# Mission on Mars
# Interactive robotics session, on videoconference, through the use of Interactive White Board (IWB)

Tullia Urschitz[1], Tasha Carl[2]

[1] B. Lorenzi Secondary School, Fumane,
Verona, Italy
tullia.urschitz@istruzione.it
[2] Freelance Software and Hardware Developer,
Brussels, Belgium
tasha@carl.pro

**Abstract**. Educational Robotics, used within a school curriculum, has the aim to involve students of different ages from primary school to high school, in the study of scientific-technological subjects in different ways, stimulating motivation and encouraging the acquisition of multiple competences. Robotics engages students of different languages, cultures, ages and learning styles, thanks to the use of a universal language and an experimental and cooperative approach.
It enables a greater involvement in the study of scientific and technological subjects also by female students, reducing the gender gap.
The aim is not only solving scientific or mathematic problems, it is also using language, analysing different situations and media sources or sharing ideas and experiences with schoolmates from other school or nation. Another main objective is realizing interactive lessons (missions) in videoconference through the use of Interactive White Boards.

**Keywords:** educational robotics, key competences, IWB, videoconference, interactive lesson, learning, overcoming gender gap.

## Introduction

In Bartolomeo Lorenzi secondary school in Fumane, Verona, educational robotics has been used as a didactic method in some classes for about four years thanks to the collaboration with the School of Robotics of Genoa, both during extra-curricular lab activities and within the Maths and Science curriculum. In the last two years it has been introduced in the POF, i.e. the Plan for the Educational Offer, a project which foresees the inclusion of robotics in the whole curriculum, with discovery paths for kindergarten and paths of continuity for primary and secondary school. Sometimes activities are carried out in the different stages of schooling thanks to didactic paths among peers, in which older students are tutoring younger ones.

In some classes at least one hour a week of the common Maths and Science curriculum is spent in robotics sessions. Students appreciate these kind of lessons and their feedback can be measured in terms of increased motivation and developed inquiring skills, improved use of specific language, increased mathematic, scientific and digital skills and group work skills. About 15% of the students who usually use robotics in curricular activities apply for mathematics competitions (Maths Games organised by Pristem - Bocconi University of Milan) and get good grades in the national evaluation tests by INVALSI (the Italian National Institute for the Evaluation of the Educational System).

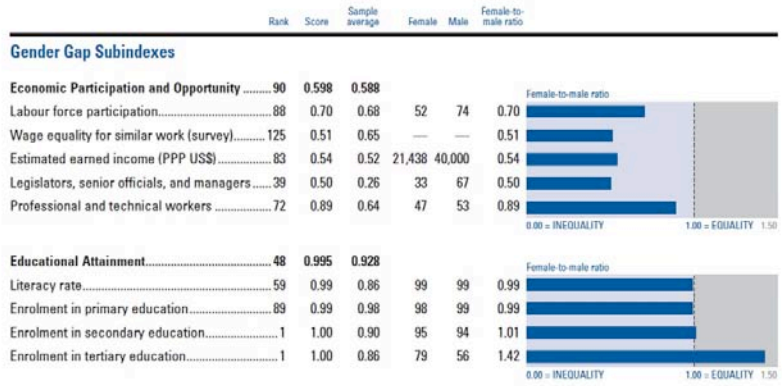
In September 2011 the School of Robotics of Genoa, the Italian National Coordinator for EuRobotics Week, brought us into contact with Greenlight for Girls Organisation of Bruxelles, which was organizing Greenlight@Brussels Day 2011, in collaboration with the European Centre for Women and Technology (ECWT), suggesting us an interactive session of robotics addressed to girls only.

Greenlight@Brussels Day, an event in its second year, is aimed at inspiring young girls to pursue studies and careers in Science or Technology areas by showing them how fun and interesting these areas are. The mission of Greenlight for Girls seems to go back to the mission of "Roberta Project: girls discover robots", coordinated in Italy by the School of Robotics: in this project, robotics is a teaching tool to overcome gender gap in STEM studies.

## Educational robotics and girls

"The pipeline, which makes women leak out of the scientific and technological world, already starts to leak in primary school. This means that the decision against science and technology is in many cases already made a long time before the choice of study and career".[10]

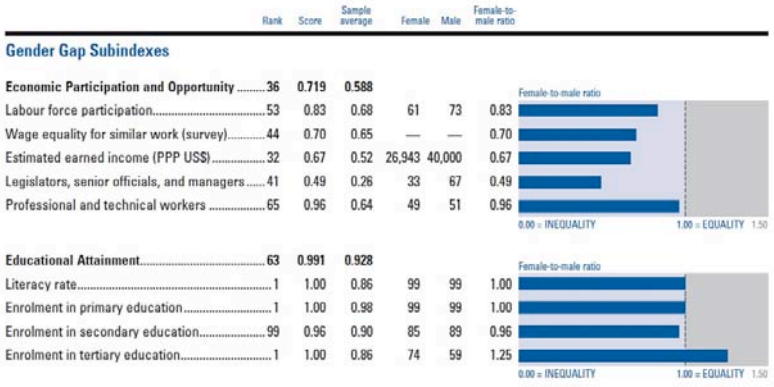
A UNESCO study shows that, at international level, the average percentage of female graduates in the science and technology field in Europe (33%) is third, behind South Africa (37%) and Brazil (37%).[9] The Global Gender Gap Report 2011, furthermore, shows that there are still some differences between males and females in economic participation and inside educational attainment (pictures 1, 2).[3]



| | Rank | Score | Sample average | Female | Male | Female-to-male ratio |
|---|---|---|---|---|---|---|
| **Gender Gap Subindexes** | | | | | | |
| **Economic Participation and Opportunity** | 90 | 0.598 | 0.588 | | | |
| Labour force participation | 88 | 0.70 | 0.68 | 52 | 74 | 0.70 |
| Wage equality for similar work (survey) | 125 | 0.51 | 0.65 | — | — | 0.51 |
| Estimated earned income (PPP US$) | 83 | 0.54 | 0.52 | 21,438 | 40,000 | 0.54 |
| Legislators, senior officials, and managers | 39 | 0.50 | 0.26 | 33 | 67 | 0.50 |
| Professional and technical workers | 72 | 0.89 | 0.64 | 47 | 53 | 0.89 |
| **Educational Attainment** | 48 | 0.995 | 0.928 | | | |
| Literacy rate | 59 | 0.99 | 0.86 | 99 | 99 | 0.99 |
| Enrolment in primary education | 89 | 0.99 | 0.98 | 98 | 99 | 0.99 |
| Enrolment in secondary education | 1 | 1.00 | 0.90 | 95 | 94 | 1.01 |
| Enrolment in tertiary education | 1 | 1.00 | 0.86 | 79 | 56 | 1.42 |



Picture 1 – Italy profile inside The Global Gender Gap Report 2011



| | Rank | Score | Sample average | Female | Male | Female-to-male ratio |
|---|---|---|---|---|---|---|
| **Gender Gap Subindexes** | | | | | | |
| **Economic Participation and Opportunity** | 36 | 0.719 | 0.588 | | | |
| Labour force participation | 53 | 0.83 | 0.68 | 61 | 73 | 0.83 |
| Wage equality for similar work (survey) | 44 | 0.70 | 0.65 | — | — | 0.70 |
| Estimated earned income (PPP US$) | 32 | 0.67 | 0.52 | 26,943 | 40,000 | 0.67 |
| Legislators, senior officials, and managers | 41 | 0.49 | 0.26 | 33 | 67 | 0.49 |
| Professional and technical workers | 65 | 0.96 | 0.64 | 49 | 51 | 0.96 |
| **Educational Attainment** | 63 | 0.991 | 0.928 | | | |
| Literacy rate | 1 | 1.00 | 0.86 | 99 | 99 | 1.00 |
| Enrolment in primary education | 1 | 1.00 | 0.98 | 99 | 99 | 1.00 |
| Enrolment in secondary education | 99 | 0.96 | 0.90 | 85 | 89 | 0.96 |
| Enrolment in tertiary education | 1 | 1.00 | 0.86 | 74 | 59 | 1.25 |



Picture 2 – Belgium profile inside The Global Gender Gap Report 2011

The European Centre for Women and Technology developed a Position Paper with the goal to join forces for implementing the Digital Agenda and the Europe 2020 Strategy with a gendered approach. School of Robotics of Genoa, Italy and Greenlightforgirls of Brussels, Belgium, as part of ECWT (European Centre for Women and Technology), based their action plans on attracting girls in science and ICT, also with the help of educational robotics.[2]

The School of Robotics is italian regional centre of the Project "Roberta, Girls discover robots". The "Roberta Project" was started in 2001 at Fraunhofer IAIS, Bonn, with the aim of spreading the use of robotics as an educational tool to promote girls interest in scientific and technical education.

The project is especially dedicated to girls from primary to the secondary schools, but it show good results also with boys. The experimentations with "Roberta Project" showed that educational robotics represent an excellent tool for learning sciences, developing different kind of competences and promoting team work.

Proceedings of 3rd International Workshop
Teaching Robotics, Teaching with Robotics
Integrating Robotics in School Curriculum
Riva del Garda (Trento, Italy) April 20, 2012
ISBN 978-88-95872-05-6
pp. 144-152

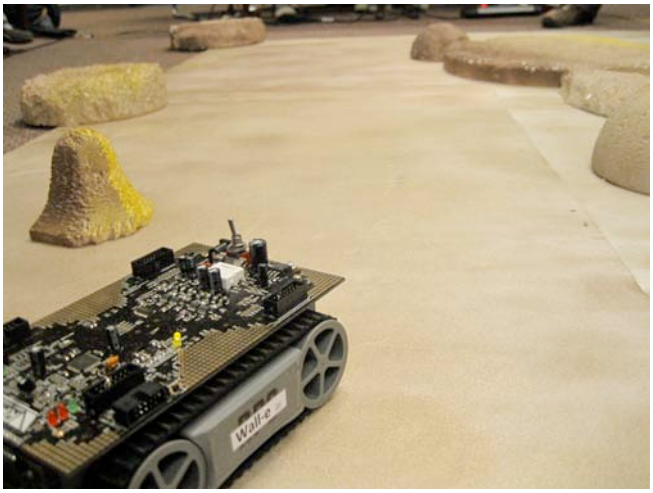
## Preparing our mission

It is, without a doubt, an unique chance: to organize a robotics workshop in Bruxelles, addressed to girls between 11-15 and, at the same time, a robotics workshop in Fumane, engaging about 50 girls of the same age from all the classes of secondary school; this way involving Italian and Belgian girls in a common session in videoconference using an IWB. [1]

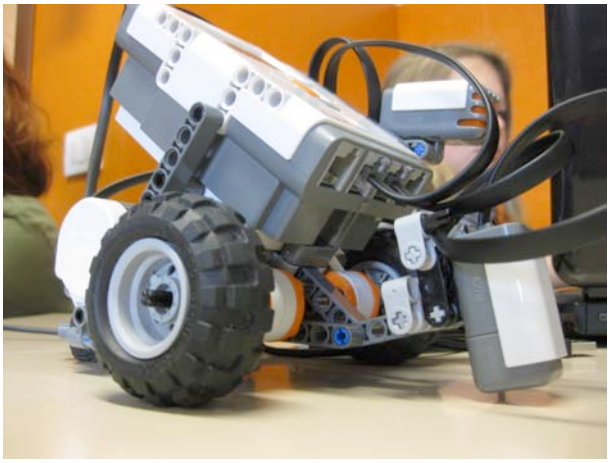
One of the most inspiring aspect to help teachers decide if they will use robotics as teaching method is the lesson planning. Teachers share their students' project paths: it is never a straightforward and fixed path as it usually happens in traditional teaching units. You move on through problem solving. From the very beginning, teachers give up their traditional role and become facilitators, using robots with their students.

In Bruxelles, Tasha Carl, freelance software and hardware programmer, led the Belgian team in a fun lab; in Fumane, Tullia Urschitz, Maths and Science teacher led the Italian team in a 5-hour robotics workshop.

In Belgium it was decided to use the cheap Arexx RP6 robots (picture 3) and in Italy the Lego Mindstorm NXT (picture 4), provided by the school.




Picture 3 - robot Arexx RP6

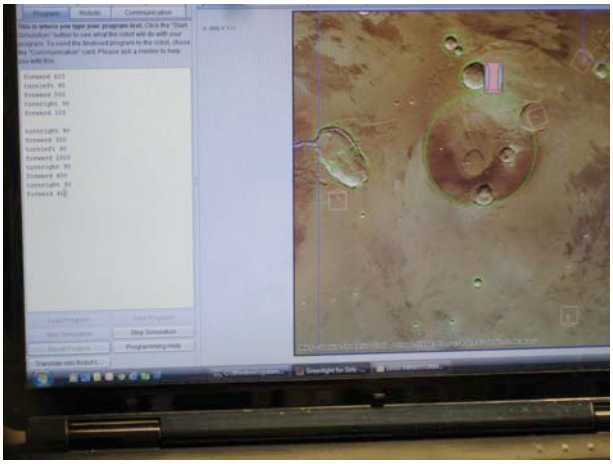


Picture 4 - robot Lego NXT

In the following months Tasha and Tullia shared their experiences and skills as programmer and teacher, through several Skype calls and determined the event framework as well as the videoconference flowchart.

The first problem to face was that the RP6 program of Arexx robots in C language might be too difficult for girls. To solve this problem Tasha wrote an easier program (Domain Specific Language) and designed a simulator, named Sagan (picture 5) to create a virtual test setting.


ISBN 978-88-95872-05-6



Picture 5 - simulator Sagan-1

The name SAGAN has been chosen for the simulator as a tribute to Dr. Carl Sagan, a very open-minded American astronomer, astrophysicist, cosmologist, author, science populariser and science communicator in astronomy and natural sciences.

To justify the use of the simulator, it was planned a Mission on Mars: the simulator should have been used as a test, before sending the program to the rovers, which should have carried it out.

To explain the mission, was decided the following:

*"The European Space Agency ESA requested technical support from the 'Greenlight for girls' specialists for programming their 5 Mars Explorer robots! Because of the distance between the Earth and Mars, sending a program to the robots takes more than 5 minutes and the answer takes again 5 minutes. For this reason, we cannot guide the robots directly, but we have to write the complete program on our graphical simulator and send it to Mars when we certain that our proceeding way do not cause damage to the robots. Thanks to previous ESA missions, we have detailed maps of Mars surface and we are able to plan our work exactly. We will also work in cooperation with the Italian robotics scientists, which will demonstrate how to program robots over a large distance."*

The first stage of the Italy-Belgium collaboration was a task for the Italian girls: editing the program on the simulator. Downloading it on RP6 robots was the assignment for the Belgian girls.

The two teams worked in videoconference through the IWB (picture 6).

Picture 6 - IWB

In the meanwhile, while the Belgian girls were testing the programs on the RP6 robots, the Italian girls had to program and make NXT robots move on a scale

Proceedings of 3rd International Workshop
Teaching Robotics, Teaching with Robotics
Integrating Robotics in School Curriculum
Riva del Garda (Trento, Italy) April 20, 2012
ISBN 978-88-95872-05-6
pp. 144-152

reproduction of Mars surface, according to the mission they had studied on the simulator. This stage added an important experimental element to the simulation and activated mathematic, scientific and digital competences, required to program the robots and move them on a real surface (pictures 7, 8, 9, 10).

Picture 7 - measuring on Mars surface

Picture 8 - defining robots' paths

Picture 9 - programming NXT robots

Proceedings of 3rd International Workshop
Teaching Robotics, Teaching with Robotics
Integrating Robotics in School Curriculum
Riva del Garda (Trento, Italy) April 20, 2012
ISBN 978-88-95872-05-6
pp. 144-152

Picture 10 - robots on Mars

## Teaching aspects and advantages of this kind of experience

In an increasing number of Italian schools, in different areas and grades, teachers use and intent to develop planning, assembling and programming robots as didactic tools which reinforce and help the comprehension of specific curricular concepts[5].

B. Lorenzi school took part in the European Comenius Multilateral Project "KeyTTT: Teamwork, Training and Technology for development of Key Competences", from November 2009 onwards. It proved how educational robotics is not only a tool able to arise learning, but also a methodology able to develop key competences.[6]

For key competences we mean those required for a long-life learning or, in other words, a combination of knowledge, skills and attitudes suited for the context, according to the European Parliament: [8]

- communication in the mother tongue;
- communication in foreign languages;
- mathematical competence and basic competences in science and technology;
- digital competence;
- learning to learn;
- social and civic competences;
- sense of initiative and entrepreneurship;
- cultural awareness and expression.

While analysing Mars surface on the simulator, students take charge of the problem they have to solve and develop problem solving strategies.[7]

Connecting abstraction and concrete thinking enables students to better understand every single school subject, not only the scientific ones. The subsequent experimentation of what has been assumed in the preparatory stage, enables a change in the girls' approach to mathematic, physical and technological competences, necessary for the following stage of programming robots. This allows to mediate scientific concepts according to different perspectives, affordable to different kinds of intelligences.

Another important aspect to be taken into account is the added value of when our students don't feel the burden of a task linked to a specific subject, but they understand its overall usefulness. It is the case of a student who applies a mathematical formula in order to get a certain reaction in robots.

The following stage, in which robots perform the program, enables the girls to experiment the effects of their actions on real objects. This way, they become aware of their learning strategies making them explicit through a continuous transfer from hypothesis to experimentation.

A further didactic opportunity that the girls involved in the interactive videoconference can experience, is the idea of being a member of a scientific community, through planning common paths, assembling and programming robots,

Proceedings of 3rd International Workshop
Teaching Robotics, Teaching with Robotics
Integrating Robotics in School Curriculum
Riva del Garda (Trento, Italy) April 20, 2012
ISBN 978-88-95872-05-6
pp. 144-152

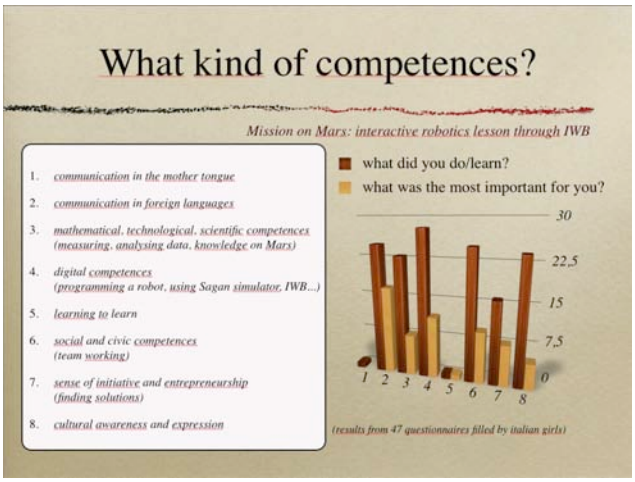
sharing ideas, proposals and solutions among the members of the two teams involved in the common mission.

Group working and awareness of the different intelligences and strategies of the other members, help the students recognize differences and accept them, in order to get better results. Understanding and working with differences are two elements of the social aspects, which robotics contributes to develop.

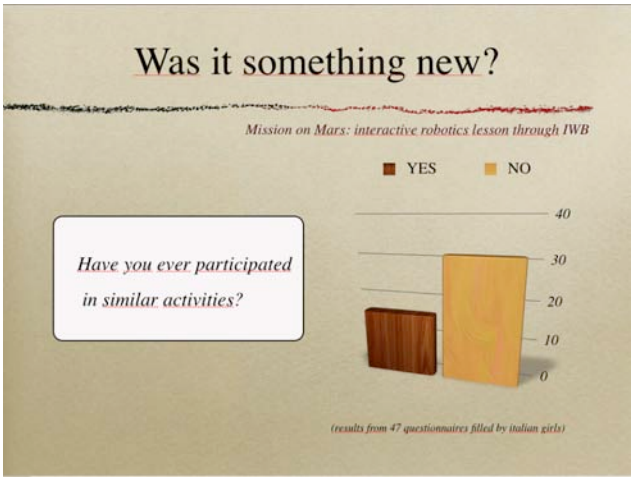
In order to share information and results, Italian and Belgian girls had to face the challenge of communication using English, as a common mean.

## Feedbacks and results

80 girls attended to Mission on Mars during the Greenlight@Brussels Day 2011. Although there were no written feedback questionnaires about this special experience as the activity was hold as a "fun lab", the attendees gave a very positive feedback. On the other side, in Italy, 47 girls were attending to the session inside school activities. They were asked to fill out a short questionnaire, which had the aim to emerge the impact of the interactive session with robots (pictures 11, 12, 13).

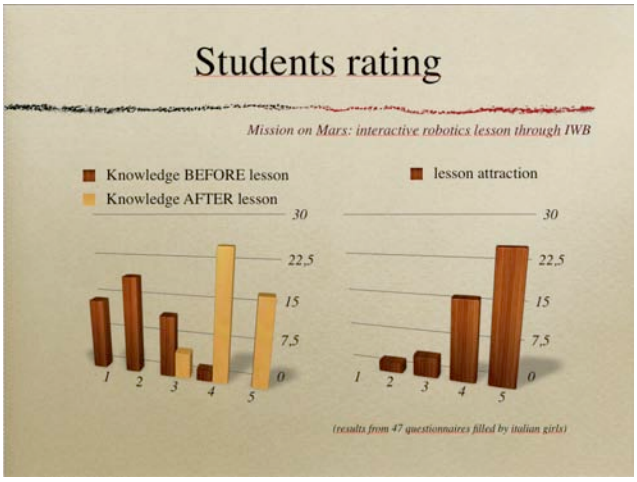



Picture 11 – competences




Picture 12 – experience of participants

Proceedings of 3rd International Workshop
Teaching Robotics, Teaching with Robotics
Integrating Robotics in School Curriculum
Riva del Garda (Trento, Italy) April 20, 2012
ISBN 978-88-95872-05-6
pp. 144-152




Picture 13 – students satisfaction

The most interesting evidences that carried out from questionnaires is that girls not only found nice and useful working with robots for developing scientific, technological and digital competences, but that they also appreciated team work, especially because of the chance to communicate with pairs from abroad.

## Conclusions and future developments

Mission on Mars, carried out on 26th November 2011 within the EuRobotics Week during Greenlight@girls Day 2011, has been a starting point for future activities of the same type. This mission, thought for girls, has been successfully repeated during lessons in mixed classes, within traditional Mathematics and Science curriculum at Fumane secondary school. However, in these lessons two elements of paramount importance were missing: interactivity of IWB and the use of English.

Simulator Sagan-1, an open source application, can be downloaded from the website http://www.sagan.be/.[17] It can be used in other activities involving robotics, by changing the background pictures and defining stages of the mission in the mission configuration and descriptor files.

The actual version enables to download the program directly on Arexx RP6 robots. However a new version for robot Lego NXT is being studied: we may use it for a similar future workshop in Autumn 2012.

The simulator can be also used alone, without downloading the software on a robot. It can be used in the starting stages of a robotics activity, when you want students to work on the planning stage of the mission.

The activities of educative robotics among the students of B. Lorenzi secondary school and other students from foreign schools, via videoconference through the use of IWB, have already been included in the POF, i.e. the Plan for the Educational Offer. During these interactive activities, robotics is the core of paths involving different types of contents from different types of school subjects such as Mathematics, Physics, Astronomy, Technology, English and History.

## References

1. Bonaiuti G.: Didattica attiva con la LIM, Erickson, Trento, (2009)
2. Fabry E., Püchner P., Sangiuliano M.: ECWT Position Paper on Gender and Technologies: Lining up for a Gender Action-Plan for the Digital Agenda (eGEN - ADA 2011-2015)
3. Hausmann R., Tyson L., Zahidi S.: The global gender gap report, Word Economic Forum, Geneva, Switzerland (2011)
4. Martin F.G.: Robotics Explorations: A Hands-on Introduction to Engineering, Prentice Hall, New Jersey (2000)
5. Micheli E., Pennazio V.: The application of robotics in school and teacher education, (2011)
6. Micheli P., Ueschitz T.: Educational robotics methodology to develop competences. In: International scientific conference on Key Competences in

Proceedings of 3rd International Workshop
Teaching Robotics, Teaching with Robotics
Integrating Robotics in School Curriculum
Riva del Garda (Trento, Italy) April 20, 2012
ISBN 978-88-95872-05-6
pp. 144-152

Education – Strategies and Practices, Stara Zagora, Bulgaria, (2011)
7. Papert, S.: Mindstorms: Bambini, computers e creatività, Emme, Milan, (1984)
8. Recommendation 2006/962/EC of the European Parliament and of the Council of 18 December 2006 on Key Competences for lifelong learning
9. UNESCO Science, Technology and Gender – Executive Summary (2007)
10. Quinn M.G. - European Commissioner for Research, Innovation and Science - ECWT Issues: Education, http://www.womenandtechnology.eu/digitalcity/w_homepage.jsp?dom=AAABECDQ&prt=AAABDUAV&men=AAABDXAC&fmn=AAABDVVQ
11. EuRobotics Project, http://www.eurobotics-project.eu/eurobotics-week/events-calendar/mission-to-mars.html
12. EuRobotics Project, press release, http://www.eurobotics-project.eu/press-room/press-releases/the-first-european-robotics-week-robots-on-display-copy.html
13. EuRobotics Week, italian site http://euroweek.scuoladirobotica.eu/index.php?page=News&id=326
14. Greenlight@Brussels Day 2011, http://www.ict2act.be/greenlight2011/
15. Istituto Comprensivo B. Lorenzi, Fumane, http://www.fumanescuola.it/robotica/85-european-robotics-week
16. Roberta Project, http://www.roberta-home.de/en/was-ist-roberta
17. The Sagan Project, http://www.sagan.be/

Proceedings of 3rd International Workshop
Teaching Robotics, Teaching with Robotics
Integrating Robotics in School Curriculum
Riva del Garda (Trento, Italy) April 20, 2012
ISBN 978-88-95872-05-6
pp. 144-152