Informatics Education in Italian High Schools

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Abstract. This paper presents the main results of an extensive monitoring exercise aimed at assessing the role of informatics education in Italian high schools. The investigation focused on the teaching and certification activities performed by the schools as well as on the role and use of information technologies for teaching and communications with the students and their families. The study has shown a very positive attitude of the schools towards informatics education: many offer specific courses to their students and promote the use of the technologies for teaching a large variety of disciplines. The certification process of ICT skills is also popular. Despite all these positive aspects, the investigation has shown that informatics education is often limited to the use of the computers and seldom addresses the foundations of the discipline.

Keywords: Informatics education, high schools, ICT certifications.

1 Introduction

Information and Communication Technologies (ICT) play a crucial role for our daily personal and professional activities. The worldwide diffusion of online social networks among young people – that is, the so-called "digital generation"– is a proof of their familiarity with these technologies, typically used straightaway with little or no difficulty at all [1]. Nevertheless, the knowledge of the digital generation of the foundations and principles upon which ICT work is usually rather superficial and often not properly included and blended in their education (see for instance [2–4]). Education systems should then take the responsibility to fill this gap by implementing some specific learning processes.

Another important step in these processes is represented by independent certification exams aimed at assessing the knowledge and skills acquired. The relevance of ICT certifications in the job market is confirmed by the large number of organizations investing in this field. Among the most renowned organizations, we can name CompTIA (http://www.comptia.org), an international organization whose mission is focused on ICT, and AQA (http://www.aqa.org.uk), that provides ICT certifications in a broader range of domains and educational initiatives.

The impact of ICT certifications in Italian Universities is addressed in [5], whereas very few papers specifically analyze the use of certifications in the schools. For example, in [6] the values conveyed by offering ICT certifications at the high school level are illustrated, while in [7] the rationale for the diffusion in the schools of a specific proprietary certification is discussed.

On the contrary, the analysis of informatics education in high schools and the impact of ICT in the overall education system have been extensively addressed. Comparative studies of the educational approaches adopted in various countries are presented in [8]. In [9], authors outline that even though colleges and universities emphasize the importance of ICT for their students, the ICT skill level for incoming freshmen is often below the standard required for academic success. Nevertheless, students believe they have excellent technological skills, possibly because they compare to the skills of their parents or of high school teachers of the older generations. The situation in Austrian academic secondary schools is presented in [10]. In particular, the analysis has shown that different autonomous approaches adopted by schools in the implementation of their informatics education have led to some undesirable digital gaps at the end of the lower secondary level. As a consequence, a more ambitious informatics education becomes unfeasible in academic secondary schools. An analysis of Lithuanian situation is described in [11], where the author discusses the goals for introducing ICT in high schools and the competencies and values to be developed for informatics education. In [12], the authors focused on the answers of about 400 Israeli high school students who were asked about their ICT skills and knowledge.

A recent report [13] has shown that in the USA roughly two-thirds of the states have few computer science education standards for secondary school education, and most states treat high school computer science courses as simply an elective and not part of a student's core education. Moreover, much of what passes for high school computer science instruction is actually about Information Technology literacy rather than algorithm design, programming, or computational thinking.

This paper presents the results of an extensive monitoring exercise performed in the year 2010 and aimed at assessing how informatics education is perceived and organized in Italian high schools. The investigation, that involved the schools of eight Italian Regions, focused on various aspects related to teaching and certification activities performed by the schools as well as on the role of information technologies for teaching other disciplines. A previous investigation, performed in the year 2008, whose main outcomes are reported in [14], considered a much smaller number of Regions and schools and covered some of these aspects to a more limited extent.

The paper is organized as follows. Section 2 introduces the methodological approach applied for the investigation and describes the main characteristics of the schools involved in the exercise. The positions of the schools with respect to ICT are illustrated in Section 3, whereas the organization adopted by the schools to teach informatics is described in Section 4. Section 5 presents the

projects of the schools in the framework of informatics certification. Finally, some concluding remarks are outlined in Section 6.

2 Methodological approach

2.1 The context

Italian high schools extend over five years. Within the Italian high school system, informatics disciplines are not considered as compulsory disciplines for every type of school. In some schools – mainly technical schools – they are part of their curricular programmes, in some others these disciplines are often part of their so-called extra-curricular activities, whose organization and contents are under the responsibility of the individual schools. Some schools do not offer any informatics course at all. It is worth to point out that the Italian high school system has undergone a recent reform whose outcomes will be visible in about five years time. Table 1 presents as an example the breakdown of the teaching hours foreseen by the reform for various disciplines for technical schools addressing the ICT specialization.

Table 1. Breakdown over five years of the teaching hours in technical schools specialized in ICT based on the 2010 Italian high school reform.

Scientific and technical disciplines	1	2	3	4	5
Physics	99	99			
Chemistry	99	99			
Graphic design	99	99			
Informatics	99				
Applied sciences and technologies		99			
Complements of mathematics			33	33	
Systems and networks			132	132	132
Design of ICT systems			99	99	132
Project and enterprise management					99
For Informatics curriculum					
Informatics			198	198	198
Telecommunications			99	99	
For Telecommunication curriculum					
Informatics			99	99	
Telecommunications			198	198	198
Yearly total	396	396	561	561	561
Yearly total (including other disciplines)	1056	1056	1056	1056	1056

2.2 The monitoring exercise

The monitoring exercise relies on a web-based questionnaire designed by the authors and sent to the Directors of the high schools of eight of the 20 Italian

Regions, that is, Apulia, Lazio, Lombardy, Marche, Molise, Sicily, Umbria and Veneto. The choice of these Regions was mainly dictated by their number and type of schools: some of these Regions, such as, Lombardy, Apulia and Sicily, are characterized by the largest number of schools and student population in Italy, whereas others, such as, Molise and Umbria, have very few schools and students. Moreover, the geographical location of these eight Regions provides a good and representative coverage of the entire country from North to South, thus, taking into account the different socio-economics settings.

The investigation was launched in the spring 2010 and focused on the classes of the final three years. In total some 1,220 schools, out of 2,776 invited to participate, responded to the questionnaire, that is, approximately, 44%. From the regional distribution of the schools (see Fig. 1), we can notice that about one-fourth of the schools are located in Lombardy and slightly less than 20% in Sicily, whereas only 1.9% are located in Molise.

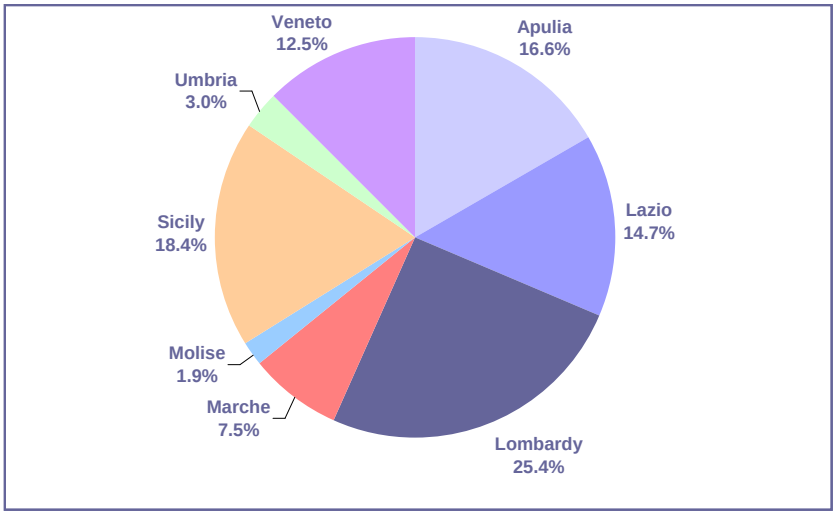

Fig. 1. Regional distribution of the schools.

The total number of students enrolled in the final years of these schools is approximately 356,000, that is, slightly less than 300 students per school and some 19.5 students per class. About one-third of these students, namely, 127,000, are enrolled in technical schools.

3 ICT in the Italian High Schools

To analyze the role of ICT in the schools, our monitoring exercise first focused on the availability of PCs for the teaching activities. The investigation has shown

that PCs are available in about 96% of the schools, with a total of some 78,500 PCs. These PCs are used as teaching tools for a large variety of disciplines. As can be seen from Figure 2, very many schools employ PCs for teaching mathematics (82% of the schools) and foreign languages (76% of the schools), whereas PCs are used only by about half of the schools for teaching drawing. Among the other

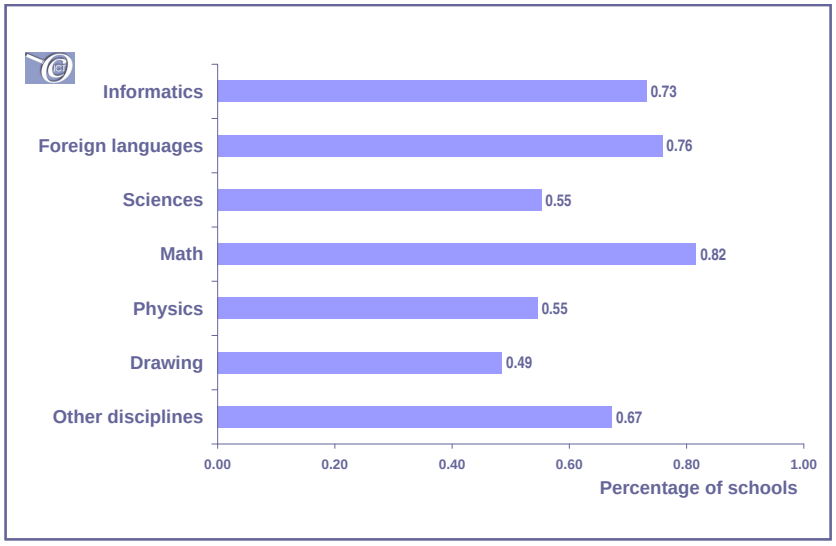

Fig. 2. Disciplines taught with the support of PCs.

disciplines selected by the schools, the most popular are humanities, such as, Italian, Latin and ancient Greek, and technical disciplines, such as, aeronautics, agronomy, mechanical constructions, advertising technologies.

The technical support for the management of PCs and ICT infrastructures (e.g., installation, configuration, update) is provided by staff specifically employed by the schools for this purpose. On average, each school employs 3.6 persons, however, the variability of the distribution among schools is rather large. For example, in some technical schools this staff consists of more than 20 persons, whereas other schools do not employ any dedicated staff at all and their duties are often performed by the teachers on a voluntary basis.

The majority of the schools, i.e., 71%, is also equipped with a large variety of technologies: servers, routers, wired and wireless networks, multimedia interactive whiteboards, overhead projectors, camcorders, audio mixers. It is important to outline that a good number of schools, i.e., 600 schools, adopts specific technologies to help students with disabilities in their learning process.

Email is rather popular within schools even though, as Figure 3 shows, there are large differences among the schools of the various Regions.

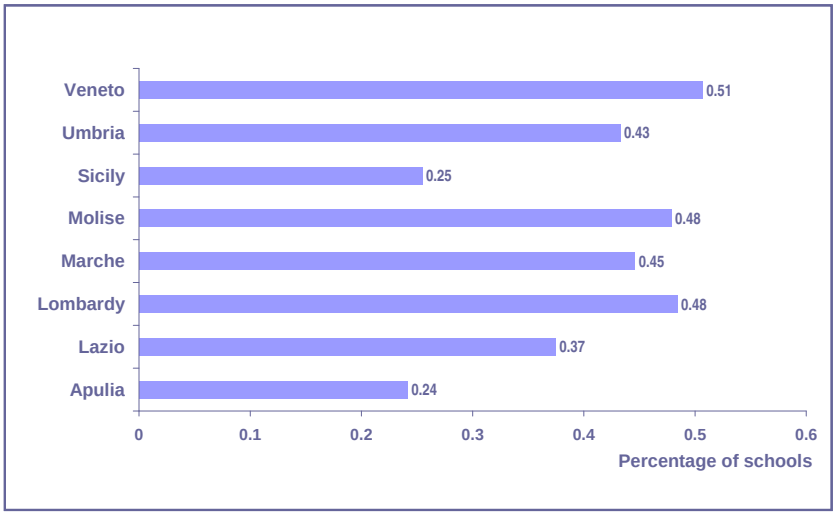

Fig. 3. Use of email within the schools of the eight Regions.

With respect to the exploitation of Web technologies, more than 92% of the schools have their own Web site usually maintained and updated by the teachers of the schools. We did not notice any significant difference among the schools of the various Regions. Schools often post on their Web sites confidential information about their student careers, e.g., absence, grades, overall assessments. For privacy reasons – in Italy privacy regulations are very strict – this sensitive information is only accessible by the parents, via login and password.

Despite the popularity of Web sites, very few schools (i.e., 192) have adopted advanced Web technologies, such as, online social networks and forums, involving teachers and students. The schools which approached these technological solutions are located in two Regions only: Apulia and Veneto.

Similarly, the organization of entertainment activities based on technological competence, such as videogames contests and digital art, is very limited. On the contrary, several schools are very active in participating to various types of international contests, such as the International Olympics in Informatics.

4 Teaching organization

Our investigation has shown that informatics disciplines are taught in about 743 schools (out of the 1,220 that responded to our questionnaire). We remark that according to the current Italian high school system, schools can teach these disciplines in mandatory courses taken by all students of a class and in optional courses taken by their students on a voluntary basis.

In particular, we can subdivide the courses offered by the schools in four different categories:

- mandatory courses belonging to the basic curriculum of a class;
- additional mandatory courses not belonging to the basic curriculum of a class, whose offer is left up to individual schools.
- optional free courses;
- optional courses requiring the payment of a fee.

Figure 4 shows the distribution of the schools according to the types of courses offered to their students. As can be seen, there is the prevalence of mandatory courses of informatics belonging to the basic curriculum of a class (offered by 441 schools, this is, 59.4% of the schools where informatics is taught). A good number of schools, i.e., 274, offer optional free courses of informatics. Of course

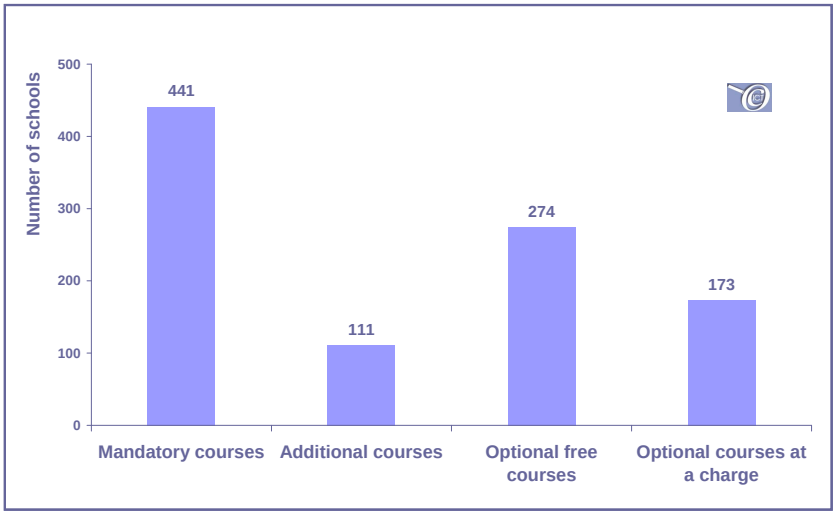

Fig. 4. Schools which teach informatics disciplines.

each school can organize courses in each of these categories. In particular, slightly less than 300 of the schools that participated to our monitoring exercise offer both mandatory and optional courses. A more detailed investigation has shown that most of these schools are technical schools. This demonstrates their strong attitude and interest towards informatics disciplines that are considered as a compelling professional need for the future of their students.

To further explore the choices of the schools, we focused on the organization of mandatory courses and in particular on the projects developed by the students as assignments. The investigation has shown that this type of assignment is

adopted by almost the 60% of the schools. As can be seen from Figure 5, most projects involved some programming activities. Very popular are also projects dealing with the development of Web sites, whereas far less popular are those addressing hardware devices.

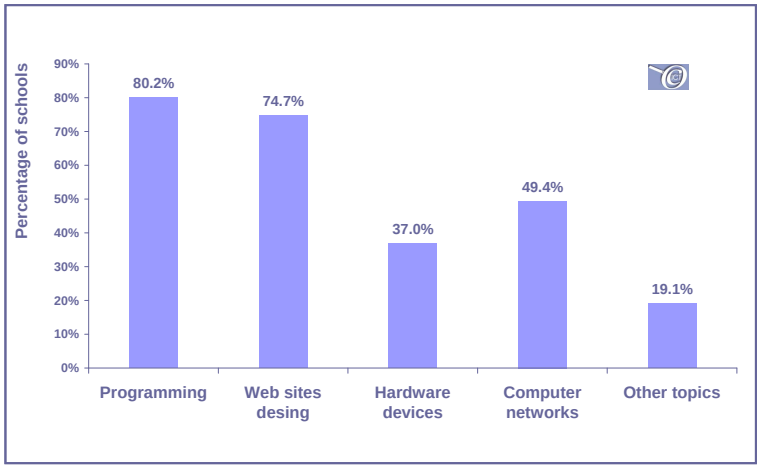

Fig. 5. Topics addressed by the projects developed in the framework of mandatory courses.

Despite mandatory courses, whose topics are defined by national regulations, the organization and content of optional courses are up to the schools. It is interesting to outline that very many optional courses focused on the use of individual productivity software suites, such as, Microsoft Office suite. Other topics, such as, Internet and navigation tools, basic concepts of informatics, are often part of these courses. Very few courses are dedicated to programming languages.

In general, it is possible to observe a bias towards teaching informatics from the end-user perspective, with a particular focus on productivity tools and Web technicalities and very seldom concentrating on fundamental aspects, such as, algorithmic aspects, logic, programming.

The average number of hours taught for each of the topics offered in the framework of optional free courses of informatics is shown in Figure 6. We can observe the large number of hours dedicated to teach programming languages.

Note that about half of the schools that responded to our questionnaire organize courses on ICT for their teachers – a rather unusual practice in a country where competence upgrade and lifelong learning of teachers are not planned nor regulated. These courses usually cover a large variety of topics, ranging from

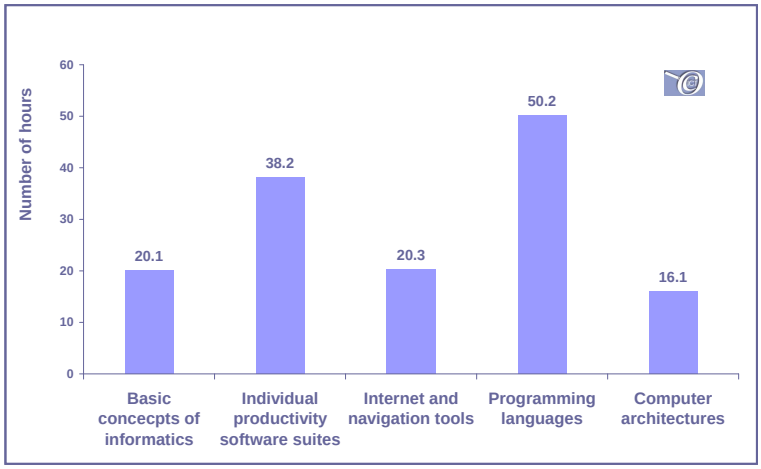

Fig. 6. Hours for the various topics addressed within the optional free courses offered by the schools.

teaching technologies and the use of multimedia interactive whiteboards to the use of the Microsoft Office suite.

5 Certification of ICT skills and education

More than half of the schools (631 out of the 1,220 that participated to our investigation) offer certification exams to their students. This approach for establishing a quality standard is especially popular in the schools of Veneto, Marche and Apulia, slightly less in Umbria and Sicily. The diffusion of certification programs is comparatively much less popular in the high schools of Lazio. Thus, regional differences exist but there is no clear explanation why.

Most high schools offer the ECDL certification (European Computer Driving Licence), with the majority of projects based on the ECDL FULL certification, obtained by passing all the seven tests foreseen by the programme, with respect to ECDL START certification, obtained by passing four out of the seven tests. In detail, the total number of certifications obtained by the students during the school year 2008-2009 was equal to 24,000. It is worth noting that 84% of these certifications refer to the ECDL family. In particular, 16,000 students received the ECDL FULL certification, whereas some 4,500 the START one. Moreover, about 1,000 students received a CISCO certification, and about 800 a Microsoft certification.

Let us remark that almost 80% of the schools that offer ICT certifications organize the certification exams within the school itself. This is mainly the case of the schools of Lombardy, Molise and Umbria.

Concerning the costs related to the certification process, we have noticed (see Fig. 7) that for the majority of the schools these costs are fully or partly covered by the families of the students. Very few schools provide their students with some financial support based on their grades or on the income of their family.

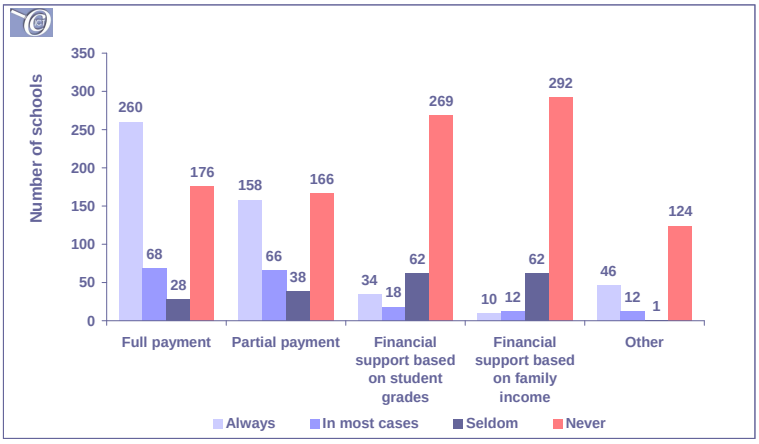

Fig. 7. Behavior of the schools with respect to the coverage of the costs associated with the ECDL certification.

It is interesting to outline that about 30% of the schools that offer ICT certifications complement them with other types of certifications, such as, language certifications for testing English proficiency. Moreover, about 10% of the schools are interested to widen their offers. These data witness a genuine interest of the schools to audit and validate the knowledge and skills developed by their students.

6 Conclusions

The extensive monitoring exercise carried out in the Italian high schools has shown their general interest towards informatics education: most schools offer several courses, either mandatory or optional, that covers various aspects of the discipline and involve a good number of students. Similarly, ICT certifications are strongly promoted by the schools that are usually equipped for an in-house implementation of the certification tests. It is interesting to note that these certifications very often complement English language certifications, thus, showing a general, positive attitude of Italian high schools with respect to third-party independent assessment of students skills.

Technologies play an important role in the schools: a very large number of schools is equipped with a big variety of technologies that are used to teach

many different disciplines. Web sites and email are also very popular, much less are other Web technologies.

Despite all the positive aspects outlined above, let us remark – as already mentioned in Sect. 4 – that the approach adopted by Italian high schools for teaching informatics is not always in line with their mission. In our digital age, schools should provide their students with fundamental problem solving knowledge and skills required for living and working in our society and problem solving by computers requires some specific education. However, in most of the schools informatics courses address simply the use of the computers, and only very few courses focus on the foundations of informatics, such as, computer architecture, programming, computational thinking. This situation has two negative implications: there is a risk for students to perceive informatics as a discipline with no scientific challenges, barely a matter of shallow playing with technologies. Moreover, the best high school students very rarely enroll in informatics degrees at the University, thus hindering the technological advancements in this field.

A different teaching framework and strategy for informatics education should then be defined as to provide the students with the skills required by next generation technologies. As a future work, we plan to analyze in details the strategies of the other European countries towards informatics education.

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