IoT-DESIR

A case study on a cooperative learning experiment in Sardinia

Carole Salis, Fabrizio Murgia, Marie Florence Wilson, Andrea Mameli
Center for Advanced Studies, Research and Development in Sardinia
CRS4
Pula (CA) - Italy
calis, fmurgia, helga, mameli @crs4.it

***Abstract*—The project IoT-DESIR, which integrates new technology and didactics events through a problem solving approach, started a year ago and involves 25 teachers and about 200 students. Fourteen Sardinian higher education schools of various backgrounds, CRS4, a Research Center and other institutions are reunited in the first online school network in order to manage, develop and test IoT scenarios, in a trans-disciplinary approach. The project, built around IoT technology and the use of Arduino boards (*www.arduino.cc*) should demonstrate that technology can successfully be introduced in higher education curricula, that it can be used to improve the attractiveness of scientific and technological subjects, that it can successfully be used in didactics and that networking favours an efficient use of technology.**

Keywords—Critical thinking, innovative technology for didactic practice, cooperative problem solving, Internet of things, IoT scenarios.

INTRODUCTION

Most analysts agree that the Internet of Things [1] will be a manor boost to economic. Cisco thinks about 50 billion devices will be connected by 2020, Morgan Stanley feels that number can actually be as high as 75 billion [2]. Gartner [3] predicts that the total number of connected people, business and industrial "things" to grow to 26 billion units by 2020, representing an almost 30-fold increase over the 900 million things in 2009. While Ericsson in its 2011 white paper estimated 50 billion objects connected to the Internet by the 2020 [4]. These connected "things" send and receive data through the network relating to a variety of physical characteristics of didactic interest to increase the understanding of environmental data quality (temperature, moisture level, light level, velocity). This leads teachers to raise some important questions: what should be analysed before deciding the nature of data measurement, which could be the suitable IoT scenario to be measured and with which technology? The Italian well known platform Arduino has become a common choice for it is easy to use and has low-cost characteristics.

OBJECTIVES

The main goals of the project are: to foster and facilitate inter-institutional cooperation on the territory; to promote student reflection and critical thinking [5], about the use of IoT technologies. The latter was chosen, in view of the fact that the concept of the Internet of Things (IoT) is becoming increasingly important. Understanding both the technical underpinning and the societal impacts of the IoT will be crucial for digital citizens of the future [6]. Moreover, as indicated in [7], "*The global accessibility of education may be provided through using Internet of Things*" [8].
Through the project, students are expected to develop meta-cognitive strategies for effective problem solving [9], [10], such as the ability to analyse problems and become capable to choose an adequate solution between several suitable options. We want them not simply to have theoretical, specific knowledge, but to develop technical skills, become able to understand the context in which they operate, and adopt appropriate solutions. They are expected to become responsible users of technology, who understand why technical innovation can provide a solution to problems, but are aware of the ethical and legal issues existing behind the scenarios.

PEDAGOGICAL BASES AND METHODS

Based on cooperative problem solving approach, the project encourages interactions between teachers and secondary school students. Such pedagogical strategy allows everyone's point of view to be expressed, thus contributing to the valorisation of the knowledge and abilities most addressed by schools, based on their academic orientation. Students are expected to develop effective cooperative approach during all phases of the project and approach innovative technology with critical sense before starting to develop or use IoT scenarios. The hands-on science approach helped them to become smart users, aware of the issues around using critically a new technology.

RELATED EXPERIMENTATIONS

IoT characteristics make it a tool with many uses, that can be adapted to various aspects of the educational process as shown in the examples below.

Wang et Al., taking advantage of the peculiar characteristics of IoT, proposed an interactive English teaching course, which integrates voice and visual sensors to evaluate student's pronunciation. Hinging on motivation, playfulness and the opportunity for teachers and students to teach and learn according to their respective inclination. [11]

In the project DISTANCE (Demonstrating the Internet of School Things - a National Collaborative Experience), "*a consortium, involving 5 commercial partners, 4 universities and 8 schools with the shared*

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vision that children are the creators of future digital data economy rather than just passive consumers." [10]..."*The project explores the emerging ecosystem of IoT in schools helping teachers, students and businesses to share certain types of data openly."..."using new IoT technologies, in ways that help make learning fun and enable students to investigate and address real-world, applied challenges using open urban data. This builds on projects such as the Participate Schools {4} and NQuire {6} where students carry out discovery-based learning with the help of supporting mobile and web technologies. Unlike its forerunners, the DISTANCE project is developing a co-created ecosystem which supports the collection of data from devices both within and outside the control of the individual*" [12], [13], [14].

The University of Cordoba developed an educational project with the objective to contribute to enhance teaching and learning through Internet of Things. They found "*evidence that the Internet of Objects, applied as a tool to support the teaching process, improves student academic performance. Furthermore, using real objects and associate them as a learning resource through the Internet of Objects facilitates meaningful learning, as it allows to link specific knowledge to a real context*". [15]

Mäenpää et Al. from University of Helsinki (Finland) during an experimental blended problem- and project-based learning course, about the improvement of an urban rooftop greenhouse, used Internet of Things as a means to provide a learning experience tailored to suit student's personal interests and competences in a meaningful personal learning experience. [16]

Moreover IoT's educational qualities are not limited to the teaching field, it is also used in case of refresher training courses, in important companies such as Cisco. Jeanne Dunn, who heads Cisco's talent acquisition and training efforts, declared: "*There is a tremendous need for upskilling and reskilling,*" "*We need to reskill about 400,000 engineers*."..."*We are going to need a fundamentally different educational system*." ... "*If we don't create talent differently than we do today, we're not going to get there.*" .. "*There is a tremendous need for upskilling and reskilling*."[17]

It is also investigated in the world of marketing, as demonstrated by the fact that the Mobile Marketing Association (MMA), the leading global trade association for the mobile industry, launched an "IoT Incubation Council" to study the impact of IoT on marketing, explore what value-added products and services can be created with this technology and train professionals to this scope [18]

STRUCTURE AND DEVELOPMENT

The project is conducted in 5 phases: Analysis, scenario definition (sensor/actuator), development, experimentation and evaluation. Between each phase, meetings with teachers and students will be organized to give a common basis of information on the concepts involved. The experimentation will be the end product of a contribution differentiated according to the academic orientation of participating institutes.

In the first phase of the project, dedicated to the definition of the subjects and the methodologies, we started brainstorming sessions with teachers in order to identify the competencies of each involved institute, useful to the scholar network. This was done, bearing in mind the characteristics of their high school curriculum It was requested them to apply problem solving approach to the analysis of the use of the chosen innovative technology. A social issue that allows ICT innovation in advanced didactics to be included was identified. The two selected topics deal respectively with the energy footprint [19] of a single student's transportation from and to school (and the combined amount of all institutes involved) and the understanding of the notion of physical quantities and their corresponding measurement which students do not perceive nor understand spontaneously.
Each participating school identified the way in which its contribution to the project could be made according to the specificities of its curricular activities. For example, Technical colleges will develop and build an IoT meta-platform able to deal with the data the project will generate, make them accessible for verification and re-use. Through the said platform called Hathor, real or digital objects will be able to be connected to the network and talk to each other and to people. Another duty of the technical schools will be to realise the necessary smart objects. Art college will be involved in the look of the site home page and in the creation of 3D smart objects, schools specialising in modern languages will translate the site and all technical documents produced, as well as the results produced during the experimental phase, as a means to opening up to the world and possibly evolve into a European network.

In this phase of the project, students were led to analyse the problem/situation, and to study the concepts underlying that of energy footprint. They were encouraged to test their problem analysis abilities and to work out innovative solutions to problems, rather than refer to standardization.

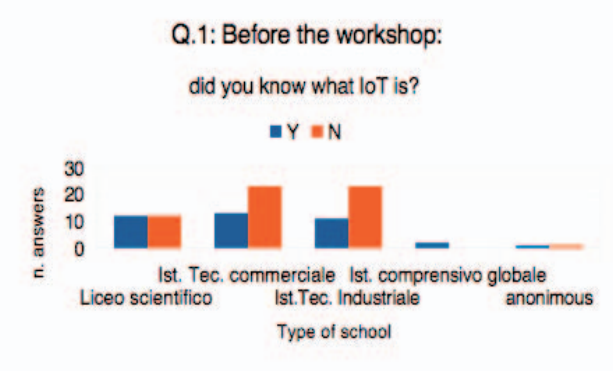
At the end of the phase of Analysis (phase one), and bearing in mind that the students came from different curricular backgrounds, a workshop was organised to offer a common knowledge level and verify the acquisition of the key concepts of the project: energy footprint, IoT, ethical and legal aspects involved in managing sensitive data, and to take stock of the situation.

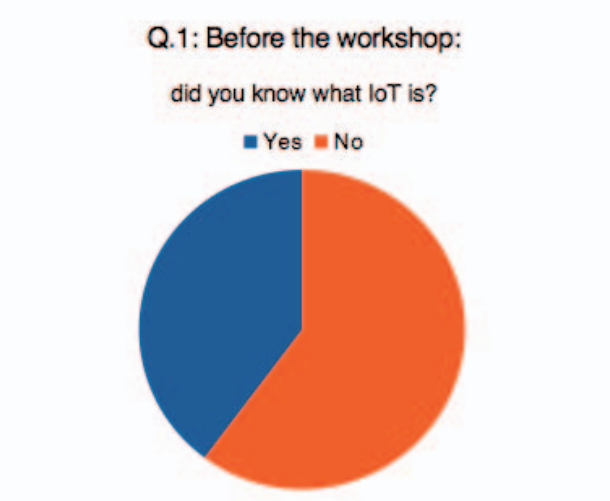
The workshop involved a variety of actors: experts, school teachers and fellow students presenting the work so far carried out in their own school. The items addressed covered various ICT topics such as information on computer networks, transmission protocols; various aspects of Internet of Things, including the existing ethical and Legal issues. A platform developed by students and the way sensors interface with an Arduino platform were also illustrated. Every session was followed by a questions and answer session.

At the end of the day, Students attending the workshop were requested to complete a questionnaire, consisting in 8 closed-format, multiple choice questions. Our scope was to evaluate the evolution of the concept of Internet of Things before and at the end of phase one. There were 98 respondents from 4 schools of different academic orientation. Two questionnaires were filled out without indicating the name of the institute. The scope of our first two questions was to find out if students had any knowledge of Internet of Things before the workshop (WS) and to establish whether the latter provided to be a useful information tool.

QUESTIONNAIRES ISSUES

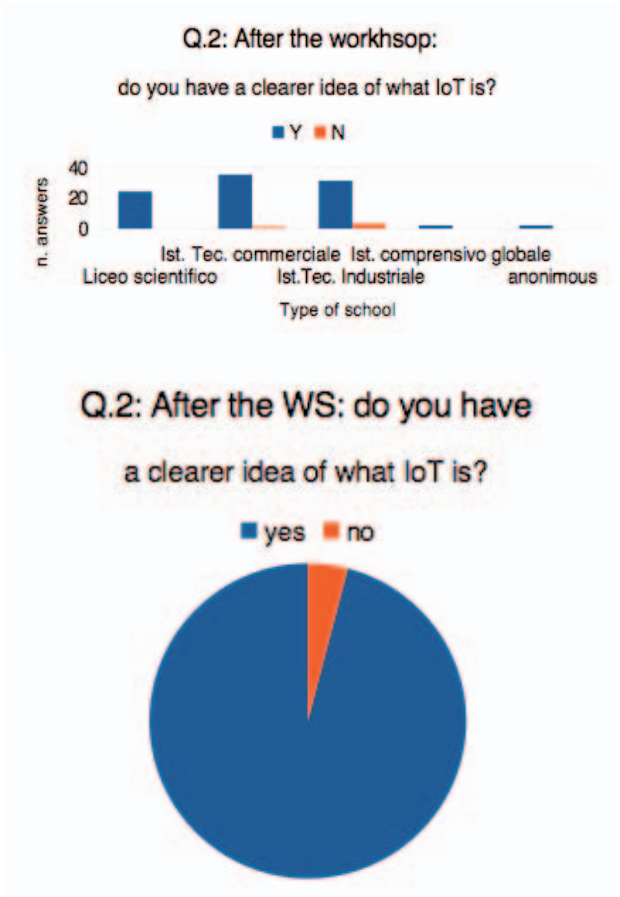
Question 1 asked: "Before the workshop (WS) did you know what IoT is and how to use this technology?"





- yes: 39,8%
- no: 60,2%

Question 2 was: "After the WS, do you have a clearer idea of the concept of IoT?"



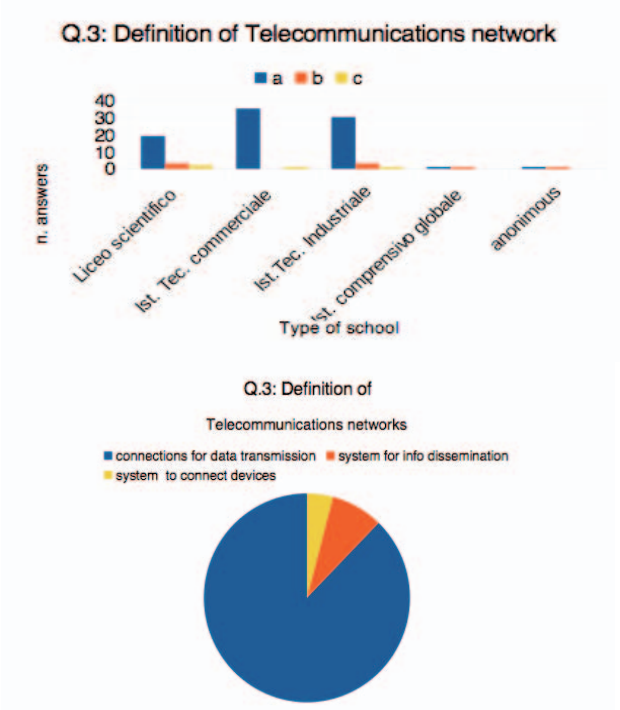
- yes: 95,92%
- no: 4,08%

If 60,2% of the students did not have a clear idea of IoT before, 95,92% declared to have mastered that concept after the WS. This result demonstrates that the speakers contributions obtained the desired result.

It is interesting to note that 77.96% of the students who declare to have little knowledge about IoT before the WS come from technical schools (Industrial and commercial technical schools).

Question 3: "How do you define a telecommunication network?"

a) connections for data transmission
b) system for info dissemination
c) system to connect devices

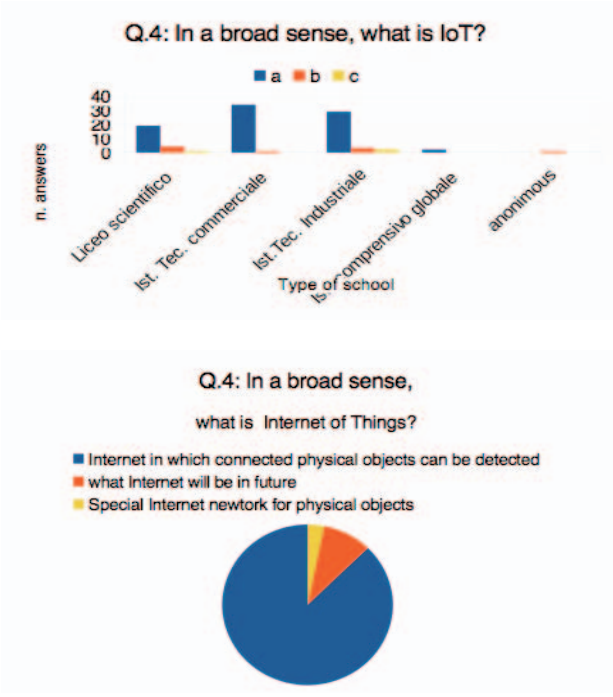


a) 88,76%
b) 8,16%
c) 4,08%

88,78% of the students gave the right answer to that question, regardless of the institute of origin.

Question 4: In a broad sense, what is Internet of Things?

a) Internet in which connected physical objects can be detected
b) what Internet will be in future
c) Special Internet newtork for physical objects



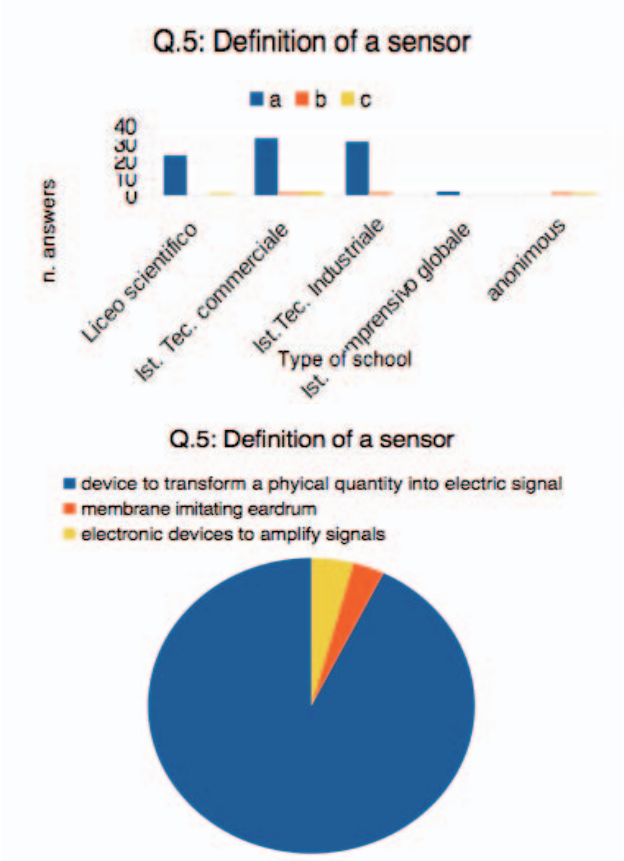
a) 87,5%
b) 9,38%
c) 3,13%

Two people did not answer this question.

After the WS, 87,5% of the students gave the right answer, i.e. understand that IoT deals with objects that talk to the internet, whereas 9,38% link IoT to a form of technology. Such results lead us to think that most students followed the workshop with attention. They seem to have grasped the content of the main talks of the day, i.e. those dealing with the concepts of IoT, ICT and the network characteristics.

Question 5: Definition of a sensor

a) device to transform a physical quantity into electric signal
b) membrane imitating eardrum
c) electronic devices to amplify signals

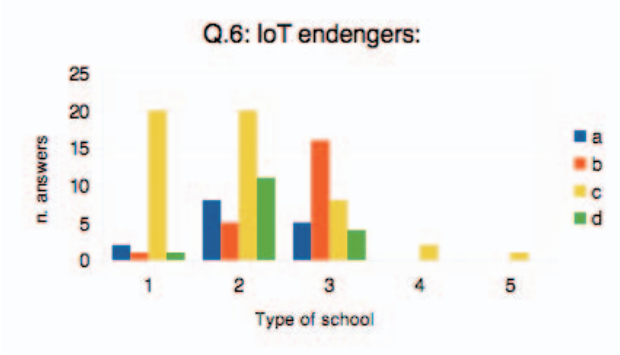


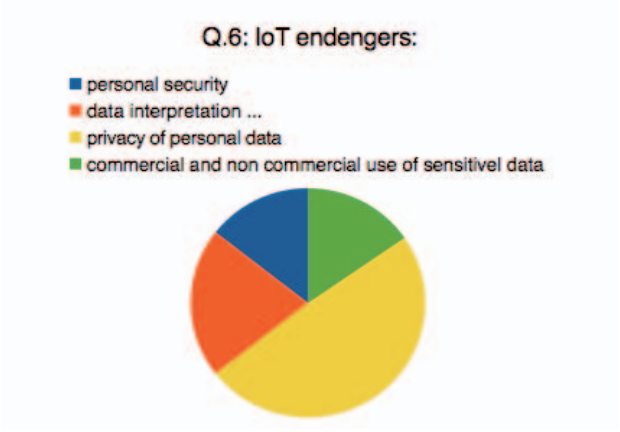
92,71% of the students gave the right answer. This might lead us to think that the characteristics of sensors were clearly explained, but since we did not ask them if they had a strong representation of what a sensor is before the workshop, it is not possible to say that the representation of what a sensor is depends on the quality of the seminar content.

Question 6. IoT endangers:

a) personal security
b) data interpretation …

c) privacy of personal data
d) commercial and non commercial use of sensitive data

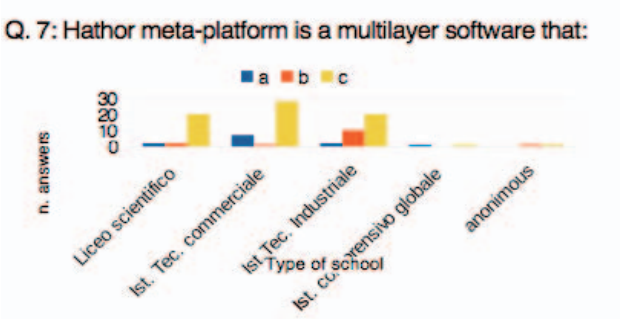


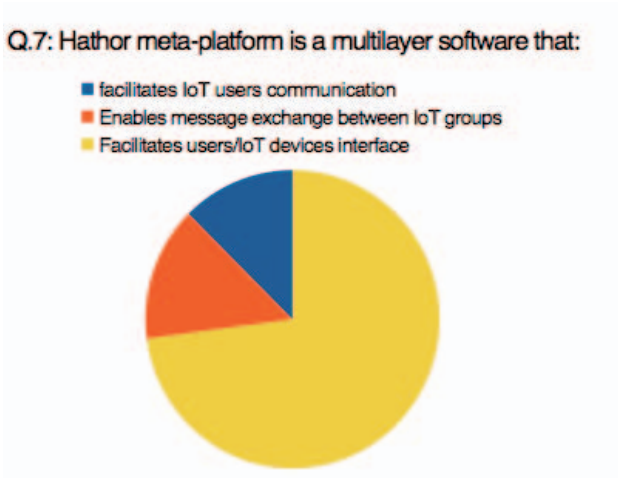


- personal security: 14,42 %
- data interpretation for easy ...: 21,15 %
- privacy of personal data: 49,04 %
- commercial and non commercial use...: 15,38 %

Two lawyers illustrated the legal aspects related to IoT and Internet, in particular the risks associated with privacy and the use of sensitive data. Their talk was followed by a great number of questions from the audience regarding the concepts of "privacy" and "risk", an indication that these concepts needed to be clarified.

Question 7: Hathor meta-platform is a multilayer software that:
a) facilitates IoT users communication
b) Enables message exchange between IoT groups
c) Facilitates users/IoT devices interface

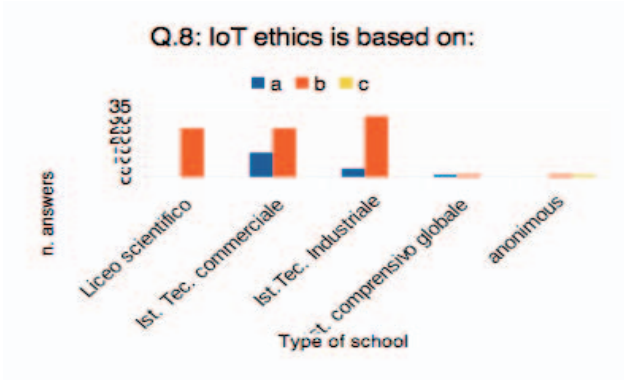


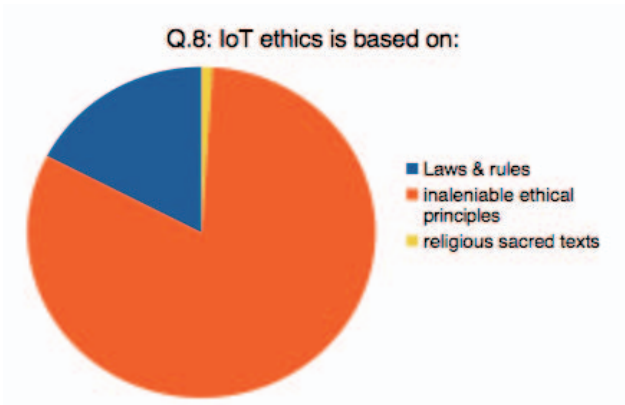


- facilitates IoT users communication : 12,5%
- Enables exchange of message between IoT groups : 14,58%
- Facilitates users/IoT device interface : 72,92%

This question is related to the content of a talk delivered by fellow students on a platform under construction. Two persons did not answer that question. The main function of the platform was understood by 72,92% of the students. Which demonstrates that the students set out the objectives of the platform in a clear way.

Question 8: IoT ethics is based on
a) Laws & rules
b) inalienable ethical principles
c) religious sacred texts





The score on the question on IoT ethics is high: 81,63% of the answers were correct.

FROM PHASE 1 TO PHASE 2

A long and intense preparation was necessary before planning the structure of phase 2. The preparation of lessons devoted to the description of the ecological footprint concepts and impact on the environment has engaged the teachers involved in the analysis of the problem for at least 4 months (step 1). Phase 1, consisting of 5 events in the presence of students and on line, has raised a real awareness of the environmental problem. Towards the end of phase 1, CRS4 organized the above mentioned Workshop. Some elements clearly emerge from the methodology used until now: the cohesion between students from different high schools was observed during the meetings online and through the issues addressed during the questions and answers sessions. There is a search for mutual solution taking into account the content oriented of each high school. The time most teachers can dedicate to the activities of the project is often limited to the afternoon. This time span sometimes does not allow the team members to give an adequately detailed feed back on the concluded activities.

Finally, we are not totally satisfied by the performance of the platforms used to make free video conferencing between 3-4 classes remotely. In particular, the audio is not manageable enough. We mainly used Hangouts the free video chat service from Google+ (plus.google.com) but also tested Edmodo (www.edmodo.com/).

CONCLUSIONS

The community of schools is getting ready to move to step two: the IoT scenario building, selection of the data collection, etc.. The project should demonstrate that technology can successfully be introduced in higher education curricula, that it can be used to improve the attractiveness of scientific and technological subjects, that it can successfully be used in didactics and that networking favours an efficient use of technology. By pooling their expertise, the participating institutes will be able to create a more complete end-product, than a single institution alone. All of them will test the end-product. Students are expected to have learned how to collaborate and make a careful and sensible use of innovative technology. A questionnaire will be submitted to the teachers to assess how much the cooperative process could have been efficient to better understand the initial problem and to better explore and apply new solutions through the use of IoT. At the end of the project, we plan to develop a good practice guide on how to create a school community and at a later stage a network of school communities through the use of technology inside didactic.

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