unimi.it/ (accessed on 15 December 2010).

Damiani, E., Esposito, A., Mariotti, M., Samarati, P., Scaccia, D. and Scarabottolo, N. (2005) 'SSRI online: first experiences in a three-years course degree offered in e-learning at the University of Milan (Italy)', Paper presented at the *11th International Conference on Distributed Multimedia Systems*, 5–7 September, Banff, Canada, pp.65–70.

DTI (2010) Università degli Studi di Milano, Department of Information Technology, available at http://ww.dti.unimi.it/ (accessed on 15 December 2010).

Honeynet (2010) *The Italian chapter of Honeynet Project*, available at http://www.honeynet.it/ (accessed on 15 December 2010).

Scarabottolo, N. (2010) *Laureati in area informatica 2008 a 12 mesi dalla laurea*, available at http://cdlonline.dti.unimi.it/pdf/Occupabilit%C3%A0_informatici_2010.pdf (accessed on 15 December 2010).

SSRI (2010) Università degli Studi di Milano, Corso di laurea in Sicurezza dei Sistemi e delle Reti Informatiche, available at http://cdlonline.dti.unimi.it/ (accessed on 15 December 2010).