

Learning by Making and Early School Leaving: an Experience with Educational Robotics

Michele Lattarulo¹, Giovanni Massidda², Erica Sozzi³

¹ Headmaster - Liceo E. Fermi - Genova

² Teacher of Philosophy and History - Liceo E. Fermi - Genova

³ Teacher of Mathematics and Physics - Liceo E. Fermi - Genova

Abstract. Early leaving education involves high costs for society and heavy consequences for the individual. Roboesl¹ project introduces an innovative use of technology to engage students at risk of ESL. Liceo Fermi can be considered a suitable environment to check Roboesl effectiveness because it well shows the Italian educational situation. This document briefly outlines Italian strategies against ESL and describes the contribution to Roboesl by Liceo Fermi, highlighting experiences of our teachers who attended courses in Riga and Athens and showing the results of a first round of activities with students.

Keywords: early school leaving; compulsory schooling; compulsory education; high school; Roboesl; National Plan for Digital Schools; educational robotics.

1 Introduction

It is known that the phenomenon of students dropping out of school and giving up education and training at an early stage causes high costs for society and negative consequences for the individual. On the other hand, a higher level of education can lead to a benefit for the individual and society in matters such as employment, higher salaries, better health, less crime, higher social cohesion, lower public and social costs and higher productivity and growth.

1.1 Early school leaving in Italy: the current situation

Looking at the most recent ELET rates² (Eurostat, 2013; see Figure 1), it should be noted that in the EU-28 the rates vary from 3.9 % in Slovenia to 23.6 % in Spain, with an EU average of 12.0 %. In particular, Italy has a rate (17% in 2013) above 10% (the Europe 2020 headline target) and also above the current EU average (12.0 %).

¹ Project co-funded by the Erasmus+ Programme of the European Union. Project code 2015-1-IT02-KA201-015141

² the Eurostat definition considers the percentage of 18-24 year olds with only lower secondary education or less who are no longer in education or training.



Figure 1 - Percentage of early leavers from education and training, 2009-2013, and national targets as compared with the EU headline target

In the ranking of the twenty-eight EU countries, Italy occupies the fifth position from the bottom. The gap with the European average is higher for the male component (20,5% vs 14,5%), than for the female one (14,5% vs 11,0%).

At the regional level the situation is heterogeneous (Figure 2). Early school leaving is more accentuated in Southern Italy. In Liguria, the region where Genoa is, ELET rate has increased in comparison to 2011 (+2,1%).

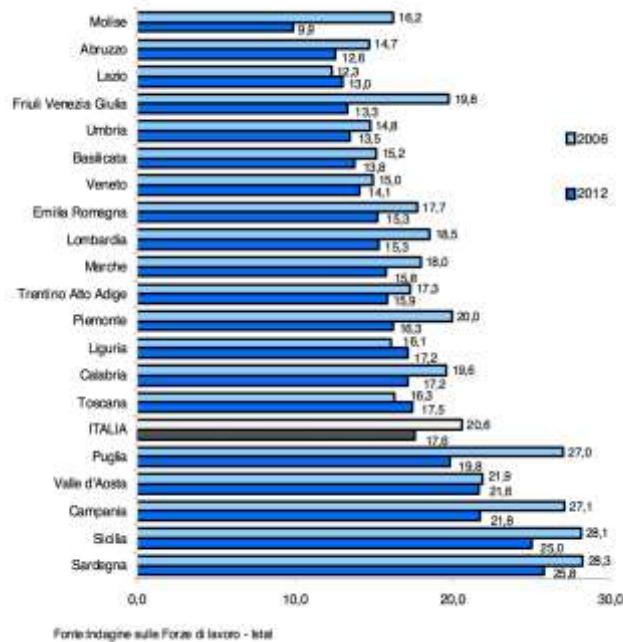


Figure 2 - ELET rate at a regional level in Italy

Article 34 of the Italian Constitution states that “the education, imparted for at least eight years, is compulsory and free”. Act of Parliament nr 296 of 2006 set ten years of compulsory schooling (“obbligo scolastico”), so nowadays in Italy the compulsory schooling covers the age group between 6 and 16. Students have to attend five years at primary school, three years at junior high school and two years at high school, or, as an alternative, attending education courses and vocational training implemented by educational institutions accredited by the Regions or by a Professional Institute.

Legislative decree nr 76 of 2005 defined compulsory education (“obbligo formativo”) as “right and duty to education and training aimed at the completion of a qualification course of at least three years, by the age of eighteen”. Students can:

- finish high school and get their diploma;
- attend, after the first two years of secondary school, a professional training course to obtain a qualification;
- work with a contract of apprenticeship or other similar type of contract.

Legislative decree nr 76 of 2005 established also the Registry National System of Students (Sistema Nazionale delle Anagrafi degli Studenti). This system requires of the school a better control of the information and their constant update.

Table 1 shows the data concerning students at risk of early school leaving for the school year 2011-2012.

students at risk of early school leaving			
	number of students	% of students	number of students registered in September
junior high school	3409	0.2	1716549
high school	31397	1.2	2523719
1 st class	6732	1.2	578804
2 nd class	4635	0.9	510373
3 rd class	7050	1.4	508533
4 th class	8246	1.8	466752
5 th class	4734	1.0	459357

Table 1 - *Students at risk of early school leaving, 2013/14*

As the table above shows, in high school students tend to drop out especially in the third and fourth years. The majority of students leaving school attend vocational school.

Figure 3 shows the age composition of Italian students at risk of early school leaving (high school).

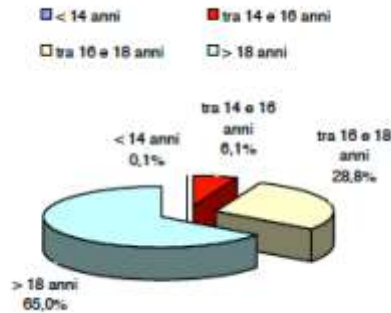


Figure 3 - Age composition of Italian students at risk of early school leaving (high school), 2011/12

Socio-economic disadvantage and educational disadvantage are closely linked.

In general, early leavers are much more likely to come from families with a low socio-economic status, i.e. unemployed parents, low household income, and low levels of parental education, or to belong to vulnerable social groups such as migrants.

Young people born abroad are largely over-represented among the early leavers from education and training in many European countries. The rates are particularly high in Greece, Spain and Italy (see Figure 4).

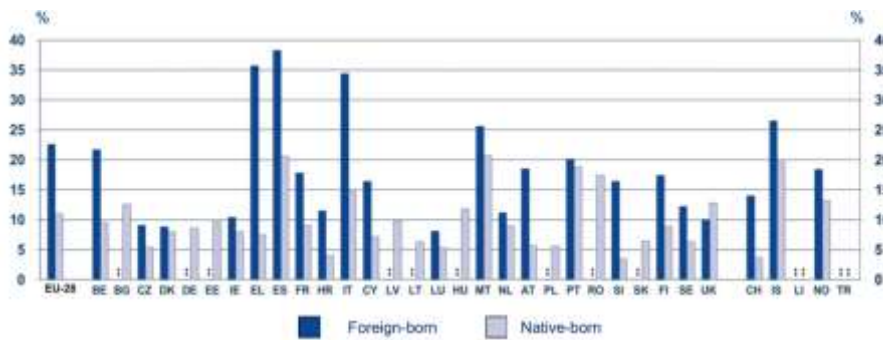
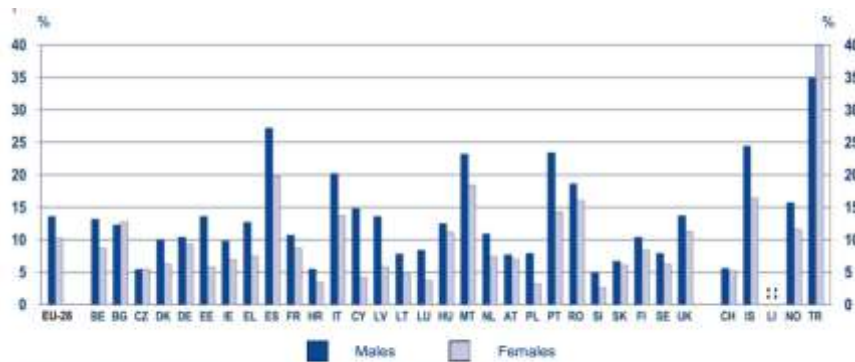


Figure 4 - Percentage of early leavers from education and training according to origin (foreign-born and native), 2013

International and national research confirms that male students are more likely to be early leavers than female students. Girls tend to outperform boys at school, and more girls than boys receive upper secondary education (OECD, 2012).

International assessments of student achievement reveal that girls have a visible advantage over boys in reading. Boys on the other hand perform better in mathematics and science than girls. However, both boys and girls can equally be

affected by socio-economic disadvantage, which in turn increases the risk of low attainment. Gender, therefore, constitutes only one of numerous factors accounting for the variations in educational achievement in different subject fields.



Source: Eurostat, EU_LFS [edat_lfse_14] (data extracted October 2014).

Figure 5 - Percentage of early leavers from education and training by sex, 2013

1.2 Early school leaving in Italy: the strategies.

In April 2016 a decree of the Ministry of Education University and Research³ allocated 10 million euros to reduce the problem of early school leaving in the peripheral areas of some large cities. This is the latest action against drop-out (the so called National plan to prevent early school leaving in the suburbs) and, although it is a significant measure, it can't be considered as a 'structural' intervention because:

- it concerns only schools in cities such as Roma, Milano, Napoli, Palermo;
- it funds the projects with a una tantum allocation of maximum 15.000 euros for each school;
- activities to be funded cover a restricted range of thematic areas.

This example shows that the main problem related to the challenge of preventing early leaving is, in an overall perspective, to place the different measures within a global and consistent strategy.

The situation in Italy is described in the latest Eurydice/Cedefop report as follows:

“All European countries have policies and measures in place that can help to reduce early leaving, even though they may not be part of a comprehensive strategy or been introduced to address this problem specifically. This is the case of Italy, as showed in the Figure 4.

³ D.M. 273 (27/04/2016)

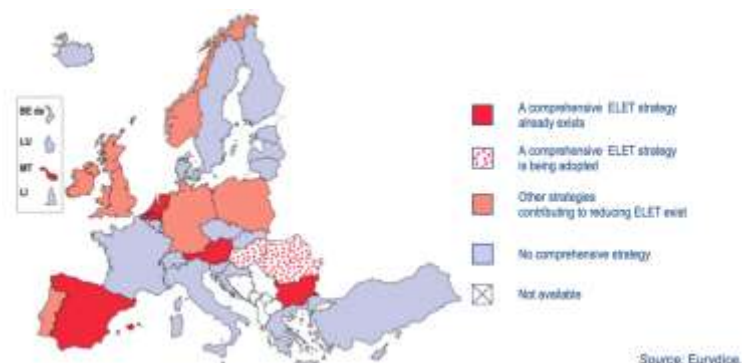


Figure 4 - *Strategies for tackling early leaving from education and training, 2013/14*

However, in Italy some steps have recently been taken to reinforce cross-government cooperation.

A Forum for Lifelong Guidance to tackle the problem of students dropping out has been established within the Italian Ministry of Education Universities and Research. Other members of this Forum are: the Ministry of Health, the Ministry of Labour, the State/Region conference, the Institute for professional development of workers (ISFOL), the Italian Manufacturers' Association (Confindustria), the Union of Chambers of Commerce (Unioncamere) and some experts from universities. This Forum has recently been merged into a steering committee, set up within the State/Regions Conference, which has established coordination and cooperation mechanisms for lifelong guidance among the various stakeholders.”⁴

An important consideration which rises from the report is that the intervention of the government aims to address the problem of early school leaving also with the collaboration of partners outside the education system, which play the role of stakeholders.

The Eurydice and Cedefop report (2014), again, summarizes the main measures against early leaving in Italy:

- a series of intervention and economic measures aimed at fighting drop-out, such as integrative teaching in compulsory education in the areas with higher risk of drop-out and the extension of school timetable for groups of students;
- implementing extra-curricular activities in the afternoon (sportive, cultural, artistic and leisure activities);
- increasing flexibility and permeability of the education system through the full integration and recognition of non-formal and informal pathways within the education system;

⁴ European Commission/EACEA/Eurydice/Cedefop, 2014.

Tackling Early Leaving from Education and Training in Europe: Strategies, Policies and Measures. Eurydice and Cedefop Report. Luxembourg: Publications Office of the European Union.

- Setting up local networks of guidance in each Regional School Office aiming at training teachers, promoting lifelong learning guidance and identifying needs, with the participation of the different actors involved in guidance;
- developing the students' register to identify early leavers;
- reorganising the adult education system. Former centres and evening classes will merge into the new Centres for Adult Education (CPIA) providing young people and adults with personalised learning paths for obtaining lower and upper secondary education qualifications. Centres will also offer literacy courses and Italian language courses to foreign adults;
- integrating classes in institutes for the detention of minors and adults.⁵

In the same year (2014) a report⁶ of the 7th Commission of the Italian Chambers of the Deputies (Lower House in Parliament) emphasized the need to open schools to the partnership and the cooperation with the surroundings, clearly stating that it is impossible to imagine that early leaving could be tackled only by actions inside the education system.

However, the same document recommended, among the key-actions against drop-out,

- didactic innovation through innovative training of the teachers
- creation of innovative learning environments.

It means that, even if the partnership with other subjects is really important in the struggle against early leaving, every strategy would be vain without a previous reconsideration of the learning and teaching methods and tools.

An important attempt to merge the two aspects (partnership with the stakeholders and innovation inside the education system) is contained in the latest and most important education reform in Italy, that is Act of Parliament nr 107/2015. Prevention and recovery of school leaving are included among the objectives of this structural reform of the education system. They are also considered as priority educational targets to be achieved through the *three-year educational offer plan* (i.e. the strategical policy document of each educational institution).⁷

In the reform act of Italian education system, the paragraphs from 56 to 62 announce the National Plan for Digital Schools (PNSD) which is not, of course, only a measure against early school leaving, but contains many suggestions and offers various useful tools about it.

⁵ European Commission/EACEA/Eurydice/Cedefop, 2014.

Tackling Early Leaving from Education and Training in Europe: Strategies, Policies and Measures. Eurydice and Cedefop Report. Luxembourg: Publications Office of the European Union.

⁶ Camera dei Deputati, 7a Commissione Cultura, scienza e istruzione: Indagine conoscitiva sulle strategie per contrastare la dispersione scolastica.

⁷ Legge 13 luglio 2015, n.107 (Gazzetta Ufficiale n.162 del 15 luglio 2015)

The Plan was published in October 2015, with the intention of contributing to the modernization and reorganization of the education system in Italy.

More specifically, the document consists of 35 actions, including – for instance – wideband implementation, BYOD, open resources etc.

Educational robotics appears in some contexts of the Plan:

- The project for *creative ateliers* in the first cycle of education (from 6 to 14 years of age).
- Introduction of elements of educational robotics in the second cycle of education.
- Use of educational robotics in interdisciplinary courses for skill development.

The link between the reform act of the education system (law nr 107/2015) and the National Plan for Digital Schools demonstrates that an important role in the innovation of teaching and learning is played by technology. Furthermore such innovation has, among its priority objectives, to tackle early school leaving. It means that technology could be considered as one of the most powerful tools against the drop-out: this statement, however, is true only if the didactic use of technology devices is carefully planned in advance ground.

Very suggestive is the idea of creating a sort of *digital carpet* capable of conjugating imagination and manual skills, where educational robotics (and electronics) could represent the inspiring subject for new learning scenarios. In this context the reference to logics and computational thinking could become crucial, as long as we consider its practical aspects rather than the theory about it.

1.3 Early school leaving at Liceo E. Fermi of Genoa.

Liceo Fermi in Genoa is attended by students from varied backgrounds including students from immigrant families (see Table 2 and 3). The school has to meet the requirement to keep learning standards adequate but at the same time it devotes energy and care to supporting pupils who are confronted with school difficulties. This day-to-day experience is the basis of the contribution that Liceo Fermi brings to the project.

	students without Italian citizenship (number)	students without Italian citizenship (percentage)	students without Italian citizenship born in Italy (number)	students without Italian citizenship born in Italy (percentage)
1 st class	17	2.5%	12	1.8%
2 nd class	18	2.6%	6	0.9%
3 rd class	10	1.5%	0	0
4 th class	8	1.2%	0	0
5 th class	5	0.7%	1	0.1%
	58	8.5%	19	2.8%

Table 2 - Students from immigrant families at Liceo Fermi, 2014/15

Foreign state of birth	number of students	percentage in relation to the number of foreign students	percentage in relation to the total number of students
Albania	29	50%	4.3%
Ecuador	12	20.7%	1.8%
Morocco	6	10.3%	0.9%
Tunisia	1	1.7%	0.15%
Peru	3	5.2%	0.44%
Iran	1	1.7%	0.15%
Ukraine	1	1.7%	0.15%
Kazakhstan	1	1.7%	0.15%
Bolivia	1	1.7%	0.15%
China	1	1.7%	0.15%
Pakistan	1	1.7%	0.15%
India	1	1.7%	0.15%
	58	100%	8.5%

Table 3 - *Foreign state of birth of students without Italian citizenship*

The comparison between national data concerning students at risk of early school leaving and analogue data from Liceo Fermi highlights that ELET rate in this school is higher than the national one for second, fourth and fifth class (see Table 4).

	% of students at risk of early school leaving			
	Liceo Fermi	Genoa	Liguria	Italy
1 st class	0.0	0.3	0.8	0.5
2 nd class	0.7	0.5	0.7	0.5
3 rd class	0.0	0.9	1.3	0.7
4 th class	1.4	0.6	0.9	0.9
5 th class	0.7	0.8	0.8	0.5

Table 4 - *Students at risk of early school leaving at Liceo Fermi compared with regional and national data, 2014/15*

Data from our school confirm that male students are more likely to be early leavers than female students and that social groups such as migrants are more vulnerable (see Table 5 and 6): foreign students were 8.5% in the school year 2014/15 (if 100% corresponds to the total number of students) but foreign students at risk of early leaving were 26% in the same school year (if 100% corresponds to the number of students which left school early).

male students	female students
68%	32%
Italian students	foreign students
74%	26%

Table 5 - *Students at risk of early school leaving at Liceo Fermi - details, 2014/15*

male students	female students
71%	29%
Italian students	foreign students
65%	35%

Table 6 - *Students at risk of early school leaving at Liceo Fermi - details, 2015/16*

Data showed above highlight that Liceo Fermi can be considered a suitable environment to check Roboesl effectiveness.

2 Our experience from ROBOESL training courses

Teachers teach as they have been taught: this was, in our experience, the starting point for the training courses in Athens and in Riga. But it can often be somehow difficult for a teacher to become a learner, because this sort of *metamorphosis* requires of teachers a disposition to reconsider their attitudes and urges them to be ready to take new challenges.

This problem didn't arise during the two training courses because of the approach they had: it was, actually, not a theoretical but a practical approach, whose first aim was to enter into the topics by assembling the *tools* and becoming familiar with them.

Learning by doing has become nowadays a common slogan, in programmatic documents and legislative acts about education, but this catch-phrase

has lost its deepest meaning. In the two courses we could touch (not only figuratively) the effectiveness of this learning approach.

Moreover we could understand that the improvement in term of effectiveness is even more considerable when we succeed in passing on to the students the significance of *Learning by making*. The specific meaning of this expression is clearly explained by Seymour Papert:

“we learn best of all by the special kind of doing that consists of constructing something outside of ourselves: a child building a tower, writing a story, constructing a working robotic device or making a video game are all examples of constructing and the list goes on indefinitely.”⁸

Therefore, after the training courses, an important result was to clearly understand

- that the effort to find and increase motivation in their work is for the teachers the first step to meet the challenge that they have to face while trying to motivate students at risk of early leaving;
- that *making* could be a precious way to prevent or overcome deadlocks

3 Robotics activities at Liceo Fermi

In Spring 2016 we initially selected more than 30 students for robotics activities, on the basis of proficiency as resulting from school reports and teachers' further evaluation.

Some students didn't choose to take the course, so we included students with better assessments. We knew the risk of this choice: “the best” students could prevaricate on the other ones.

Our first course lasted twelve hours (four three-hour lessons) and it involved 36 students from 6 classes.

The students involved were aged 16, they were from our second class.

Robotics lessons started at h12,30 and went on till h15,30 (in our school classes are usually dismissed at h13,50)

This schedule, which partly overlapped ordinary classes, was meant to facilitate students' participation and to avoid making their school days too hard and tiresome.

The day of the week was not always the same to avoid taking students away from the same lessons.

We equipped two classrooms for robotics activities, in addition to a computer lab.

⁸ Papert S.A., *What is logo? And who needs it?* Logo Computer Systems Inc. 1999, p.XIII

In our school there is an interactive multimedia board in every classroom, so also in the classrooms used for robotics activities we could use this useful tool.

We arranged the desks so that they would leave enough space for the robots' motions.

However we allowed students to move their robots on the floor.

Initially students formed groups spontaneously, but these groups consisted mostly of pupils from the same class. So we formed groups with students from different classes to be able to test better their aptitude for collaboration.

Three or four students were part of each group.

According to the principles of cooperative learning methodology, in a small team with students of different ability levels, each member of a team collaborates with peers to improve his understanding of a subject. Each student is responsible, not only for learning what is taught, but also for helping his or her teammates learn — thus creating an atmosphere of cooperation.

During activities, we observed students promoting each others' learning, discussing and explaining assignment topics with each other.

Students had the sense that they were together, acting as a whole and feeling that each member's individual effort would not only help him, but the whole group.

We think that students involved learned not only the subject we proposed, but also interpersonal skills and how to work in teams.

Almost all pupils attended all the lessons.

However, as highlighted by the following graph (Figure 6), in the last session participation decreased significantly. This because some students were involved in another activity outside the school. In the next round we should be more careful about organization and communication, so that colleagues not directly involved in the robotics activities could contribute to the success of the project.

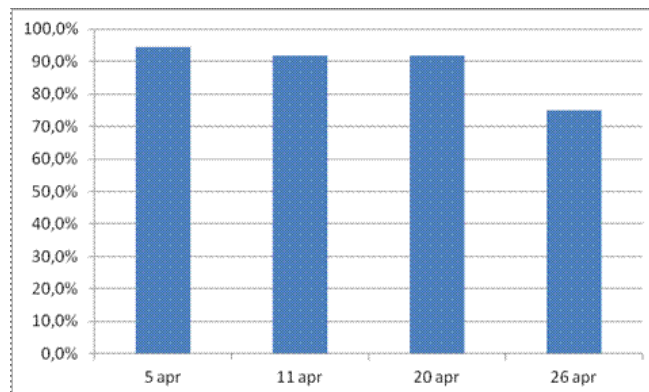


Figure 6 - Student attendance in robotics activities at Liceo Fermi (Roboesl project), spring 2016

Five teachers supported the students during the training. These teachers have participated in all lessons (except for short absences due to other unavoidable engagements).

Teachers involved in the project teach different disciplines: history and philosophy, mathematics and physics, science, drawing and art history.

For this reason, in the early stages of the project we insisted on the need for interdisciplinary curricula. However, during the activities with students we realized that it is better to insist on the STEM aspects, although interdisciplinarity still constitutes a valuable asset because STEM subjects can be understood in a better way if they are showed from different points of view.

The collaboration among different teachers offers automatically this variety of approaches in a way more effective than an imposed interdisciplinarity.

During activities:

- most of the students seemed excited;
- few students seemed little affected;
- students with the best assessments appeared more creative: they showed a tendency to look for personal solutions and try to vary what is proposed;
- sometimes excessive enthusiasm led them not to follow directives;
- the students appeared very responsible: nothing was broken or lost;
- usually students were seeking the correct values of the parameters by trial; only rarely they sought a mathematical solution.

In the time available, we were able to apply the first three curricula (Roborail, Go to Park, Desert Scout) only in the main aspects.

Students were involved in a special way by “Go to park” curriculum, because it offers a more practical context close to real situations.

After the end of the course, reflecting on what we have observed and experienced, we think that:

- many students would have been pleased to continue the course
- a 12-hour course is too short to transmit a satisfactory knowledge and to satisfy the curiosity and interest of pupils
- however, to be able to do more we would need to involve other colleagues. But at the moment, no further colleague is available. Nevertheless, we’ll try to add some hours (15 hours instead 12).

It seems that the robotic activities have had a positive impact on the results achieved by students. Table 7 shows the grade average of students involved in Roboesl.

Only three students have finished the scholastic year with a fail.

For all the others there was a positive change in their grade average.

student	average mark (interim assessment)	average mark (final assessment)	average mark change
1	5,50	6,30	0,80
2	6,00	6,30	0,30
3	6,00	6,50	0,50

4	5,40	6,50	1,10
5	6,00	6,40	0,40
6	6,10	6,70	0,60
7	6,20	6,40	0,20
8	5,60	6,10	0,50
9	5,50	6,00	0,50
10	6,20	6,70	0,50
11	6,00	5,70	-0,30
12	5,50	6,40	0,90
13	6,10	6,50	0,40
14	6,10	6,50	0,40
15	6,10	6,50	0,40
16	5,70	6,40	0,70
17	6,20	6,90	0,70
18	5,30	6,70	1,40
19	5,80	6,50	0,70
20	5,70	6,70	1,00
21	6,10	6,60	0,50
22	6,20	6,70	0,50
23	6,00	6,50	0,50
24	5,90	5,60	-0,30
25	5,50	5,90	0,40
26	6,10	6,90	0,80
27	6,09	6,45	0,36
28	5,80	6,10	0,30
<hr/>			
overall average	5,88	6,41	0,53
<hr/>			
29	6,70	7,30	0,60
30	7,90	8,00	0,10
31	7,60	7,70	0,10
32	6,90	7,60	0,70

33	7,10	7,60	0,50
34	6,30	6,70	0,40
35	6,60	6,70	0,10
36	7,30	7,60	0,30
overall average	7,05	7,40	0,35

Table 7 – *Grade average of students involved in Roboesl*⁹

4 Conclusions

As the National Plan for Digital Schools (PNSD) states, “simply introducing more technology in schools is no longer sufficient; if we concentrate our efforts solely on technology we risk ignoring the larger issues, namely knowledge and culture”.¹⁰

Roboesl project seems to accomplish this aim, considering robotic activities within a systemic vision, according to declarations in PNSD:

“Education in the digital age must be viewed above all as a cultural initiative. It begins with a new concept of school: an open space for learning — more than just a physical place, a springboard that enables students to develop skills for life. In this vision, technology is empowering, habitual, ordinary and ready to serve the school, primarily in activities aimed at training and learning, but also in administration, spreading to — and in fact bringing together — all school settings: classrooms, common spaces, laboratories, private and informal spaces. It is an organic plan for innovation in Italian schools, with cohesive programs and actions organized into five main areas: tools, skills, content, staff training and supporting measures”¹¹.

After this first positive experience with the Erasmus project in Liceo Fermi, we can establish some purposes for the future:

- involving already trained students in peers tutoring methodology;
- increasing the number of sessions of the course for students;
- sharing Roboesl objectives within the educational community;
- recording and spreading procedures and results to support robotic activities after the end of Roboesl.

⁹ The second part of the table refers to students with better assessments, so we splitted the average calculation.

¹⁰ http://www.istruzione.it/scuola_digitale/allegati/2016/pnsd_en.pdf

¹¹ http://www.istruzione.it/scuola_digitale/allegati/2016/pnsd_en.pdf

References

1. European Commission/EACEA/Eurydice/Cedefop, 2014. Tackling Early Leaving from Education and Training in Europe: Strategies, Policies and Measures. Eurydice and Cedefop Report. Luxembourg: Publications Office of the European Union
2. Ministero dell'Istruzione, dell'Università e della Ricerca / Servizio statistico 2013. Focus: La dispersione scolastica
3. Ministero dell'Istruzione, dell'Università e della Ricerca, 2015. Piano Nazionale Scuola Digitale
4. Legislative decree 16 January 2013, n. 13 - Definizione delle norme generali e dei livelli essenziali delle prestazioni per l'individuazione e validazione degli apprendimenti non formali e informali e degli standard minimi di servizio del sistema nazionale di certificazione delle competenze, a norma dell'articolo 4, commi 58 e 68, della legge 28 giugno 2012, n.92. (13G00043) (GU Serie Generale n.39 del 15-2-2013)
5. Papert S.A., *What is logo? And who needs it?* Logo Computer Systems Inc. 1999