# ONLINE VS. CLASSROOM STUDENTS
# IN AN UNDERGRADUATE UNIVERSITY DEGREE

Nello Scarabottolo

*Dipartimento di Informatica – sede di Crema – Università degli Studi di Milano*
*Via Bramante, 65, 26013 Crema (CR), Italy*

**ABSTRACT**

This paper compares the students enrolled to a three-year undergraduate, bachelor degree on Security of Computer Systems and Networks – offered in traditional, classroom fashion as well as online at the University of Milan (Italy) – in terms of results in exams of the various courses as well as in the final dissertation for obtaining the degree. This gives useful information about the effectiveness of e-learning vs. traditional learning in presence, and the possibility of using e-learning as a vehicle for extending the enrollment to already existing traditional university degrees.

**KEYWORDS**

E-learning, Online Bachelor Degree, Online Students, Classroom Students

## 1. INTRODUCTION

As discussed e.g. in Damiani (2005), Frati (2010), Milani (2014), Scarabottolo (2016-1) and Scarabottolo (2016-2), the University of Milan (Italy) offers an undergraduate, three-year degree on Security of Computer Systems and Networks in a university campus located in Crema, a small town 40 Kilometers east of Milan. Such a degree (from here on denoted as SSRI from its Italian name: "Sicurezza dei Sistemi e delle Reti Informatiche") has been activated in academic year 2003/04 as a traditional, classroom based university degree, but starting from academic year 2004/05 it is also offered online. Being SSRI an ICT-centered degree, we expected students more prone to the use of e-learning than students of other less technological degrees.

The online version of SSRI required a significant design process, involving a deep revision of all teaching materials already prepared for classroom lectures by teachers as well as of the role of the staff supporting the student learning activities. Such a process has been coordinated by CTU (the e-Learning Centre of the University of Milan) initially supported by consultants from Isvor Knowledge System (an Italian company specialized in the production of e-learning courses). Main characteristics of the resulting degree structure are the following:

- lectures are supplied in form of videos mainly constituted by slide sequences and/or desktop capturing synchronized with teacher's voice, or blackboard-like effects recording teacher's voice and handwriting (almost no video recording of the teacher her/himself);
- each topic of the various courses is covered by a video-lecture whose duration is around one fourth of the time spent by the teacher to present the same topic in classroom; in other words, the video-lecture is optimized for transferring the learning content in a short time, to maximize the attention of the online student, who has the opportunity to review the lecture several times;
- to furtherly facilitate online students learning, the academic year is divided into three four-month periods, each accommodating learning activities corresponding to around 20 ECTS credits; on the contrary, classroom students follow the regular semester-based organization, with around 30 ECTS credits per semester;
- students are supported by one Expert tutor for each single course of the degree and for each group of 40/50 students;
- in addition, the degree is supported by a Process tutor, who acts as e-moderator, process facilitator, adviser/counsellor for the whole community of online students;

- online students must come to the Crema campus for intermediate and final exams (by law, exams cannot be undertaken online) scheduled in reserved sessions on Friday afternoon and Saturday to facilitate participation of students already employed (the majority of online students);
- if online students do not succeed in passing all exams in the reserved sessions, they must present themselves in regular exam sessions, together with classroom students;
- performance of students in each single exam is given by a number ranging from 18 (fairly passed) to 30 (excellent) eventually "cum laude" (outstanding);
- when a student graduates (i.e., obtains the "laurea") her/his overall performance is given by a number ranging from 66 (fair) to 110 (excellent) eventually "cum laude" (outstanding).

To evaluate the effectiveness of the learning scheme adopted for SSRI online, this paper compares the results of the online students vs. the classroom students over eight years, from 2010 to 2017. Comparison is made in terms of grades obtained in the various exams, time passed between the end of each course and the corresponding exam, sequence of passed exams vs. sequence of courses in the study plan, grade obtained in the final degree.

## 2. STRUCTURE OF THE DEGREE

The structure of SSRI obviously complies with the general rules given by the Italian Ministry of Education and University for undergraduate degrees: the degree has a three-year duration and requires students to earn 180 ECTS credits (around 60 credits per year) to graduate. The general approach to design these undergraduate degrees foresees basic and introductory courses during the first year, core courses of the discipline during the second year, specialization courses and elective courses plus preparation of the final dissertation during the third year. This general approach results for SSRI in the organization reported in Table 1: 17 mandatory courses (7 in 1st and 2nd year and 3 in 3rd year) plus 2 elective courses in 3rd year.

Table 1. Organization of courses in the SSRI degree

| Year | Course | No of ECTS credits |
|---|---|---|
| FIRST | Mathematical Analysis | 12 |
| | Algebra and Geometry | 6 |
| | Probability and Statistics | 6 |
| | Computer Architecture | 6 |
| | Computer Programming | 12 |
| | Security in Web and Mobile Systems[1] | 6 |
| | IT Law | 6 |
| SECOND | Algorithms and Data Structures | 12 |
| | Databases | 12 |
| | Computer Networks | 12 |
| | Operating Systems I | 6 |
| | Operating Systems II | 6 |
| | Cryptography | 6 |
| | Technologies for Security and Privacy | 6 |
| THIRD | Systems and Networks Security | 12 |
| | Secure Software Design | 6 |
| | IT Incident Management | 6 |
| | *elective courses* | *6+6* |
| | *personal skills, foreign language, etc.* | *6* |
| | *final thesis preparation* | *24* |

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[1] This course has been introduced pretty recently in the curriculum of SSRI, and still there are not enough data to consider it in the following sections and figures.

As it can be seen:
- the first year is mostly dedicated to mathematics and basic courses in computer architecture and computer programming;
- the second year concentrates on core courses for every ICT professional, plus some insights into topics typical of computer security and privacy;
- the third year deepens student knowledge in systems and networks security and management of IT incidents. Twelve ECTS credits are reserved to elective courses, while all other courses listed in Table 1 are mandatory.

## 3. GRADES OBTAINED IN EXAMS

A first, significant comparison of the two categories of students is given in Figure 1, showing the average grades obtained in the exams of the courses listed in Table 1.
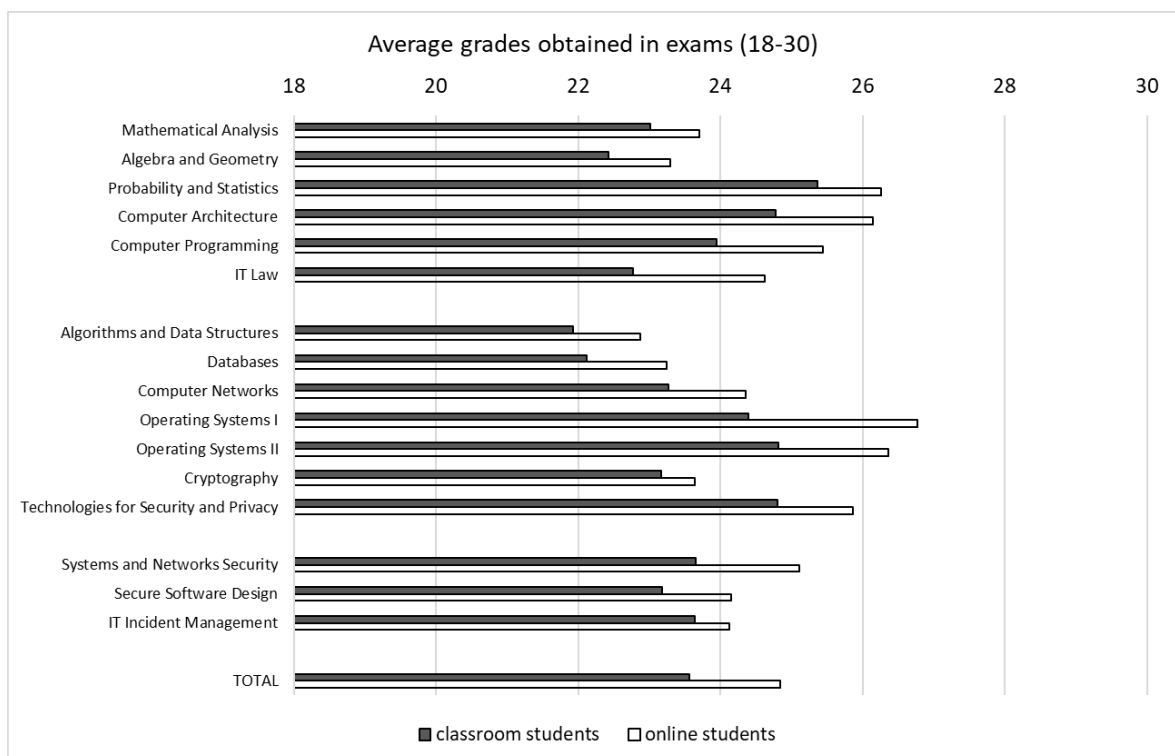


Figure 1. Average grades obtained in SSRI exams

Perhaps surprisingly, online students outperform classroom ones in the exam results for all courses of the degree, in some cases (e.g., Operating Systems I) with a difference of more than two points. Considering that the range of grades for passed exams is 12 points (from 18 to 30) this means that online students have an average performance up to 20% better than classroom students.

Such a result is definitely a proof of the effectiveness of the didactical organization of SSRI online: the learning process based on the video-lectures, supported by the team of tutors and planned to concentrate on few courses in each four-month period allows students to come to exams well prepared and to pass them with better results.

However, this does not imply that the learning process for classroom students (traditional lectures, no tutors, more courses in parallel due to the semester-based planning of courses) is less effective: results in exams are also strictly dependent on student motivation, i.e., commitment to improve personal knowledge and skills. To this regard, it may be argued that online students are far more committed than classroom ones mainly for two reasons.

1. As shown in Figure 2, the age of classroom students enrolling to SSRI online is completely different from that of classroom students. Classroom students are in large majority "conventional" young people, entering the university just after completion of the high schools. On the contrary, online students are definitely older people, generally employed, coming back to university to improve their professional profile. For them, study implies to sacrifice evenings and weekends with families and children, thus it is reasonable to expect far more motivation to succeed.

2. Online students are requested to pay – besides the same tuition of classroom students, ranging from few hundreds to three thousands euros on the basis of the incomes of the student family – an additional fee of 1,500 euros for online services (tutorship, weekend exams, didactic material updating, etc.). Again, something pushing toward commitment…
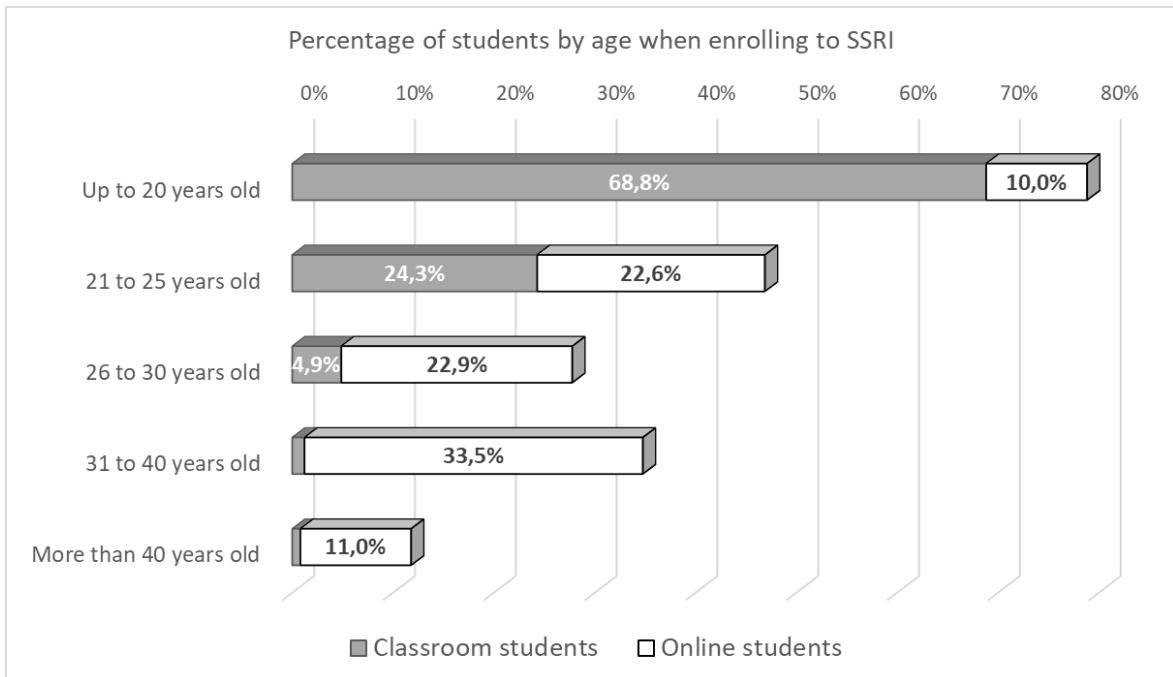


Figure 2. Age of students enrolling to SSRI

## 4.  TIME TO PASS EXAMS

Another comparison giving significant information about the two categories of students is the analysis of the average time required to prepare and to pass exams at the end of the lectures period, reported in Figure 3.

A first, immediate consideration coming from data in Figure 3 is the very long average time (no too far from one year) that both categories of SSRI students require to pass exams. Such a bad situation is unfortunately not that surprising: the job market is definitely eager of IT professionals, and a significant percentage of IT students starts working (usually part time) before graduating, thus lengthening the study period.

A second consideration seems to contradict what already said about commitment of online students: in fact, online students show longer preparation times for almost all exams with respect to classroom students. This contradiction disappears by limiting the analysis to the subset of students already graduated – i.e., students who passed all exams and obtained the final degree ("laurea") – as shown in Figure 4. Besides a general reduction in the time required for passing the exams, it becomes evident that online students are generally faster than classroom ones, as expected given the previous considerations about their commitment.

The fact that data in Figures 3 and 4 show completely different situations can be explained by considering the number of students whose data are used in these analyses, summarized in Table 2:

- part of the students considered in these analyses registered to SSRI in the most recent years of the 2010-2017 period, thus they were still far from the end of the bachelor; this partially explains the low percentages of graduated students;
- the significant length of the average time to obtain the final degree (around one year more than planned for a three year bachelor degree) – mainly due to the above considerations about part time work activities during studies – furtherly justifies the low percentages of graduated students;
- the very low percentage of online students who obtained their final degree by the end of 2017 (less than one half of the percentage of classroom students) is mainly due to the far higher number of online students leaving the degree without terminating it, having underestimated the effort required to come back to university at an older age.
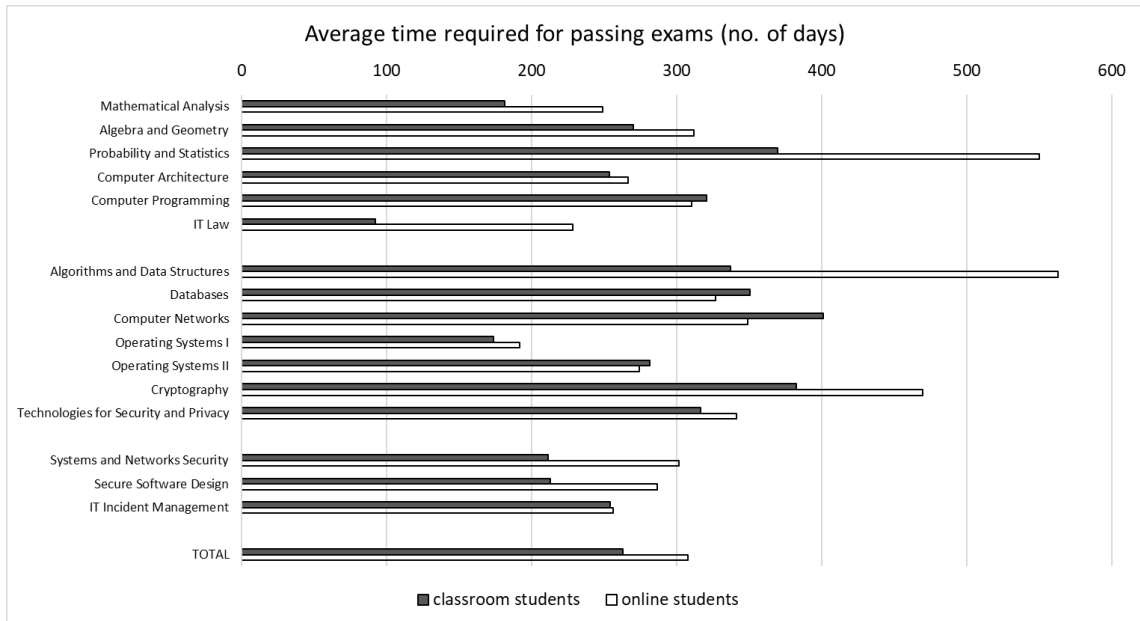


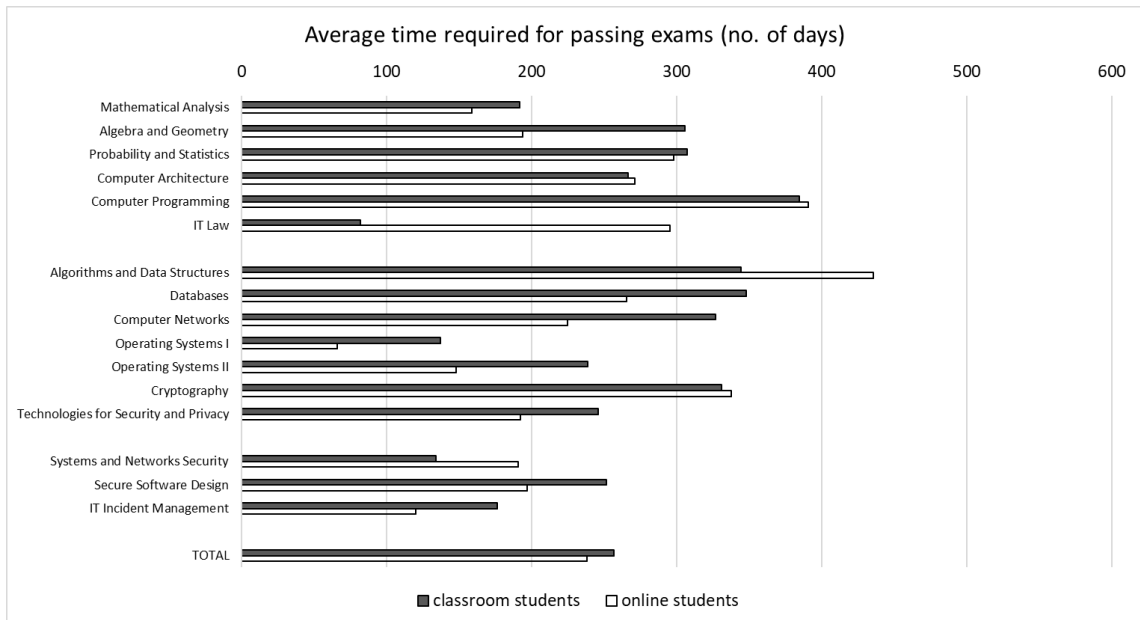Figure 3. Average time to prepare and pass SSRI exams after end of lectures



Figure 4. Average time to prepare and pass SSRI exams after end of lectures by graduated students

Table 2. Students used to perform the analyses reported in this paper

| | Classroom students | Online students |
|---|---|---|
| Number of students considered in the analyses | 315 | 341 |
| Number of students graduated at the end of 2017 | 75 | 37 |
| Percentage of students graduated at the end of 2017 | 23,81% | 10,85% |
| Time to graduate (no. of days) | 1411 | 1317 |

# 5.  WHEN STUDENTS TAKE EXAMS

Data in Figures 3 and 4 also show significant differences in the times required to pass the exams of the various courses, regardless to the number of ECTS credits (i.e., estimated study time) associated. For sure, not all topics are equally easy/difficult to learn, and (even more…) the effort to convince the teacher to give a positive grade is definitely not the same in all cases!

However, another reason for those differences in times could be the decision of a student to postpone the exam of a course already terminated to concentrate on the lectures of other courses. In other words, it is possible for students not to fully adhere to the degree planning given in Table 1, delaying some exams considered harder, or less interesting, etc. Figure 5 presents three different approaches to the mandatory exams by students.
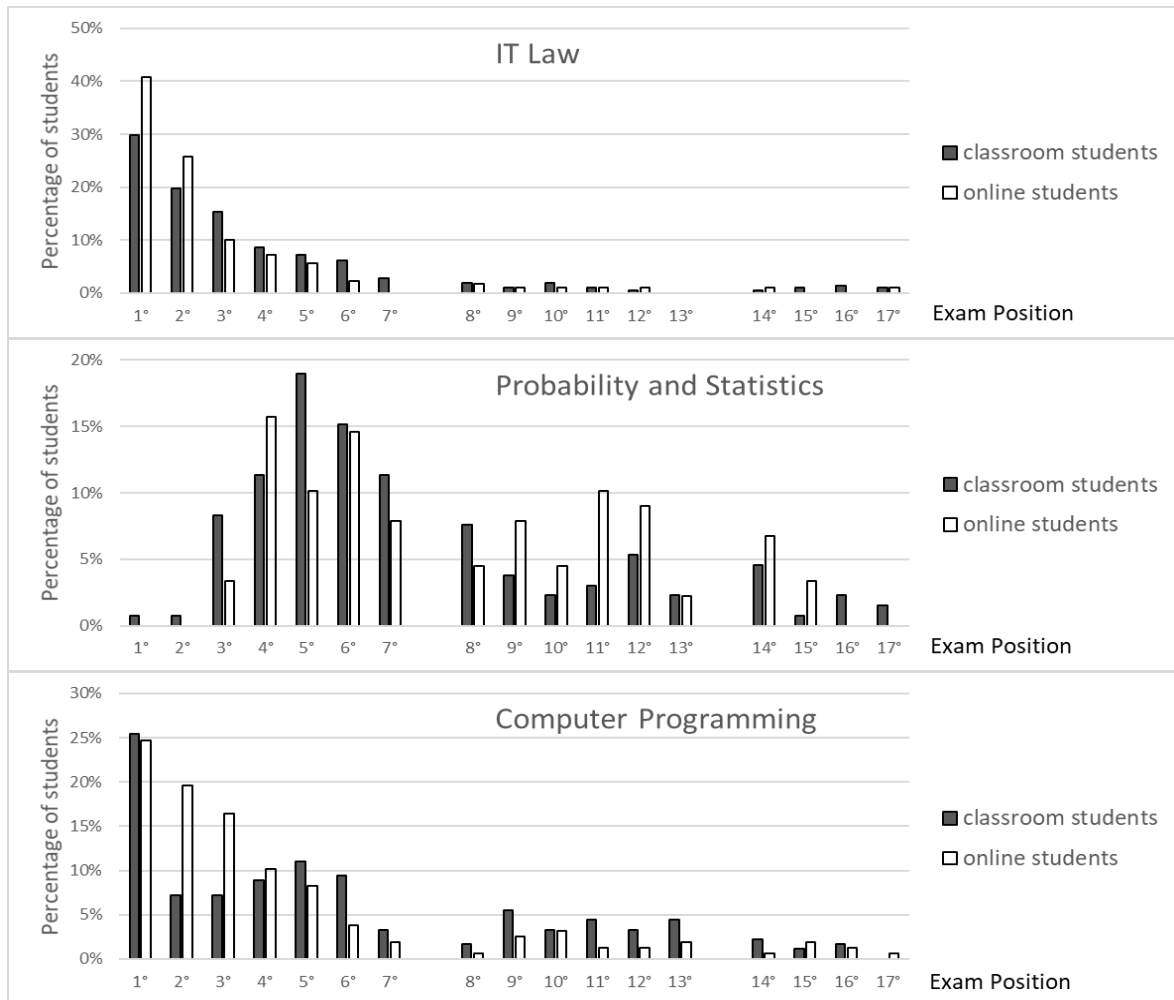


Figure 5. Position of some mandatory exams in the 17-exam plan of SSRI

A first possible behavior of students – represented in Figure 5 by IT Law – is the ideal situation: for most of the students, this exam is one of the first exams of their career, which requires passing 17 mandatory exams before discussing the final dissertation.

A second possible behavior of students – represented by Probability and Statistics – is on the contrary the worst situation: even if the course is planned for the first year of the degree, it is taken by a significant percentage of students in the second and even in the third year. There are several possible reasons for that: difficulty of the topic (but not for this particular course, looking at the average grades in Figure 1) scarce interest of students for the topic, feeling that the topic is not functional to the comprehension of the following courses, etc. In any case, this requires reconsidering the study plan of the degree to limit this delaying.

A third possible behavior of students – represented by Computer Programming – is a course showing quite a significant difference in the behavior of online vs classroom students. Here, most of the online students correctly pass the exam during the first year, while a significant percentage of classroom students delays the exam, even if the specific topic is definitely preparatory to second year exams. This is most likely due to the different organization of the calendar: online students follow courses in four-month periods, and can take intermediate tests, while classroom students follow courses in semesters without intermediate tests. Again, a redesign of the study plan and student evaluation procedure would limit the problem.

## 6. QUICK MEANS GOOD?

Last, it is possible to investigate about a possible correlation between time required to complete the degree and grade obtained after the final dissertation. Data relative to the students already graduated in SSRI allow to plot the graphs of Figure 6, and to draw the trend lines shown there.
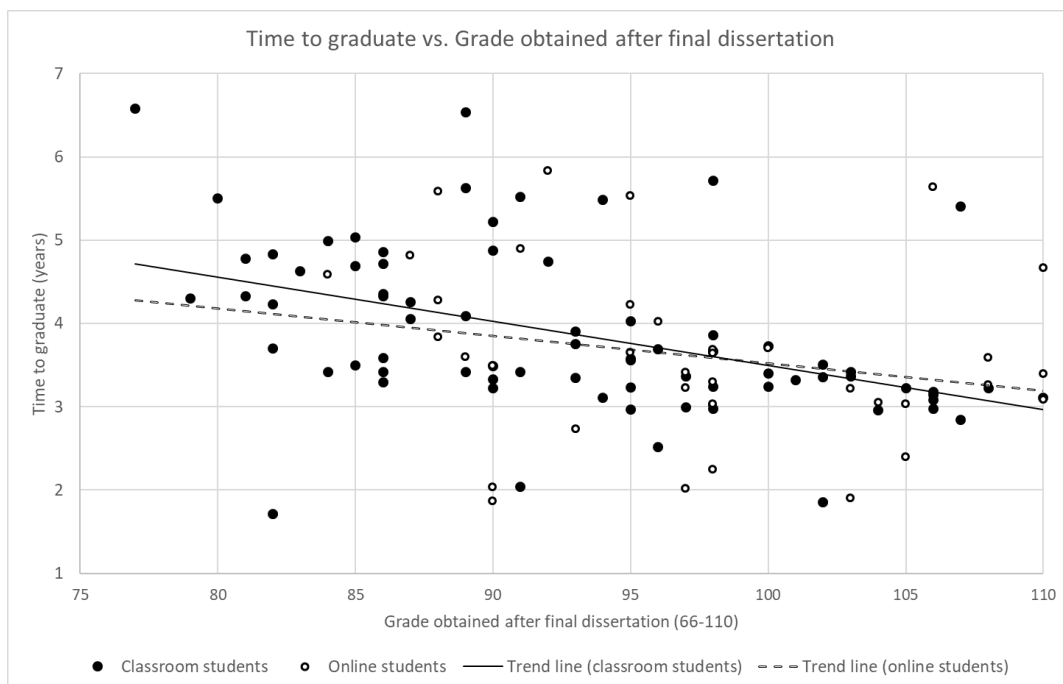


Figure 6. Correlation between time to graduate and final grade obtained

The slope of the trend lines in Figure 6 is – as easily predictable – negative: "faster" students obtain final better final grades. However – contrary to what presumable – it is evident that the correlation between the two sets of values is very fair, especially for online students, whose dots in Figure 6 are less concentrated around the trend line than the ones of classroom students. In fact, the Pearson's correlation coefficients $\rho$ computed for the two categories of students are the following:

$$\rho_{classroom} = -0,4471 \qquad \rho_{online} = -0,2256$$

meaning as expected an inverse correlation, but moderate ($-0,7 < \rho < -0,3$) for classroom students and definitely fair ($-0,3 < \rho < 0$) for online students.

# 7. CONCLUSIONS

This paper presented a comparison of performance in studies for two different categories of students, enrolled to the same undergraduate university degree but in two different versions: traditional learning (lectures in classroom) and e-learning (video-lectures available online, and tutorship using forums and emails).

Such a comparison took into account students enrolled from 2010 to 2017, and considered results in exams (i.e., grades obtained at the end of each course), time to pass exams after the end of the lectures period, sequence of passed exams vs planned curriculum, time to reach the final degree and grade obtained.

Main conclusions are the following.

- Online students demonstrate a stronger commitment to study and pass exams than classroom students. In fact:
    - exam grades obtained by online students are higher in almost all courses;
    - time to pass exams for online students who are able to keep the correct study pace is almost always shorter.
- A consequence of the above is that the online approach adopted for SSRI proved to be very effective, since it allows committed online students not to be penalized in their learning process.
- The counterpart is that online students not sufficiently committed, or too busy in their professional life, tend to delay excessively exams and final dissertation.
- Not all exams are passed when planned by the curriculum of the degree: especially classroom students tend to postpone some exams even if related to basic topics.
- There is no significant correlation between time to graduate and grade obtained after the final dissertation: several "slow" students – both classroom and online – obtain excellent results. As already said, most IT students find part time job during their studies, thus delaying final dissertation regardless to their own skills.

# ACKNOWLEDGEMENT

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