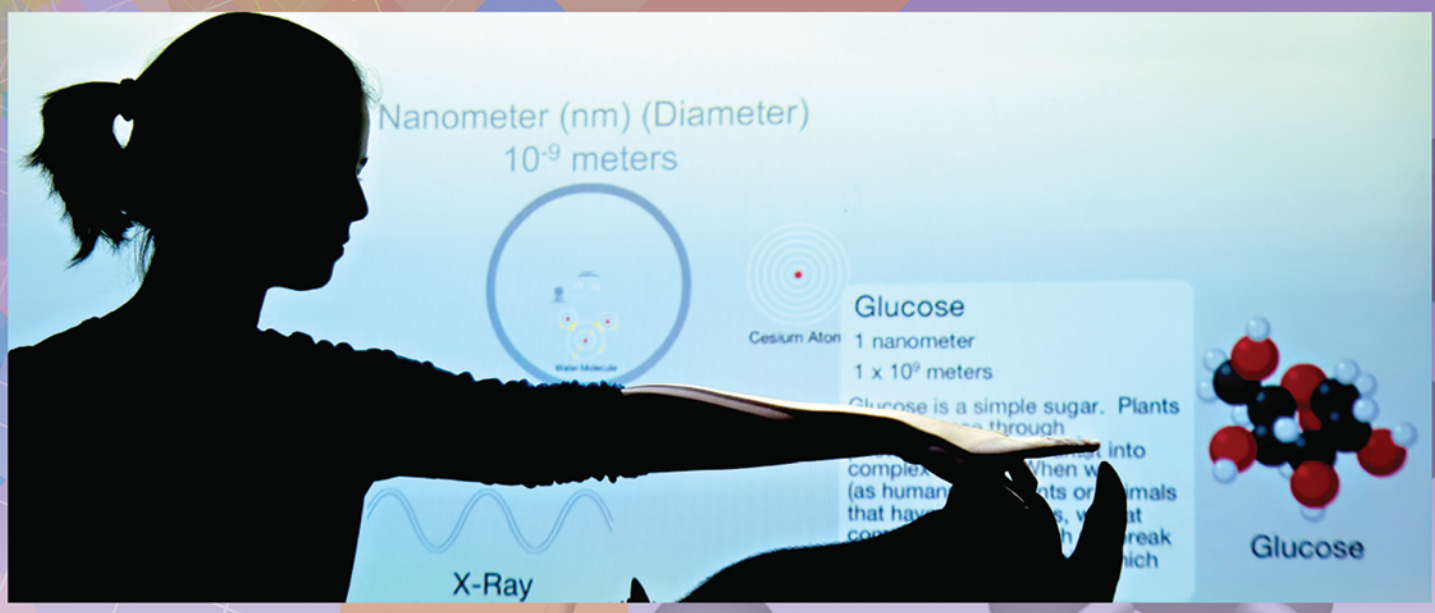
Lifelong Learning Programme

NANO TECH SCIENCE EDUCATION

Nano-Technology Science Education

ANNUAL



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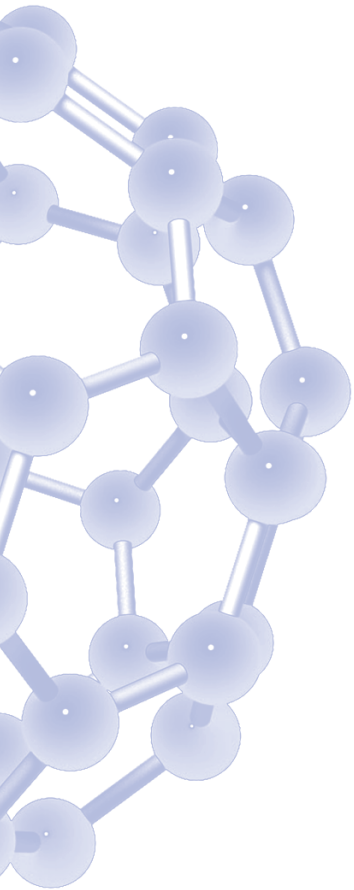

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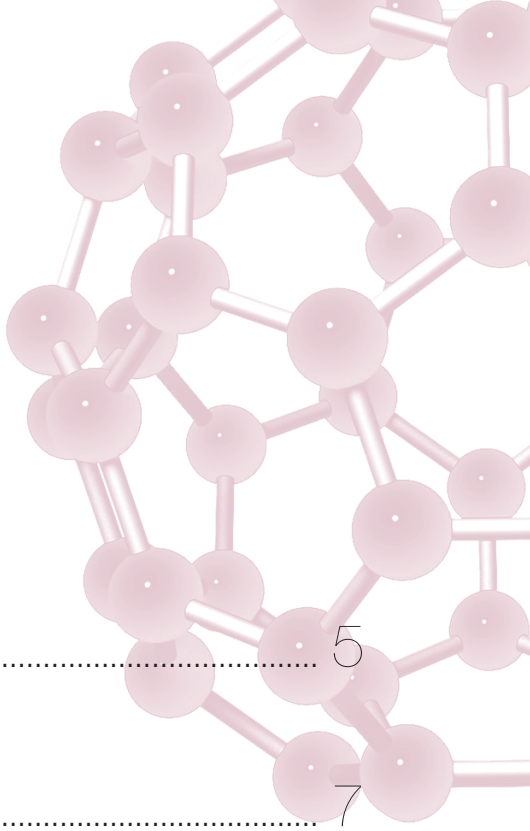

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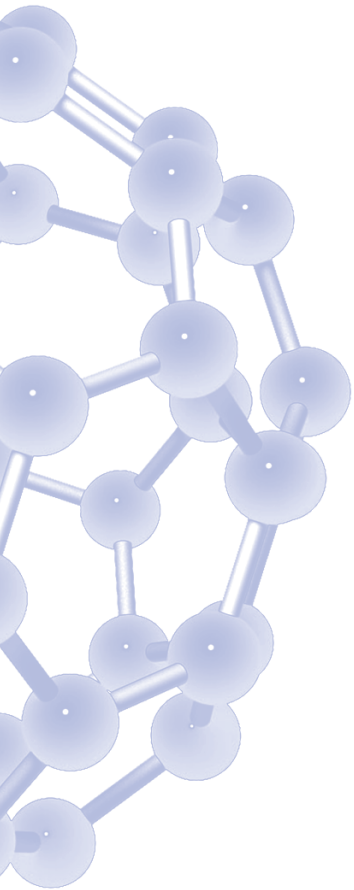


I. INTRODUCTION

Dear readers;

"Logic will get you from A to Z; imagination will get you everywhere."
Albert Einstein

The Nano Tech Annual has been produced for Nano Tech readers to acknowledge them about the achievements of the project including the facts, numbers, statistics and graphics related to the NTSE project within 3 year. The primary purpose of this book is to provide teachers, prospective teachers and students with a clear and concise picture of how to structure the NTSE Project to make the science education more meaningful, attractive and accessible for students so that they can meet the science literacy standards.

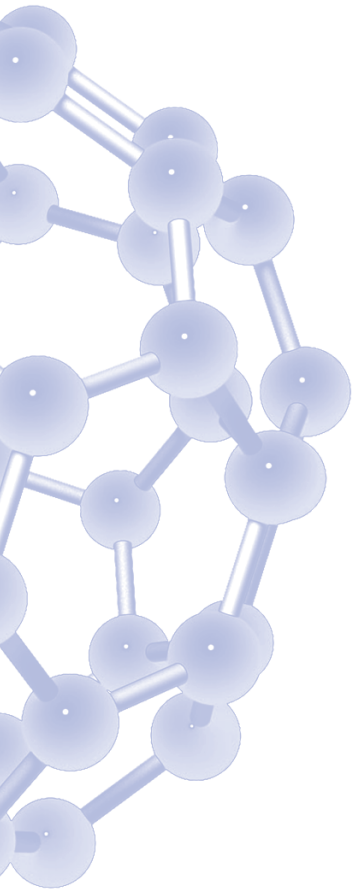
As NTSE Project team, we want to set the spark towards the classrooms that are more dynamic leading to higher thinking strategies and deeper understanding of science as the reflection of the nature itself. During the project probably the most daunting task was to build devices that facilitate constructing the knowledge of science and technology for the users (teachers, students and prospective teachers) (NTSE, 2010, concept paper). Science no longer exists isolated from society and it means that its progress impacts insensibly the development of humanity and the world. It is also amazing that the science of small will have a HUGE impact on society. Nanoscience and nanotechnology are the study and application of extremely small things and can be used across all the other science fields, such as chemistry, biology, physics, materials science, and engineering. Nanotechnology is truly interdisciplinary. An interdisciplinary curriculum that encompasses a broad understanding of basic sciences intertwined with engineering sciences and information sciences pertinent to nanotechnology is essential (Uddin, 2001). It is essential to build efficient devices and innovations for science teaching and to contribute to the development of science in general, NTSE Project was created to reconstruct science education integrating ICT and nanotechnology.

The pedagogical approach while creating the educational tools is to promote the inquiry-based approach, case studies encouraging the learners to wonder about phenomena through posing the questions connected with the real life, to find solutions and exchanging information through video conferences from partner countries. Mostly it is believed that science education should show what the students learn in classroom is related to external world and daily life, should make the students be able to perform experiments and should enhance the personal interest of the student toward science., In addition to that, science education should include the use of information technologies (ICT), offer short reports on modern achievements in science at the micro- and Nano- level by short talks in every learning unit to raise the awareness related to the nanotechnology.

When Nano Technology for Science Education (NTSE) Project was funded in 2011, the only things that we had were the Nano biotechnology laboratory and a very ambitious and creative project team. In three years each product of the project is designed and developed from scratch to support the use of ICT as a tool to make the learning of science subjects more attractive and accessible. The project seeks to address the problems by integrating well established but currently independent technological developments, within creative and motivating teaching materials and virtual learning spaces to create the appealing and motivating educational tools to engage the learners science education and Nanotechnology and the ICT tools were the magic of it.

The NTSE Virtual Laboratory was established as the milestone to cover all these supportive educational tools. During the project, Virtual Lab. has been serving as a hub for science-learning including recorded appealing experiments, illustrated simulations and guidelines on Nanotechnology and science education. Inspired by the virtual laboratory, the NTSE Kit was developed by our project experts, which was not planned before the initiation of the project. NTSE Kit comprises nine experiments from the virtual laboratory and it will be in next years' science curriculum at Doga Schools. The kit will be introduced to approximately 8000 secondary level students.

The project has reached more students and teachers than expected. For example, 214 students between the age 13 to 18 with 115 posters from Bulgaria, Greece, Germany, Italy, Romania and Turkey joined the Nano-Tech poster competition. International Nano Technology Science Education Congress took place in Istanbul (TURKEY) on November 2013 and in two days; approximately 200 students and teachers participated in the congress. Besides, the NTSE project has been selected to be included in the publication called the "Information and Communication Technology for Education: Experiences from the Lifelong Learning Program KA3 ICT" prepared by the Education, Audiovisual and Culture Executive Agency (EACEA). This annual will present the readers the miracles of the nanotechnology and ICT in science classrooms and impacts of our educational tools on our target groups. The project was dreamed but results of NTSE Project are beyond our imagination.



II. USING VIRTUAL LABORATORIES IN THE ACTUAL SCIENCE EDUCATION

It is quite worrying the European situation as effectively resumed in the most recent reports of EU (Rocard Report, 2007) highlighting an alarming decline in young people's interest for key science studies and mathematics. Despite the numerous projects and actions that are being implemented to reverse this trend, the signs of improvement are still modest. Unless more effective action is taken, Europe's longer term capacity to innovate, and the quality of its research will also decline. Reluctance of the students to learn science, rote learning and traditional teaching approaches and the lack of supportive and powerful educational materials advancing science education can be shown as the main reasons. The current initiatives in Europe actively pursuing the renewal of science education through "inquiry based" methods show great promise but are not of the scale to bring about substantial impact, and are not able to exploit fully the potential European level support for dissemination and integration (Science Education Now: a Renewed Pedagogy for the Future of Europe, European Commission, 2007). Considering this reference frame, Furthermore, among the population in general, the acquisition of skills that are becoming essential in all walks of life, in a society increasingly dependent on the use of knowledge, is also under increasing threat. Therefore, the education of science needs to be renovated and enhanced with the new science technology and computer technology (NTSE Concept Paper, 2010).

Nowadays, virtual learning environments represent important technological resources that help the learners (but also the teachers and trainers) to introduce and demonstrate science concepts, to acquire knowledge, and to perform experimentation without risks. Thus, a virtual lab "enables the learner to link between the theoretical aspect and the practical one, without papers and pens, being electronically programmed in computer, in order to simulate the real experiments inside the real laboratories." (Keller & Keller, 2005).

A Virtual Lab is entitled with several features, underlined by various authors (Carnival, 2003; Keller & Keller, 2005):

- creates new intellectual model in education, better than the real, and more beautiful than imagination;
- produces knowledge-building and inculcate information;
- encourages and guides the students;
- registers students' information and evaluates them automatically (in many applications);
- performs experiments, which are difficult to be performed in the traditional lab due to its danger and / or high cost;
- reduces the learning time spent in the traditional laboratory;
- develops the exploration skills, based on scientific assumptions and processes;
- represents a permanently updated interface.

In those respects, a virtual lab becomes a suitable environment for teaching and learning actual issues as *Nanoscience* and *Nanotechnology*. Both of them are truly interdisciplinary, and an interdisciplinary curriculum which encompasses a broad understanding of basic sciences intertwined with engineering sciences and information sciences pertinent to nanotechnology is essential (Uddin & Chowdhury, 2001). *Nanoscience* and *Nanotechnology* represent – in fact – study and application of extremely small things and can be used across all the other science fields, such as Chemistry, Biology, Physics, Materials science and Engineering. A virtual laboratory covering the fields of Physics, Chemistry and Biology, enriched with Nanotechnology and stimulating the users to discover details after presenting a clear picture of Nanoscience would open up a new door to learn Science.

But what is the right place of virtual experiments in the actual curricula of NTSE project partner countries?

Bulgaria

In the recent years there has been a lack of strong government policies and nation-wide educational initiatives in the area of e-learning. The so-called National educational web portal of the Ministry of education that was aimed to be a gathering point for all participants in the educational process (teachers, students, parents, MoE and RIO administrators) never actually played such a role. The National portal was expected to provide access to quality educational materials, lesson plans, rich multimedia and interactive tools (such as virtual labs and simulations) that could assist the educational process from kindergarten till upper secondary grades. What the National educational web portal managed to meet is just a small part of those expectations offering access to a number of electronic textbooks and one big collection of more than 1000 interactive e-lessons on Math and Sciences.

Apart from the National educational web portal there exists several big private e-learning initiatives in Bulgaria that are worth mentioning. Among those are *Teacher.bg* – Bulgarian teachers' social network and useful materials portal; *Ucha.se* – the Bulgarian analogue of the Khan Academy project offering video lessons on many school disciplines; *Znam.bg* – the knowledge web portal offering more than 100k educational materials, multimedia and reading literature.

Unfortunately there are not many examples of good red pool of interactive e-lessons present on the National web portal of MON is maybe the biggest and most representative collection of multimedia resources in the area of interactive science education in Bulgaria. The above mention educational resources on Sciences that offer also some real interactivity as simulation tools and virtual experiments. Currently the NTSE Virtual laboratory is actively linked through a banner to the *National Educational Portal.*

In all this in mind, the Virtual Laboratory developed under the NTSE project has a big potential to attract a huge number of eager for interactive and Multimedia science endeavors students and teachers, who can lay their hands on the experiments developed by the NTSE project experts. During the test implementation sessions that were held in Bulgaria, the Bulgarian local teams noticed great interest of both teachers and students towards the virtual laboratory experiments, assisting materials, video and simulation interactions etc.

Greece

The use of ICT in education and training has been a priority in most European countries (and not only), in the last decade. Nevertheless, the progress has not been evident. On the contrary, there are great differences between countries and even between districts/counties of the same country.

Greece is ranked among the last places of the EU countries in all issues related to *Science and Innovation.* According to European Schoolnet *"Survey of Schools: ICT in Education"*, Greece ranks below most countries as regards virtual learning environments.

Students in Greece have relatively low levels of access to computers compared to other countries. More positively, broadband provision and *connectedness* are almost universal (bandwidth is generally lower than the EU average). Despite the actual infrastructure obstacles, encouragingly high percentages of students are in schools where teachers and students frequently use ICT. Both teachers' and students' confidence in their ICT skills is below EU means, and professional development in ICT is patchy, as is the presence of an ICT coordinator in school.

Results from the *"Survey of Schools: ICT and Education"* suggest that a digitally supportive school develops strong concrete support measures for teachers to use ICT in teaching and learning.

In Greece, in the last decades, many projects were implemented for the introduction of ICT in the educational system. The *Greek Ministry of Education* within his *strategic plan for the improvement of the education in Greece (New School vision),* has setup a whole action called *"Digital School"* (http://dschool.edu.gr/). It's a national large-scale project for ICT in Greek Schools aimed at specifying a *Digital Educational Platform,* building and operating an educational knowledge base, adapting and annotating learning objects with educational metadata, building the infrastructure to support exemplary teaching practices and the use of the participatory web. Towards this aim, a series of actions is planned and has started implementing.

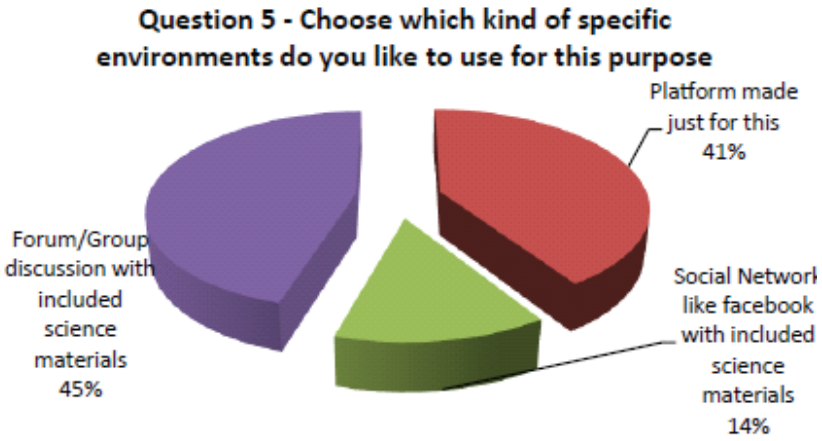


Fig. 2.1: The Digital School Portal (http://dschool.edu.gr/)

These actions are:

- reinforcement of the network and computer infrastructure of the schools targeting the creation of the *"digital class".* A digital class has fast Internet access, is equipped with interactive whiteboards, and the teacher and students interact in a dynamic fashion through the use of those modern ICT tools;
- rich, interactive digital education content that is matched to the curriculum for all classes and disciplines;
- teacher education and training focused on the educational utilization of ICT;
- integrated electronic school and educational content Management System.

Funded by the *European Social Fund,* the portal developed by the Greek Ministry of Education provides free educational resources to teachers and students. With over 1700 registered users, the portal offers OER ranging all educational levels, from primary school to high school level. It also aims to prepare its users for entry exams in *Hellenic Universities.* The Digital School portal includes the *Photodentro,* the *Greek Digital Learning Object Repository* (LOR). *Photodendro* is the *National Aggregator* that gathers metadata from collections of digital resources in digital libraries and other repositories (museums, libraries, audiovisual archives etc), which could be exploited in the learning process.

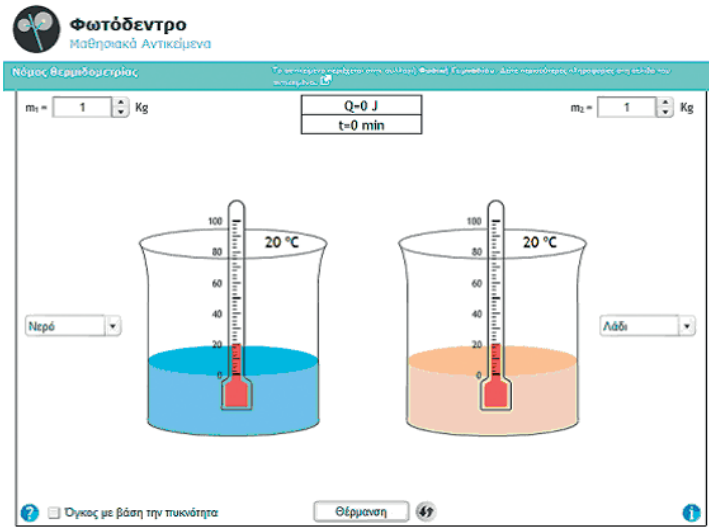


Fig. 2.2: An Interactive experiment (A Photodendro learning object)

Italy

Laboratorial teaching means that teachers should plan educational paths endorsing the skill already gathered by the students making them true and transferable. In this perspective the use of ICT is essential because it increase the opportunities in their contents and subsequently making them more personalized. The recent programs – both at Italian and European scale – purpose to redesign the educational careers in a perspective of a higher quality.

The *Council for the European Cooperation* in Education and Training held on May 12th 2009, underlined the importance of transversal skills like ICT literacy, learning to learn, enterprising spirit and sensitivity to culture.

The Decision no. 1720/2006/CE of the *European Parliament* promoted an *Action Plan* for lifelong learning, in the context of promoting a multi-years programme to effectively integrate ICT in Education and training in Europe.

The use of new technologies in school learning represent a crucial point of a wider process aimed to reorganize high and vocational schools promoted by the *Italian Ministry of Education.*

In order to adopt the European guidelines, it has been launched the *ADI (Italian Digital Agenda)* that on the October 4th 2012 published the so called *Decreto Crescita 2.0 (Development 2.0 Decree).* This measure promotes – for instance – the adoption of digital books and the realization of digital scholastic centers.

In this sense, the *Italian Ministry of Education,* technically supported by *INDIRE,* planned also the management of *Structural Funds* for the period 2007-2013, disposing the so called *Obiettivo/Azione D.4,* which aimed to promote Information Society creating appropriate services centers.

According with *Obiettivo/Azione D.4*, schools can develop projects aimed to improve ICT literacy, in order to provide with appropriate skills all the stakeholders as teachers and school personnel, in general.

Similarly, *INDIRE* promoted the upgrading of ICT skills of the teachers as foreseen in the project ***DIDATEC,*** as well as the ***Piano Nazionale Lauree Scientifiche*** *(National Plan for Scientific Degrees)* that aims to promote scientific development through the use of both methodological and computer based laboratories.

The *Piano Nazionale* focused its attention on three main objectives. One of these is *"to improve the knowledge and the feeling of scientific subjects allowing the students to attend amazing and attractive curricular and extracurricular educational activities".*

The Direzione Generale per gli Studi, la Statistica e i Sistemi Informativi (Central Direction for Studies, Statistics and ICT) promoted the so called ***Piano Scuola Digitale*** *(Digital School Plan)* which aimed to modify the learning environment integrating them with new technologies.

Other interesting initiatives are represented by ***Progetto Classi 2.0*** – mainly aimed to assess the effectiveness of new technologies in school environment, monitoring the empowering of communication, cooperative work, learning by doing etc. – and Edmondo – a virtual environment where teachers and students can interact as avatars, and move, share and ask for information, chat etc.

Here it can be recalled also the program ***Experimenta*** – promoted by the *Direzione Generale per gli Ordinamenti Scolastici e per l'Autonomia Scolastica,* a Department of the *Italian Ministry of Education* – aimed to promote a real use of laboratories and new technologies, and to train the students to explore phenomena, observing and describing them with an appropriate language, in order to develop new knowledge.

In this framework, it is important to mention ***3GIORNIPERLASCUOLA, Smart Education & Technology Days,*** an annual convention – annually held in *Città della Scienza of Naples* – aimed to promote the use of new technologies for teaching and learning.

Romania

In Romania, the field of Science education comprises the following school subjects: Mathematics, Physics, Chemistry and Biology. All those subjects are included in lower and upper secondary curriculum with different number of teaching hours, at different levels. The Science curriculum tries to be in trends with the European directions for Science teaching and learning in terms of new methodologies that are advised, but also of new teaching behaviors. At the same time, there were started to be introduced: new roles for the students, new ways of evaluation, new technologies and materials and other new curricular recommendations and trends.

Basically, the trends in the Romanian Science curriculum are oriented on new innovative ways of content structuring, where Sciences contents tend to be structured in an increasingly inclusive manner, particularly in the Chemistry curriculum. Aims and goals in Sciences school subjects are focused on competences of scientific information processing, research skills, and humanistic values. The highly recommended methodology is oriented on inquiry based learning, experiential learning and discovery based learning. In addition, the teachers are regarded as designers of enriching learning situations and guiders in the knowledge construction.

In those respects, virtual experiments play an important role in Romanian science education, starting with the second half of the first century decade. One of the major steps related to the introduction of virtual experiments in science education was made by the *AeL project* (http://www.siveco.ro/en), where its *eContent* brings new approaches in pedagogy, stimulating creativity and facilitating learning by discovering, not through mechanical memorizing of information. The entire educational process takes place in a virtual secured environment, controlled by efficient technologies, intuitive and attractive for students. *AeL eContent* includes simulations, experiments, video-clips, animations and other multimedia resources, meant to stimulate students' natural curiosity, applicability, trans-disciplinary, individual work and project–based learning. The educational software allows students to repeat the digital lessons as many times as necessary in order to understand a certain subject. And as the application interface is user friendly, any student with basic computer skills can use the *AeL lessons,* just following the instructions on the screen.

Beside the main implementations of the *AeL project,* there are several international and national projects that introduced virtual experiments in science education, together with specific and accredited training sessions for teachers *(http://www.vccsse.ssai.valahia.ro, http://edutic.ssai.valahia.ro/)*. In this sense, some remarks can be underlined according to the Romanian teachers' feedback, related to the use of virtual experiments in the classroom (Olteanu et al., 2009):

- virtual instrumentation applications are regarded as a source of inspiration in teaching actions that should be used as an alternative and complementary to traditional tools, and as a means for improving students' understanding of abstract concepts;
- ƒimproving students' motivation for learning in creating and maintaining students' interest for science topics as well in obtaining better results in evaluation;
- ƒincreasing the attractivity for Science teaching and learning.

Turkey

National and international indicators show that there is a big inadequacy in science and technology education in Turkey as compared to other countries. This important problem affects the young students' structure of thinking perspective and perceptions of nature in a wrong way. The main problems with science and technology education are insufficient number of science and technology teachers' taking active role in the preparation of the programs, the insufficient in-service training of the science teacher in the transition state of a new program, the huge numbers of the students in the class, the informational education orienting students towards only exam achievement, the broken link with other lessons (e.g. mathematics program) and insufficient physical conditions of schools (less laboratory opportunities) (Ozden, 2006).

In Turkey science teaching starts only at grade four and central guidelines or specific recommendations encourage schools to provide extra-curricular activities in science. The curriculum of Science and Technology from 6th to 8th graders were redesigned and developed in 2004 by the *MoNE Board of Education* with the frame of educational reform. The Science and Technology Lesson are based on 7 learning domains *(Living Organisms and Life, Matter and Change of Matter, Physical Changes, Earth and Space, Science-Technology-Society-Environment Relations, Scientific Process Skills, Attitudes and Values)*, being designed for 4 hours in a week. Physics, Chemistry and Biology lessons are compulsory for 9th grade students and each subject is taught for 2 hours per week. Students studying at 10th, 11th and 12th grades may take Physics lesson as a selective course. Accordingly 10th grade students may take the lesson 2-3 hours per week, 11th grade students 2-4 hours per week and 12th grade students 2-3 per week.

Educational authorities recommend that schools offer science-related activities outside curriculum time. The most common aim in organising such activities is to supplement the science curriculum and help pupils to achieve the defined targets. In Turkey, as well as reinforcing what is taught in the classroom, extracurricular activities provide an opportunity to promote inquiry-based learning approaches for students.

In Turkey, specific bodies have been established by official authorities to coordinate measures for supporting science education. *The Scientific and Technological Research Council of Turkey (TÜBİTAK)* established in 1963, is an autonomous institution with a mission to advance science and technology, conduct research and support Turkish researchers. *TÜBİTAK* is responsible for research and development in line with national targets and priorities. It runs several annual activities in the field of science education for pupils and students and also supports municipalities wishing to establish science centres in their cities (Eurydice, 2011).

In Turkey, teachers' frequency of use of ICT is more than the EU average. The most intense use of ICT is found at grade 11th vocational, with high levels also at grade 8th. As regards teachers' use of ICT (Section 3 of the main report), few teachers in Turkey have been using ICT in lessons for more than six years.

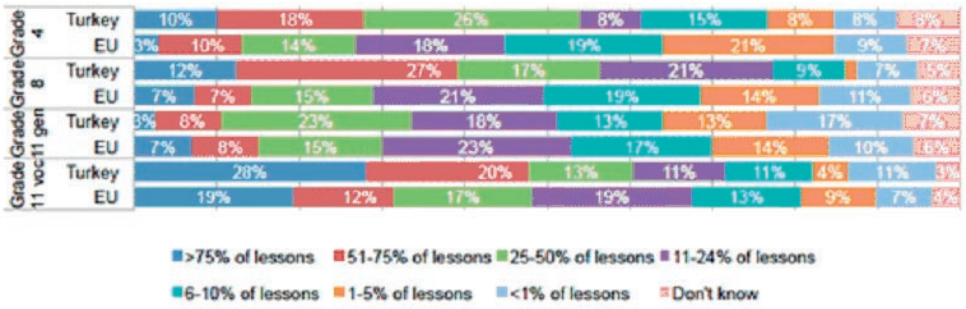


Fig. 2.3: Frequency use of ICT equipment by teachers, in lessons (in % students, Turkey and EU, 2011)

The reason of high percentages for the ICT usage of teachers depends on mostly the *Fatih Project. "Movement of Enhancing Opportunities and Improving Technology",* known as *FATIH,* is among the most significant educational investments of Turkey. *FATIH Project* proposes that *"Smart Class"* project is put into practice in all schools around Turkey. With this project, 42000 schools and 570000 classes will be equipped with the latest information technologies and will be transformed into computerized classes *(Smart Class).* Turkey has initiated *FATIH Project* with the aim of enabling equal opportunities in education and improving technology in the schools, for the efficient usage of ICT tools in the learning-teaching processes, by appealing to more sensory organs in all 42000 schools and 570000 classes, in the preschool education, primary and secondary education through providing *tablets* and *LCD Interactive Boards.* In-service trainings for teachers are being held in order to provide effective usage of the ICT equipment in the classrooms, in the learning/teaching process. In this transformation process, educational e-contents are going to be formed in accordance with the current teaching programs. During the 2013-2014 school terms, it was initiated to install the smart boards in high schools all over Turkey and all the teachers are being trained. In 2014-2015 school year, the teachers in Elementary schools will be trained. However, there is a lack of e-content to provide electronic educational tools and materials for the teachers. By the way, for science education there is no real attempt to create the virtual learning environment and virtual laboratories *(http://fatihprojesi.meb.gov.tr/tr/english.php).*

Even though most of the classes are equipped with smart boards and tablets, they cannot be used effectively because of lack of the e-contents in accordance with the current teaching programs. Therefore, the results of use of virtual environment in classes in Turkey are well below the average. The percentages of students in schools that have *connected* characteristics, e.g. having a website or a *virtual learning environment* (VLE), are shown below, as well as those with none of those items. In Turkey, a lower percentage of students than the EU mean are in schools with a website, a considerably fewer in schools with a virtual learning environment. *Unconnected* schools are above the EU average, notably so for pupils in schools at Grade 8th. Turkey ranks at 8th and 11th grades are well below the ranks of European Union, as regards virtual learning environments *(https://ec.europa.eu/digital-agenda/sites/digital-agenda/files/Turkey%20country%20profile.pdf).*

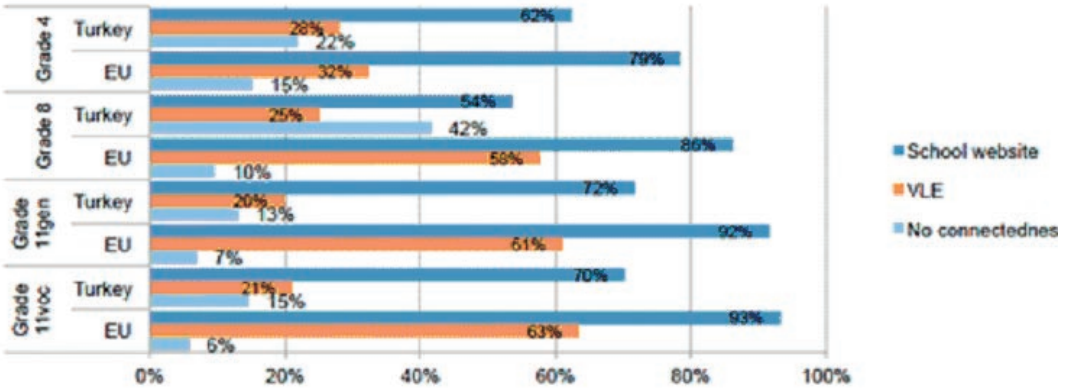


Fig. 2.4: Percentage of students in connected schools – website, virtual environment, no connectedness (Turkey and EU, 2011-2012)

It is important to mention that the *NTSE Project* and the use of virtual laboratories in Science education represent an innovation in Turkey. The use of ICT and virtual laboratories are being effectively and intensively used in *Doga Schools.* Apart from this, in 4 state schools (3 vocational schools, 1 high school), all the NTSE on-line educational tools are being actively used. In the next school years, the usage of the *NTSE Virtual Laboratory* and related *NTSE Nano Kit* will be introduced to more state schools. More students and teachers will find a love for those fields because digital lessons allow for more repetition and instant feedback.

III. ROLE OF NTSE PROJECT IN MEETING THE IDENTIFIED TRAINING NEEDS

This chapter resumes the process aimed to identify the training needs and the educational contents for the NTSE Virtual Lab.

The information gathered by this process have been reported in the Concept Paper for NTSE Virtual Lab, a written document aimed to drive the main framework and the general contents of the Virtual Lab. It has been written during the first year of the project and its first version has been provided on the beginning of September 2011.

As specified in the NTSE's application form, the writing of the text has been preceded by a research and analysis work.

As first step all partner carried out a complex research concerning the scientific subject (physics, chemistry and biology) taught from 8th to 13th degree in high and vocational school in their own countries. Aim of this work has been to allow every beneficiary of the project to use effectively the educational tools provided by the Virtual Lab. Starting from this research, the common subjects characterizing science teaching in high school in every involved country have been identified. Then the common subjects related to nano science and nanotechnologies have been selected in order to provide the beneficiaries of the Virtual Lab – in particular the students – with arguments and experiences understandable on the basis of their skills. The appendix below shows a synthesis of the results gathered from the analysis.

The second step has been the word processing of three different questionnaires respectively addressed to the main beneficiaries of the project: science teachers in course, students from 8th to 13th degree and perspective science teachers.

Besides the analysis of the curricula described above, in the spring 2011 the partners elaborated some questionnaires addressed to samples of people representative of the main beneficiaries of the Virtual Lab. The questionnaires were aimed to recognize the opinions of the beneficiaries concerning several different aspects of their activity investigating on three main thematic areas in order to better define the features the Virtual Lab should have: ICT, scientific contents and educational methodology.

The questionnaires have been submitted to samples of beneficiaries respectively in Turkey, Greece and Romania (students, teachers and perspective teachers), Bulgaria (teachers) and Italy (teachers and students). These analysis represent both a tool for the development of the project and also an interesting compared study about the needs and the opinions of the main stakeholders in the educational systems of different countries.

In the next pages of this chapter the most relevant issues emerged from the analysis of the questionnaire will be briefly resumed followed by detailed quantitative data about their results as gathered in each partner country.

As already said, the general results gathered from these analysis oriented the educational criteria reported in the concept paper and adopted in the creation of the Virtual Lab as well as in the development of other actions carried out in the framework of the project.

Two relevant concepts – mutually related – have been individuated:

- The adoption of scientific method also as a tool for the educational approach to be adopted in the Virtual Lab;
- The effectiveness of non formal education and the consequent adoption of Inquiry Based Scientific Education (IBSE) approach to design the Lesson Plans of the Virtual Lab.

To what extent scientific method, two quite relevant statements have been considered . The first is that the scientific method, is substantially applicable not only to the generation of new knowledge, but also as an effective tool for its transmission. So it can be considered also as a powerful educational instrument.

The second one deals with that particular step of scientific method consisting of organizing observations within an abstract axiomatic-deductive scheme. We could even renounce the idea of formalizing such a scheme in mathematics terms, expecting only that it is a coherent and organized scheme of logic, then the same methods can be applied to research and didactics in natural disciplines (usually labelled "scientific"), as to research and didactics in every other discipline (historical, philosophical, linguistic, etc.).

In this regard, from the point of stimulating the attitude to participate actively in the production of inter-subjective knowledge it is not important what one learns or teaches, but how one learns or teaches.

Starting from this last statement non formal education and IBSE become in the running. Non formal education is represented by all those kinds of organized educational activities out of the field of formal education according with curricula recognized by Ministries of Education. European Union acknowledges them on the same plane of formal education activities but, despite of this point, not everywhere in Europe non formal education is considered equal with formal system. For instance in Italy non formal education activities are carried out by organizations that could provide just certificates of attendance but not official qualifications.

IBSE (inquiry Based Science Education) represents a significant example of non formal pedagogical approach promoted by European Commission based on investigation and aimed to stimulate questions and actions to solve problems and explain phenomena. This approach considers an innovative series of phases in respect to ways of teaching: learners face with the object of study (e.g. a biological or physical phenomena, measurement tools, etc.), formulate questions and hypothesis, verify them by mean of experiments and talk over the gathered results.

III.1. Curricula matches and analysis of the questionnaires

In the next pages are resumed the results emerged by both the common scientific subjects emerged from the research on the comparison of curricula in science in the different countries, and the analysis of the questionnaire filled by students, teachers and perspective teachers.

Analysis of the curricula in science

To what extent the curricula matches, the tables below show some general scientific subjects faced in the schools recognized by the analysis of the partner countries and some related nano topics.

As showed in the tables, from the analysis emerged that there is a widespread core of common scientific subjects characterizing the educational background in science for the students of the high schools of each partner country. More complex is to relate the punctual subjects to the age of the students because of the different frameworks of the educational systems in each country (to examine in depth this point, see the Concept Paper).

Physics

Basic skills	Size and Scale
The nature of physics	
Heat, Temperature and Phase Changes	Preparation of a Cholesteryl Ester Liquid Crystal Thermometer
Properties of matter	Lotus Effect Activity
Electrostatic; Electric current and the effects of electricity	Periodic Properties and Light Emitting Diodes
Waves and sound	NiTi Shape Memory Alloy Springs
Structure of Atom	Solid-State Model Kit
Enlightenment	Preparation of an Organic Light Emitting Diode

Chemistry

General and organic chemistry, mineralogy, electrochemistry, radioactivity	X-Ray Diffraction and Scanning Probe Microscopy Solid-State Model Kit Amorphous Metal Activity Citrate Synthesis of Gold Nanoparticles:

Biology

Botany and zoology	Preparation of an Organic Light Emitting Diode (related to photosynthesis) Nanowire sensor slides
Genetics	DNA Optical Transform Kit DNA barcode slides Quantum Dots
Vegetal, animal and human physiology	

Analysis of the questionnaires

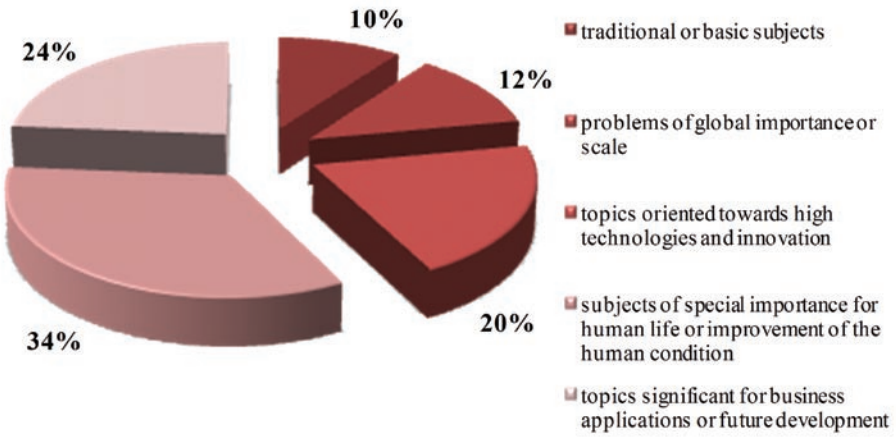
In June 2011, as the project started, three questionnaires to students, teachers and prospective teachers were prepared and applied. According to the evaluations of the questionnaires, the nano experiments of the Virtual Lab were defined. The most significant information gathered in each country from the questionnaire are reported below.

Romania (Partner Valahia University of Targoviste)

In order to raise students', prospective teachers' and teachers' reflection related to which are the most important topics to be taught or learned in Science lessons and which are the most suitable methods and tools to be used during those lessons. Based on the answers collected from the respondents, the partnership could better define the features of the Virtual Lab. The total number of interviewed people in Romania was 101.

The first section of the evaluation questionnaires was focused on finding out which kind of topics in Science education are considered from the teachers and prospective teachers point of view to be more appealing for students, which of the extracurricular topics should be integrated with Science lessons or what kind of extracurricular subjects are considered to be important and/or innovative in teaching Science. Similar topics were raised also to the students from the learning perspective.

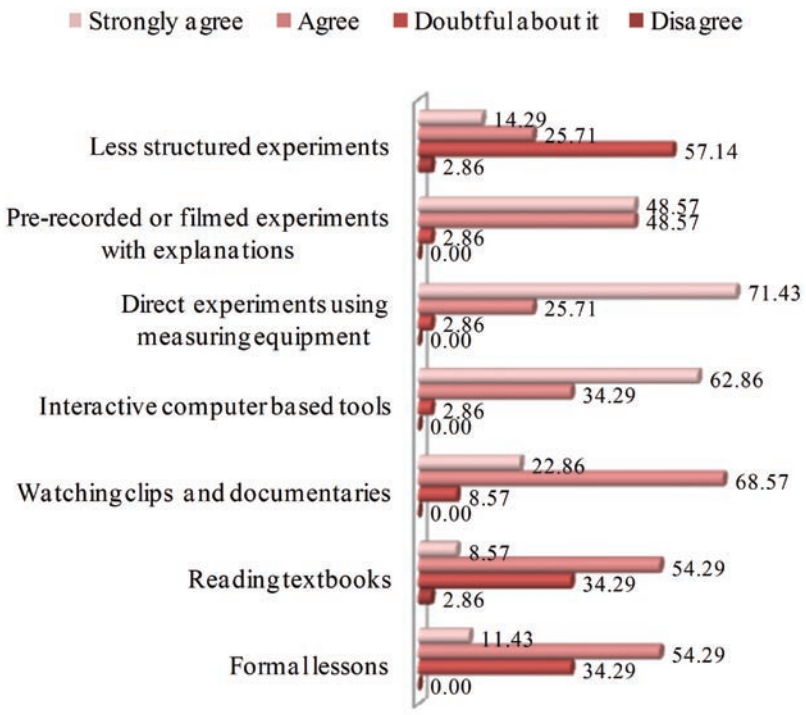
The following figure illustrates the teachers' suggestions related to which kinds of topics in Science education are considered to be more appealing for students.



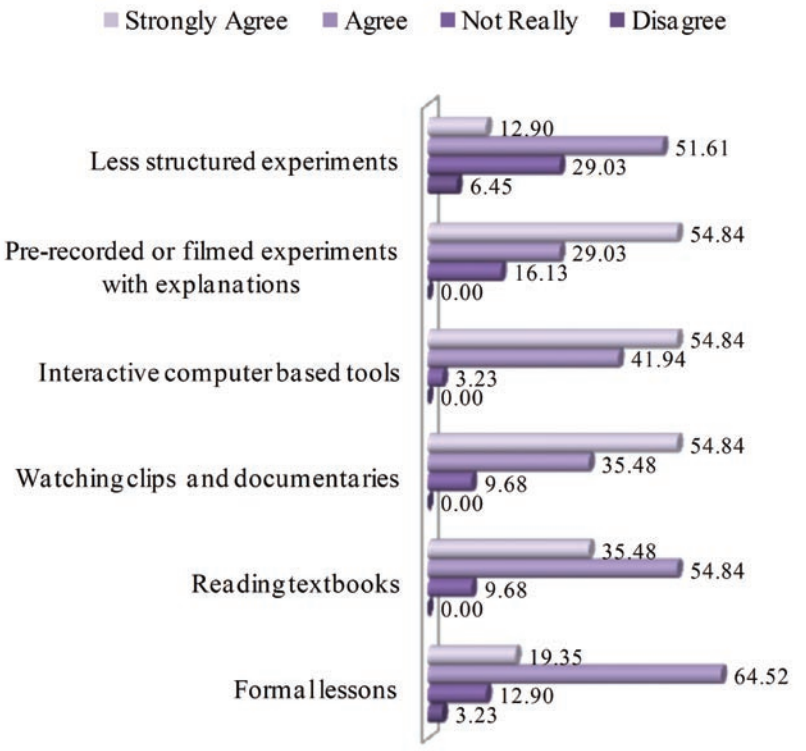
Science education topics identified by the Romanian in-service teachers to be appealing for students

Whereas the teachers emphasized topics related to "how energy can be saved or used in a more effective way" (74.29%), to "ozone layer and how it may be affected by humans" (60.00%) or "how technology helps us to handle waste, garbage and sewage" (57.14%) like topics that should be integrated in the Science lessons, the most interesting subjects from the students' perspective, were topics like: "structure of DNA, genetic studies, heredity and how genes influence how we develop" (68.57%), "parts of human body and how the systems work" (65.71%) or "life and death and human soul" (62.86%). The data analysis for all the topics proposed in the questionnaire proved that there is a gap between the teachers ideas about what have to be taught and the students' expectances. This can possibly explain the decreasing of the students' interest to Science lessons. However, there have been identified also topics that are interesting both for teachers and students (like "very recent inventions and discoveries in Science and Technology" or "Nanotechnology and its' use in life") and those ones have to be exploited during the Science lessons.

Another section of the evaluation questionnaire was oriented to find the most effective ways to introduce different concepts and phenomena during the Science lessons in order to obtain a meaningful and permanent learning. For finding those aspects, different options like formal lessons, reading textbooks, watching clips and documentaries, interactive computer based tools, direct experiments using measuring equipment, pre-recorded or filmed experiments with explanations, or less structured experiments have been addressed to the interviewees. The following two figures illustrate the in-service and prospective teachers' ideas related to the effective ways to introduce different Science and Nanotechnology topics in actual education.



In-service teachers' perspective concerning the effective ways to introduce specific topics during the Science lessons

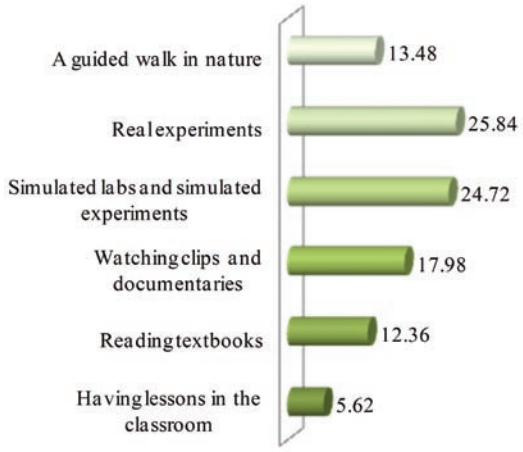


Prospective teachers' perspective concerning the effective ways to introduce specific topics during the Science lessons

From the pedagogical use of ICT, it can be emphasized that both target groups identified activities like: watching clips and documentaries, interactive computer based tools or pre-recorded or filmed experiments with explanations as efficient methods with high rates to introduce specific contents during the Science lessons.

In addition, the direct experiments with measuring equipment were also very high rated, like a meaningful teaching method by the in-service teachers. But, from those answers, it can be seen that both teachers and prospective teachers are opened to use teaching methods which are based on the use of ICT during the Science lessons, and they are capable to identify and appreciate the advantages of those new teaching methods developed in the last period.

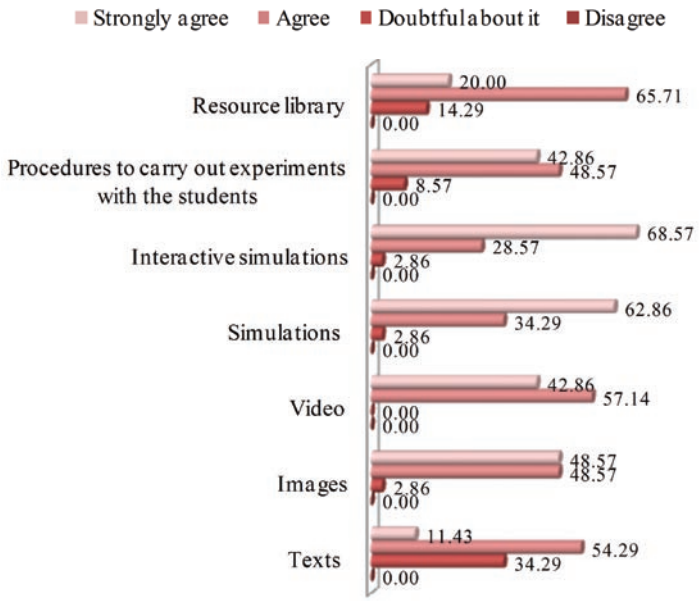
At the same time, the students' opinions related to the good ways to learn more about Science and Technology are shown in the following figure which emphasizes that simulated labs and simulated experiments or watching clips and documentaries are highly appreciated ways to learn specific scientific contents by using ICT. In addition, the real experiments are also very appreciated by the students as a way to a better understanding of the concepts and a deeper learning process.



Students opinions related to best ways to learn different Science and Technology contents

Having in view that the ICT usage proved to enhance the application in practice of inquiry-based method, the collaborative work, the constructive knowledge acquisition and the social learning, different questions related to which are the most preferred ICT tools to be used as useful components of an online virtual lab have been addressed.

The next two figures illustrate the in-service and prospective teachers' opinions and prove that 68.57% of in-service Science teachers strongly agree that interactive simulations are important for an on-line Virtual Lab, 62.86% of them strongly agree that simulations are important for an on-line Virtual Lab and just 11.43% of these teachers strongly agree that texts are also important for an on-line Virtual Lab.

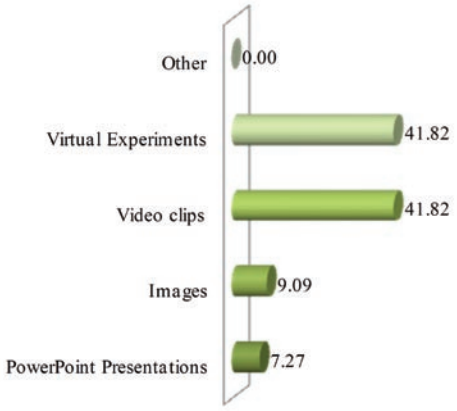


In-service teachers' perspective concerning the important tools to be included into an online virtual lab

In comparison to the presented results, 61.29% of the prospective teachers strongly agree that clear procedures to carry out experiments with students are important for an on-line Virtual Lab, while 58.06% and 54.84% of them strongly agree that interactive simulations and simulations are important for an on-line Virtual Lab. In addition, both target groups appreciated in a high rate that a resource library could be a strong tool of an on-line virtual lab.

In addition, testing the students' interest to use computers and Internet to discover and learn aspects related to Science topics, the data analysis proved that 94.29% of students are very interested by computers and Internet using while only 5.71% don't prefer to use the computers and related technologies for learning Science topics. Being interested by what kind of specific tools the students would like to use to discover and learn aspects related to Science topics, a specific question was introduced in the students' evaluation questionnaire.

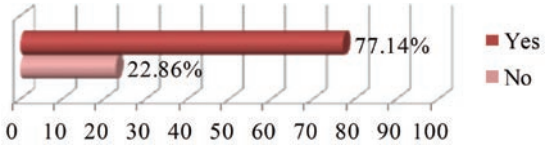
The data collected are illustrated in the following figure and emphasize that virtual experiments and video clips can be powerful and attractive ICT tools to be introduced in the on-line virtual lab dedicated to present specific Science and Nanotechnology contents.



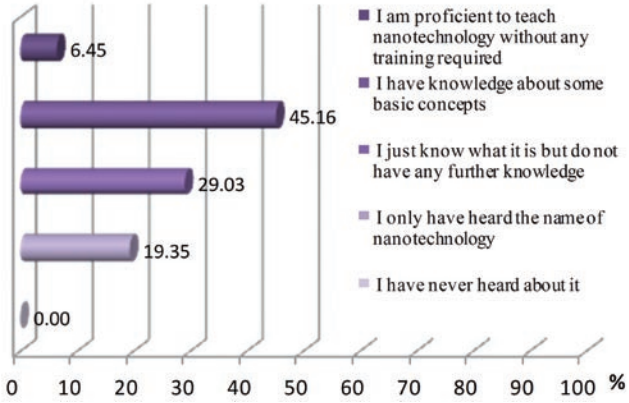
Specific ICT tools preferred by the students to discover and learn aspects related to Science topics

The data analysis of the answers provided by the interviewees from all the three target groups helped the NTSE partnership to define the most suitable features of the Virtual Lab that is developed in the frame of the project, concerning the scientific contexts and educational methodologies, and how to use ICT during the Science lessons.

In addition, as the next two figures illustrate, a lack of knowledge related to the nanotechnology topics has been identified to the level of in-service and prospective teachers.



In-service teachers' level of knowledge related to nanotechnology

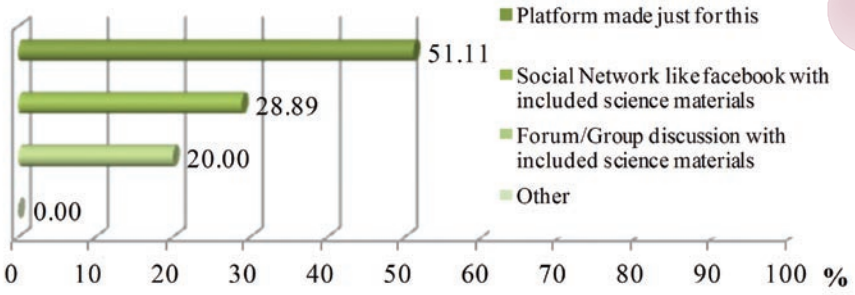


Prospective teachers' level of knowledge related to nanotechnology

Due to the reason that 23.86% of Romanian in-service teachers do not have knowledge about nanotechnology and 29.03% of prospective teachers know only what is the nanotechnology but do not have any further knowledge and other 19.35% just heard about nanotechnology, the NTSE partnership decided that a resource library (NTSE e-Repository) with scientific and methodological articles, books, papers, posters, learning objects and news about the latest discoveries in the field is imperative to be introduced in the Virtual lab in order to be consulted by both target groups.

The resources included in the NTSE e-Repository were completed with other multimedia products useful not only for the teachers and prospective teachers but also for the students. In addition, trying to raise the students' interest for Science, in general, and nanotechnology, in particular, a broadcasting room was also introduced in the virtual lab. This includes broadcasting on photos of conferences, seminars and workshops and interviews with successful women scientists, engineers and business women.

Trying to find out which are the most attractive IT environments to be used by the students for introducing the nanotechnology topics, like the next figure shows, the students like to use e-platforms dedicated to this purpose. This led the NTSE partnership to the idea to create a blog where different articles related to nanotechnology are introduced and group discussions are undertaken between the people from all target groups.



Specific IT environments preferred by students to be used for introducing nanotechnology topics

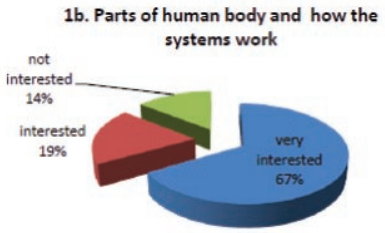
Italy (partner Fondazione Idis-Città della Scienza)

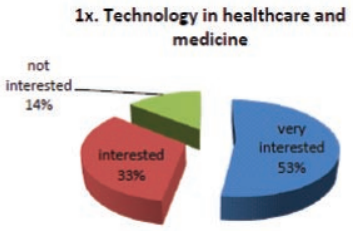
During summer 2011, the Italian partner submitted the questionnaires to two different kinds of beneficiaries of the project, high school students and science teachers. To what extend the students, the interviewed class was an 11th degree of an Italian high school (scientific lyceum)composed by 21 peoples, while the science teachers' sample was composed of 8 peoples from different schools and degrees.

Students' answers to the questionnaires

Question 1 – How interested are you in learning about the following topics in Science lessons?

This first question provides the interviewees with a list of 26 possible science-related topics. To each topic the interviewee could answer to be "strongly interested", "interested" or "not interested". The data gathered from this question are very heterogeneous but, as showed by the diagrams below, we can underline some relevant results:



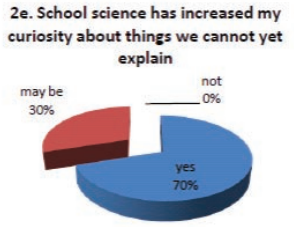


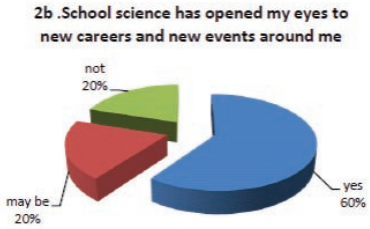
The best rated topics are:
1. Parts of human body and how the systems work (66,67% very interested; 19,05% interested; 14,29% not interested);
2. Technology in healthcare and medicine (52,38% very interested; 33,33% interested; 14,29% not interested);

Anyway other topics as "structure of DNA and genetic studies", "light and its nature", "structure of Earth", "life and death and human soul" and "how energy can be saved" scored 47,62% of "very interested". It's also interesting to notice the less interesting topics are "How radios and TVs work" (42,86% not interested) and "Robots and automated machines and their use in life", "Optics and how they are used in our daily lives" and "The use of lasers" (38.10% not interested).

Question 2 – What do you think about Science education in school?

Also this second question allows the students choose among three answers ("yes", "may be", "no") to seven different statements. From the diagrams below we can notice two best rated statements :





70,00% of students consider that "school science has increased their curiosity" while 60,00% of them consider that "school science has opened their eyes to new careers and new events"

Question 3 – I think that a good way to learn more about science and technology is…

To what extend the effectiveness of different educational way in science and technology we have a very heterogeneous range of answers. Anyway – as shown in the table – the best rated ways result to be:

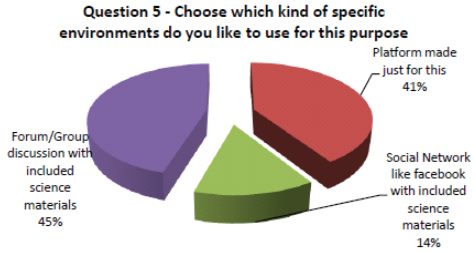
- *watching clips and documentaries (20,29%)*
- *having lessons in the classroom (18,84%)*
- *real experiments (18,84%)*

Question 4a – Do you prefer to use of computers and Internet to discover and learn aspects related to Science topics?
Question 4b – Indicate what kind of specific tools you would like to use to discover and learn aspects related to Science topics.

To what extend the use of ICT and related tools to discover and learn sciences we can notice that the most of students answered the best tools are "video clips" (45%) and "virtual experiments" (45%)

Question 5 – Choose which kind of specific environments do you like to use for discovering and learning aspects related to Science topics.

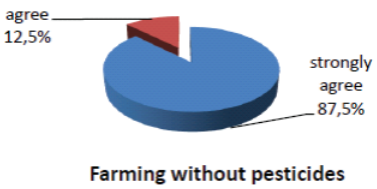
This last question was aimed to individuate the best ICT tool to be developed in the framework of the project. As we can see, among the three available answers, we got the response showed in the diagrams below:

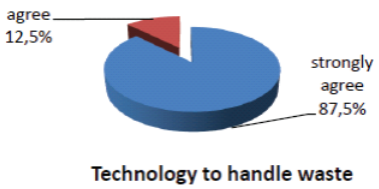


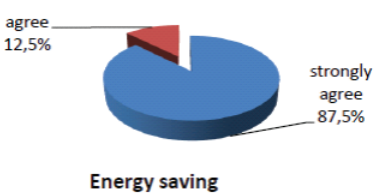
Teachers' answers to the questionnaires – relevant topics

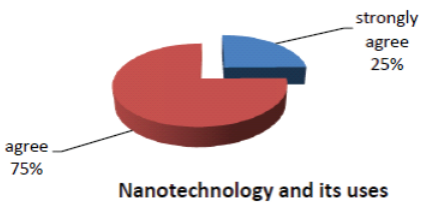
Question 2 – *Which of the extracurricular topics should be integrated with Science topics?*

Question 3a – Do you have any knowledge about Nanotechnology?
Question 3b – If yes, which of the curriculum topics are related with Nanotechnology?







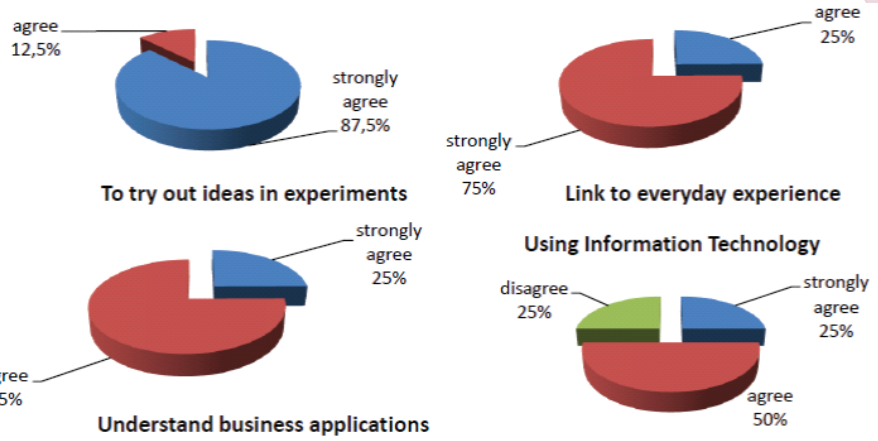


According to the questions on which extracurricular topics should be integrated with science topics taught at school, from the teachers' answers it results that there is a sensible need for teachers to be helped with topics strictly related to current events affecting local sites, like reducing use of pesticides in farming, recycle and disposal of waste and saving of energies (87,5%). Concerning Nanotechnologies, the answer given by teachers may reflect the cautiousness of teachers to express a strong agreement on a topic that they hardly can manage.

The confirmation to the last statement came when we asked to the teachers to assess their knowledge in nanotechnology and nanoscience, only one of the teachers interviewed affirmed that he knew about the topics.

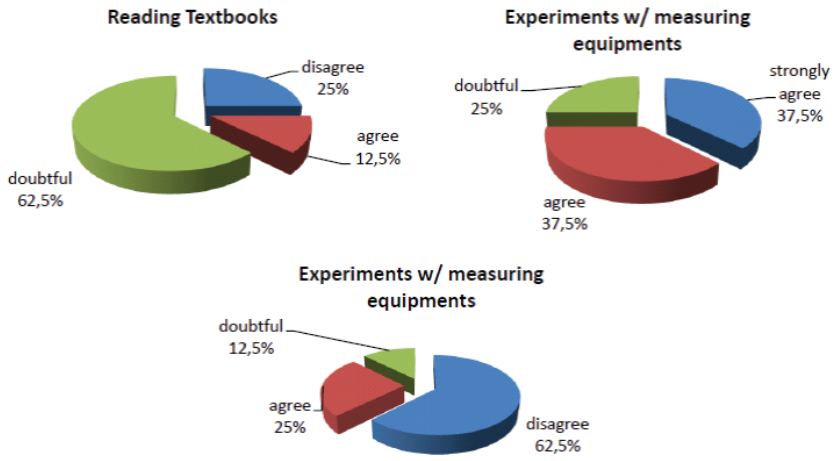
Question 5 – Science education should involve the following…

Concerning the idea of science education that the teachers had in their mind, the highest rate of agreement was for the assertion that science education has to encourage pupils to try out their own ideas in experiments. Also there was a sensible convergence of teachers on the following assertions: Science education can link new science learning to everyday experiences and help pupils to understand the importance of science in business application. Surprisingly, when we asked teachers if science education should involve the use of information technology, one quarter of the teachers expressed their disagree, underlining the difficulty that part of them meets when it comes to use technology devices.



Question 6 – The most effective ways to teach a particular scientific topic in a modern way generally would be…

When teachers were asked the most effective way to teach a particular science topic in a modern way, almost all were negative about reading textbooks (87,5%) but 25% were also doubtful about using interactive computer



Question 7 – Do you think the following tools are important for an on-line Virtual Lab?

When we introduced teachers with the topic of the virtual lab, we asked about the most important tools to be used and 85% of them strongly agreed on the use of interactive simulation, while texts and resources library generated negative answers (43% and 63% respectively).

Question n.8 and n.9

Another question involved the type of lab approach that they considered better, and everyone agreed (87,5% strongly agreed) that inquiry based laboratory activities were the ones that better suited to students.

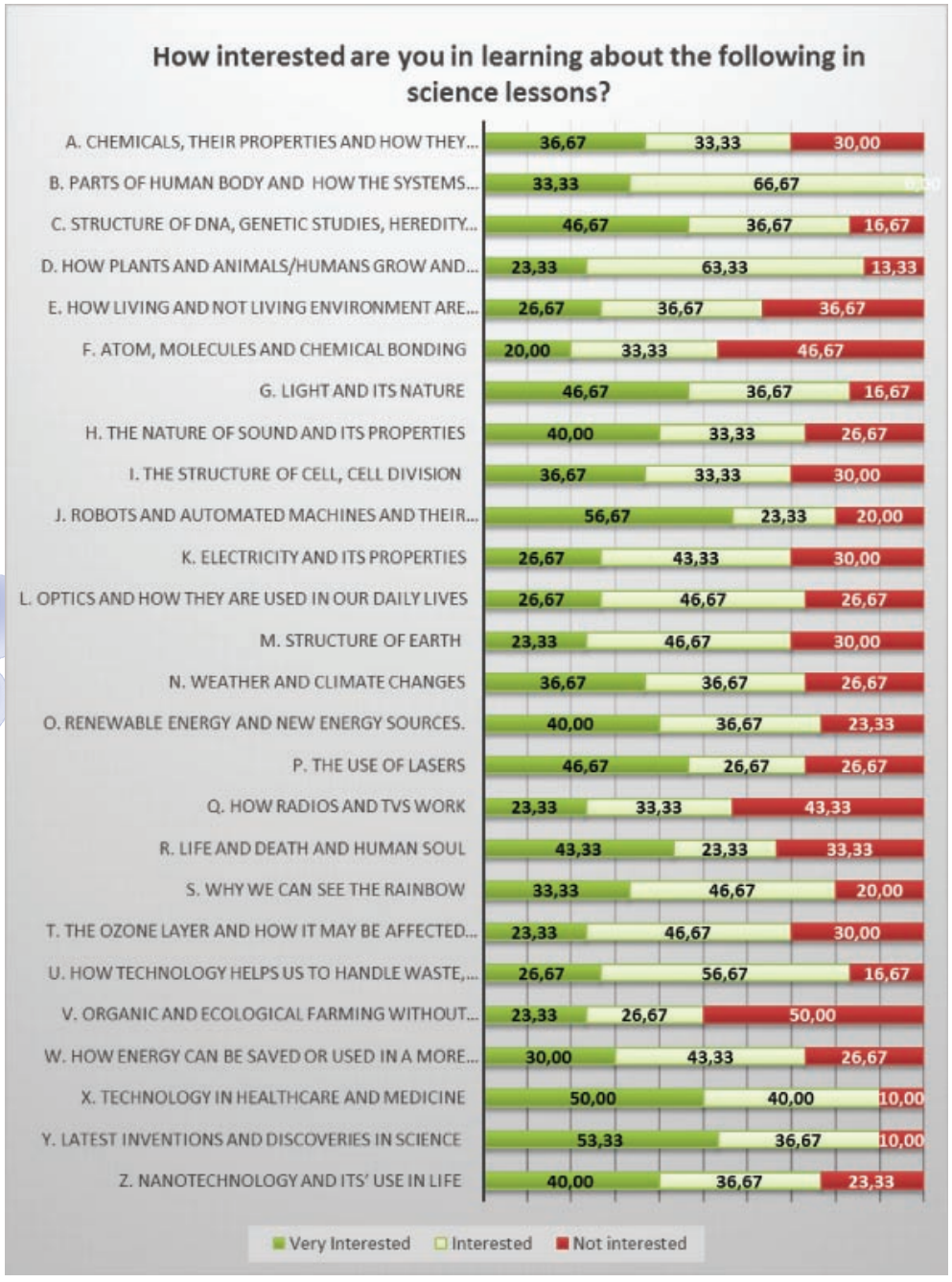
The majority of teachers (62,5%) then strongly agreed that appropriate lab activity should give students the ability to communicate their experimental findings to other via report and that students should have the possibility of using virtual experiment to perform those experiments which cannot be done in laboratory.

Question 8 – Which type of Lab approach do you think is better?

Question 9 – The appropriate activities in a laboratory would be…

Greece (partner Foundation for Research and Technology – Hellas)

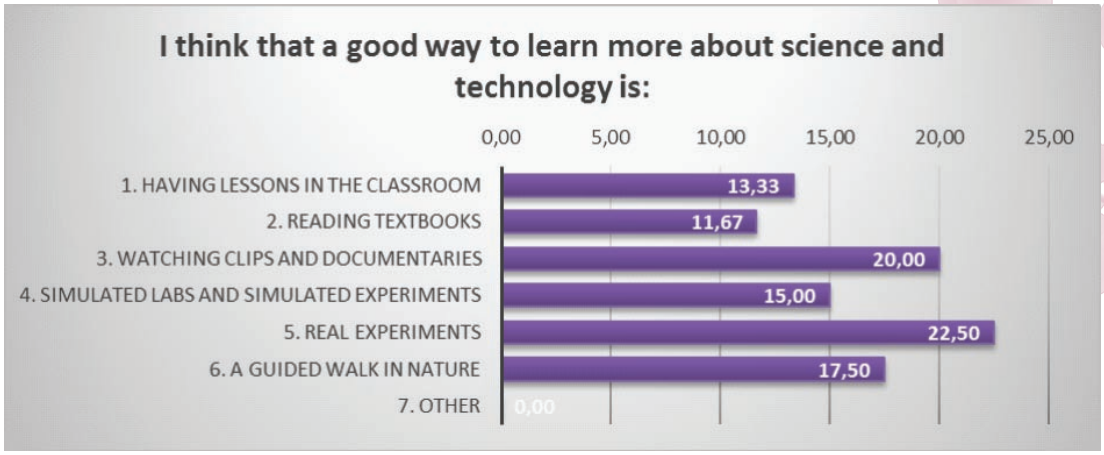
Number of questioned students: *30 – (7th to 10th grade) – June 2011.*



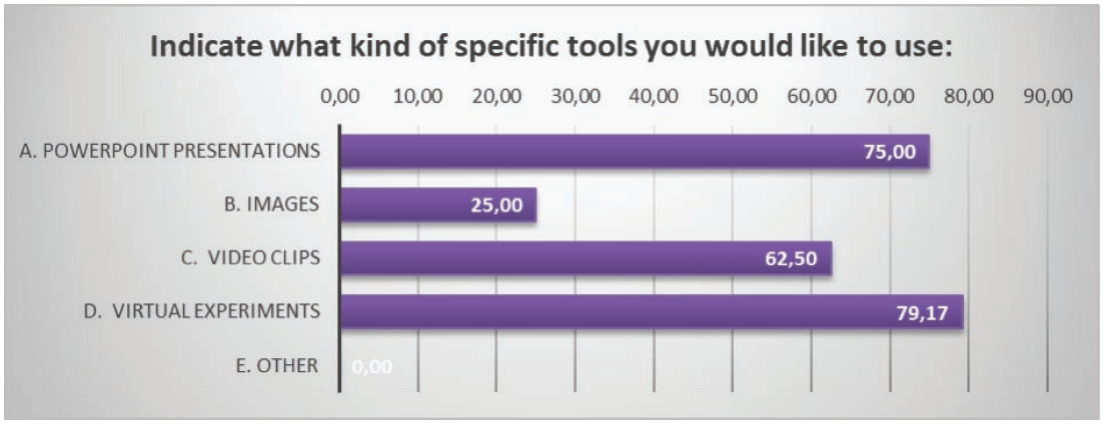
According to students' views, the most interesting subjects are:

1. Robots and automated machines and their use– 56.67%
2. Latest inventions and discoveries in science – 53.33%
3. Technology in healthcare and medicine – 50.00%

Also it's worth mentioning that ALL students are interested in "Parts of the human body and how the systems work" (Very Interested: 33.33%, Interested: 66.67%)



22.50% of the students consider real experiments as the best way to learn about Science and Technology while only 11.67% of the students appreciate textbooks as a good way to learn more about science.



Four out of five students (80.00) prefer to use computers and the Internet to discover and learn about aspects related to Science topics. Out of them, 79.17% would like to use Virtual experiments to do so, while 75.00% of them would like to use Powerpoint.

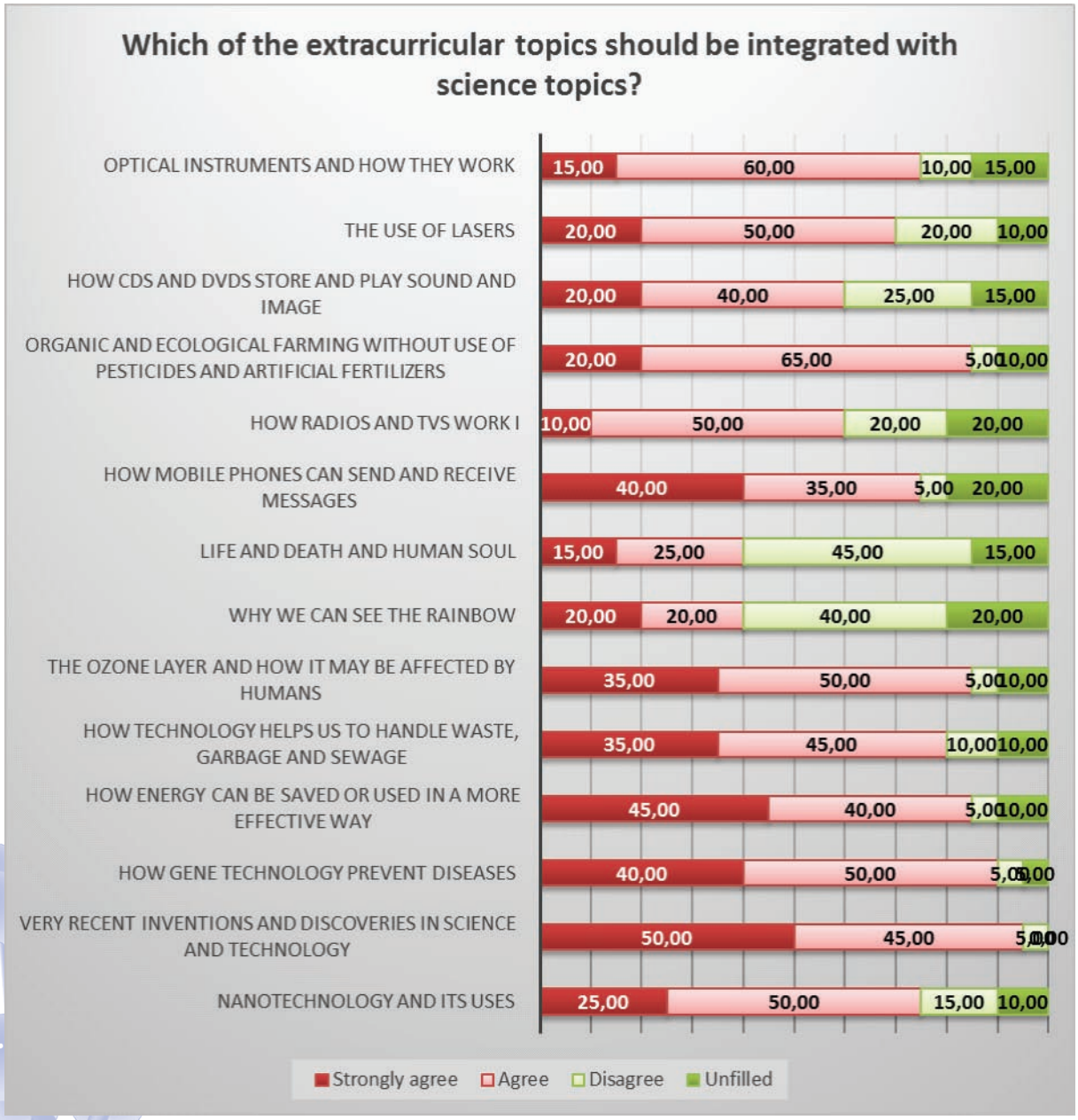
Presentations Regarding the environment they would like to use, the majority of students (58.33%) prefer a platform to be used as a support to discover and learn aspects related to Science topics.

Greece: Report on the Results gathered from the Evaluation Questionnaire for Teachers

Number of questioned Science teachers: 20 *– Secondary School (Gymnasium) and High School (Lyceum) Science teachers (Chemistry, Physics and Biology) – June to September 2011.*

70% of Science teachers consider that subjects related to special importance for human life or subjects related to the improvement of the human condition are more appealing for students, while 45% of them consider topics oriented towards high technologies and innovation are more appealing.

None of them believes that topics significant for business applications or future development are appealing for students.



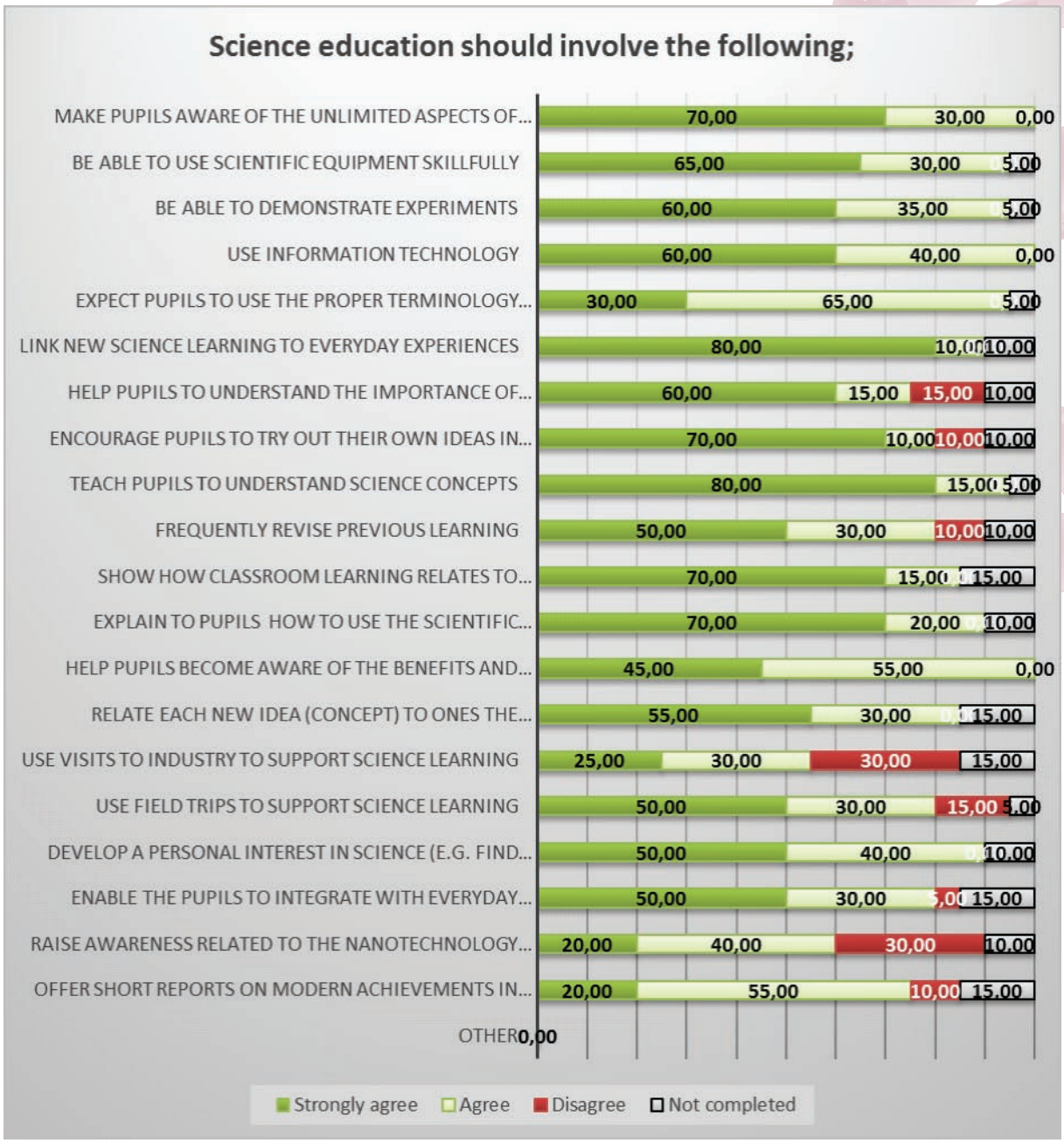
Only 5% of teachers disagree with the statement that very recent inventions and discoveries in science and technology should be integrated with Science topics. On the other hand 70% of teachers agree/strongly agree that organic and ecological farming without use of pesticides and artificial fertilizers topics should be integrated with Science topics.

65% of Science teachers declare they have some knowledge about Nanotechnology. Out of them, 76,92% mention that the following topics are related to Nanotechnology curricula:

- Chemicals, their properties and how they react.
- Atom, molecules and chemical bonding.

On the other hand, only 15.38% of Science teachers mention that the following topics are related to Nanotechnology:

- How people, animals, plants and the environment depend on each other.
- Structure of Earth and how earthquakes happen.
- Clouds, rain and the weather.



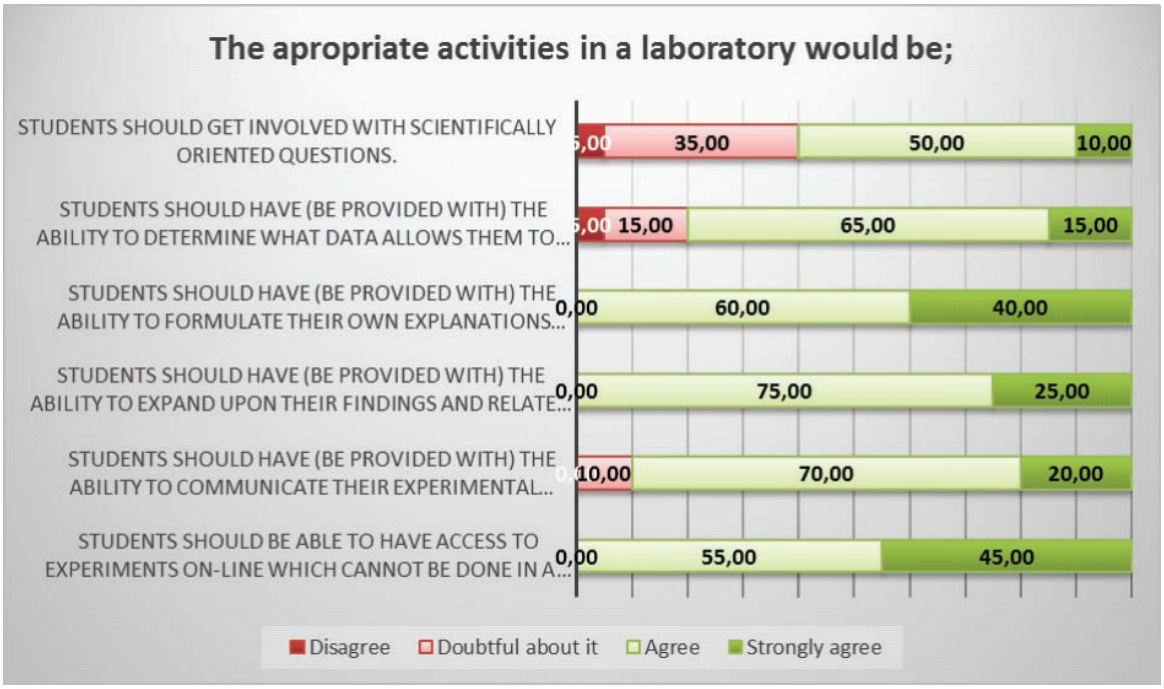
Eight out of ten of Science teachers strongly agree that linking new science learning to everyday experiences is an important factor in Science education.

According to the Science teachers the most effective ways are:

- *Direct experiments using measuring equipment (65% agree, 25% strongly agree)*
- *Interactive computer based tools (60% agree, 20% strongly agree)*
- *Watching clips and documentaries (60% agree, 5% strongly agree)*

Clearly *interactive simulations* are the most important tools for Science teachers (65% strongly agree, 35% agree).

50.00% of Science teachers are doubtful about the inquiry-based laboratory activities approach. Regarding to teachers' notes, they believe that from a theoretical point of view Inquiry-based learning is excellent but the Implementation of this is not easy given the class settings and time constrains. The majority of Science teachers consider the cook-book laboratory activities approach as the most suitable (75% agree, 10% strongly agree).



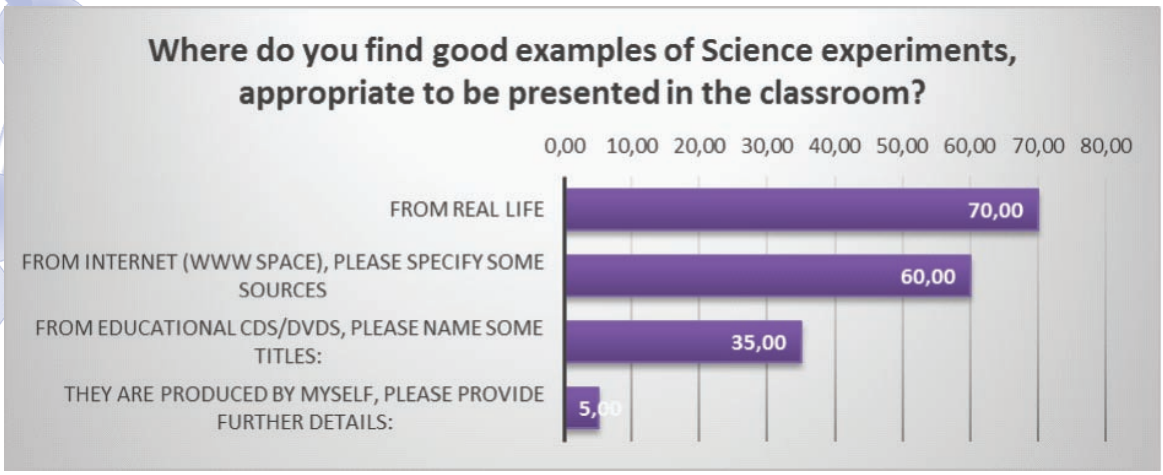
All Science teachers agree that *Students should be able to have access to experiments on-line which cannot be done in a laboratory* (55% agree and 45% strongly agree).

Also all Science teachers agree that *students should have (be provided with) the ability to expand upon their findings and relate those findings to similar situations as well as to formulate their own explanations from the evidence they have obtained. Also, students having access to an e-Library is considered as very important element (65% strongly agree, 35% agree)*

45% of Science teachers declare that sometimes implement ready-made ICT tools for teaching Science topics while one out of three Science teachers never uses ICT tools for teaching science topics.

55% of Science teachers intend to use Virtual Experiments for presenting Nano-tech experiments in the lessons while just 1 out of 20 of them uses open source software or software to build interactive experiments (eg Interactive Physics, Modelus)

Regarding IBL, 90% of Science teachers strongly agree /agree that ICT tools are important as a method to enhance creativity in teaching and learning process. However, 40.00% of them consider of very little importance the ICT tools as a channel for guiding students to explain scientific aspects and propose hypothesis for investigation.



70% of Science teachers use examples from real life for Science experiments (needed to be presented in the classroom) while 60% of Science teachers use collected / downloaded from Internet (WWW space) – from various webpages eg http://www.lila-project.org, http://phet.colorado.edu. On the other hand, only 5% of Science teachers produce their own Science experiments.

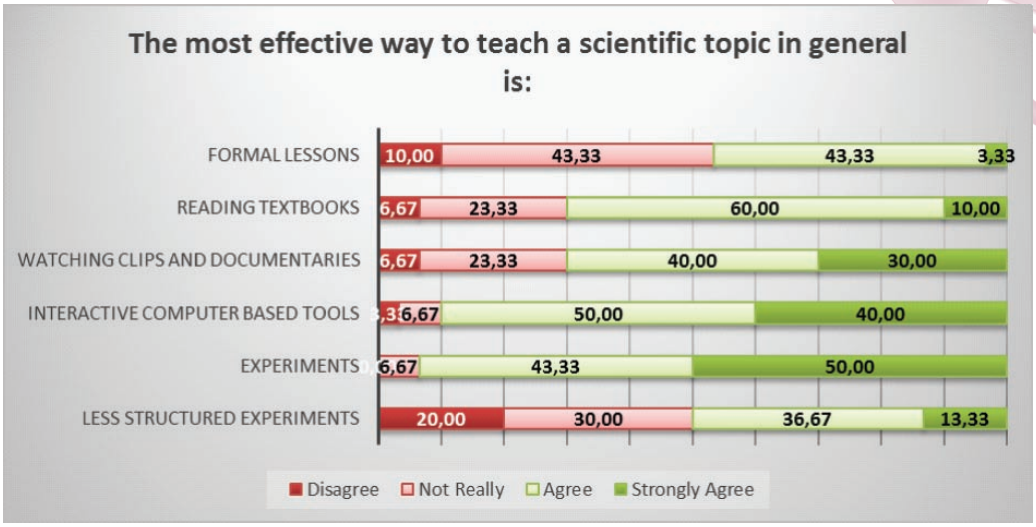
Greece: Report on the Results gathered from the Evaluation Questionnaire for Prospective Teachers

Number of questioned prospective teachers: 30 *– University of Crete, Department of Materials Science and Technology, July-September 2011*

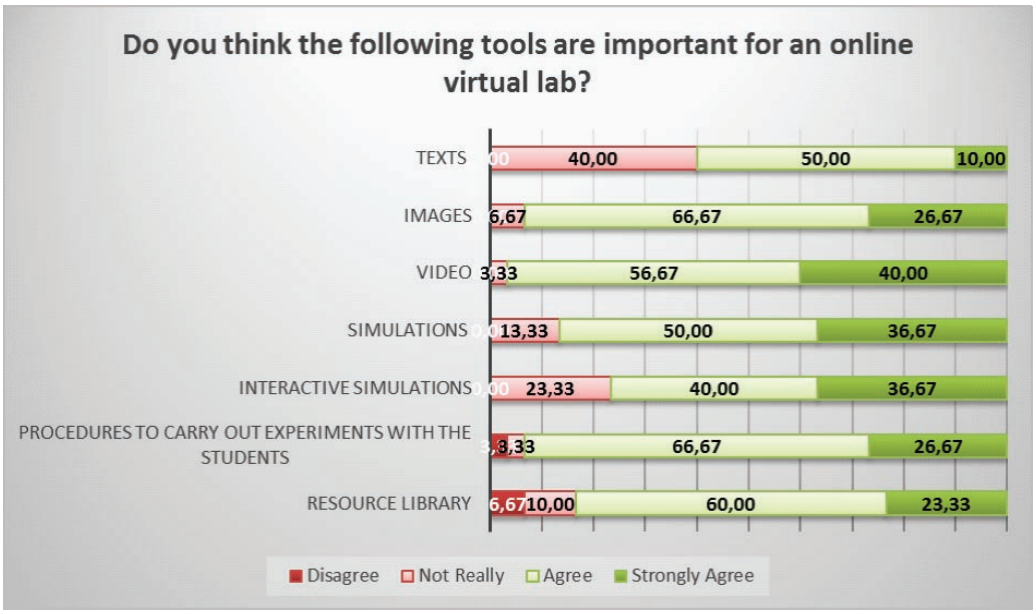
70.00% of prospective teachers consider that they know what nanotechnology is but do not have any further knowledge while 3.33% of them have never heard about it. None of them feels proficient to teach nanotechnology without any training required.

70.00% of prospective teachers consider that emerging Sciences (like Nanotechnology) should only be a course for high school students (40.00% elective, 30.00% mandatory) but none of them believes that emerging Sciences should be a mandatory course for 12 years.

The majority of prospective teachers (53.33%) consider that nanotechnology should be a complete theoretical training for the science teachers.



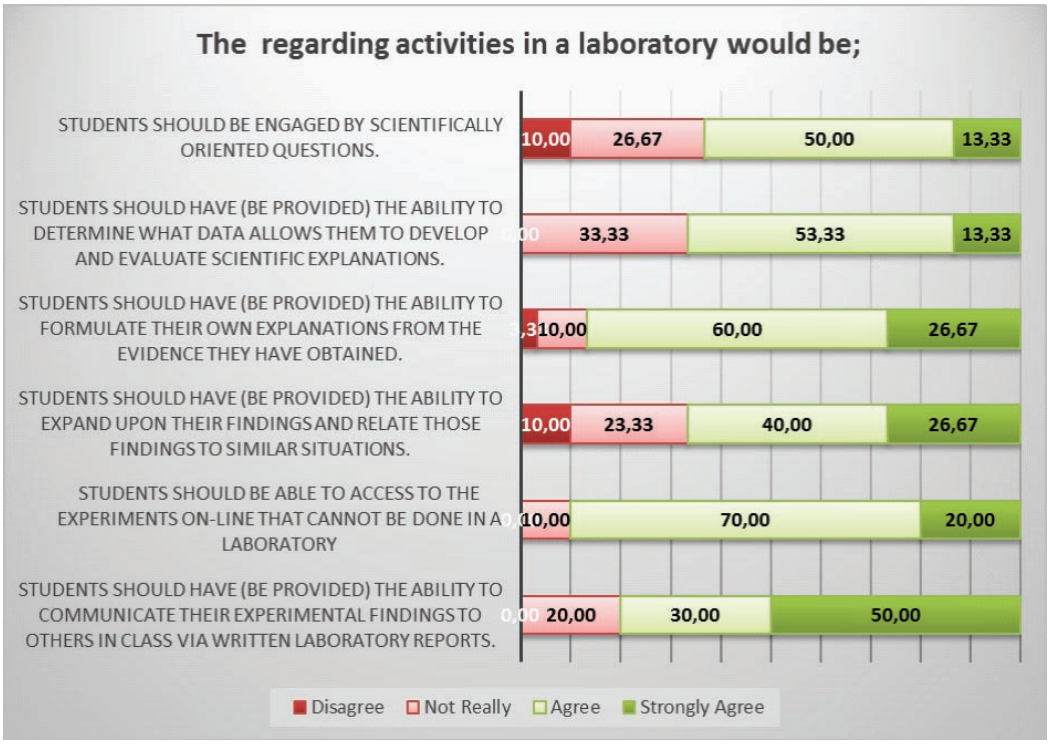
Nine out of ten students rate the use of experiments (93.33%) as the most effective way to teach nanotechnology while use of interactive computer based tools scored 90.00% too.



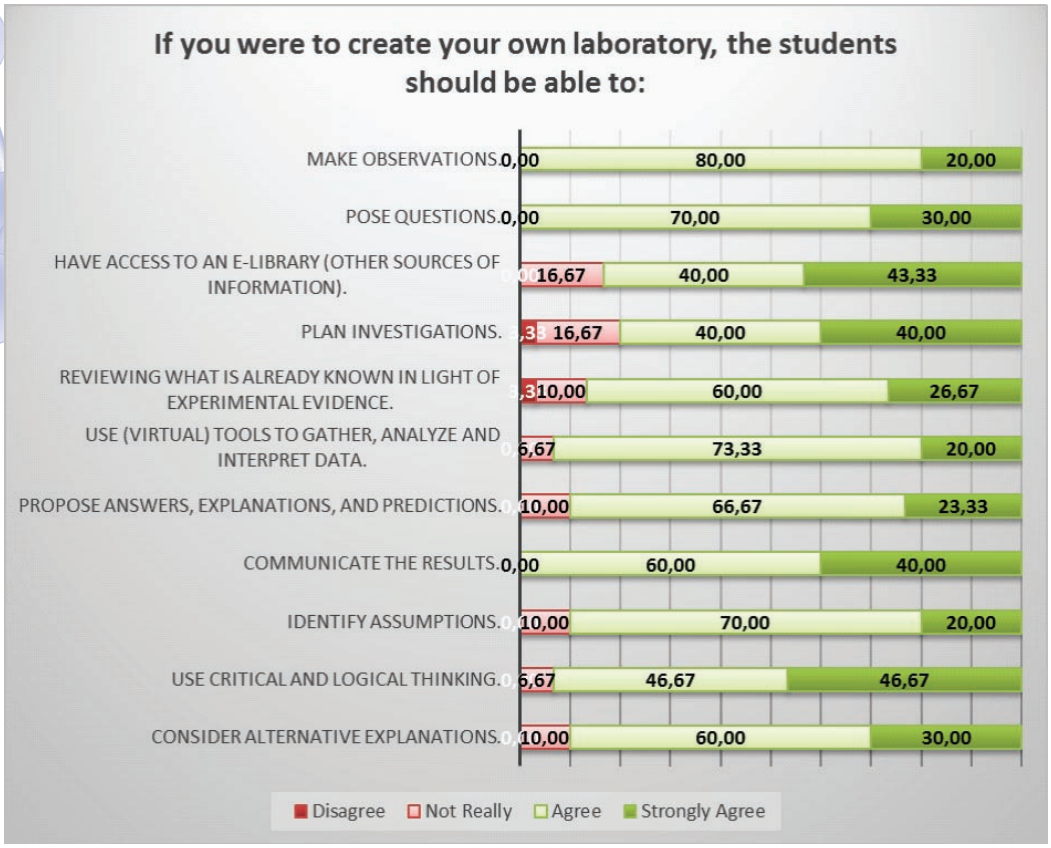
For an online virtual lab, the most important tools are: Video, procedures to carry out experiments with the students, simulations and images.

40.00% of prospective teachers strongly agree that inquiry-based laboratory activities (where students decide how to conduct the activity, and have to explore in order to figure out how the world works) are the best approach for an on-line Virtual Lab.

66.67% / 6.67% of them agree / strongly agree that cook-book type laboratory activities (step-by step instructions – to verify scientific facts) represent a proper option for an on-line Virtual Lab.

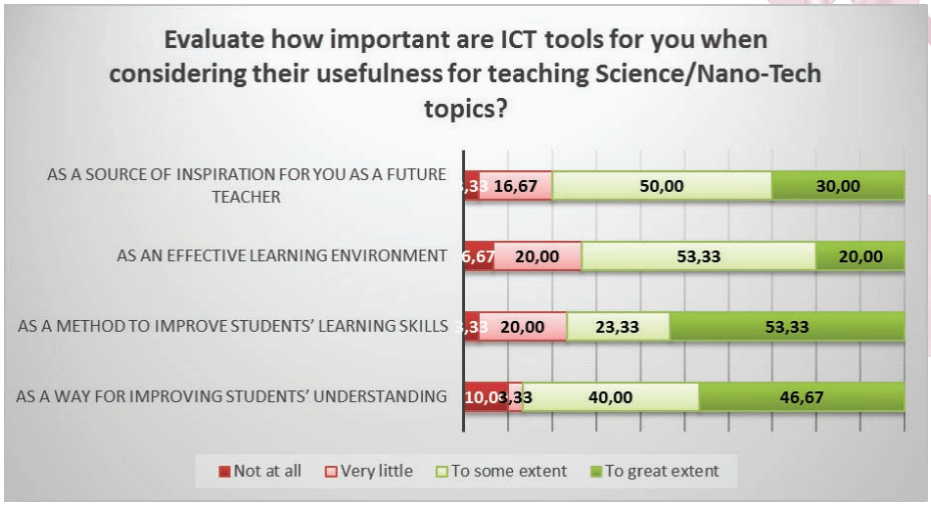


Prospective teachers strongly believe that students should be able to access online experiments that cannot be done in a laboratory. Also students should have (be provided) the ability to formulate their own explanations form the evidence they have obtained as well as to communicate their experimental findings.

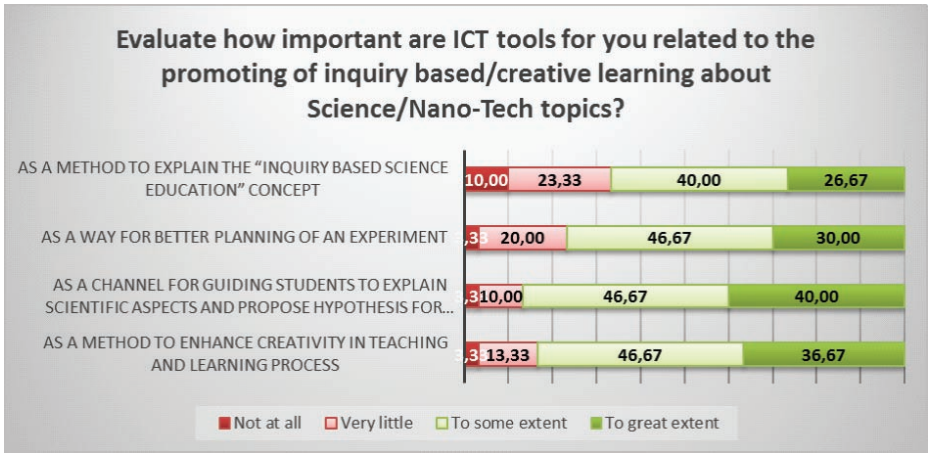


For an on-line lab, abilities like students being able to pose questions, make observations and communicate their results considered very important.

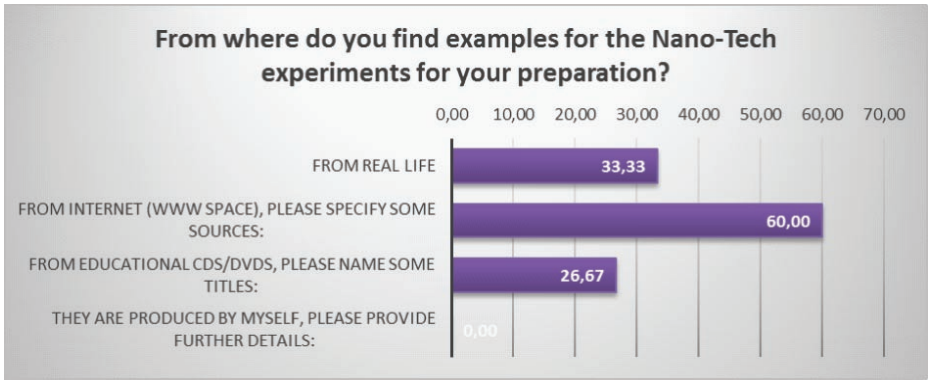
43.33% of prospective teachers consider their skills and abilities on using ICT tools for teaching Science/Nano-Tech topics as average. Two out of three of prospective teachers intend to use PowerPoint presentation for leading Nano-tech experiments in their future lessons.

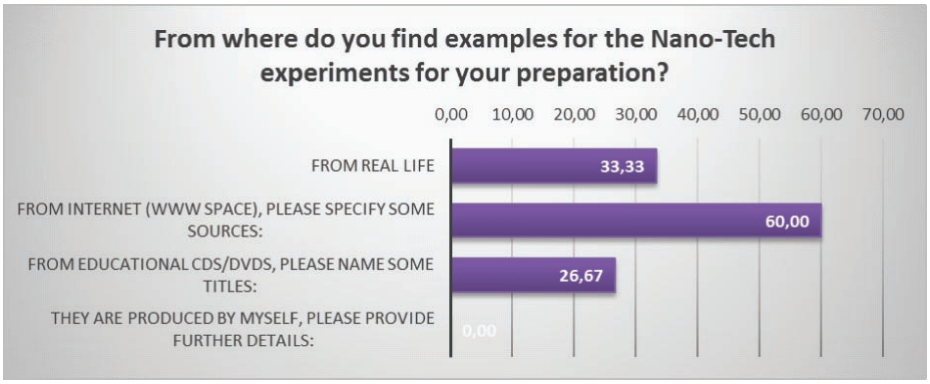


All the proposed ICT tools are considered as important (to some or a greater extent) for teaching science/ Nano-tech topics. 46.67% of prospective teachers consider (to a great extent) ICT tools as a way for improving students' understanding while 53.33% of them agree that to a great extent, ICT tools are useful as a method to improve students' learning skills.



While all of the proposed ICT tools are considered important or very important to promote the "Enquiry-based learning" concept, the use of ICT tools as a method to explain the "Inquiry Based Science Education" concept get negative marks from one out of three prospective teachers.



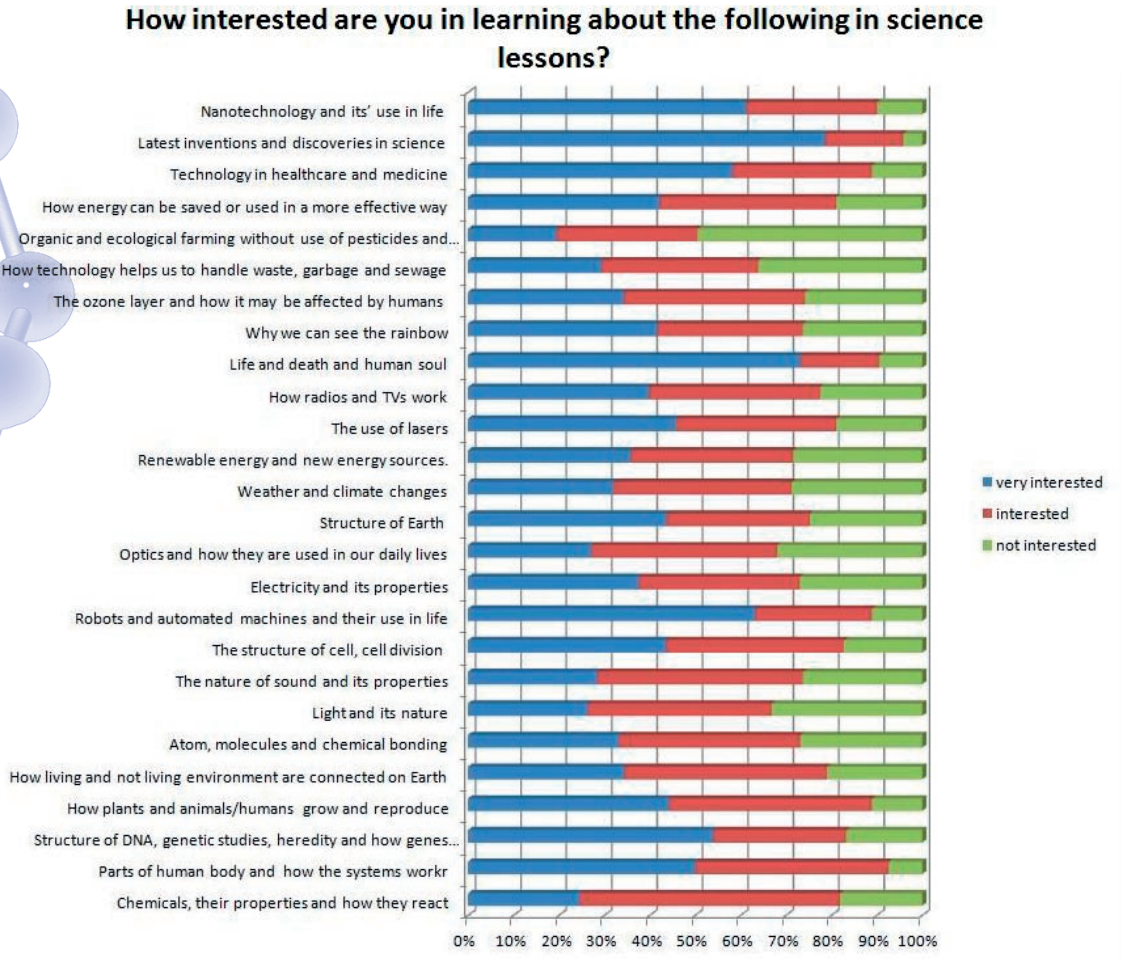


Six out of ten prospective teachers use the Internet as a source for finding examples of the Nano-Tech experiments. They use Google Search, Wikipedia and related science/nano-tech sites). One out of three of them uses real life examples while none of them produces material by themselves.

Turkey (Partner Private Doga Education Institutions)

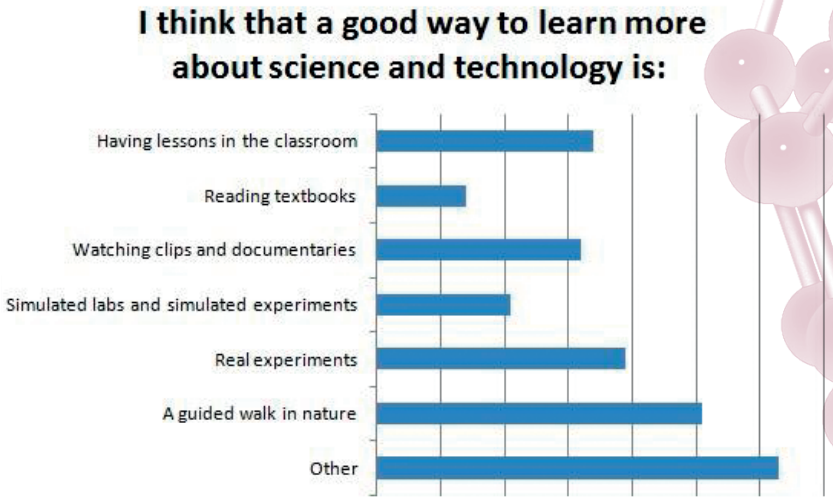
The first questionnaire conducted by Doga Schools aimed to raise students', prospective teachers' and teachers' reflection related to which are the most important topics to be taught or learned in Science lessons and which are the most suitable methods and tools to be used during those lessons. The total number of students involved with the questionnaire was 256. The evaluation of the Students' Questionnaires showed that the students are interested in learning science lessons connected to the new technologies and developments. The most interesting topics for students are:

1. Life, death and human soul (% 59,66)
2. Structure of DNA, genetic studies, heredity and how genes influence how we develop (% 56,39)
3. Technology in healthcare and medicine (% 51,10)
4. Robots and automated machines and their use in life (% 50,31)



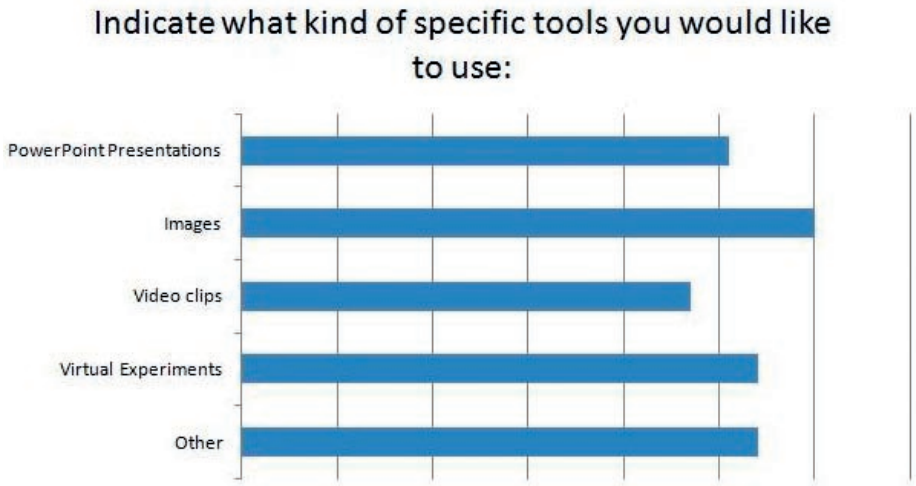
Students' Questionnaire Question No.1

63% of the students thinks that learning with ICT tools, interviews with scientists and academicians as "other ways" are good to learn science.



Students' Questionnaire Question No.3

Students are interested in learning new aspects of science via ICT tools like computers and Internet.



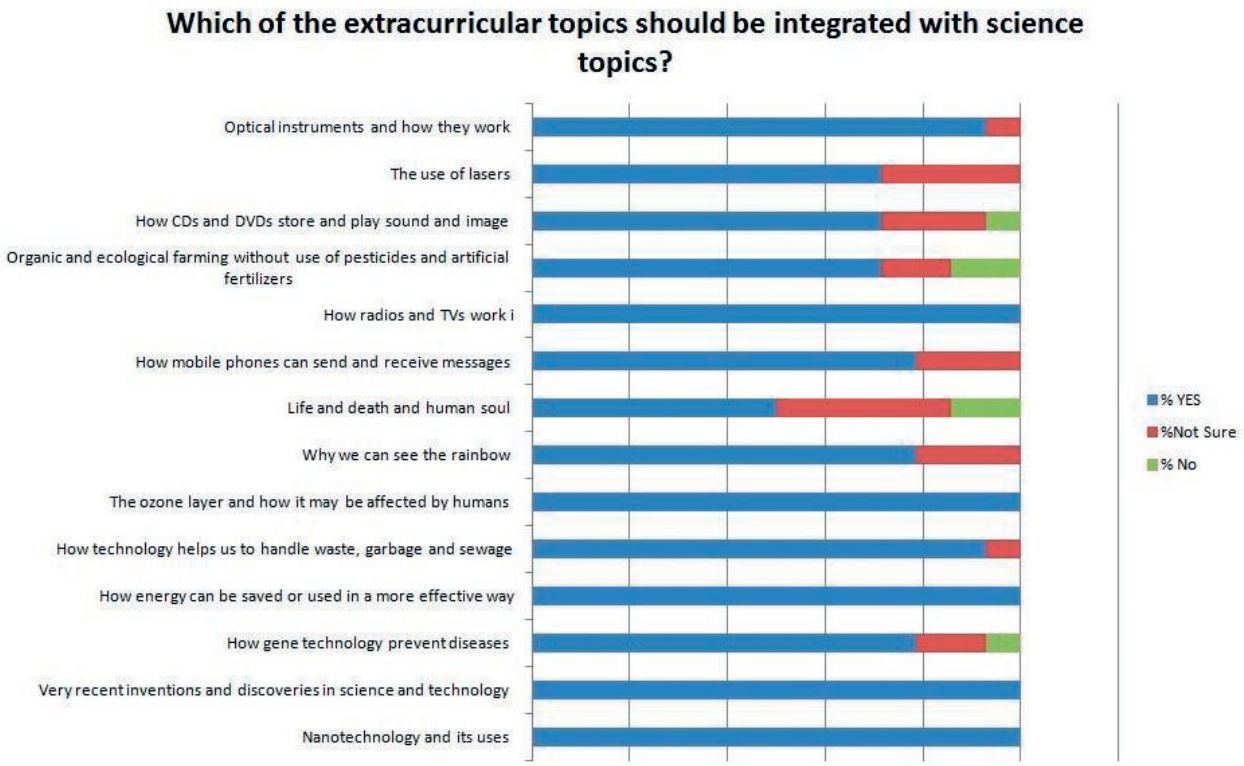
Students' Questionnaire Question No.4b

Students also indicate that they would like to use platforms specially made for them to learn science, scientific blogs and related web pages.

A total number of 67 prospective teachers and 111 teachers were involved in filling in the questionnaires.

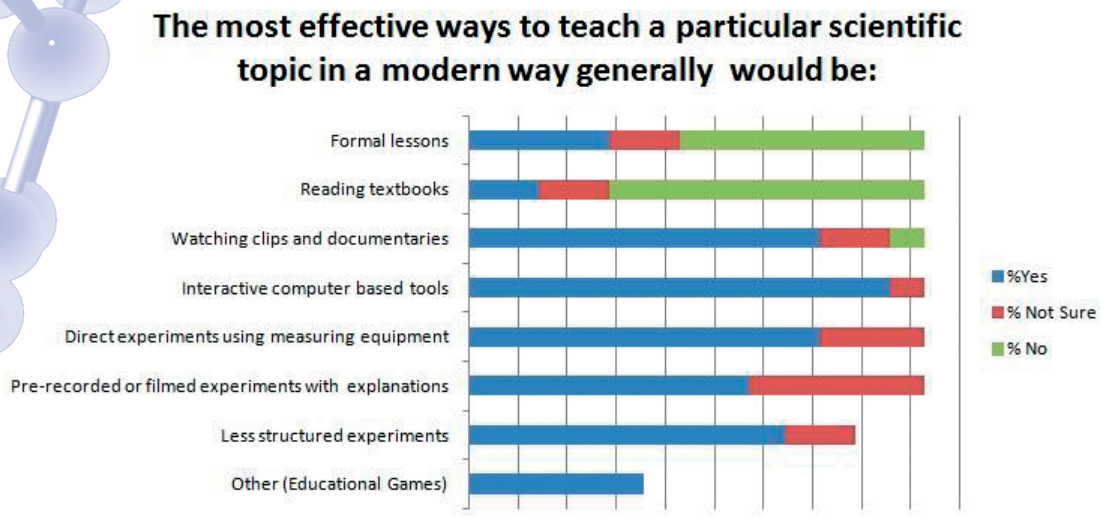
The evaluation of the questionnaires showed that most of the prospective teachers and teachers have some ideas about nanotechnology but do not have any further knowledge and do not know how to integrate basic nanotechnology topics with science lessons. Being in lack of resources about nano experiments integrated to science curriculums, they do not have the opportunity to implement and teach basic nano topics in their classrooms.

Teachers believe that topics about environmental issues and technological developments and inventions are interesting extracurricular topics for students.

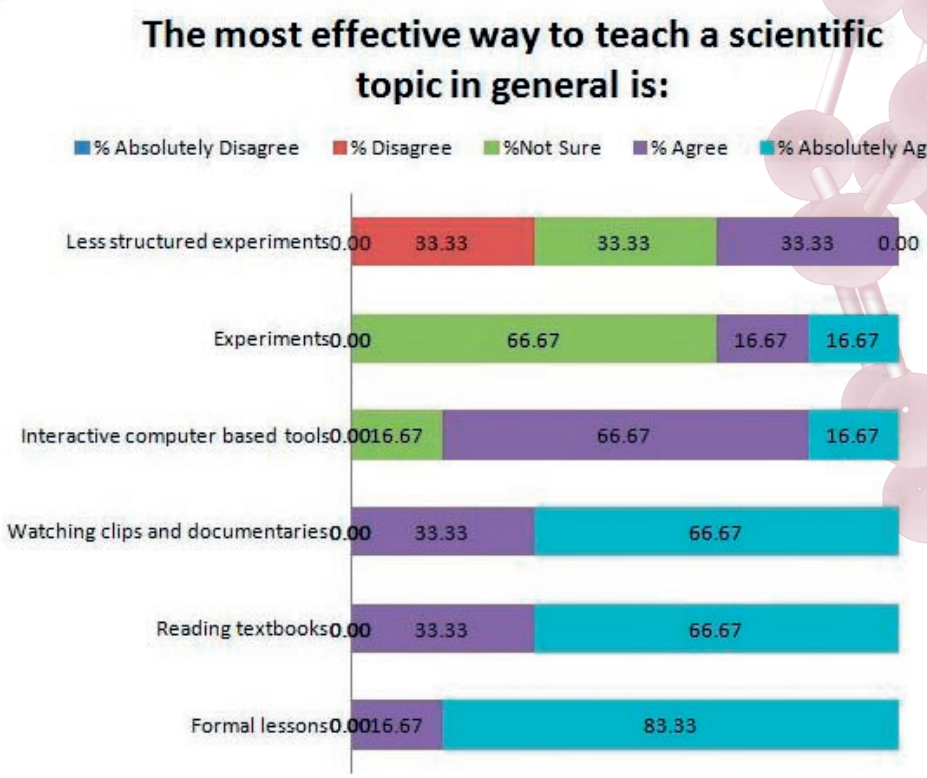


Teachers Questionnaire Question No.2

Teachers consider that interactive computer based tools are the most effective way to teach a particular scientific topic in a modern way. On the other hand, most of the prospective teachers absolutely agree that watching clips and documentaries are the most effective way to teach a scientific topic.

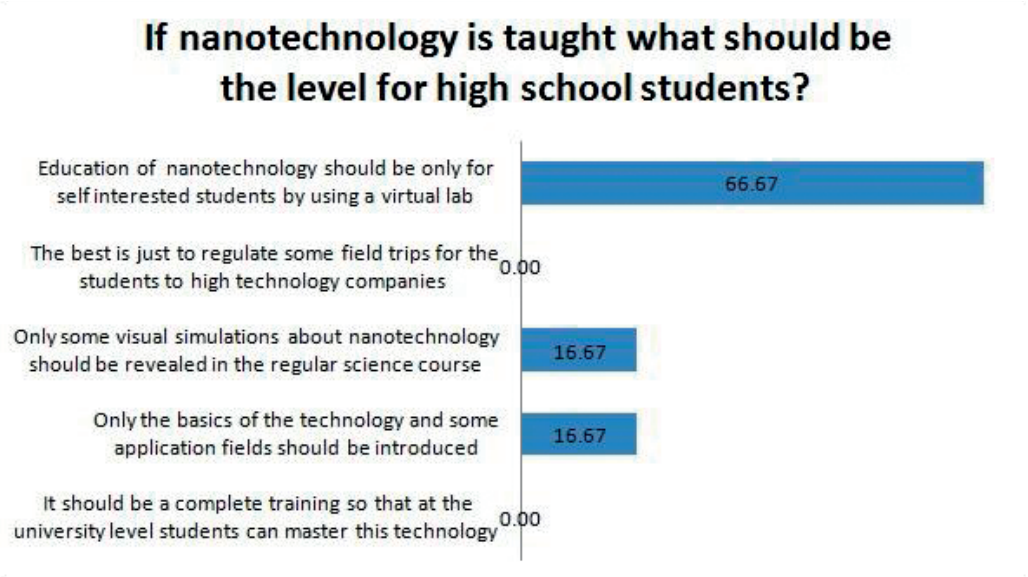


a. Teachers Questionnaire Question No.6



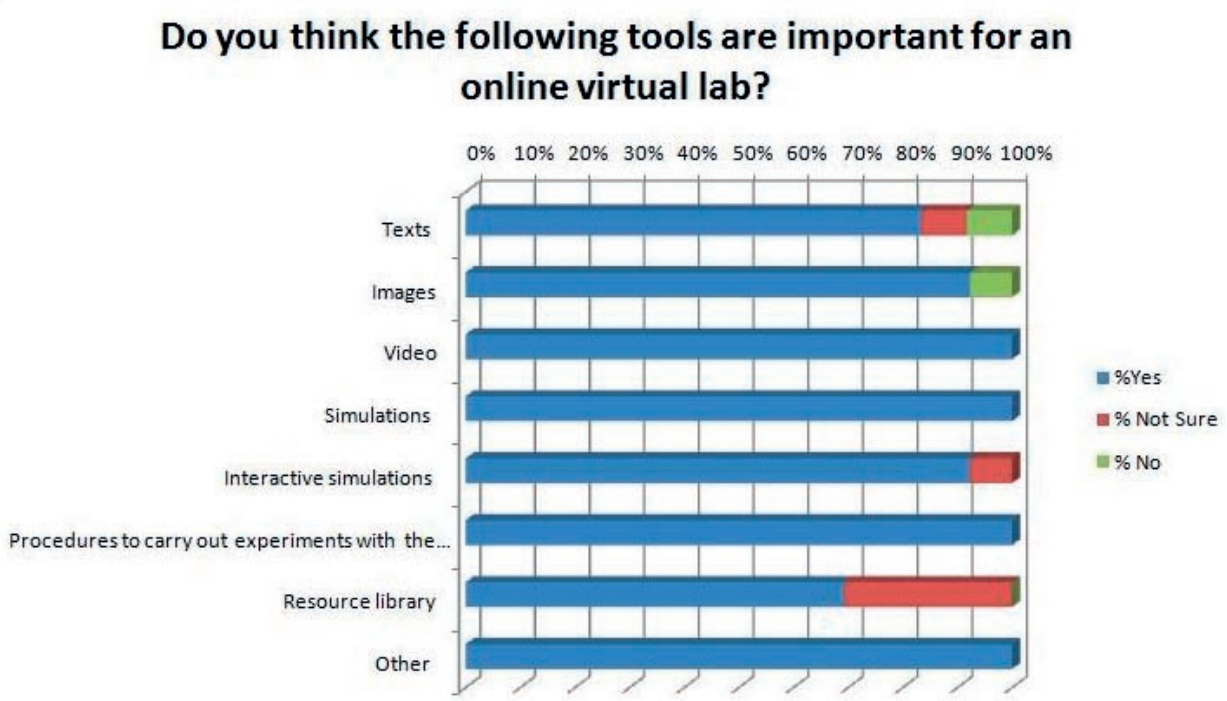
b. Prospective teachers Questionnaire Question No.6

Prospective teachers believe that some application areas of nanotechnology should be taught to high school students by using a virtual lab.

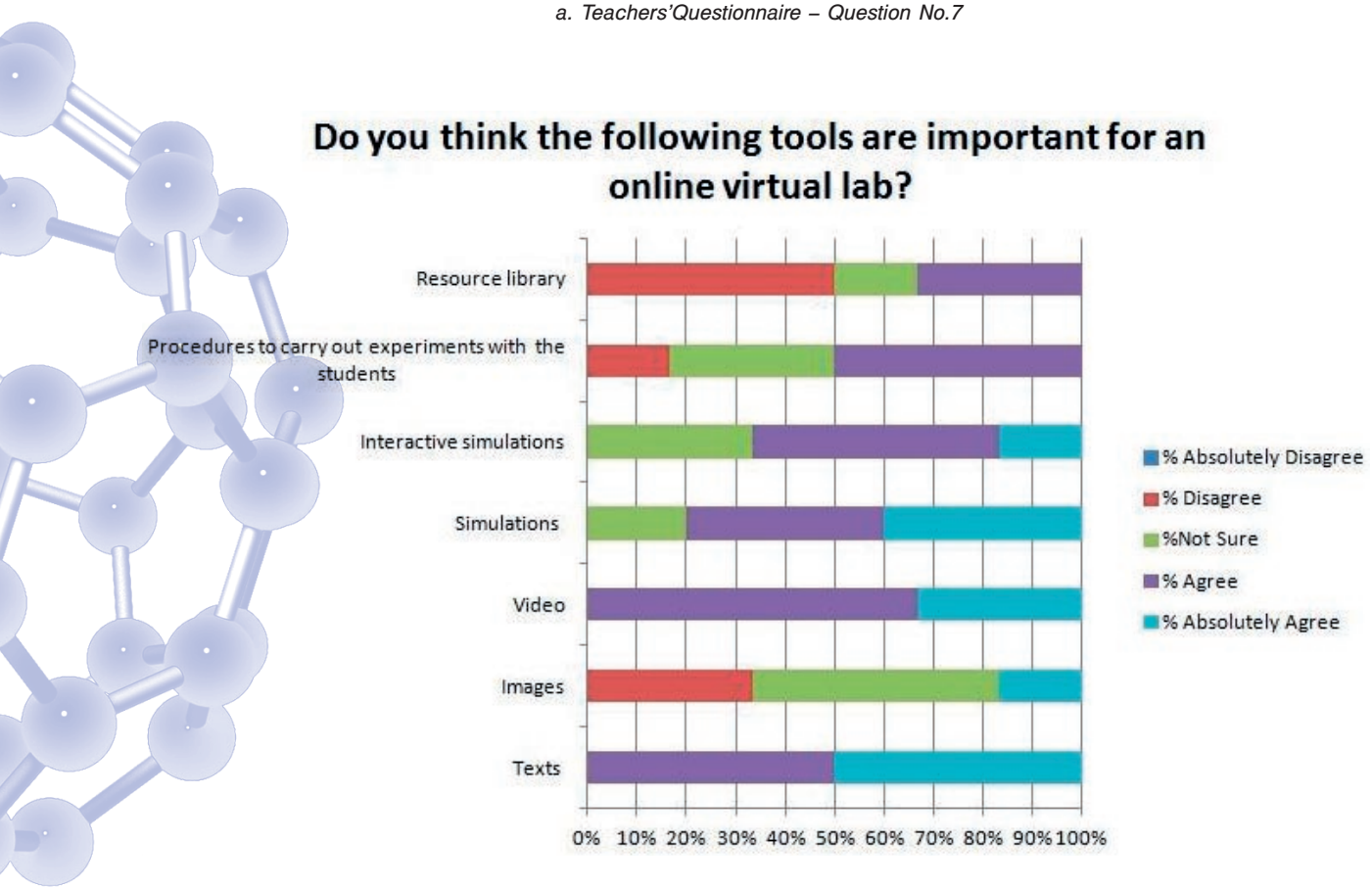


Prospective Teachers Questionnaire Question No.4

Teachers and prospective teachers indicate that videos and procedures are important for an on line virtual lab.

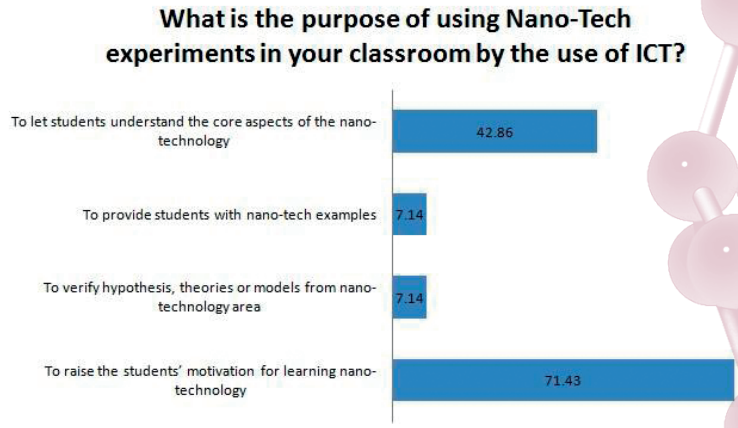


a. Teachers'Questionnaire – Question No.7



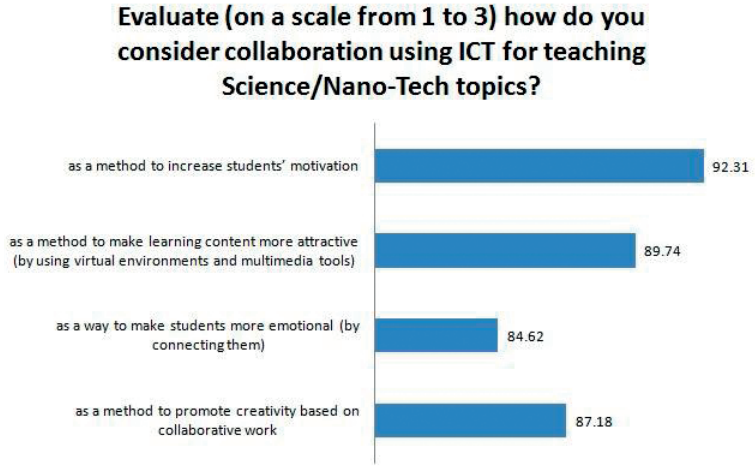
b. ProspectiveTeachers'Questionnaire – Question No.7

Teachers believe that the purpose of using Nano-Tech experiments in the classroom by the use of ICT is to raise the students' motivation for learning nano-technology

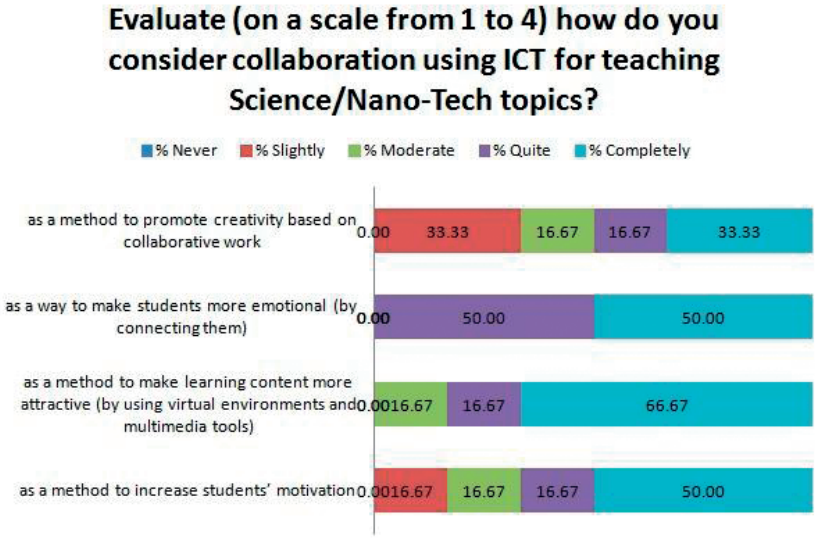


Teachers Questionnaire – Question No.13

Teachers and prospective teachers consider collaboration using ICT for teaching Science/Nano-Tech topics as a method to make learning content more attractive (by using virtual environments and multimedia tools)



a. Teachers' Questionnaire – Question No.16



b. Prospective Teachers Questionnaire – Question No. 15

Both teachers and prospective teachers find good examples of science/nanotech experiments for their lessons from the Internet.

Bulgaria

The analysis is based on the results from **42** respondents; questionnaires collected in July and August 2011.

Question no. 1:

1. Which kind of topics in science education would you consider to be more appealing for students? (e.g. traditional or basic subjects, problems of global importance or scale, topics oriented towards high technologies and innovation, subjects of special importance for human life or improvement of the human condition, topics significant for business applications or future development, other, etc.).

• The majority of teachers indicate that **all topics** are appropriate and appealing to students, but they must comply with the age and interests and to be presented in an attractive manner. Respondents believe that the topics are more intriguing when demonstrating their direct impact on how they can make human life easier.

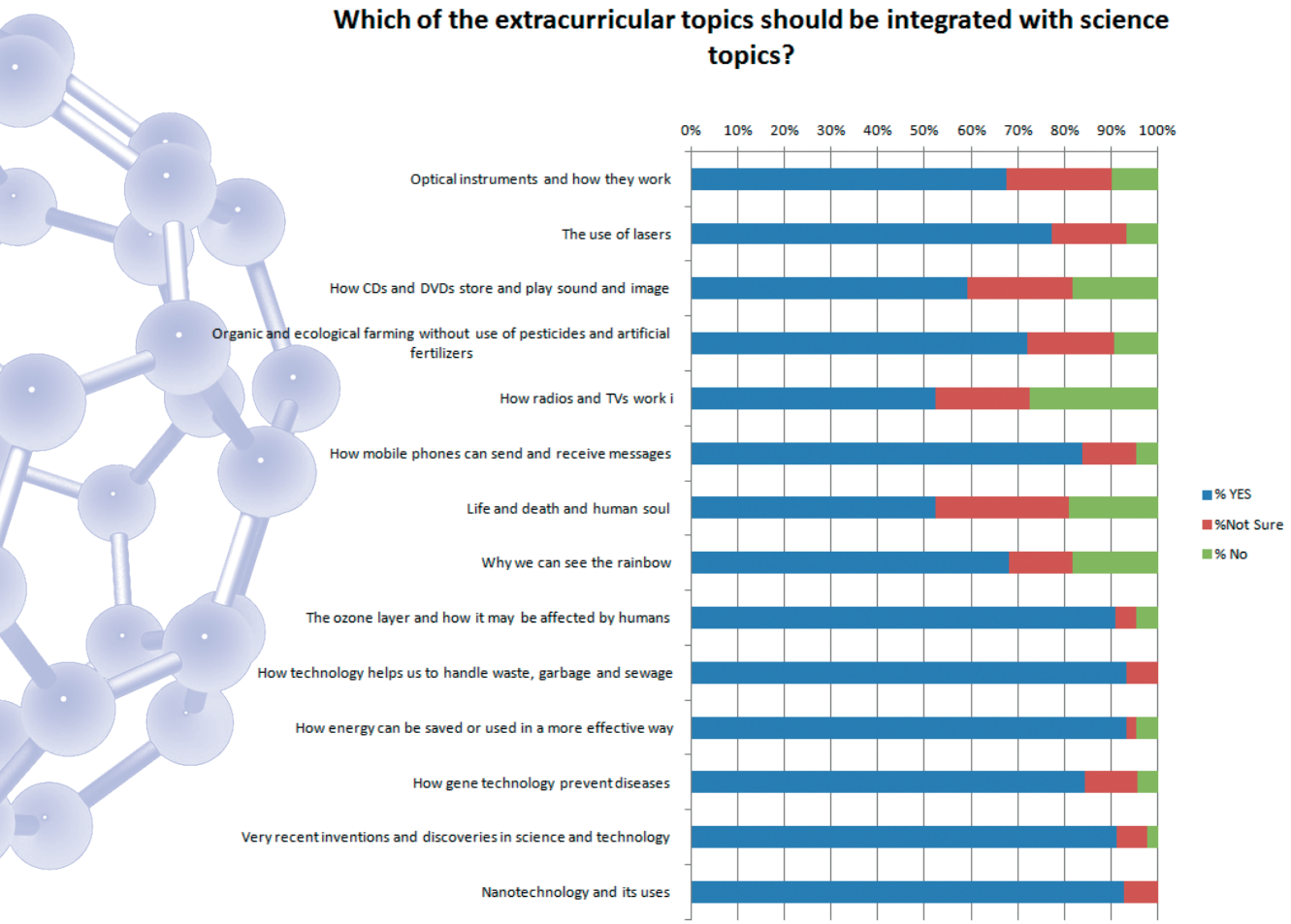
• Respondents believe that the topics should be **illustrated and explained with examples** and issues of particular importance to human life, improving conditions of human existence, oriented to the current modern discoveries in the fields of high technology and innovation, topics of importance for use in business, future personal and universal development.

• Some of those interviewed believe that for *students below seventh grade* is good to learn traditional or basic parts of the material in all natural sciences, and also to include topics on issues of global concern. For high-school students is good to include issues-oriented *high-tech subjects* of particular importance to human life or such that improve the conditions of human existence, as well as topics of importance for use in business or future development.

Question no. 2:

2. Which of the extracurricular topics should be integrated with science topics?

Results are presented in the chart below:



The most of the interviewed teachers are interested in the following subjects:

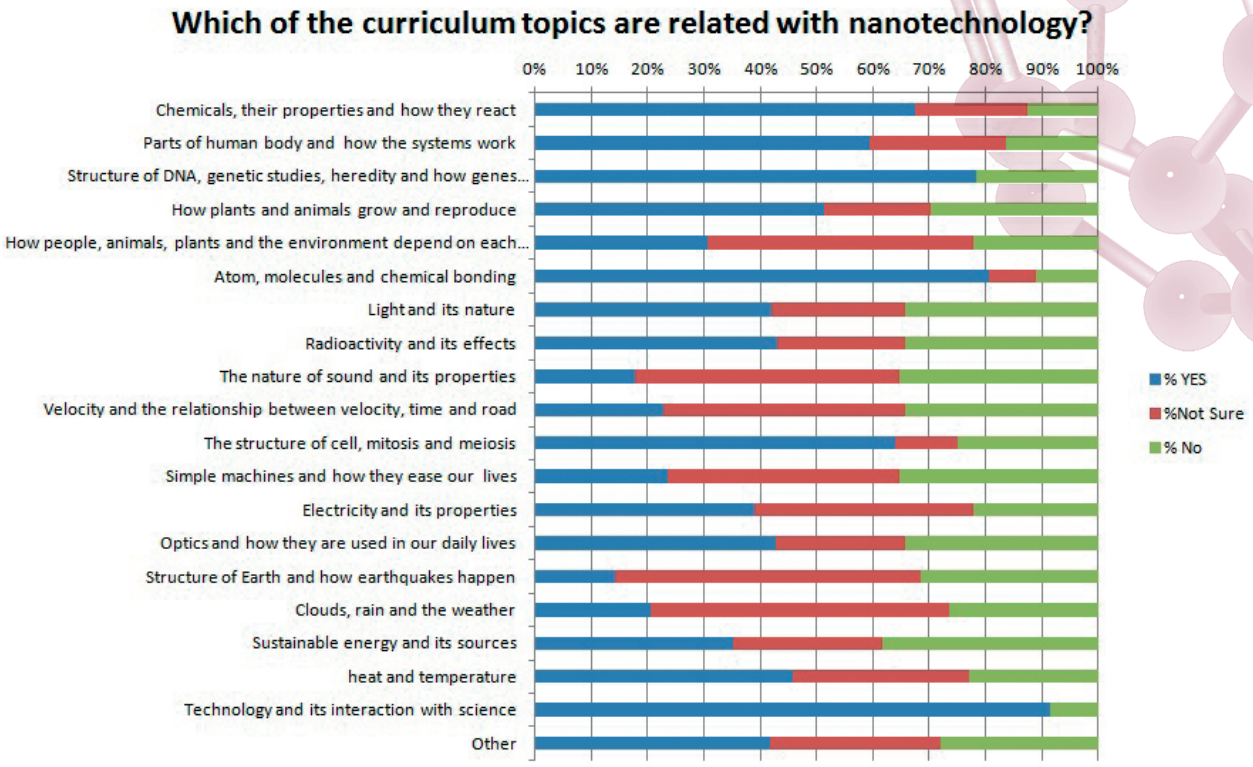
- How technology helps us to handle waste, garbage and sewage – 93.18%
- How energy can be saved or used in a more effective way – 93.18%

- Nanotechnology and its uses – 92.86%
- Very recent inventions and discoveries in science and technology – 91.11%
- The ozone layer and how it may be affected by humans – 90.91%

For this question we have to mention that all of the proposed subjects have score quite above 50% (average: 77.32%)

Question no. 3:

3. Do you have any knowledge about nanotechnology? If yes, which of the curriculum topics are related with nanotechnology?



The 3 most popular answers are:

- Technology and its interaction with science – 91.43%
- Atom, molecules and chemical bonding – 80.56%
- Structure of DNA, genetic studies, heredity and how genes influence how we develop reproduction in humans – 78.38%

The teachers distinguished also:

- Chemicals, their properties and how they react – 67.50%
- The structure of cell, mitosis and meiosis – 63.89%
- How plants and animals grow and reproduce – 51.35%
- The question contains an open field "Other [topics], please specify…" under which some of the respondents added the following:
- Diagnosis and treatment in medicine; tumor treatment
- Production of certain food products such as nutritional supplements
- Production of passive nano-materials as titanium dioxide in sunscreen cream and other cosmetic products
- Surface coatings such as silver in food products, clothing, disinfectants and household appliances, paints, varnishes and other

Most of these additional topics (if not all) are not included in the general curriculum for science subjects.

Note to Q3: We should to note that the way the question is asked does not allow analyzing whether the results show personal or professional opinion of the respondents according to the subject they teach. We are not able to separate objective opinion associated with the professional competence of the interviewed teachers related to educational content and the curriculum to the subjective opinion related to personal competence of the surveyed.

Also, since no data was collected about the subject which respondents teach, no proper analyze of the results obtained in percentages can be performed.

Question no. 4:

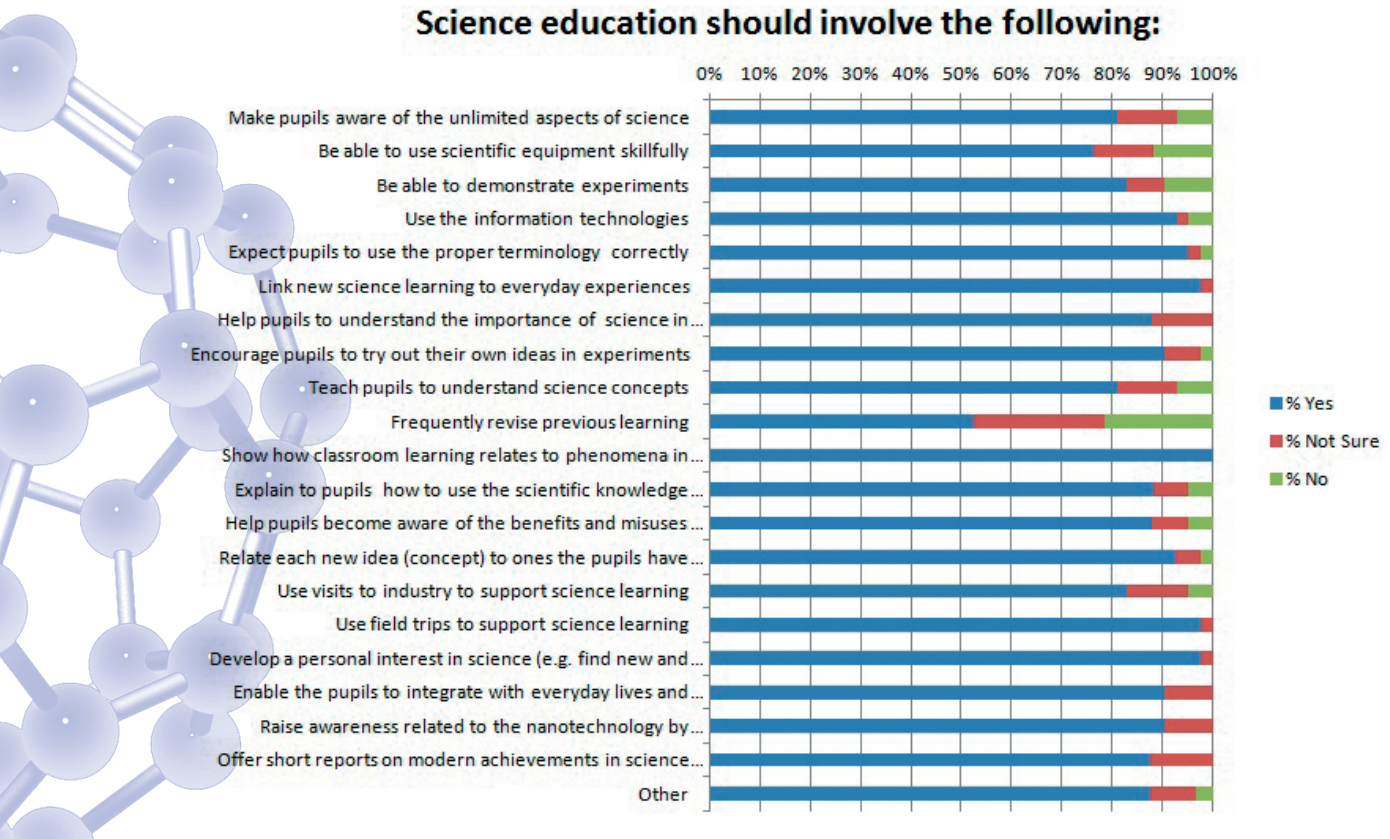
4. Which science topics do you think that should be supported with experiments for a meaningful and permanent learning?

The variety of answers to this question indicates the interest of respondents to this matter:

- Chemistry and the environment, physics and astronomy, biology and health education;
- Sustainable energy and its energy sources;
- Electricity and its properties;
- Optical phenomena and their use in everyday life;
- Simple machines and how they make life easier;
- Areas related to health;
- Energy sources;
- Technologies;
- Optics;
- Atomic and Nuclear physics;
- Magnetism;
- Structure of the cell;
- Examination of samples of materials produced by nanotechnology or those with nanocoatings.

Question no. 5:

5. Science education should involve the following:

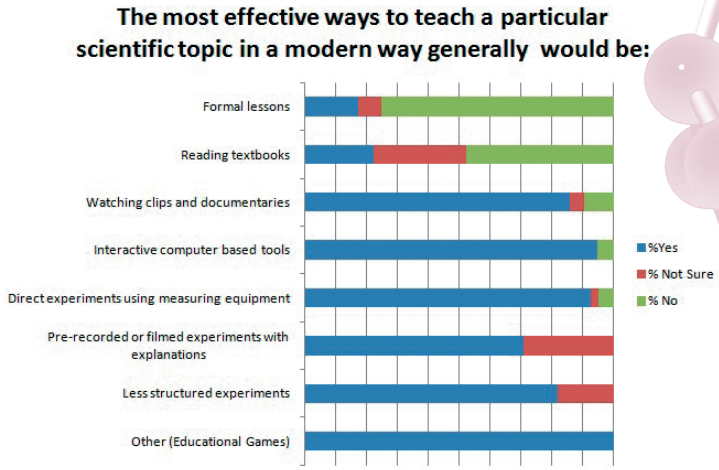


- Show how classroom learning relates to phenomena in outside world and everyday life – 100%
- Link new science learning to everyday experiences – 97,62%
- Develop a personal interest in science /e.g. find new and exciting scientific topics to enrich their understanding of new horizons/ – 97.62%
- Use field trips to support science learning – 97.56%

For this question we have to mention that all of the proposed subjects have score quite above 50% (average: 87.54%)

Question no. 6:

6. The most effective ways to teach a particular scientific topic in a modern way generally would be:

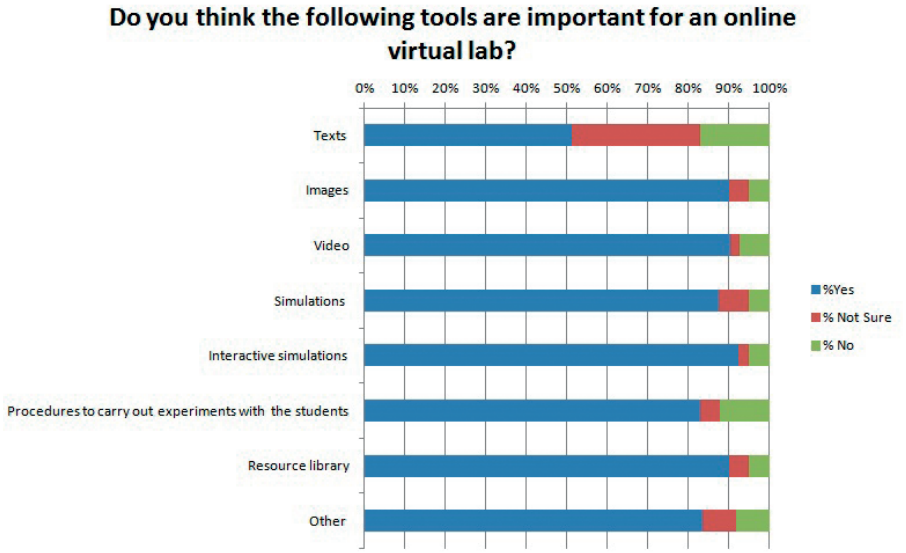


- Interactive computer based tools – 94.87%
- Direct experiments using measuring equipment – 92.50%
- Pre-recorded or filmed experiments with explanations – 87.18%
- Watching clips and documentaries – 85.71%

Only 17.50% of the interviewed teachers think that formal lessons are the effective way of teaching scientific topics.

Question no. 7:

7. Please, rate the importance of the following tools for an online virtual lab:



The importance is rated as follows:

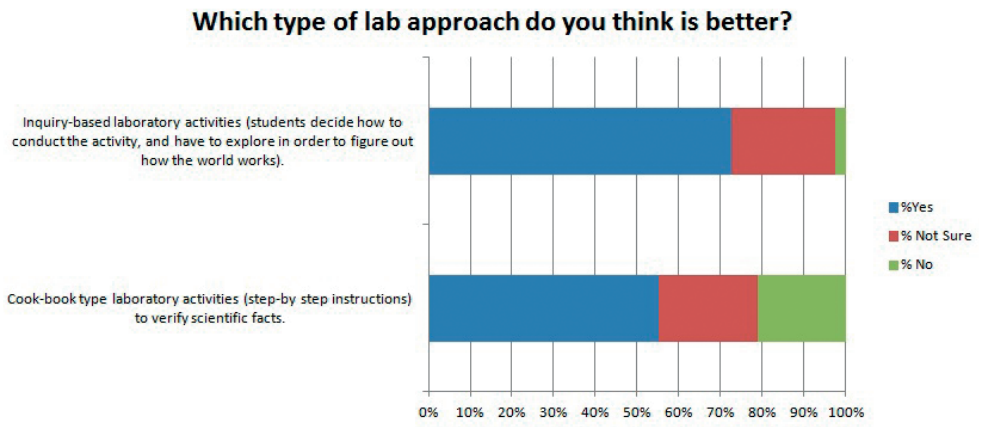
Interactive simulations	92,50%
Video	90,24%
Images	90,00%
Resource library	90,00%
Simulations	87,50%
Procedures to carry out experiments with the students	82,93%
Texts	51,22%

The question contained an open field “Other [tools], please specify…” which was not filled in by any of the 42 respondents whose answers have been taken in consideration for this analysis.

Note to Q7: This question is not sufficiently clearly defined – It does not provide definition of what does "an online virtual lab" means. As shaped the question suggests own interpretation of the respondents and does not allow analysis of the results.

Question no. 8:

8. What type of lab approach you prefer?



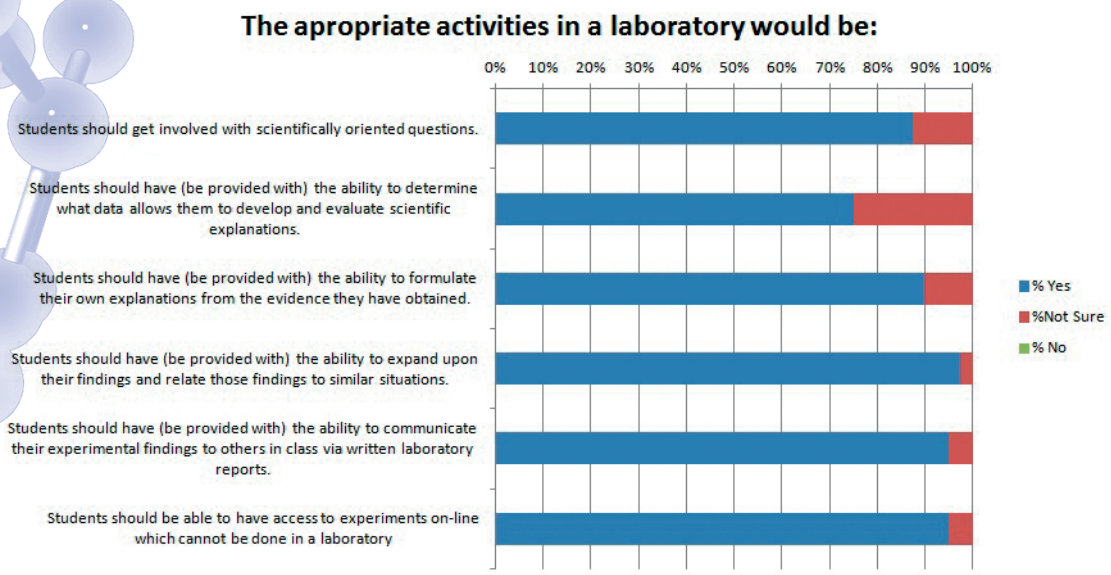
• 72,50% of the teachers prefer Inquiry-based laboratory activities (students decide how to conduct the activity, and have to explore in order to figure out how the world works);

• 55.26% prefer Cook-book type laboratory activities (step-by step instructions) to verify scientific fact

The overall result is over 100%, which means that some of the interviewed teachers pointed both answers.

Question no. 9:

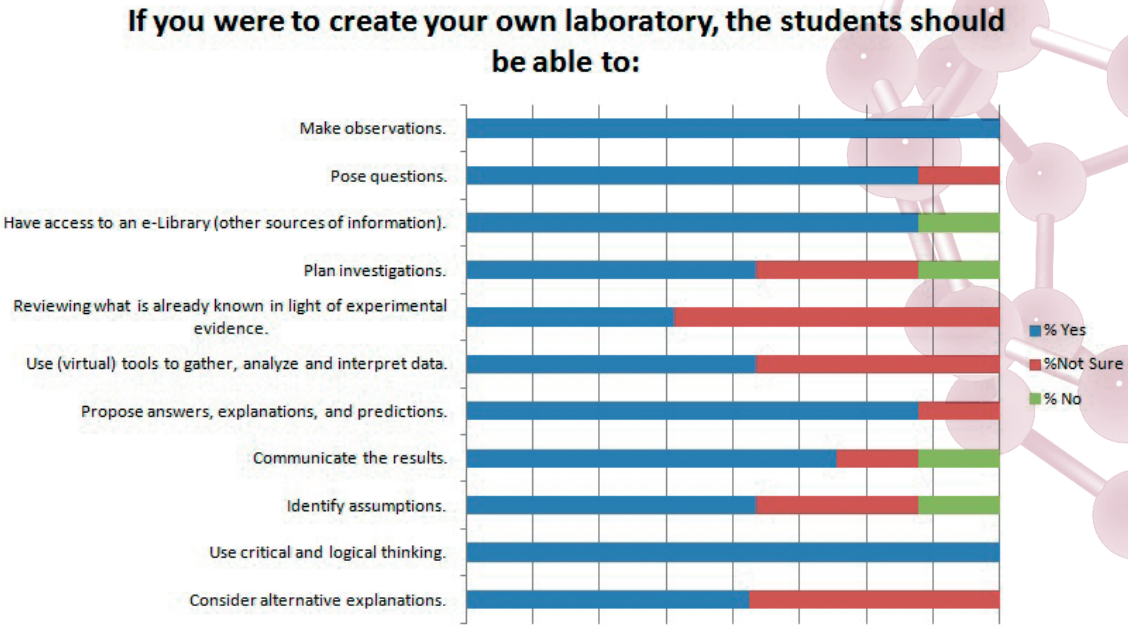
9. What do you t hink that the appropriate activities in a laboratory would be?



90.25% of all interviewed teachers think that all of the subjects pointed in that question are appropriate activities in a laboratory.

Question no. 10:

10. If you were to create your own laboratory, the students should be able to:

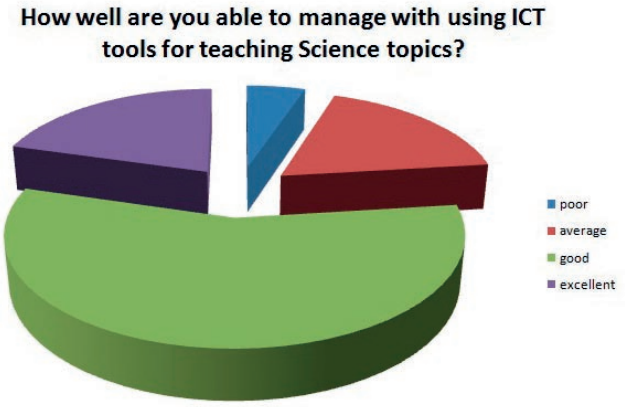


100% **of the teachers answer that the students should be able to *Make observations* and *Use critical and logical thinking.***

The other scours are also very high – average 95.32%!

Question no. 11:

11. How well are you able to manage with using ICT tools for teaching Science topics?

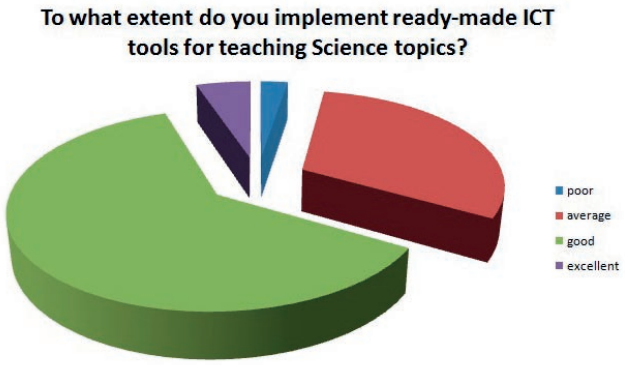


Only 20.51% declare are excellent in managing ICT tools, but 56.41% declare they are good in managing ICT tools.

Note to Q11: This question is not sufficiently precisely defined and is shaped in a way that suggests own interpretation of the respondents. What does using "ICT tools for teaching Science topics" means for each respondent? Some teachers may understand just using PPT… This assumption is partially supported also by the answers of the Q14 below.

Question no. 12:

12. To what extent do you implement ready-made ICT tools for teaching Science topics?

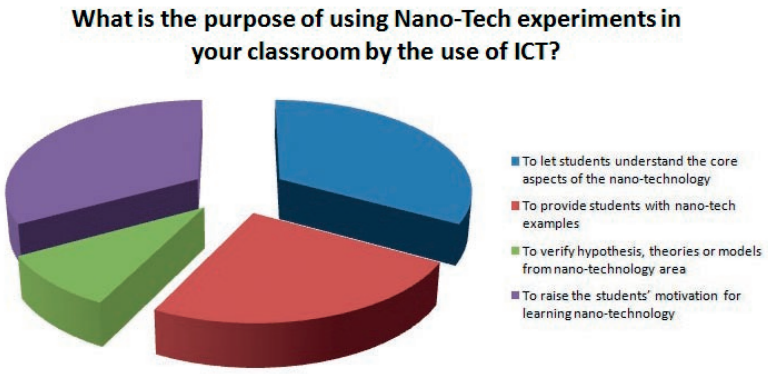


61.54% declare using ready-made ICT tools for teaching Science topics.

Note to Q12: The question failed to ask which are the sources for "ready-made ICT tools for teaching Science topics". Collecting this information would have been useful as a contribution to the contents of the NTSE virtual repository.

Question no. 13:

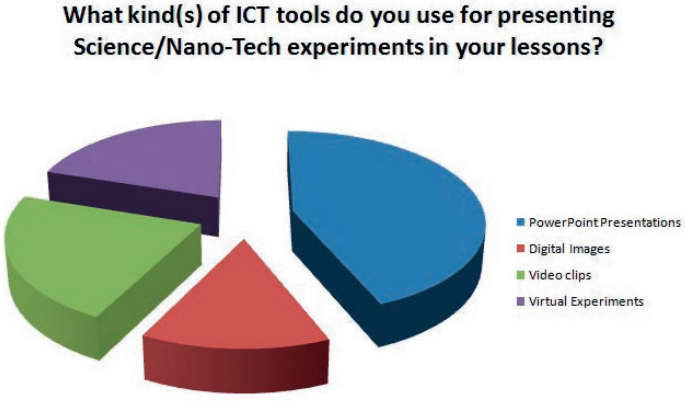
13. What is the purpose of using Nano-tech experiments in your classroom by the use of ICT?



The highest rates are for: To let students understand the core aspects of the nano-technology and To raise the students' motivation for learning nano-technology (each with 32.98%). Seem strange that the motivation for learning nano-technologies is ranged higher than the answer "to provide students with nano-tech examples" which would be the expected answer for teachers in an average schools. Possible explanation for such results would be the assumption that most of the respondents teach in specialized schools for which students choosing a career in the field of sciences is more likely.

Question no. 14:

14. What kind(s) of ICT tools do you use for presenting Science/Nano-Tech experiments in your lessons?



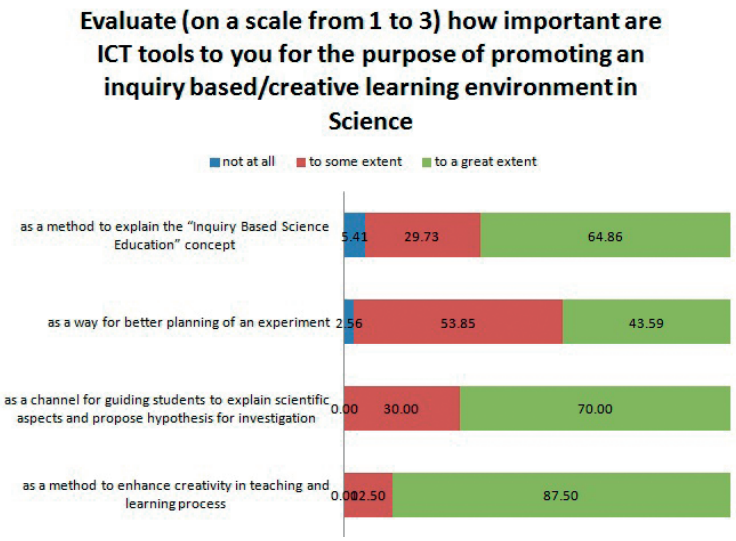
43.75% declared they use PowerPoint Presentations. Unfortunately the formulation of the question do not allow making a relevant conclusion whether this answer is an indication for the type of the *prevailing sources* which are accessible to the respondents or for the level of their ICT competences.

The question contained an open field "Other [ICT tools], please specify…" which was not filled in by any of the 42 respondents whose answers have been taken in consideration for this analysis. However, put after a relatively exhaustive enumeration, this question was addressing the **type** of the ICT tools (supposedly) used by the respondents.

Note to Q14: It was necessary for those who pointed in their answer that they use "virtual experiments" to have also sub question to identify the sources they use. This information would have been useful as a contribution to the contents of the NTSE virtual repository.

Question no. 15:

15. Evaluate (on a scale from 1 to 3) how important are ICT tools to you for the purpose of promoting an inquiry based/creative learning environment in Science teaching?

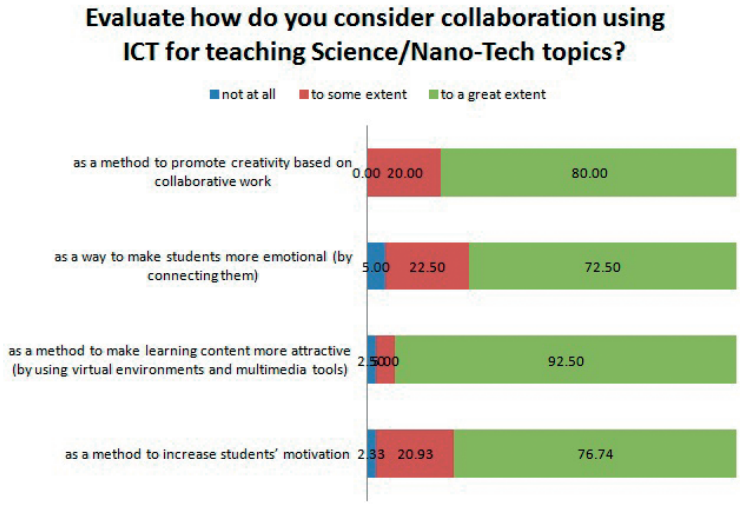


87.50% vote for ICT being *a method to enhance creativity in teaching and learning process,* and **70**% for it being *a channel for guiding students to explain scientific aspects and propose hypothesis for investigation.*

It has to be mentioned that above 50% (average: 66.67%) of the respondents rated the importance of the ICT tools for all aspects of the inquiry based/creative learning mentioned in this question.

Question no. 16:

16. Evaluate (on a scale from 1 to 3) how do you consider collaboration* using ICT for teaching Science/Nano-Tech topics?



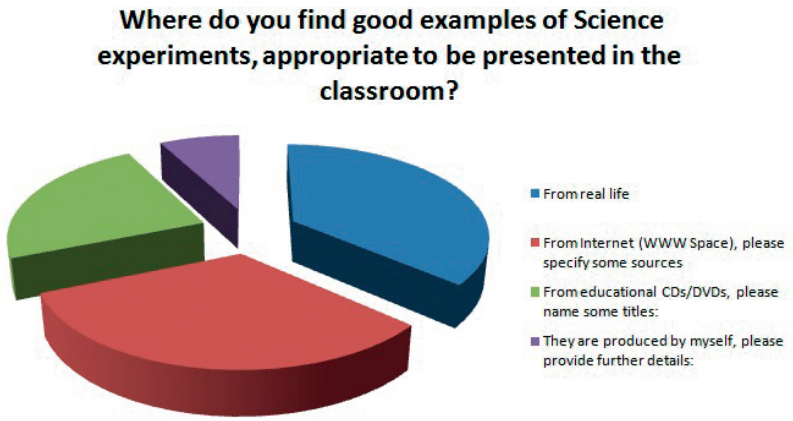
*This question in its variant in Bulgarian language contained additional specification **"collaboration with your colleagues or other specialists through ICT"** which is important to be taken in consideration when reading the data.

The importance of *collaboration using ICT* is considered most effective as a method to *make learning content more attractive* by **92,50**% of the respondents. However, the information added in the brackets puts a special emphasis on this answer, linking it with "using virtual environments and multimedia tools". This adds an ambivalent aspect on the results, as it is not clear if the leading motivation of the respondents was to emphasize in general on the role of the collaboration through ICT for making "learning content more attractive" or that they consider "using virtual environments and multimedia tools" in particular as necessary element of the collaboration.

It has to be mentioned that the use of ICT *for collaboration* is rated **above 50**% (average 80.37%) as important for teaching Science/Nano-Tech topics, incl. *as a way to make students more emotional.*

Question no. 17:

17. Where do you find good examples of Science experiments, appropriate to be presented in the classroom?



It is important to underline that the highest score here – 36,36% received the suggestion *from real life,* only then followed by the *internet* as a source for good examples. We would suggest this result to be considered for verification of the respondents' answers concerning the use of ICT and the estimation of the role of the ICT tools.

With the view of Q17 it is also important to pay attention to the fact that none of the respondents mentioned a particular web-based source or educational CD actually used in his/her practice. The possible reasons for the lack of particular data about sources/ programs could be:

a/ the fact that Q17 is the last one within a pretty long questionnaire and the respondents were already too fatigued to go into details
or
b/ the lack of real implementation of ICT based tools in their practice. However, we have no basis to support either of these two hypotheses.

IV. NTSE VIRTUAL LAB – INSTRUMENT FOR PROMOTING NANOTECHNOLOGY IN THE ACTUAL SCIENCE EDUCATION

Description of Virtual Laboratory

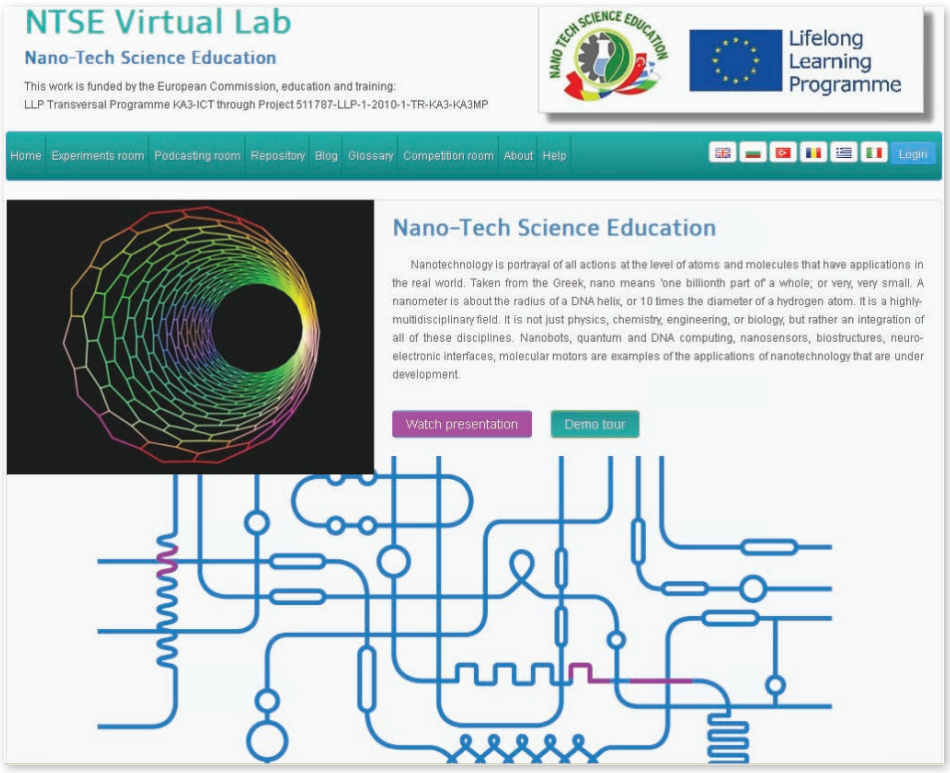
http://vlab.ntse-nanotech.eu/

The use of a Virtual Lab (VL) serve as a platform for science lessons, as a database of teaching materials and as a hub for science-learning graphic aids and recorded and illustrated appealing experiments on Nano-Tech. Students and teachers in secondary are able to use and refine the VL, for lessons and sharing information. The VL is last long after the life of the project is an on-going platform for sharing ideas, lesson plans and information.

The Virtual Lab contains the following sections:

- Home;
- Experiment room;
- Podcasting room;
- Repository;
- Blog;
- Glossary;
- Competition room;
- About;
- Help;
- Language manual;
- Log in section for admin panel of the Virtual Lab.

1. Home section – short description with pictures what Nanotechnology, presentation and demo tour of the Virtual Lab.



To watch the presentation click on the button "Watch presentation".

To watch the Demo tour click on the button "Demo tour"

2. Experiment room – Nano experiment room comprises real experiments shot by the Nano-tech academicians, animations created from the scenarios, students and teacher guides and additional resources for each experiment. The main aim is to create our authentic experiments different from the published and finalized nano projects and support each video with simulations and scenarios to make them more simple and attractive for virtual lab users.

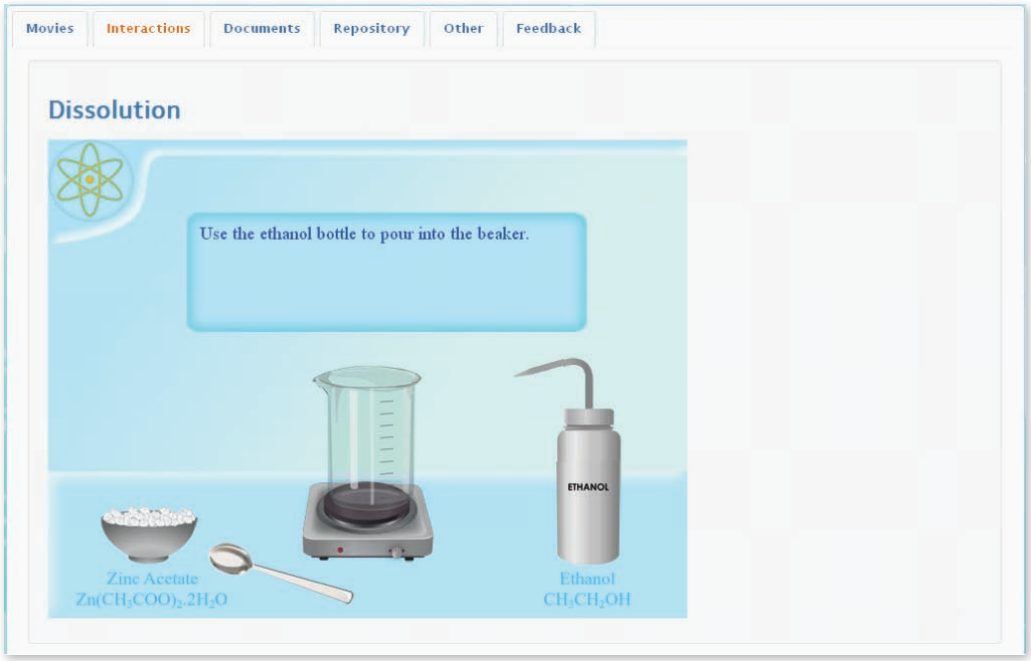
To open an experiment click on the picture of the experiment.

Each experiment contains:

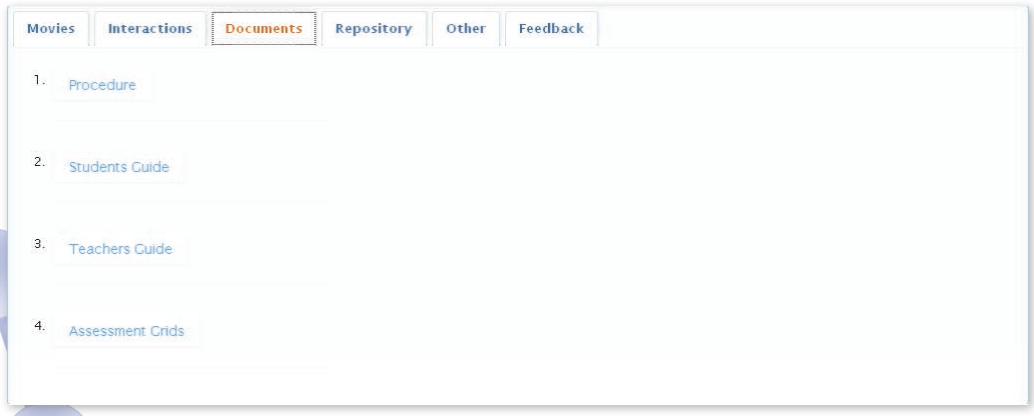
- Name and description of the experiment;
- Movie section;
- Interactions;
- Documents – students guides, teachers guides, assessment grids and procedure;
- Repository – links to the repository related with the topic of the experiment;
- Other – contains other links and documents useful for the experiment;
- Feedback section – it is a space where each visitor can send his comment or question.

To watch an experiment movie click on the "Movie" button and you can play the video.

To open an interaction click on the "Interactions" button and you can play the interaction.

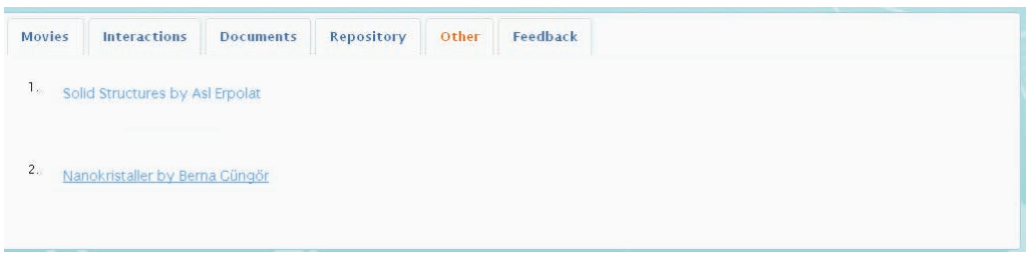


To know what the procedure of the experiment is and find all document that you need to implement the experiment, click on the "Documents" button.

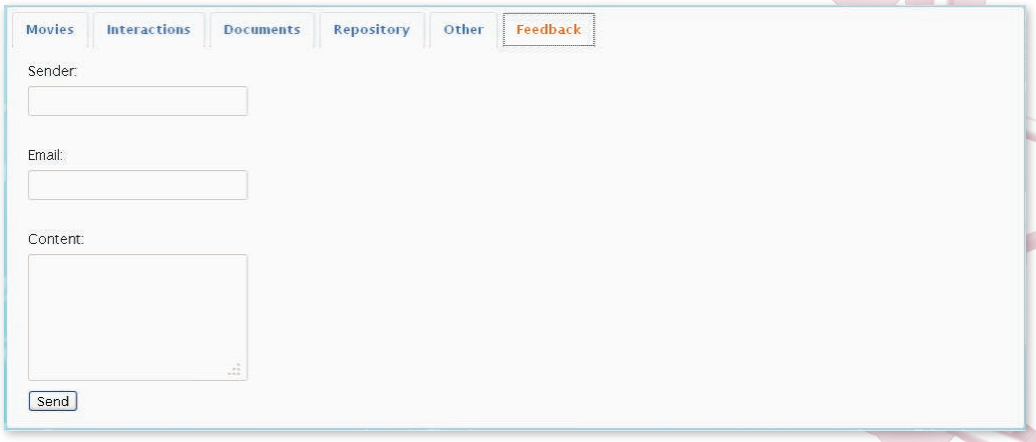


Click on "Repository" button to find more resources related with the topic of the experiment. You will be forwarded to the Repository of the project.

"Other" section opens other links or documents useful for the experiments which are extra materials not in the Repository.



In "Feedback" section you can contact the partners of the project or you can leave you comments.

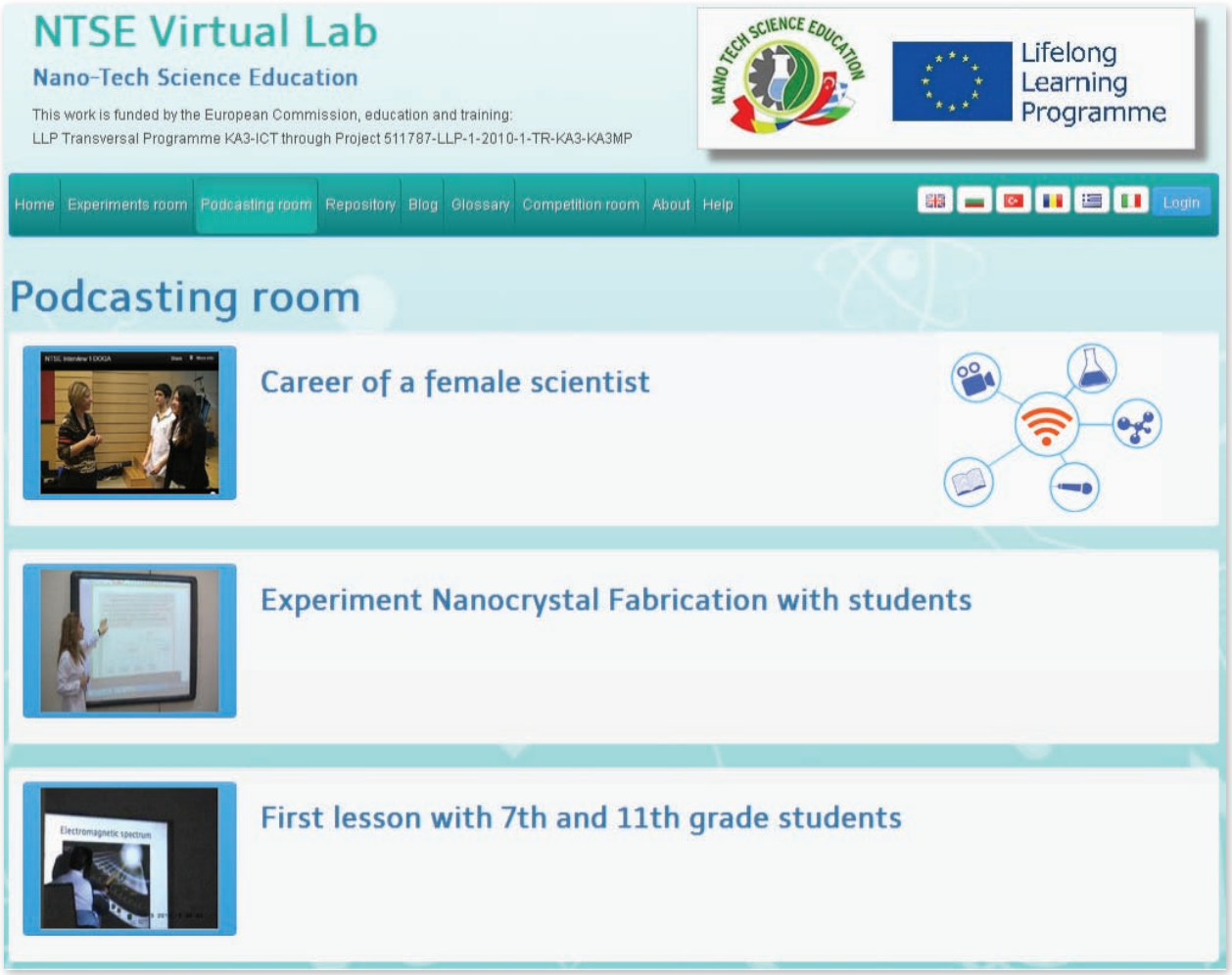


3. Podcasting room – Podcasting room comprises the videos, audios and pictures of the interviews related to the gender aspect, calls for the VC sessions, video conferences, classroom implementations records and dissemination activities of the project.

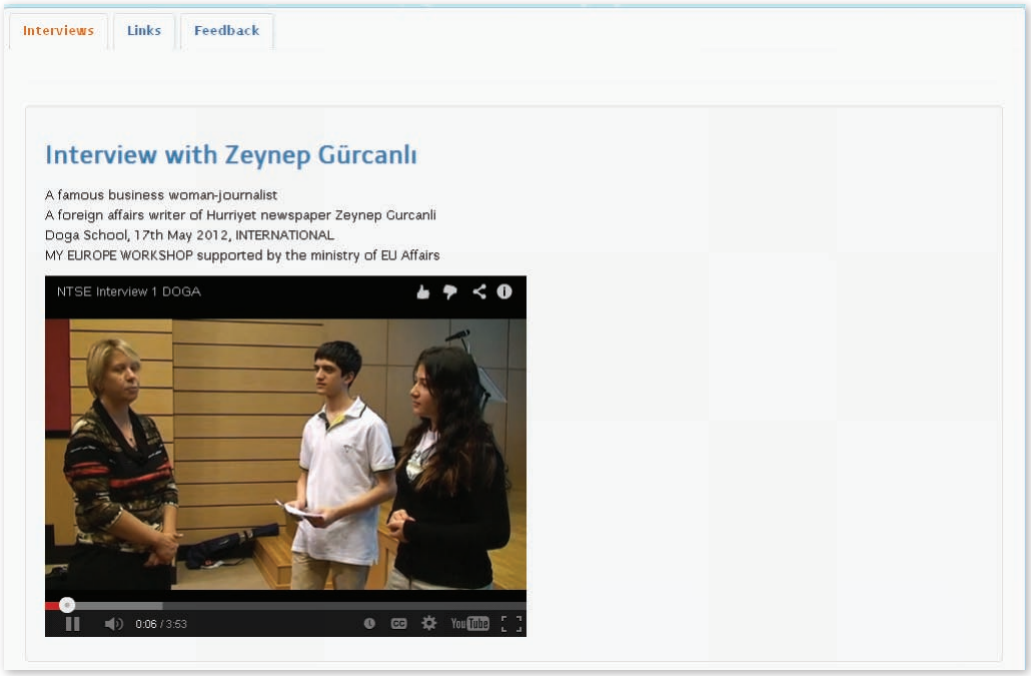
The podcasting room contains:

- Name and short description of the session;
- Video or interview section;
- Feedback link.

To open a podcasting activity click on the picture of the podcasting session.

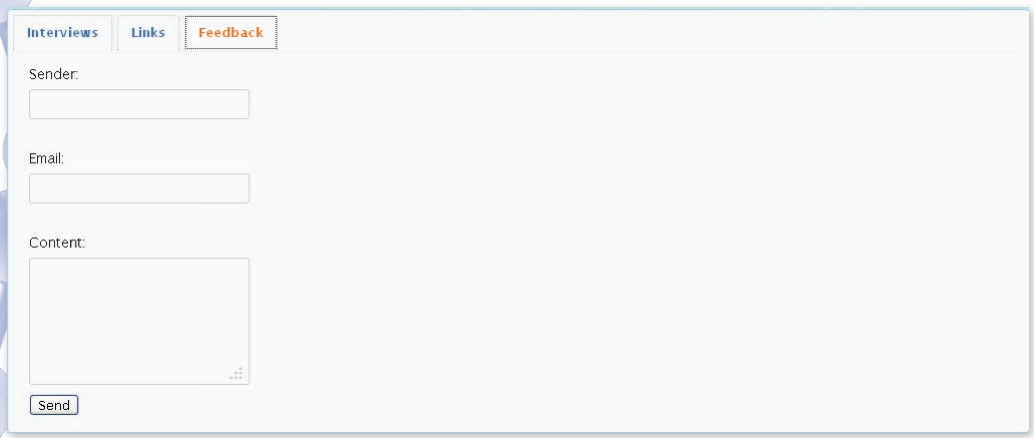


When you open the topic of the podcasting entity you can play the interview, video or you can see the pictures of the podcasting activity from "Interviews" or "Movie" button.



In "Link" section you can find additional materials related with the topic of the podcasting activity.

In "Feedback" section you can contact the partners of the project or you can leave you comments.



4. Repository – the NTSE Repository / Database has been designed as extra reading and reference related to Nano-Science and Nano-Technology readings, to be used by the virtual lab users. It includes: articles, books, chapters, posters, videos, experiments, methodological documents which introduce actual findings and researches developed in different countries. The role of the Database is to update the virtual lab users' knowledge and to raise their awareness on Nano-Science and Nano-Technology.

The "Repository" button in the Virtual Lab will link you to the Repository page: http://ntse.ssai.valahia.ro

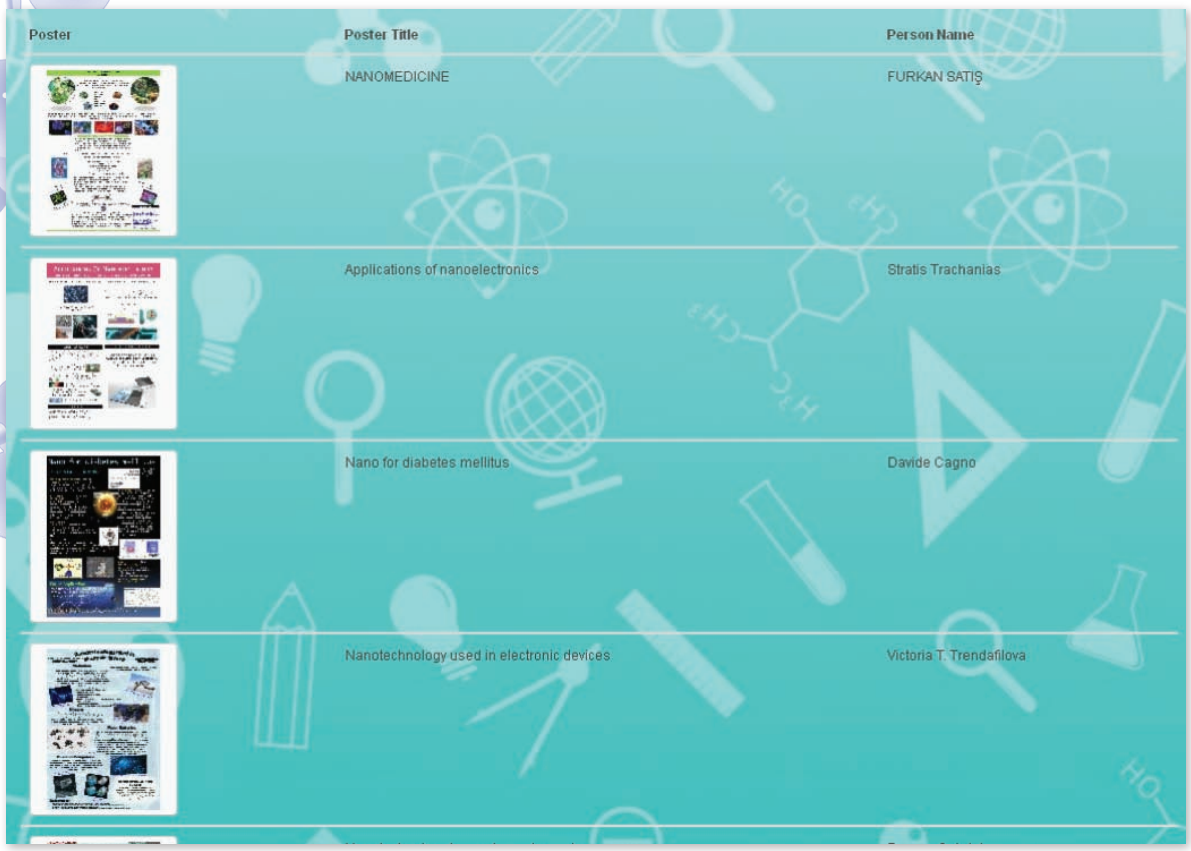
5. Blog – apart from Virtual Lab and repository, partners have set up a portal system, to enable the implementers to share knowledge about the articles, implementations on project related issues. Discussion space will be created in the blog format and it will be used for making comments and submitting articles. All submitted articles will be reviewed and validated for publication after validation process by the project experts.

The „Blog" button in the Virtual Lab will link you to Blog page: http://ntse.iacm.forth.gr/index.php

6. Glossary – it is vocabulary with definitions of nano terms.

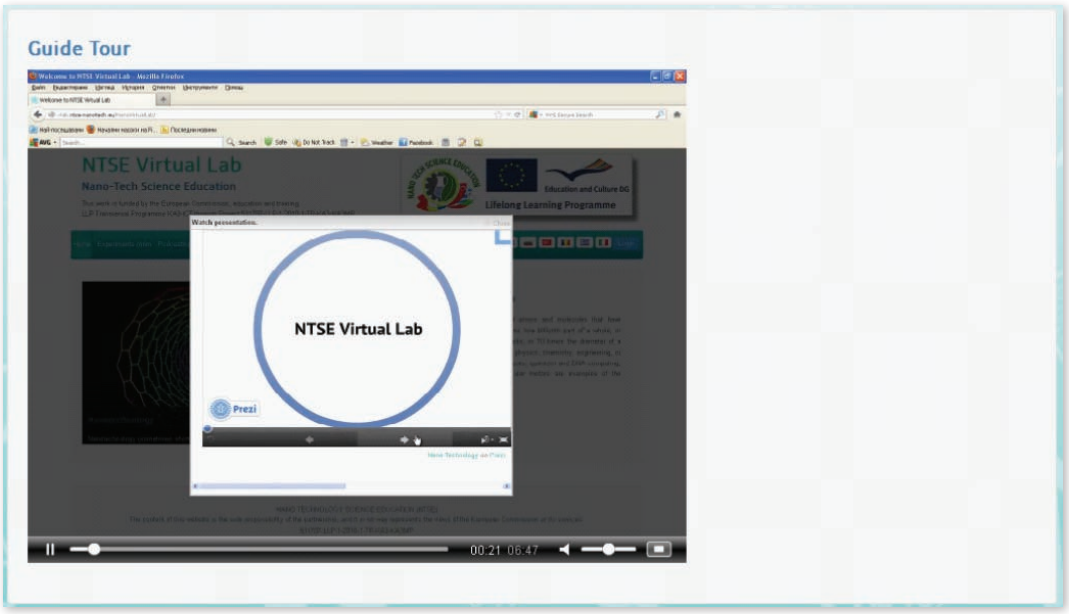
To see the definition of the word, click on the nano term.

7. Competition room – contains presentations and information about Nano competitions. Provides tools for uploading files, contains gallery of posters and insures voting in order to cover the whole process of the Nano Competition.

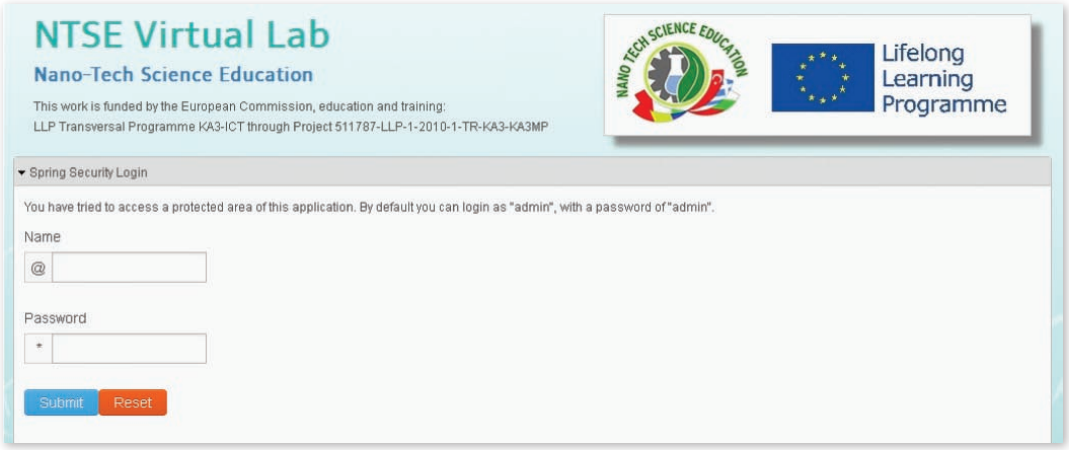


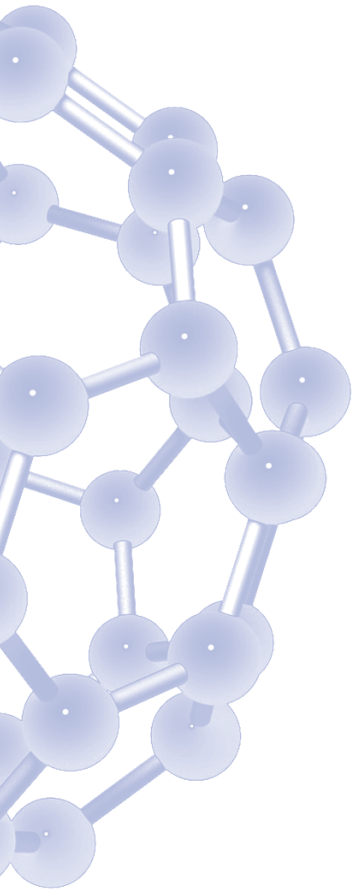
8. About – contains short description of the project.

9. Help – it is a place with Guided Tour of Virtual lab to support users how to use the platform.



10. Log in section for admin panel of the Virtual Lab – this panel is for managing or editing of the whole Virtual Lab functionalities from the partners.





V. METHODS AND RESULTS OF THE NTSE VIRTUAL LAB IMPLEMENTATIONS

Need Analysis and Curriculum Match

The educational basis of the project was initiated with the planning of need analysis studies to define the pedagogical features required for ICT-based science teaching on nanotech, for different target groups as students between the ages 13-18, teachers and prospective teachers. This study also comprises the basis of educational tool in the virtual laboratory.

Before applying the questionnaires on the target groups "National Curriculum for Science Education" for the students between the ages 13-18 of the Partner Countries were examined. This description highlighted, in what extent the Nano Project team have to add some extra information on existing system and guide to the science teachers on Nanotechnology.

The curriculum of physics, chemistry, biology subjects in high schools and science curriculum in secondary schools were analysed in each country according to the content of the topics in each subject in order to find out the nano related topics. In the curriculum match table, the nano related topics, the content (background) of these topics, matching Nano Experiments of the Virtual Lab and the related grades of the schools in partner countries are defined. The most common matched Nano activities in partner countries are "Making Origami Buckyball" and "Carbon Nanotubes". These activities are both related with physics and chemistry topics in TR, RO, GR and IT. "Making Origami Buckyball" and "Carbon Nanotubes" experiments are matched with "Atomic Structure, Chemical Bonding, Compounds, Periodic Table" topics. These topics are current in TR in 8th, 10th grades chemistry and 11th grade physics; in GR 11th grade chemistry and 12th grade physics; in RO in 9th grade chemistry and in IT in 12th grade chemistry. "LEDs" experiment is another common activity in partner countries matched with "Photoelectric and Compton effect" in physics and "Structure of Atom" in chemistry. In GR and RO, the activity is related to the physics topic in 12th grades and in IT in 13th grades. In TR, the activity is matched with 11th grade physics and 10th grade chemistry. "Iron Nanoparticles and Ferrofluid" experiment is also common in TR, GR and RO while IT has no matching topic. It is matched with "Magnetism" in physics and "Atomic Structure, Chemical Bonding and Electrochemistry" in chemistry. In TR and GR the activity is related with 11th grades and in RO it is related with 12th grades in physics. Only in TR, the activity is matched with 10th and 11th grade chemistry topics. "Understanding Nanoscale" experiment is mainly matched with physics topic "The nature of Physics" in partner countries. The activity is related with physics topics in GR in 8th and 10th grades, in IT 12th grades, in TR 9th grades and in 8th grade chemistry."Nanocrystal Fabrication" experiment is a common activity for chemistry topics "States of Matter and Mixtures" in all partner countries. It is related with chemistry topics in GR 8th and 10th grades, in RO 9th grades, in TR 10th grades and in IT 12th grades."Waves and Dancing Ferrofluid" experiment is matched with physics topic "Magnetism". The topic is current in TR and GR in 11th grades and in RO in 12th grades. On the other hand, there is matching with this activity in IT."Lotus Effect" activity is matched with the topic "Properties of matter" in 10th grade physics in TR and in 8th grade chemistry in GR."Waveguide Fabrication by Sol-Gel" activity is matched with 9th grade physics topic "Waves" only in TR. There is no other matching topic in partner countries.

After the survey of the state of art of the partner countries the curriculum, match the nano related topics, the content (background) of these topics, matching Nano Experiments of the Virtual Lab and the related grades of the schools in partner countries are defined. Curriculum matches between basic science and technical skills and nano related issues represent powerful tools aimed to involve school classes and their teachers from different countries in educational experiences under the guidance of experts both in didactics and in nano sciences. The curriculum matching analysis emerged that there is a widespread core of common scientific subjects characterizing the educational background in science for the students of the high schools of each partner country.

The curriculum matches and mainly the results arising from the questionnaires provided to different samples of the beneficiaries of the project, as well as some considerations arising from the comparison of the school curricula in science in the countries of the partner organizations paved the way of writing the concept paper that draws the strategies in order to define method in experiments and identify the components of the virtual laboratory.

As underlined in the concept paper, according to the statistics of the questionnaires for the students, teachers and prospective teachers the best way to make easier the learning of science is an experimental approach like performing real experiments, having direct contacts with nature or, secondarily, enjoying simulated experiments on virtual labs and the like. During the process of setting up the Virtual Lab, the components and educational materials drew the guidance for the target groups as Inquiry Based Scientific Education (IBSE) approach

METHODS AND RESULTS OF THE NTSE VIRTUAL LAB IMPLEMENTATIONS – TURKEY

Test Implementations – Video Conference- Case studies Test implementations

FIRST TEST IMPLEMENTATION

	Lesson Plan	School	Grade	Date	Teacher	Student	Boys	Girls
1	UNDERSTANDING NANOSCALE	Üsküdar Doğa School	9th, 10th	Dec. 2012	Sema Balkan	21	9	13
2		Ankara Doğa School	9th	Jan. 2013	Aytekin Köşker	24	15	9
3		Ataşehir Doğa School	7th	Feb. 2013	Mustafa Rahmi Hazar	23	13	10
4		Kurtköy Doğa School	7th, 8th	Jan. 2013	Selcan Çınar	24	9	15
5		Bostancı Doğa School	9th	Jan. 2013	Berna Güngör	24	10	14
6		Kocaeli Doğa School	8th	Dec. 2012	Selin Dülger	23	10	13
7		Manisa Doğa School	10th	Dec. 2012	Serpil Yapıcı	24	14	10
8		Batman Doğa School	8th, 9th, 10th	Dec. 2012	Aslı Erpolat	21	15	6
9		Kocaeli Doğa School	8th	Feb. 2012	Selin Dülger & Ahmet Kök	22	10	12
10		Sarıyer Doğa School	8th	Dec. 2012	Kezban Şenel	15	7	8
11		Çekirge Doğa School	10th, 11th	Dec. 2012	İdil Akçay	13	6	7
12		Sakıp Sabancı Highschool	11th	Dec. 2012	Didem Sünbül	15	7	8
13	NANOCRYSTAL FABRICATION	Üskudar Doğa School	10th	Dec. 2012	Sema Balkan	15	7	8
14		Ankara Doğa School	9th	Dec. 2012	Aytekin Köşker	15	8	7
15		Kurtköy Doğa School	7th	Dec. 2012	Selcan Çınar	15	6	9
16		Bostancı Doğa School	11th	Dec. 2012	Berna Güngör	17	8	9
17		Kocaeli Doğa School	8th	Dec. 2012	Selin Dülger	22	12	10
18		Manisa Doğa School	10th	Dec. 2012	Serpil Yapıcı	22	10	12
19		Düzce Doğa School	11th	Dec. 2012	Muzaffer Kaya	22	12	10
20		Denizli Doğa	10th	Dec. 2012	Selda Öksüzoğlu	12	5	7
21		Ankara Doğa School	10th	Dec. 2012	Alfer Baş	22	10	12
22		Elazığ Doğa School	10th	Dec. 2012	Pınar Çeçen	23	13	10
23		Acarkent Doğa School	9th	Dec. 2012	Mihrican Satış	15	7	8
24		Çekirge Doğa School	10th, 11th	Dec. 2012	İdil Akçay	15	7	8
25		Denizli Doğa School	9th	Dec. 2012	Özge Eray	17	8	9
26		Batman Doğa School	9th, 10th, 11th	Dec. 2012	Aslı Erpolat	19	9	10
27		Sakıp Sabancı Highschool	11th	Dec. 2012	Didem Sünbül	15	7	8
28	BUCKY-BALL	Çekirge Doğa School	10th, 11th	Dec. 2012	İdil Akçay	22	10	12
29	LO-TUS	Sakıp Sabancı Highschool	10th	Dec. 2012	Didem Sünbül	19	9	10

SECOND TEST IMPLEMENTATION

	Lesson plan	School	Grade	Date	Teacher	Students	Boys	Girls
1	Understanding Nanoscale	Halkalı Doğa School	7th	Nov. 2013	Sevda Terzi	15	6	9
2		Sarıyer Doğa School	7th	Nov. 2013	Seda Arslan/Nezihe Telci	14	8	6
3		Avcılar Doga School	5th	Nov. 2013	Timur Kılıç	13	6	7
4		Ataşehir Doga School	11th	Nov. 2013	Aykut Güven	15	6	9
5		Acarkent Doğa School	9th	Nov. 2013	Mihrican Satış	8	0	8
6		30 Agustos Female Vocational High School	9th	Nov. 2013	Didem Sünbül & Pınar Arpa	25	0	25
7		Acıbadem Doğa Pearson	5th	Nov. 2013	Isıl Aydın & Didem Sünbül	8	5	3
8		Cevizlibağ Doğa School	9th	Nov. 2013	Ayşegül Karapınar Mantu	11	6	5
9		Şişli Doğa School	9th	Nov. 2013	Duyşen Kuş	12	7	5

FIRST AND SECOND TEST IMPLEMENTATION PROCESS: STUDENTS' QUESTIONNAIRES

The charts are drawn based on the first implementation period of the lesson plans developed within the project. The results are based on the students questionnaires conducted after the lessons. The questionnaires were conducted in two phases according to the implementation stages, completion of virtual laboratories and redesign of the lesson plans with inquiry-based learning. The first implementation stage, including 5 experiments, continued till March 2013. The data shown in the charts reflect ideas and thoughts of 195 students with an age range of 13-17, from 15 different schools[1] of elementary and high school level related to the components of virtual laboratory and our educational materials (guidelines, simulations, videos etc.) in the 1st Implementation Phase.

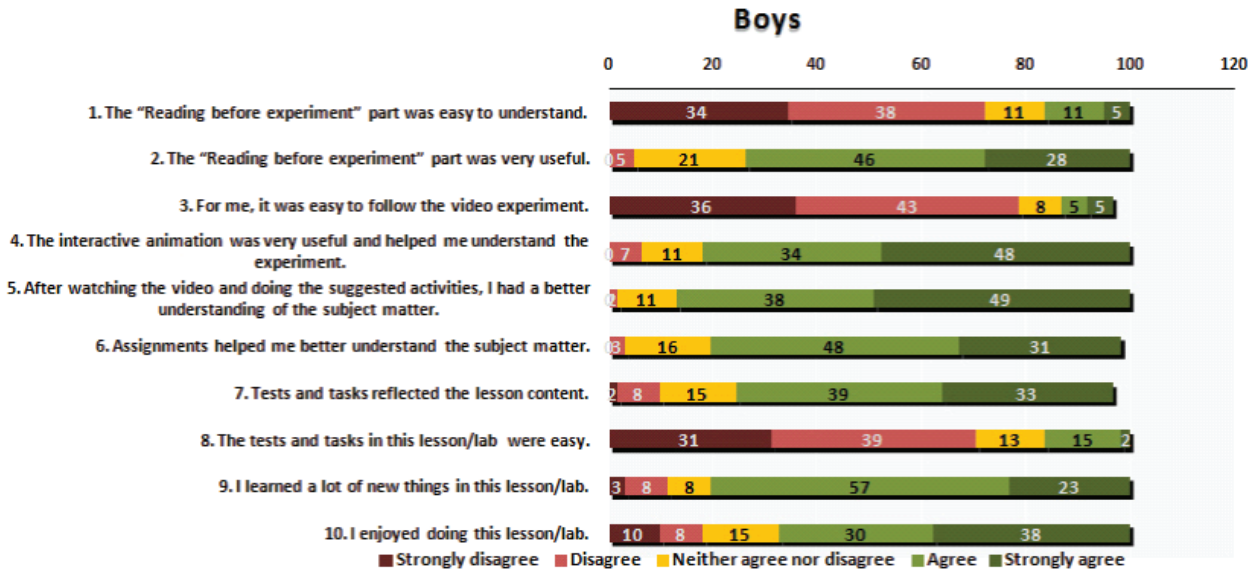


Figure 1: Student questionnaires for boys for the 1st Implementation Phase.

[1] Kurtköy Doğa Koleji, Çekirge Doğa School, Ankara Doğa School, Manisa Doğa School, Üsküdar Doğa School, Batman Doğa School, Ataşehir Doğa School, Kocaeli Doğa School, Bostancı Doğa School, Sarıyer Doğa School, Düzce Doğa School, Elazığ Doğa School, Denizli Doğa School, Ankara Doğa School, Beşiktaş Sabancı Anadolu Lisesi.
Ataşehir Doğa School, Acarkent Doğa School, Şişli Bomonti Doğa School, 30 Ağustos Female Vocational High School, Batman Doğa School, Üsküdar Doğa School, Manisa Doğa School, Ankara Doğa School, Bostancı Doğa School.

From the boys' chart it can be inferred that they had some difficulties to follow video experiments and the tests, tasks in the lesson. Yet, they gave positive answers for the rest of the questions. Most of them enjoyed the lesson, interactive animation and activities helped them to better understand the topic and they learned new things.

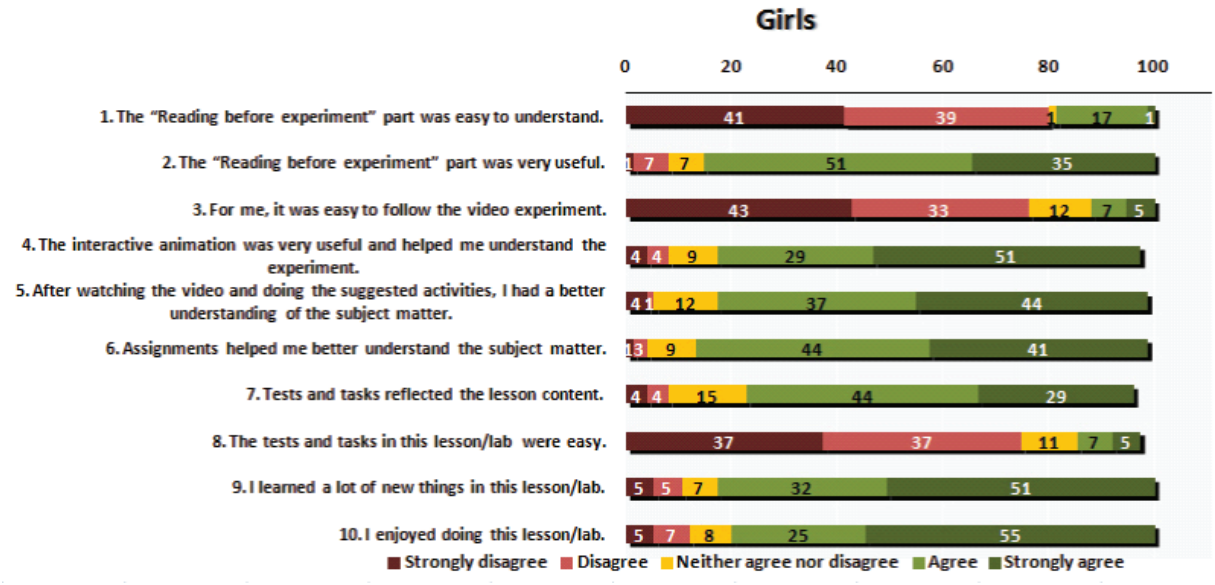


Figure 2: Student questionnaires for girls for the 1st Implementation Phase.

From the girls' chart it can be inferred that they had the same problems with boys. They had some difficulties to follow video experiments and the tests, tasks in the lesson. Additionally, only half of the girls found the "Reading before the experiment" part easy to understand.

The charts below (Fig.3-4) reflect views of high school students after the revision of lesson plans in the 2nd Implementation Stage. The second implementation phase covers the finalization of NTSE virtual laboratory, revision of the 9 experiments with all supportive educational tools according to inquiry based method, reinforcement of virtual experiments with Nano – kits and simplification and tailoring the guidelines for the lower grades between 10-13 ages. The questionnaires were conducted for 71 (52 girls, 19 boys) students studying at 9 different high schools between the age of 15-18[2].

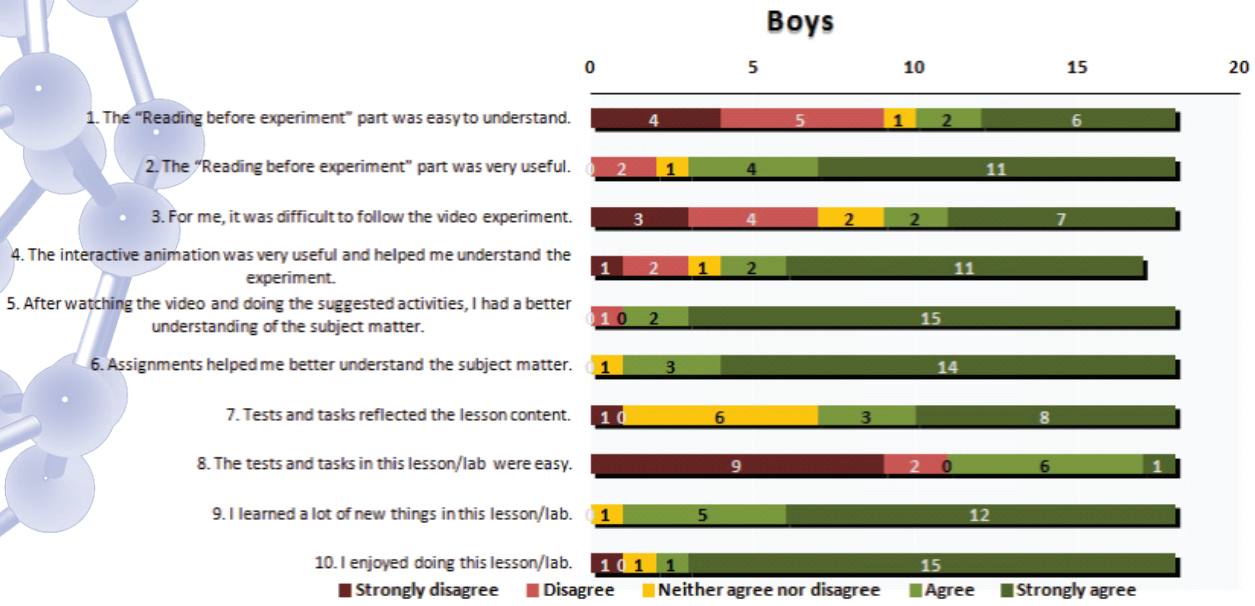


Figure 3: Student questionnaires conducted on September for boys studying at high school for the 2nd Implementation Stage.

[1] Ataşehir Doğa School, Acarkent Doğa School, Şişli Bomonti Doğa School, 30 Ağustos Female Vocational High School, Batman Doğa School, Üsküdar Doğa School, Manisa Doğa School, Ankara Doğa School, Bostancı Doğa School.

From the boys' chart it can be inferred that even though most of the boys found "Reading before experiment" part difficult to understand, they still thought that it is useful. As found out in the first implementation phase, following video experiment was still hard for students in the second implementation phase yet, they were able to better understand videos after using interactive animation and doing activities.

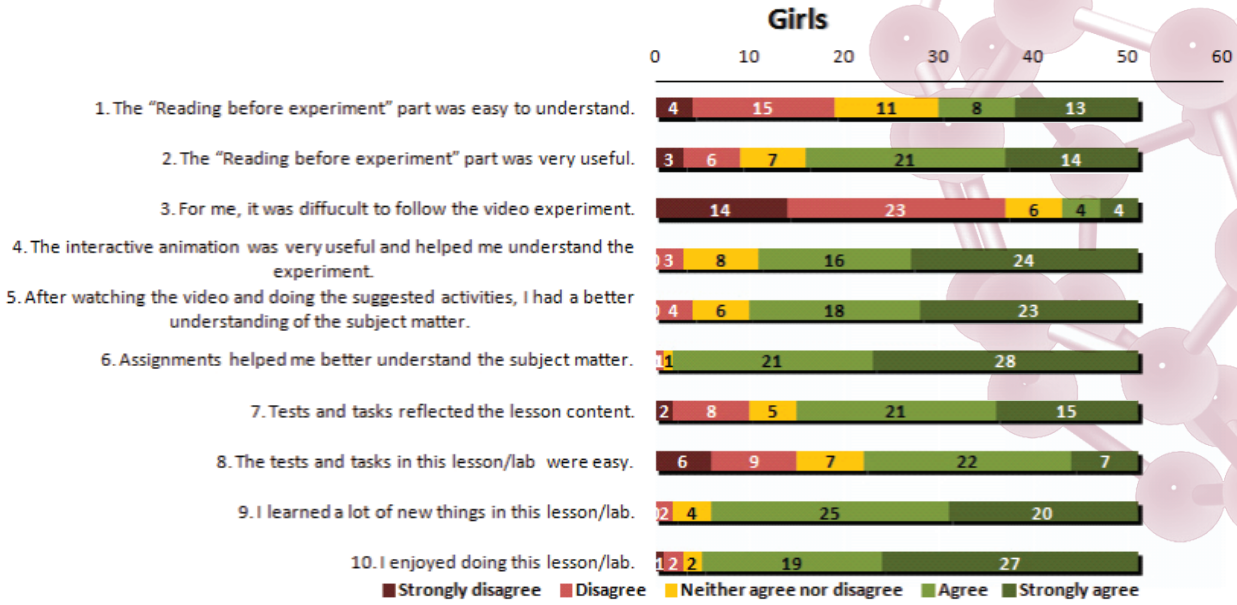


Figure 4: Student questionnaires conducted on September for girls studying at high school for the 2nd Implementation Stage.

Girls' ideas and thoughts about the lesson plans and experiments do not show a big difference from boys in the second implementation phase. However, most of the girls chose assignments as the best way to better understand the subject matter instead of videos or interactive animation.

The questionnaires were conducted for 42 elementary school students (20 boys, 22 girls) studying at 3 different schools (Halkalı Doğa School, Sarıyer Doğa School, Avcılar Doğa School). The age range of the students is between 10-15 years old. The questionnaires reflect the views of the students after simplification of the guidelines in our experiments room.

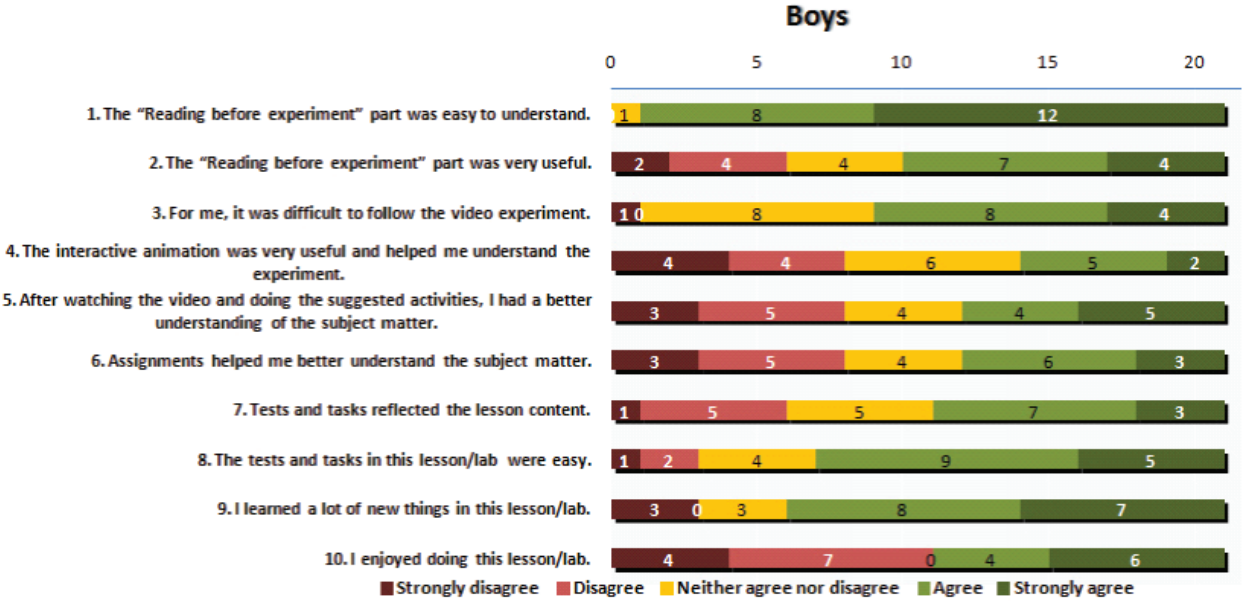


Figure 5: Student questionnaires conducted on September for boys studying at elementary school for the 2nd Implementation Stage.

The positive effects of changes made in the second implementation process are more visible when we look at the elementary school students' questionnaires. Compared to boys studying at high school, more boys found "Reading before experiment part" easy to understand and useful. It is obviously become easier to follow the video experiments and more of the students thought that tasks and tests in the lesson were easy.

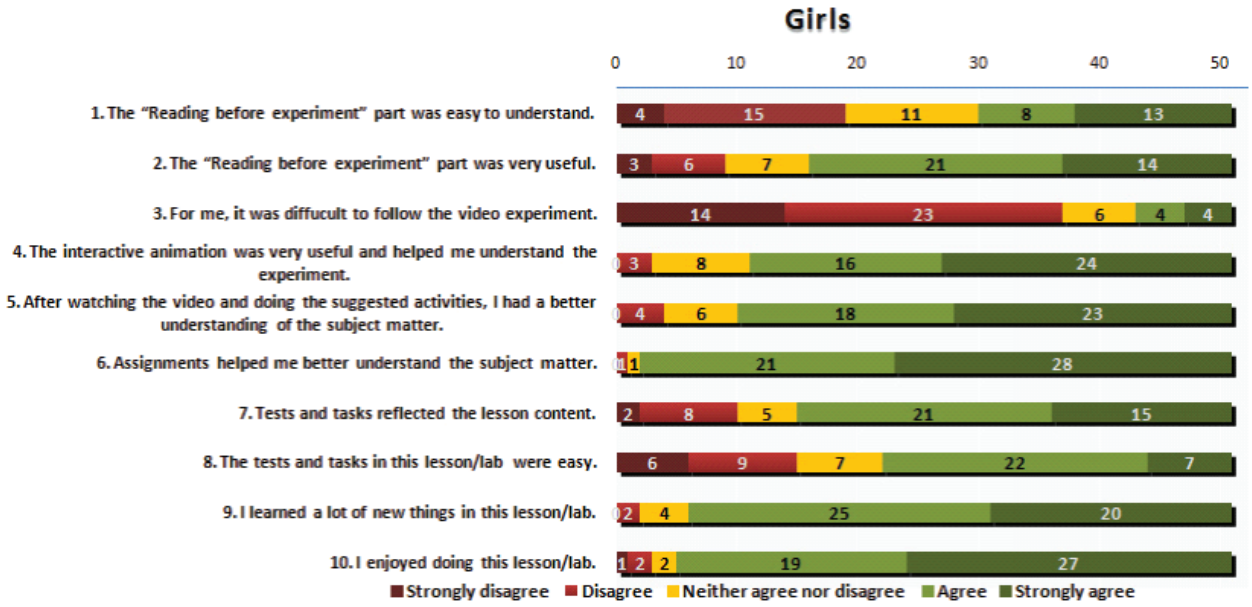


Figure 6: Student questionnaires conducted on September for girls studying at elementary school for the 2nd Implementation Stage.

It is observable that the changes made in the lesson plans and experiments also reflected in the girls understanding of the lessons. Compared to the girls studying at high school, more girls found "Reading before experiment part" easy to understand and useful. It is obviously become easier to follow the video experiments and more of the students thought that tasks and tests in the lesson were easy. Different than the boys studying at elementary school, girls found it harder to follow the video experiments.

THEMATIC ANALYSIS OF THE TEACHERS' REFLECTIONS ON IMPLEMENTED LESSON PLANS

7 high school teachers and 4 elementary school teachers provided reflections on their classroom implementations. Their reflections were analyzed using the thematic analysis through defining the main and sub themes in their reflections. The data was analyzed by a content analysis approach. The content analysis is used in four stages to process the qualitative research data received from the documents: (1) coding the data, (2) identifying the themes, (3) arranging of codes and themes, and (4) identifying and interpreting the findings. Inductive coding is made in order to reveal the concepts, and the relationship between these concepts that underlay the data and themes are determined accordingly. The themes are placed under four topics during the analysis process: applicability, difficulty, enjoyment, curriculum match. In order to filter the data under four areas, uncertain expressions and repeats are eliminated. Each table is interpreted in accordance with the themes determined and an attempt is to define the impact of our educational tools on the students and teachers. The results were listed according to their frequency. Some of the teachers gave more than one answers to same questions.

According to the thematic analysis of the Teachers' Reflection Questions; the videos, simulations (ICT tools) and hands-on activities are helping students to understand science better and relate it with real life. It is obvious that the experiments are well integrated with the science curriculum, so that the students can learn the topics more easily as well as raising their awareness in nanotechnology. The experiments with hands on activities, simulations, and videos are the most applicable tools and parts of the educational tools of the Virtual Laboratory for teachers.

On the contrary, traditional teaching in science education such as conversion of units is the most difficult part while implementing Nano Scale Lesson Plan. Apart from this, the language barrier in understanding videos and simulations are another obstacles in our Virtual laboratory. Time constraints in planning and implementing the lesson and mostly the hands on activities are anothe problems explained by teachers. It is observed that the obstacles are mostly about the logistic supports. Only one of them is about the content of the topic. But it totally proved that traditional teaching makes students learning more challenging and monotonous. This problem can be easily eliminated through revising the lesson plans in our Virtual Laboratory. Apart from this, it is useful to insert the notes for the teachers to let them modify the lesson plans according to the levels of their learners. Another problem about the language barriers can be sorted out with the translations. The time constraint in teaching is a big challenge for the teachers. Pre- planning the hands on activities and giving clear instructions before hands on activities can be the practical solutions to prevent this obstacle.

MAIN THEMES	SUB THEMES	FREQ	QUOTES FROM THE TEACHERS
APPLICABLE PARTS	Videos of the experiments	6	"The videos are very short and easy." to follow." "My students especially like sugar cubes activities."
	Hands on activities	4	
	Simulations	2	
	Conversion of units	3	
	Links with the real life implementations	1	
DIFFICULT PARTS	Conversion of units in traditional way	4	"It takes longer than I expected to plan and prepare the activities with the students. I spent at least 90 minutes for each lesson." "Our students had difficulty to convert the units in traditional way since it requires good mathematical skills." "Some of my students had difficulty to understand and follow the simulations in English. The language barrier hinders their learning."
	Language barriers while watching videos&simulations	3	
	Time constraints in planning and implementing hands on activities	2	
	Transitions of the activities from videos to simulations	1	
	New terms and topics about Nanotechnology	1	
ENJOYABLE PARTS	Videos of the experiments	7	"Students were mostly impressed by videos of the experiments." "I observed that the students enjoyed to measure desks and chairs with with a nanoscale ruler."
	Hands on activities and use of Nano Kit	6	
	Simulations	4	
TOPICS MATCHED WITH THE CURRICULUM	Nano Crystal Fabrication, Iron Nano Particles and Ferrofluid match with Atomic structure	6	"Lesson materials were matched with chemistry Curriculum. The lessons will especially help students to learn atomic structure more easily." "Topics of conversion of unit, nanotechnology and state of matter are directly linked to lesson plans." "The Nano Crystal Fabrication Lesson Plan is in relation to the topics of atomic structure, scale and conversion of unit."
	States of matter	6	
	Understanding Nanoscale matches with the topic, The nature of physics:Scales	3	
	Conversion of Unit	1	

Videos of the experiments were highly voted educational tools in our Virtual Laboratory. Hands on activities and use of Nano kits are another enjoyable parts of teachers' implementations. Simulations are defined as the third enjoyable tools in their classroom implementations. The teacher believe that these educational tools are both applicable and enjoyable in their teaching since they reinforce students' learning and raise their motivation while implementing in their classrooms.

The last question shows that the topics of Atomic structure and States of Matter in Chemistry and Physics Education are the mostly matched with the Nano topics. These topics are Nano Crystal Fabrication, Nano Particles and Ferrofluid. Apart from this, the topic of Nature of Physics in Physics Curriculum is the second topic matched with the Nano scale topic. Conversion of Units is the last topic that can be matched with the Nano Scale topic. According to the results, all teachers found the matched the Nano Technology topics with their science education. So it is quite clear that the students' background knowledge in these topics supports their learning and make the topics easier and meaningful since they can find the connection with their previous learning.

CASE STUDY:

The case studies on our project were prepared after at least three weeks classroom implementations. The teachers selected at least 3 lesson plans from our virtual laboratory to observe the impact on their students' motivation, academic achievement and attitude towards science education. By the way they tried to define the effect of use of ICT in science education. The pre and post questionnaires, students' grids and reflections were used as the tools to gather the data from the students. During the implementations, the teachers tried to balance the number of the girls and boys. In two case studies were conducted on Vocational Schools. One of them is Female schools to define the attitude and perceptions of the girls on science education and use of ICT through using Nano Technology. The latter case study was conducted in Vocational School for boys to analyze the differences between two genders. The detailed information is presented below in table:

NO	TITLE OF THE CASE STUDY	TEACHERS' NAME	TYPE OF SCHOOL	GRADE	STUDENTS
1	The impact of nanotechnology and ICT integrated science education on female vocational high school learners	Pınar Arpa Didem Sünbül	30 Ağustos Female Technical and Vocational High School (TR)	10th	26 students (girls)
2	The impact of virtual lab. instruments on vocational school learners.	Banu Kızmaz	Adana – Ceyhan – Ceyhun Biliciler Anatolia Hotel And Tourism Vocational High School	9th, 10th	24 students
3	Effect Of Ntse Virtual Laboratory On Image Of Scientists Within The Scope Of Biology Course	Duyşen Kuş Ayşegül Karapınar Mantu	Cevizlibağ Doğa High School Sisli Doğa High School	9th	30 students

The results of the case studies showed that, the students have prejudice to learn the science education and they believe that it is challenging to learn the science at schools. After classroom implementations, it is quite clear that the perception towards science education has changed. It is observed that they like the science education when it was connected with the real life, supported with the hands on activities, videos and simulations. Even though the term and topics of Nanotechnology were very new and innovative for the students, they were open to learn and had positive attitudes since they can easily connect with the real life experiences. The case study on "The impact of nanotechnology and ICT integrated science education on female vocational high school learners" was presented in INT-NTSE "International Nano-Tech Science Education Congress" on November 16, 2013 by Pınar Arpa and Didem Sünbül.

METHODS AND RESULTS OF THE NTSE VIRTUAL LAB IMPLEMENTATIONS – GREECE

Test Implementations – Video Conference

Test implementations

In total, seven implementations were conducted. Four teachers implemented the "Introduction to Nanotechnology/ Nanoscale" lesson plan in three state schools from October 2013 to December 2013. Total number of students: 157 (77 boys and 80 girls).

More implementations are planned in the Experimental School of Heraklion during this school year. The lesson plans to be tested are "Lotus effect" and "Buckyballs".

	Lesson plan	Deviations from lesson plan	School	Grade	Date	Teacher	Students	Boys	Girls
1	Nanoscale	No	High School, Argiroupoli Rethymnon, Crete	10th	Oct. 2013	Ioannis Sgouros	16	10	6
2	Nanoscale	Yes	2nd Gymnasium Heraklion Crete	8th	Nov. 2013	Theodora Katsiouli	22	11	11
3	Nanoscale	Yes	2nd Gymnasium Heraklion Crete	8th	Nov. 2013	Theodora Katsiouli	22	10	12
4	Nanoscale	Yes	2nd Gymnasium Heraklion Crete	8th	Nov. 2013	Paraskevi Ktistaki	24	13	11
5	Nanoscale	Yes	2nd Gymnasium Heraklion Crete	8th	Nov. 2013	Paraskevi Ktistaki	22	10	12
6	Nanoscale	Yes	Experimental Gymnasium Heraklion Crete	9th	Dec. 2013	Ioannis Karadamoglou	25	17	8
7	Nanoscale	Yes	Experimental Gymnasium Heraklion Crete	9th	Dec. 2013	Ioannis Karadamoglou	26	6	20
Totals:						4	157	77	80

General Remarks

The aim of all implementations was to introduce nanotechnology and nanoscale to the students by using the material provided in the Virtual Lab. The lessons' objectives were:

- To increase awareness about nanotechnology
- To comprehend nanoscale
- To enhance the ability to convert units into nanometres

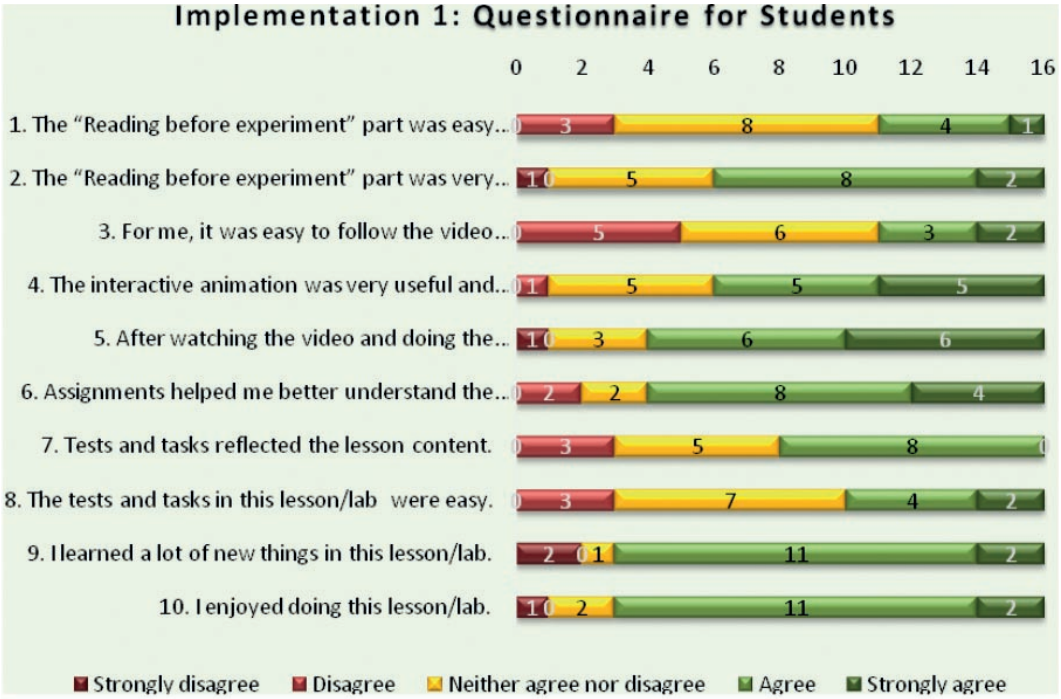
The students were provided in advance with the "Student's Guidelines" booklet. The duration of the lessons was 45 minutes. At the end, all students and their teacher filled in questionnaires and assessment grids. The questionnaires aimed at evaluating and collecting information and suggestions on the content, usability and pedagogical effectiveness of the NTSE Project teaching materials (video, interactive animation, teacher guidelines, student guidelines).

1st Implementation – High School of Argiroupoli, Crete

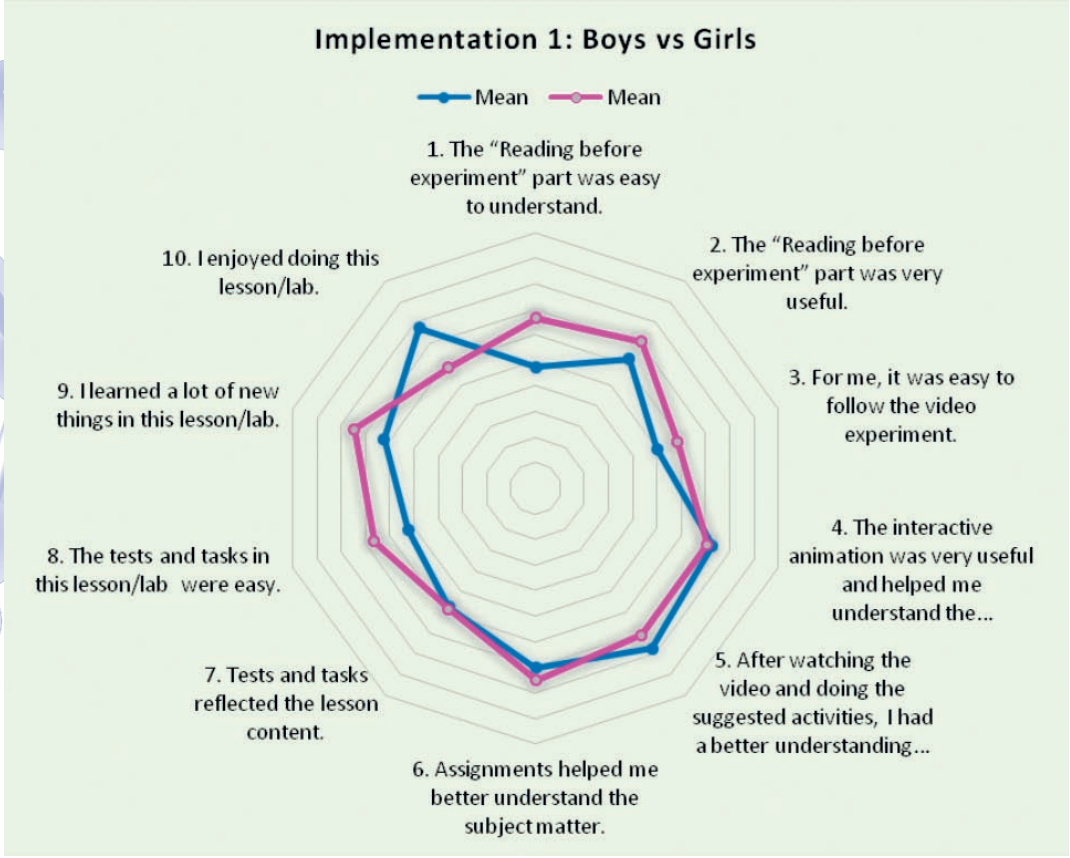
The first implementation was conducted in a high school class (10th grade) of 16 pupils in Argiroupoli, Crete. Argiroupoli is a village in an agricultural area in western Crete. Students from this high school participated in the nano poster competition. The physics' teacher, Ioannis Sgouros, participated in the nanocamp as a Greek expert since he is a PhD student (Teaching nanoscience in Secondary Education, Pedagogical Department, University of Crete).

No deviations from the lesson plan, as described in the teacher's guidelines booklet, were made.

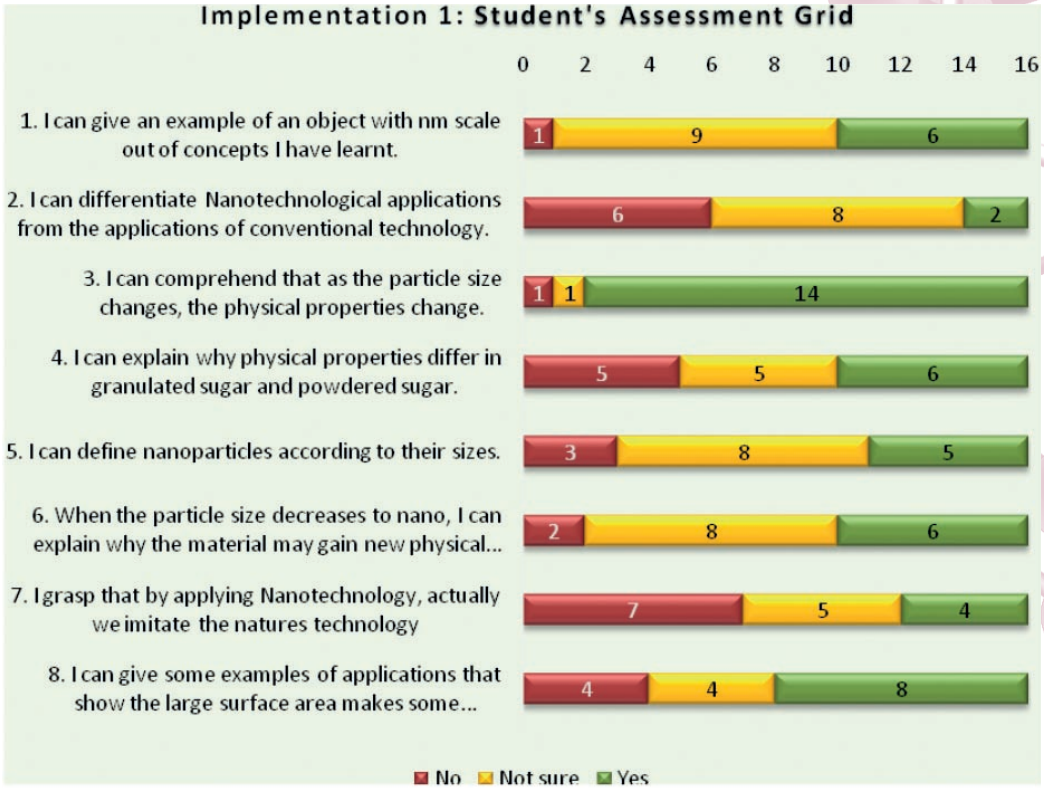
Impact on students



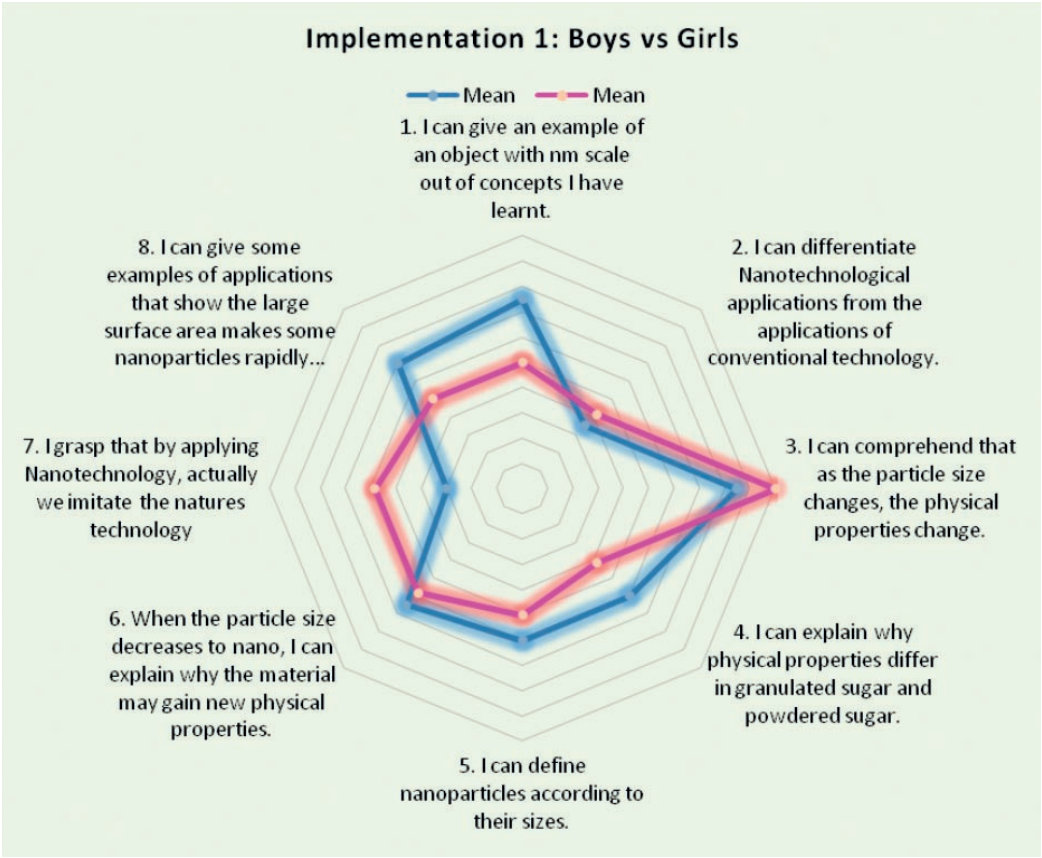
According to students' views, they enjoyed the lesson and learned many new things. The video as well as the assignments, helped them understand the nanoscale. On the other hand, they did not find the "Reading before experiment" part easy.



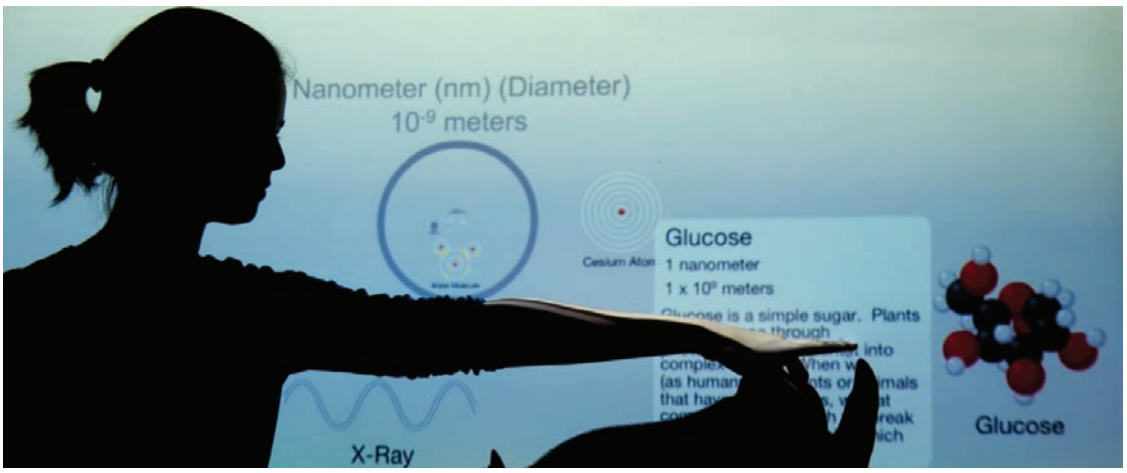
There are no significant differences in views between boys and girls. The boys seemed to enjoy the lesson more while the girls found the "Reading before experiment" part and the tests easier.



Students comprehended in a high degree the relation between particle size – physical properties. They experienced difficulties in differentiating nano apllications from conventional technology applications.



Boys found it easier to give examples of objects on the nanoscale and nano applications related to size/volume ratio. On the other hand, girls had a better grasp of the idea of biomimicry.



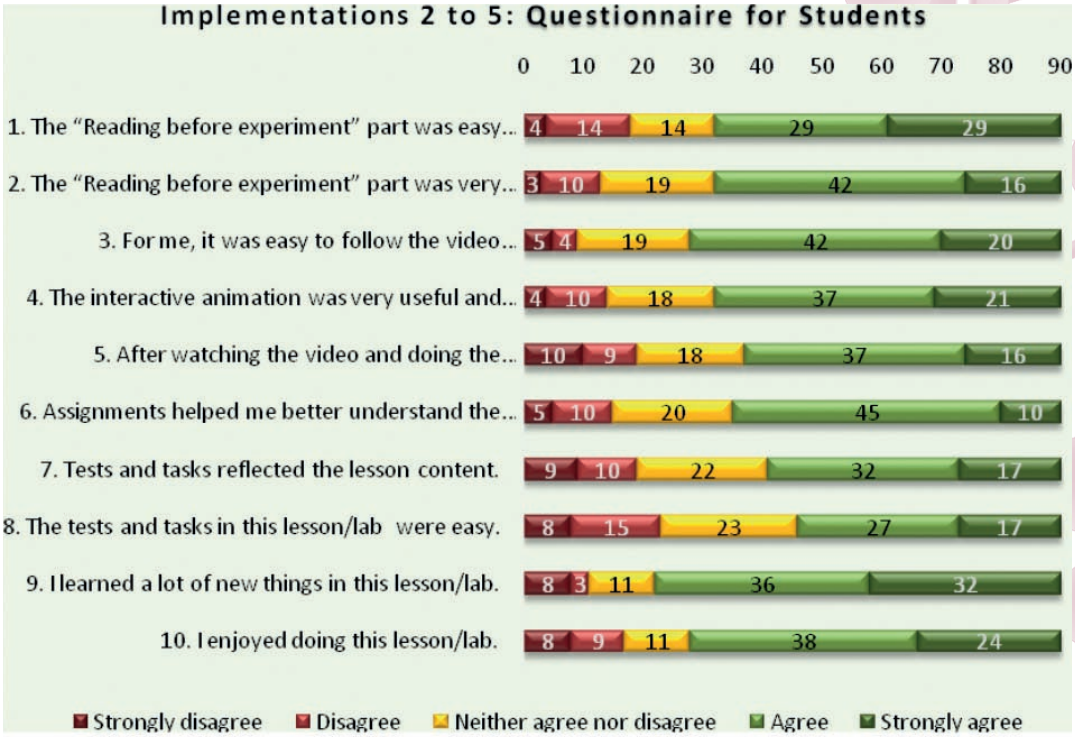
Implementations 2 to 5: 2nd Gymnasium of Heraklion, Crete

Those implementations were conducted in four classes (8th grade) with 90 students in total. The Second Gymnasium of Heraklion is a school with a very good reputation in the city of Heraklion, Crete. According to data gathered from the school, the average score of these four classes in physics and chemistry is 16.2/20.

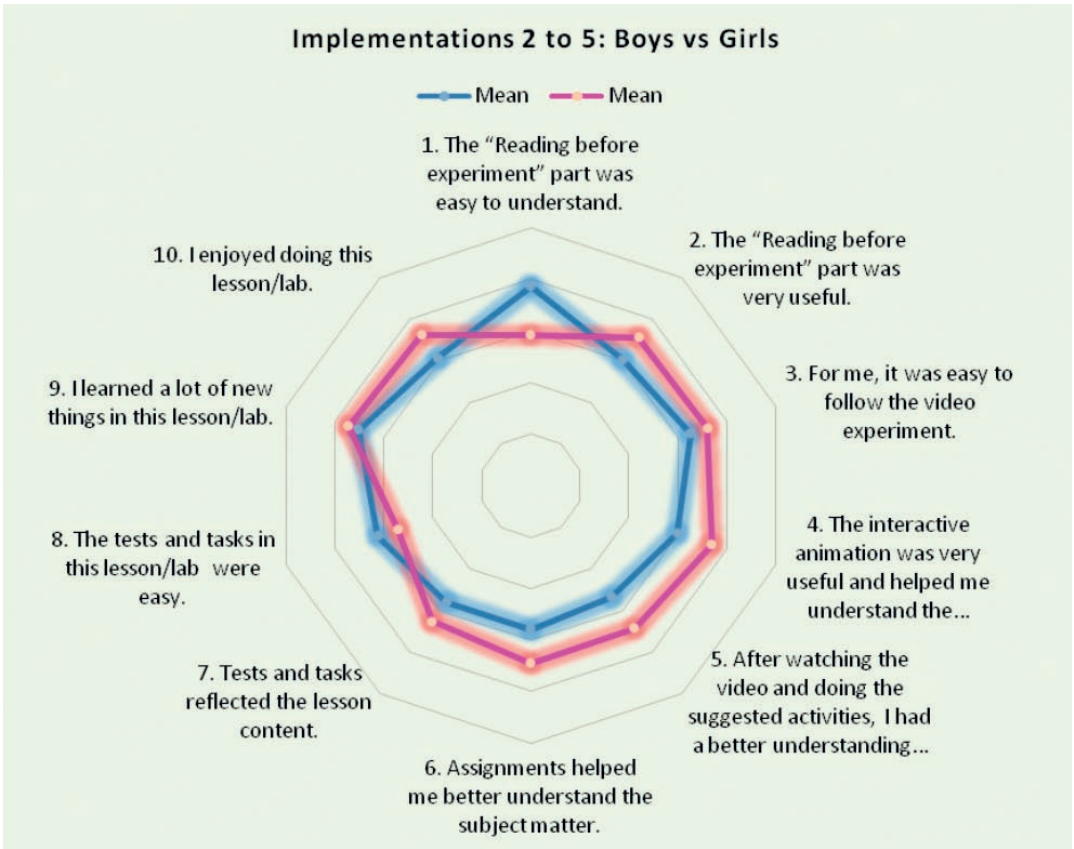
The school was very active during the nano poster competition since eight groups of students participated in the competition. The winning poster for Greece came from this school. Four students (older than those participating in these implementations) along with the headmaster took part in the nanocamp in July, 2013.

There were some deviations from the original lesson plan:

- The video "Powers of Ten" was not used due to time constraints. Emphasis was given to "Scale of the Universe II" interactive application.
- A PowerPoint presentation titled "Introduction to nanotechnology" was used.
- Two videos showing nanotechnology applications (nano-coating) and future materials (buckypaper) were also used

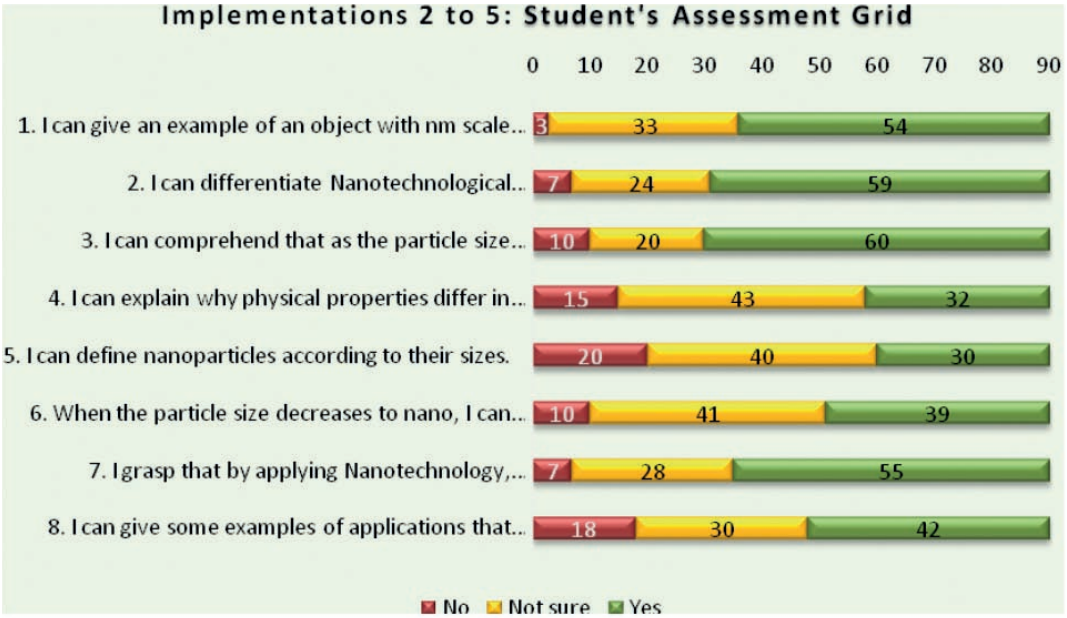


Students enjoyed the lesson and learned many new things. But 4:10 of them had difficulties with the tests. In general, they seem to have a good grasp of the subject.

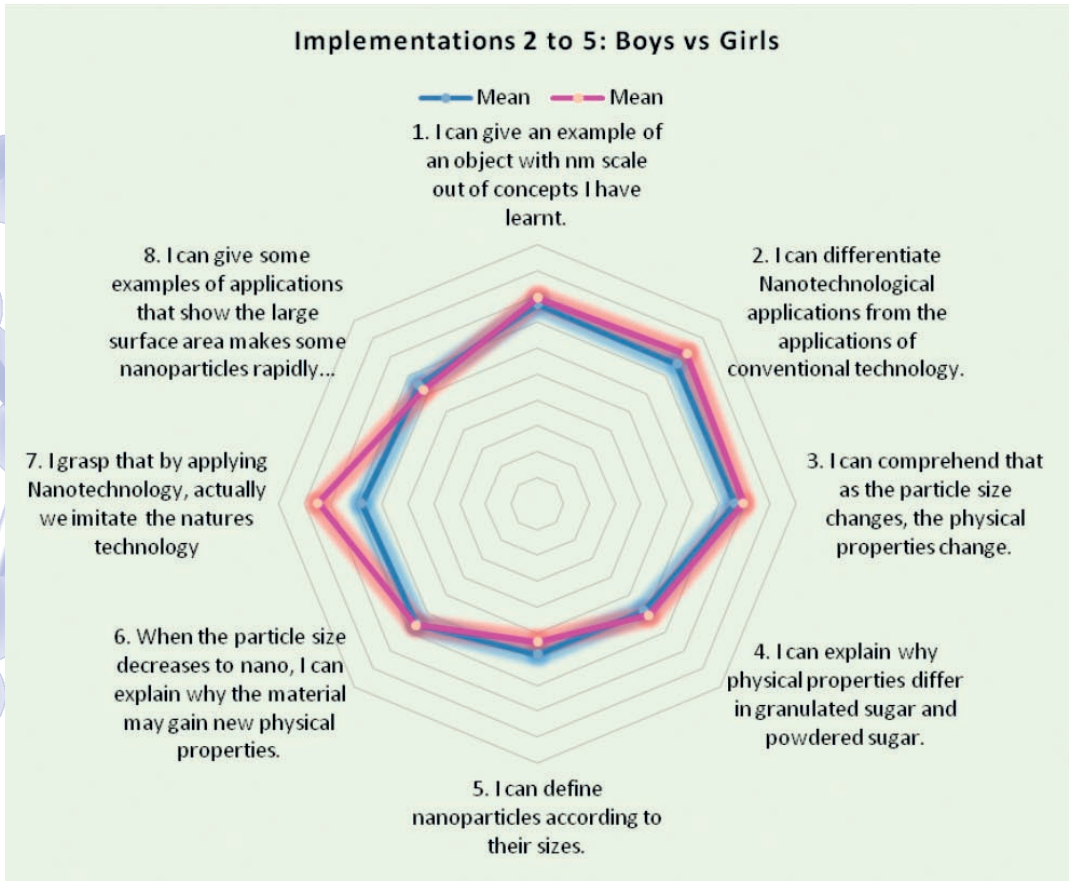


Girls scored significantly higher in most statements even if they had more difficulty with the "Reading before the experiment" part than the boys.

Impact on students



Difficulties in defining nanoparticles and explaining the relation between physical properties to size/volume ratio were observed.



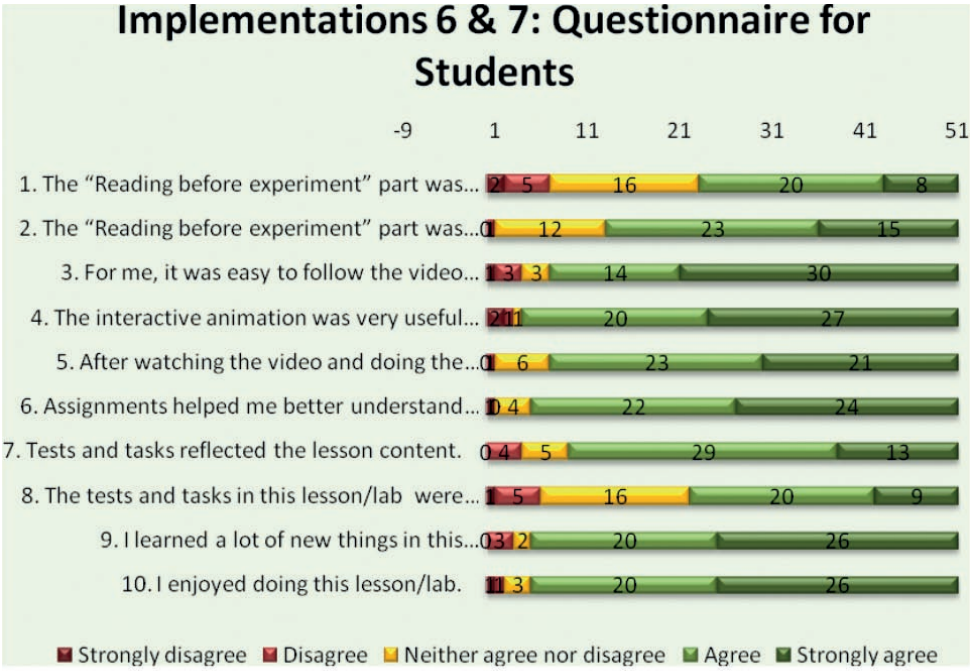
No significant differences in comprehension of nanoscale concepts were noted except that girls comprehended the concept of biomimicry better.

Implementations 6 and 7: Experimental Gymnasium of Heraklion, Crete

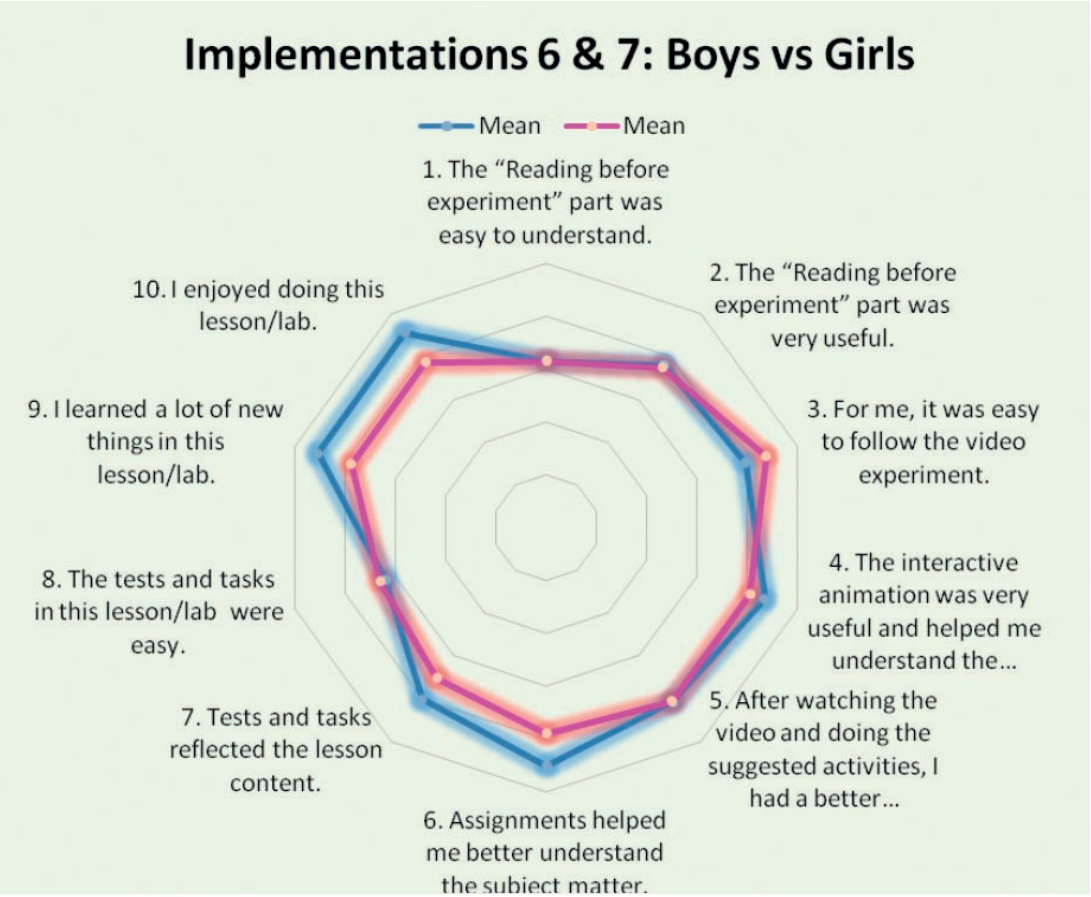
The implementations were conducted in two classes (9th grade) with 51 students in total. The Model Experimental Gymnasium of Heraklion is an elite school in Heraklion district. Students gain entry through an entrance exam that has recently been implemented. All classrooms are equipped with interactive whiteboards.

Deviations were made from the original lesson plan: As per implementations 2 to 7. In addition two short videos showing differences in burning behavior between a conventional film-forming latex film and a polymer-silica nanocomposite film were used.

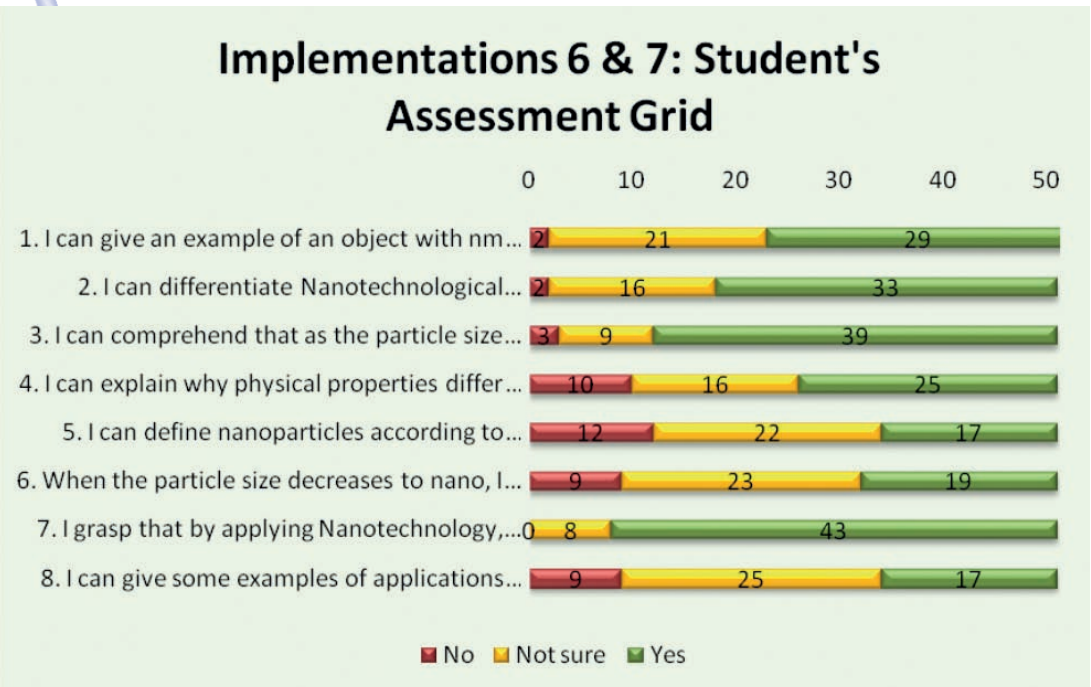
Impact on students



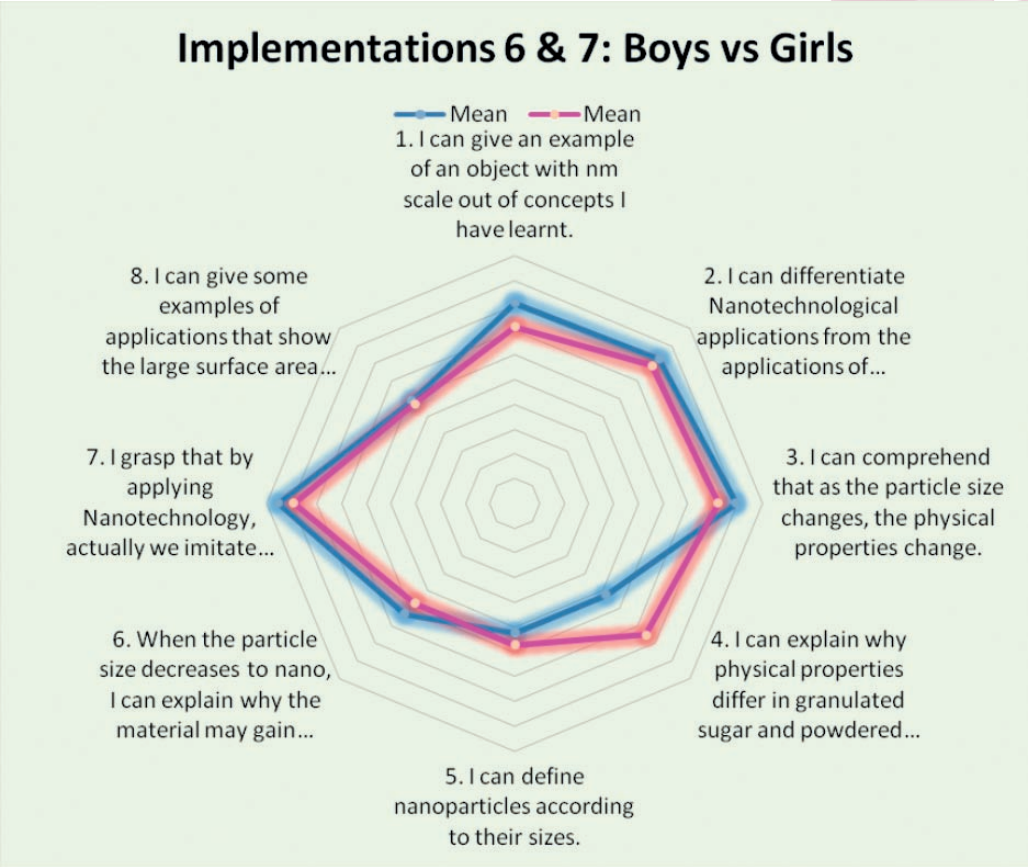
High scores on all indicators regarding the lessons were observed. Again the "Reading before the experiment" part and the tests caused difficulties for some students.



Boys scored slightly higher on some statements.



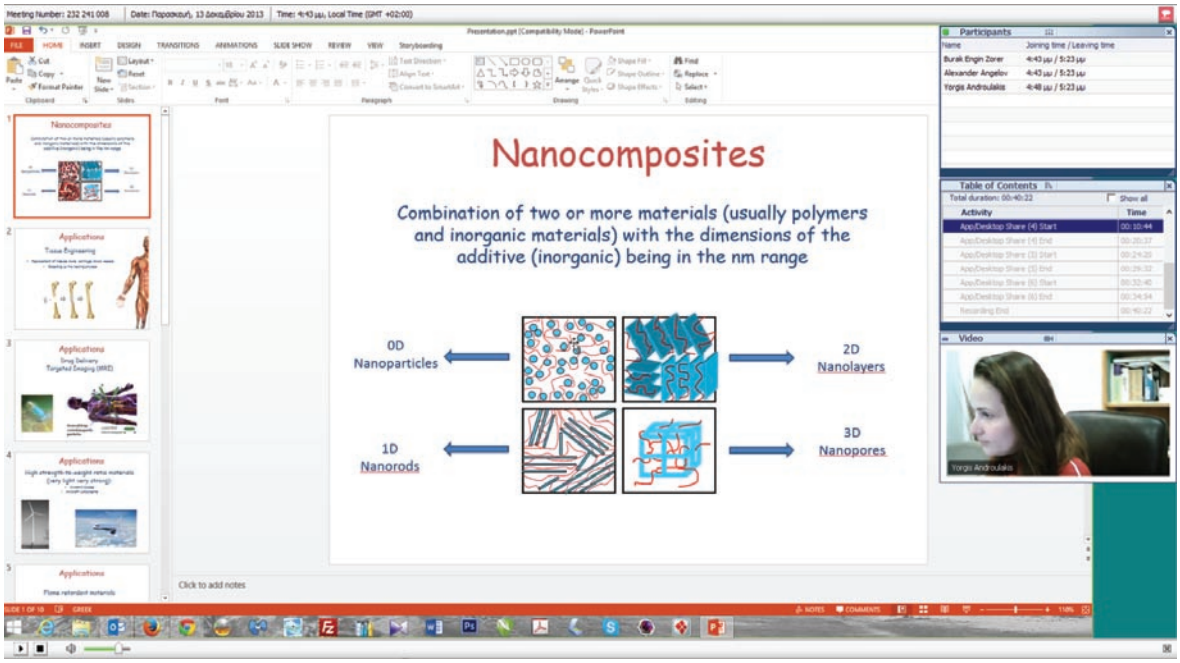
Again difficulties in connecting physical properties to size were experienced.



Boys found it difficult to explain why physical properties of granulated sugar differ from powered sugar.

VIDEO CONFERENCE

On December 2013, a 40-minute video conference was conducted between a Greek expert and a class and their Biology teacher from a school in Sofia. The Greek expert, Eleni Papananou is a PhD student doing research in the field of polymer nanocomposites in the Institute of Electronic Structure and Laser / FORTH. Mrs. Papananou talked about her research activities /interests and nano applications and the students asked questions on the subject matter. A PowerPoint presentation and related short videos were used.



The meeting was hosted on WebEx, a free VC platform, developed by CISCO and the recording is available on the Podcasting room of the Virtual Lab.

VIDEOCONFERENCE SESSIONS

Videoconference sessions planned between at least two institutions with similar profiles (two remote locations). The main purpose of the video conference sessions are to share the good practices, test and prove the applicability of the educational materials in our virtual laboratory and create an online platform for the students and teachers to know each other.

Videoconferences were initiated in the some of the following setups:
- Classroom – Classroom
- Classroom – Laboratory
- Classroom – Expert
- Any two or more locations that are interested in same / similar topic

Three concepts of video sessions are available:

1. Nano-Tech Lesson Plan (classroom – laboratory, classroom – classroom or classroom – expert): participating schools and a moderator are connected online via any videoconference tool (e.g. *Adobe Connect, Skype, Gtalk,* etc.). The aim of the video session is to implement an activity from the chosen nano-experiment. Students of participant schools make the activities at the same time with the instructions given by the moderator. After the activity is done they share their experience and conclusions.

2. Quiz Show (classroom – classroom): Students participating in the videoconference session answer questions about the selected nano-experiment / topic to get higher scores.

3. Question and Answer (classroom – expert): Participating schools are connected to one of the project experts in order to ask their own questions and gain further information about the selected nano-topic.

In the table below you can find the detailed information about the video conference sessions in our project consortium such as the profile of the schools, implemented activities, number of the students involved in video conference sessions for three years.

No	MATCHED COUNTRIES	MATCHED SCHOOLS	GRADE	NUMBER OF STUDENTS	DATE	ACTIVITY / LESSON
1	TR – BG	Acarkent Doğa High School (TR)/ John Atasanov High School (BG)	9th and 10th	14 TR students/ 15 BG students	14.05.2012	"Nanocrystal Fabrication"/ Toothpick Activity
2	TR – BG	Bursa Çekirge Doğa School (TR)/ John Atanasov High School (BG)	9th and 10th	30 TR students/ 15 BG students	December 2011	Led (Light Emitting Diodes)
3	TR – IT	Bursa Çekirge Doğa School (TR)/ Liceo Scientifico Mazzini Napoli IT	10th and 11th	20 TR students/ 24 IT students	27.06.2013	Introduction to Nanotechnology
4	TR – BG	Bursa Çekirge Doğa School/ John Atanasov High School (BG)	9th and 10th	20 TR students / 15 BG students	28.06.2013	Making Origami Buckyball, Understanding Nanoscale
5	TR – IT	Acarkent Doğa Elementary School (TR)/ Scuola Primaria San Tarcisio, Herculaneum, IT	5th	15 TR students 15 IT students	14.05.2013	Introduction to Nanotechnology and lotus effect
6	TR – RO	Expert (TR) / Expert UVT, University Students & Mater Students / Propective teachers UVT (RO)	University Students & Mater Students / Propective teachers	20 RO university students & master students / prospective teachers	16.12.2013	"The World of Nanomaterials" (Presentations of Allotropes of Carbon: "Carbon Nanotubes" and "Fullerenes", followed by the Presentation of Virtual Lab, in the frame of the Webinar – part II: http://conf.dogakoleji.com/p73386291/)
7	RO – IT	"Ioan Alexandru Bratescu Voinesti" School Targoviste, RO & Scuola Primaria San Tarcisio, IT	3rd (RO) and 5th (IT)	25 RO primary students & 20 IT primary students	06.12.2013	"Is There Any Lotus Effect Around Us?" (Double Implementation and Exploitation of the "Lotus Effect" Virtual Lab Activity)
8	BG – EL	2nd English Language School "Thomas Jefferson" and FORTH	12th grade and PhD Researcher from FORTH	25 High school students, Chemistry teacher + Scientist in the field of Nanotechnology	13.12.2013	Q&A session about nanocomposites, list of questions is available here

During the project implementation process , 13 teachers and 20 university and master students / prospective teachers (the last ones are coming from the Faculty of Sciences and Arts) were involved in our video conference sessions. All partners matched the schools and videoconference participants according to the level of the students and the content of the video conference sessions. End of the videoconference sessions, the reflection notes of teachers and students were kept and analysed to test the applicability of the educational materials and revise the guidelines in our virtual laboratory.

ITALY – BASIC DESCRIPTION OF THE METHODS OF IMPLEMENTATION & MAIN RESULTS OBTAINED AFTER THE IMPLEMENTATION PROCESS

In Italy, the process of NTSE Virtual Lab implementation has been carried out in some schools involving teachers and pupils. In those contexts, the roles of local experts in the test-implementation process consisted on the organizing of the whole process of implementation in collaboration with the involved teachers to realize 3 Case Studies and 3 implementations in videoconference. Being a quite new topic for science communicators and educators, we asked our experts also to support before and during the activities (introducing the topic, stimulating their creativity, moderating the process, gathering the data, telling their experience to friends and family members).

Five classes, six teachers and around 120 pupils have been involved in the implementation process in the period April – December 2013:

- Classe IV (12th degree) – Liceo Scientifico Statale Tito Lucrezio Caro di Sarno (NA);
- Classe III (11th degree) – Liceo Statale Giuseppe Mazzini di Napoli;
- Classe IV (12th degree) – Liceo Scientifico Statale Arturo Labriola di Napoli;
- Classe III (11th degree) – Istituto Superiore Carlo Cattaneo di Volla (NA);
- Classe V (5th degree) – Scuola Primaria San Tarcisio di Ercolano (NA).

The subjects of implementations in ITALIAN classes were:

- A presentation of NTSE project and a general introduction to the subjects of nano sciences and nanotechnologies through the implementation of the contents of the lesson plan *"Understanding nanoscale"* developed for NTSE's Virtual Lab (every involved class);
- Lesson plan *"Lotus effect"* (Liceo Mazzini, Liceo Labriola, Scuola Primaria San Tarcisio);
- Lesson plan *"LED, Light Emitting Diodes"* (Istituto Superiore Cattaneo).

Three case studies related to the carried out experiences were developed by the teachers of the classes listed above (Liceo Mazzini, Liceo Labriola, Istituto Superiore Cattaneo).

The lesson plans dealt in the implementation phases have been chosen because we considered them the most appropriated for several reasons:

- "Understanding nanoscale" or, at least, its more significant topics have been proposed to every involved class because it was necessary to provide teachers and pupils with an adequate background about nano world;
- "Lotus effect" has been chosen because its contents were considered both by the experts of Idis and the teachers the most enjoyable and amazing for the pupils, easy to reproduce and related to daily life;
- "LED, Light Emitting Diodes" has been chosen in just one case being the involved school (Istituto Cattaneo) vocationally aimed to technical subjects and its student were already skilled in such subjects as electricity and electronics.

In the large majority of the cases, the teachers have been contacted by the experts of Fondazione Idis to involve their students in the nanocompetition (see chapter VI) happened in spring 2013. The experts presented to the teachers the lesson plans available in the Virtual Lab and then they agreed together about the Lessons to be implemented with the classes.

The responses expressed by all the involved stakeholders have been generally very positive, as showed by the results of the assessment grids resumed below as well as by the comment of the teachers.

Concerning the primary school involved in the experience, it is to be specified that even if the lesson plans developed in the framework of the project were addressed to students from 8th to 13th degree, the partners decided to involve also some children classes in order to explore the flexibility of the lesson plans. In particular, in the implementation carried out in Italy it has been chosen the "Lotus effect" because the expert and the involved teacher considered it the most enjoyable for such young pupils, as already said above.

Moreover, three videoconferences where the contents of the mentioned lesson plans were implemented together with classes of other countries among the ones involved in the project:

- Scuola Primaria San Tarcisio – a primary school class from Doga School (TR), (spring 2013);
- Liceo Scientifico Labriola – a high school class from Doga School (TR), (spring 2013);

• Scuola Primaria San Tarcisio – a primary school class from "Ioan Alexandru Bratescu Voinesti" School Targoviste (RO), (December 2013).

Concerning the videoconference, we have to report that just three have been effectively carried out even if more were been planned, and this for several reasons comprising the lack in adequate ITC equipment of the schools as well as the difficulties to arrange an appointment between two classes when schools are very busy in their curricular activities.

Assessment of the results of the implementations

The lesson plans implemented in the schools have been mainly assessed asking the pupils to fill the grids specifically fitted. The grids have been filled just by the older pupils from high and vocational schools, being them specifically designed for their ages.

The gathered results are shown below. It is to be considered that the results upcoming from both the lyceum classes have been joined together being related to the same lesson plan (Lotus effect) while the ones upcoming from the vocational school – related to LEDs – have been elaborated apart.

Lotus effect (Liceo Scientifico Labriola and Liceo Mazzini)

Even if joined and shown in only one sequence, the results gathered for each question from both the classes are very similar and then comparable.

The large majority of the students agree with the first three statements. These results can be explained considering the previous skills of the students.

Also in this case we can see a very large majority of the students agreeing with the statement. Anyway we have to consider that the statement concerns an hypothetical future experience the students could deal, therefore not everybody is sure to see a lotus flower in the future.

Just the pupils from Liceo Labriola answered to this question while the ones from Liceo Mazzini didn't dealt this topic and therefore they didn't give a response. This the reason with the anomalous numbers.

The students got information about the subject of this statement just from the Student's Guidelines having not any other information about water walking insects. However the large majority of them agree with the statement.

The results of this statements are more heterogeneous. Notice that the whole sentence contains two different statements, this could explain the resulting uncertainty.

As for the previous, also this sentence could be split in two different statements with different meanings. Anyway the majority of the interviewed students agree with the sentence.

LEDs, Light Emitting Diodes (Istituto Superiore Cattaneo)

An absolutely large majority of the student expresses a positive response due, may be, from their previous skills deriving from their curricular background. This question shows less sharp results that could be explained considering its contents more scientific and less technically related.

The largely positive results can be explained considering the confidence the pupils have with formulas applied in electronics.

A significant number of pupils answered "not" to this statement. In this case they honestly acknowledge they understood "what happen" but not "why".

The large majority of positive responses could be explained considering the effectiveness of some practical experiences proposed in the lesson plan.

In the lesson plan the subject of this question is dealt in a way similar to the one adopted in usual frontal lessons at school. This can explain the significant number of responses as "not sure" or "not".

Concerning the implementation of the Lesson Plans in Italy, we can notice a general positive outcome. The information and the educational tolls provided by the Virtual Lab can be effectively exploited adapting them to the educational needs of the involved classes.

ROMANIA – BASIC DESCRIPTION OF THE METHODS OF IMPLEMENTATION & MAIN RESULTS OBTAINED AFTER THE IMPLEMENTATION PROCESS

In Romania, the process of NTSE Virtual Lab implementation was carried out in schools (involving teachers / pupils) and university (involving university students/prospective Science teachers, master students and PhD students (researchers)). In those contexts, the roles of local experts in the test-implementation process consisted on the organizing of the whole process of implementation and assuring the necessary logistic (e.g. designing the *Lesson Plans, Laboratory Sequence of Events*) and collaborating with promoters (teachers, university staff, PhD students) for realizing *5 Case Studies*. At the same time, the experts offered the necessary support *before* and *during* the designed activities (moderating the implementation process, leading the discussions, presenting scientific information), and also they disseminates the NTSE project and emphasized on the importance of the NTSE Virtual Lab implementation to the education community and local mass-media.

At the pre-university level, four schools ("Vasile Carlova" School Targoviste, Gimnasium School Gura-Sutii, "Balasa Doamna" High School Targoviste and "Ion Alexandru-Bratescu Voinesti" School Targoviste) have been involved in the implementation process in the period April – December 2013. During the implementation process, 7 teachers, 6 university experts & 100 pupils took part in the "school test-implementation" phase, at the 3rd, 7th, 8th and 9th school grades.

The subjects of implementations in Romanian classes were:

- *"Nanotechnology as Future Technology"* that included parts from *"Nanoscale and Nanotechnology"* teaching materials uploaded in the Virtual Lab;
- *"Nanotechnology and Nanobiomimicry"* that included the Virtual Lab clips: *"Understanding Nanoscale"* and *"Lotus Effect"*, but also the related teaching materials;
- *"Allotropes of Carbon. Are there any Buckyballs?"* that included the Virtual Lab clips: *"Understanding Nanoscale"* and *"Making Origami Buckyball"*, but also the related teaching materials;
- *"Is there any Lotus Effect around us?"* that included the Virtual Lab clips: *"Understanding Nanoscale"* and *"Lotus Effect"*, but also the related teaching materials.

The lessons designed for the secondary education level sought to develop the knowledge, skills and attitudes of students involved, so that they can participate effectively in discussions on topical issues. They stressed the direct exchanges of ideas and experience, for students involved in the project, to take a clearer picture of the investigative approach in action. In this respect, the objectives were the following: increasing the interest of students towards civic issues as well as to the scientific findings; training the young people to express their views on various Science issues; acquiring by students of investigative capacities and skills; stimulating students' desire to understand the current problems of the actual society; increasing the students' confidence and their self-esteem to be involved in the discussion of issues that can be found in ordinary newspapers.

From the scientific point of view, the lessons activities allowed students to learn about the defined characteristics of:

- certain physical systems encountered in the wild;
- nanotechnologies phenomena;
- possibilities of practical application related to theoretical knowledge of nanotechnologies;
- phenomena in the field of nanotechnologies;
- physical characteristics of the phenomena in the field of nanotechnologies;
- causal existed relations;
- carrying out the physical phenomena specific to nanotechnologies;
- application of the knowledge gained through the study of Science in related fields;
- presentation (in written or oral form) of the results of an investigative approach using specific Science terminology;
- advantages and disadvantages of nanotechnologies from the environmental perspective.

The classroom management and the sequence of events were decided by each teacher according not only to the chosen topic, but also to the students' level and knowledge. As procedural resources, the following teaching and learning methods and processes can be emphasized: presentation, conversation, observation, explanation, exercise, discussion, experimentation, modeling, deliberation (also including the SAC Method – Structured Academic Controversy). As class activities organization, both group and individual forms of organization were applied. Concerning the material resources used during the implementation process, video-projector, flipcharts, media texts, PCs, Internet, sticks and modeling clay, teaching materials and learning sheets developed by the teachers can be enumerated.

At the university level, 5 university staff (project experts), 45 university students (second year of study on Faculty of Science and Arts & Faculty of Environmental Engineering and Food Science), 25 master students and 8 PhD students took part in the university test-implementation phase. The implementation process took place in April-November 2013 and was organized the Science Department laboratories and halls.

The subjects of implementations were: *"Nanoparticles/Nanomaterials – Small Things behind a Stunning World", "Nanofibers"* and *"Deposition of TiO2 Nanoparticles on Optoelectronic Materials for Achieving Dye-Sensitized Solar Cells"* which led students to explore the NTSE Virtual Lab and consult materials from NTSE Repository alongside other scientific materials from the university library and international databases.

The role of Valahia University Targoviste local experts in the process of test-implementations organized at the university level was oriented on: organizing the process of implementation and assuring the necessary logistic (VL videos & repository materials, additional resources, materials for laboratory activities); offering support in the developed activity (leading the discussions, presenting scientific information) and collaborating with master students / PhD researchers to meet their needs / requirements.

In completing the activities, university students, as well as master and PhD students, developed a variety of process skills critical to their further specialization including: working collaboratively; interpreting and prioritizing data / information; acquiring (by students) of investigative capacities and skills; defending an argument; increasing their confidence and self-esteem to be involved in the discussion of scientific issues that can be found in specialized newspapers and scientific journals; experimenting and obtaining reliable results.

From the scientific point of view, the proposed activities allowed students to learn about the defined characteristics of:

- nanotechnologies phenomena;
- possibilities of practical application related to theoretical knowledge of nanotechnologies;
- phenomena in the field of nanotechnologies;
- physical characteristics of the phenomena in the field of nanotechnologies;
- causal existed relations;
- carrying out the physical phenomena specific to nanotechnologies;
- application of the knowledge gained through the study of Science in related fields;
- presentation of the results of an investigative approach using specific Science terminology;
- advantages and disadvantages of nanotechnologies from the environmental perspective;
- new working methods and various tools of analysis.

Concerning the classroom management and sequence of events during the implementation stage at the university students' level, before the starting of activity, students should understand that many materials that belong to the natural world have properties which are the result of inherent nanostructures. The interaction of light, water and other materials with such nanostructures gives natural materials special properties that we can see with your own eyes. Nanomaterials study shows an increased interest in scientific research in recent decades. These materials, which are characterized by very small particle size, have great potential for use in many industrial applications, biomedical, electronics, etc. Alternatively, the instructor / teacher could present them some of the basic concepts concerning "nano" term and experimental examples by using appropriated images and videos. The students from each team must shared interesting facts and ideas found in the documented text, in order to arrive at a better understanding of the analyzed documents. It was recommended to start the documentation from the experiments proposed in the NTSE Virtual Lab (http://vlab.ntse-nanotech.eu/NanoVirtualLab/) and completed by using the NTSE Repository (http://ntse.ssai.valahia.ro/).

As a guideline for students the activity was divided into six "sessions" (as is foreseen in Table 1), some inside laboratory and some outside laboratory.

Sequence	Location	Activities
Introduction and Session 1	Chemistry lab (50–90 min)	The teacher / instructor facilitates students discussion about nano terms. Students split into work teams (7 work teams formed by 4–5 students) and receive scenario / task and data and brainstorm potential main experiment to be made
Session 2	Outside lab	Teams asses information and search for additional information
Session 3	Outside lab	Teams outline and produce drafts of essays
Session 4	Chemistry lab (30–40 min)	Teams present preliminary drafts to the teacher and verify for reagents, materials etc. in order to be available for experimental work
Session 5	Outside lab	Teams revise products according to reviewers' suggestions
Session 6	Chemistry lab (90 min)	Teams present products to entire group Each team reviews and evaluate one other team's designed experiment. The experiment selected (in terms of structure, didactical approach, scientific notions etc.) is made by all teams

Table 1. Sequence of Events

Related to procedural resources, the following teaching and learning methods and processes can be emphasized: experimenting, explanation, observation, conversation, discussion, deliberation. The organization of class activities included individual activities, group work and frontal discussions. Concerning the material resources used during the implementation process, video-projector, flipcharts, media texts, PCs, Internet, teaching materials and learning sheets developed by the project experts, Colloidal Chemistry laboratory resources (instruments, glassware, reagents, utilities etc.) were used.

When acquiring the information and after realizing the activities, students had to be able to:

- edit a report/essay where to submit arguments in respect of decisions taken and the related reasons;
- identify the consequences of applying nanotechnologies to human health, environment and society;
- retrieve specific information in the proposed websites;
- analyze selected information in relation to the proposed objectives;
- decide as a team how to deliver structured information in terms of didactical and pedagogical issues (terms, notions, experimental stages);
- analyze the pros and cons of applied nanotechnologies;
- submit collective conclusions made in front of the colleagues, in the laboratory.

As it was mentioned before, one of the results of the test-implementation phase was the development by the Romanian partner of *5 case-studies* emphasizing the use of different facilities of NTSE Virtual Laboratory during the practical activities organized at lower secondary school students, upper secondary school students, university students (prospective Science teachers), master students and PhD students.

Two of those case-studies were developed during the implementation of two experiments from Virtual Lab on the level of lower and upper secondary school students: (*"Allotropes of Carbon. Are There any Buckyballs?"* – Teacher: Nadia Bădoiu, Gymnasium School, Gura-Şuţii, Romania (using the Buckyball Experiment of VL) and *"Nanotechnology and Nanobiomimicry"* – Teacher: Carmen ANTONESCU, Bălaşa Doamna High School, Târgovişte, Romania (using the *Lotus Effect Experiment* of VL).

The first case study – designed for lower secondary education (8th form) – introduced and explained the *allotropes of carbon:* diamond, graphite, fullerenes, carbon nanotubes, amorphous carbon. During the activity, students learned about the defined characteristics of: (i) allotropes of carbon; (ii) structure of buckyball (fullerenes); (iii) application areas of buckyballs (fullerenes) and buckytubes (carbon nanotubes); (iv) different covalent bond structures of carbon; (v) crystal structure of allotropes of carbon.

In the beginning of the lesson activity, the students watched a *ppt presentation* (prepared by the teacher), in which the concepts of *Nanotechnology* and *Nanoscale* are introduced and discussed. After that they became more familiarized with the topic by using Virtual Lab resources (*Understanding Nanoscale* and *Carbon Nanotubes*) and *Nano Repository* ones, but also an animation related to *The Scale of the Universe 2* (http://htwins.net/scale2/). Then, the teacher made the connection between *Nanotechnology / Nanoscale* and the *allotropes of carbon,* using an interactive ppt presentation, and formulating the central questions for students: *What represents the allotropes of carbon? Do you know about other famous allotropes in the nature?* One by one, there were presented and discussed: (i) *diamond* – students being asked to solve the first task: *"Build your own diamond model using equal length sticks and modeling clay. You can use the modeling clay to symbolize carbon atoms and the sticks to symbolize the bonds in between.";* (ii) *graphite* – students being asked to solve the second task: *"Build your own graphite model, using equal length sticks and modeling clay. You can use the modeling clay to symbolize carbon atoms and the sticks to symbolize the bonds in between.";* (iii) *buckyball* – students being asked to solve the third task: *"Build your own buckyball model, using a prototype printed on the special cardboard, prepared for you by the teacher. Simultaneously, you are invited to watch and notice another method for building a buckyball model,* illustrated in the *NTSE Virtual Lab – Making Origami Buckyballs."* At the same time, students are asked to explain the nano dimensions of the allotropes of carbon, analyzing the presented evidences. Finally the students concluded the most important aspects, but they were also assessed, being requested to complete a written test.

The second case study – designed for upper secondary education (9th form) – introduced the topic of *Nanobiomimicry*, a concept which combine *Nanotechnology* with *Biomimetics.* In fact, *Nanobiomimicry* is seen as the biological imitation of nano and macro scale structures and processes (http://www.targethealth.com/Pages/Publications/ONTARGET/2013/09082013.htm#3). During the activity, students discovered things that researchers in nanotechnology had learned from Mother Nature, using a strategy represented by the format of exchanging of ideas and arguments, with the view to assume the best explanations related to the importance of *Nanoscience* and *Nanotechnology* in the actual world. The analyzed examples were: (i) lotus effect; (ii) biomorphic mineralization; (iii) biologically inspired engineering; (iv) nanowires, nanotubes and quantum dots; (v) display technology; (vi) structural coloration; (vii) flock of sheep; (viii) biomimetic crystallization and structural analysis; (ix) biomineralized tissues; (x) inorganic-polymeric complex architectures; (xi) template directed synthesis; (xii) porous scaffolds for regenerative medicine; (xiii) burr → velcro; (xiv) bug → water collection; (xv) sharkskin → swimsuit.

In the beginning of the lesson activity, the concepts of *Nanotechnology* and *Nanobiomimicry* are introduced, the class being divided into groups of students, each student playing a specific role (physicist, doctor, biologist and chemist). Each group has to decide on the advisability of applying of nanotechnology in the actual society context, by answering to central questions: *What is Nanotechnology? What is Nanobiomimicry? How those areas influence our life and what could be the main application?* With the view to offer the best answer, the groups must undertake a research (documentation), analyze the evidences, formulate the arguments and present the conclusions. Resources from *Virtual Lab (Understanding Nanoscale* and *Lotus Effect)* are proposed to be consulted, as well as some *Nano Repository* objects.

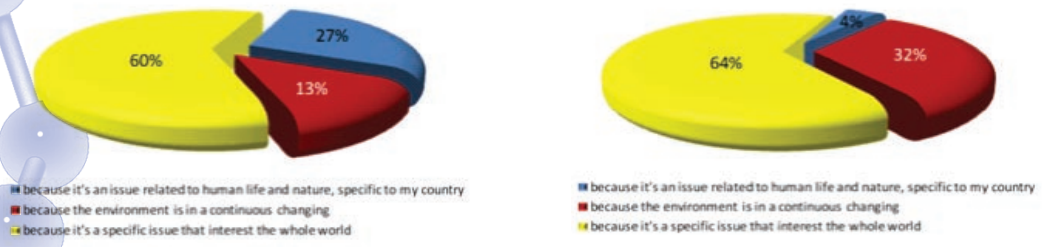
For finalizing the didactic process, sets of questions were proposed. The students from each group must express their personal opinions, answering to the following specific questions:

- Which are the consequences of using nanotechnology?
- Which were the most powerful pros arguments?
- Which were the most powerful cons arguments?
- Why Nanotechnology is important?
- Have you changed your opinion after the discussions? Why?
- Have you learned anything new from this lesson?
- What you have learned (specifically) from your colleagues?
- What would you like to learn more?
- From where did you get the information?
- Was your opinion adopted by the group?
- Which were, however, the areas of consensus in your group?

Figure 1 illustrates students' answers to the question: *"Why do you consider that Nanotechnology is important?"* As it can be observed, most of the students are aware that this is an area which causes a huge interest for the actual research (actual world). But there is also a slight perception between the category of students when they associate *Nano* area with human life / nature and the continuous changing of the environment.

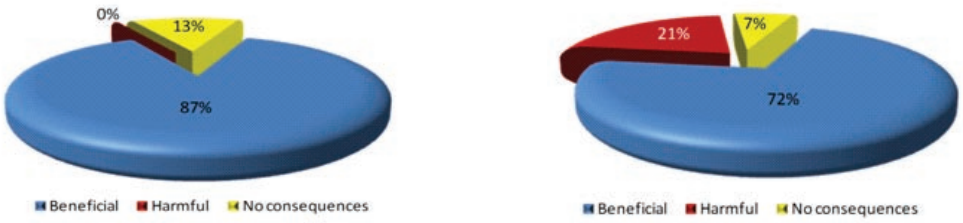
Figure 2 shows the students' understanding related to the possible consequences of using *Nanotechnology* in our daily life. In this case, there is an overwhelming feedback saying that the introducing of *Nanotechnology* on a large scale is beneficial. However, it was recorded an important percentage of answers (just from upper secondary students) which expressed that *Nanotechnology* can have a harmful impact in our life. At the same time, there were students who said that there are no consequences in this sense.

Figure 1. Students' answers to the question: "Why do you consider that Nanotechnology is important?"



(a) Lower secondary Students (b) Upper secondary students

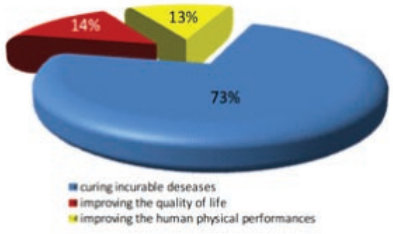
Figure 2. Students' appreciations related to the possible consequences of introducing Nanotechnology in our life



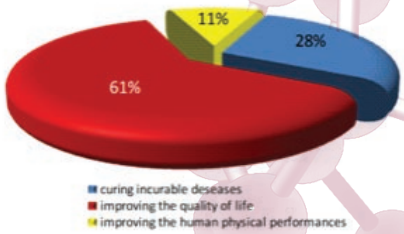
(a) Lower secondary Students (b) Upper secondary students

Figures 3 and 4 illustrate the students' pros and cons arguments related to developing and applying of Nanotechnology in some specific contexts. The results can be analyzed from different perspectives, but it is important to mention that students are aware that Nanotechnology has important strong potential for improving the quality of life and curing incurable diseases. On the other hands, the students know that it is a high-consuming resources area and there are not so much money allocated in Romania.

Figure 3. Students' pros-arguments related to developing and applying of Nanotechnology

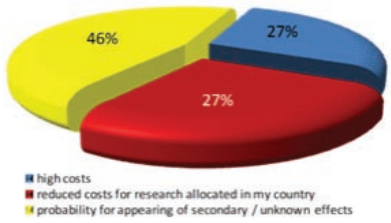


(a) Lower secondary Students

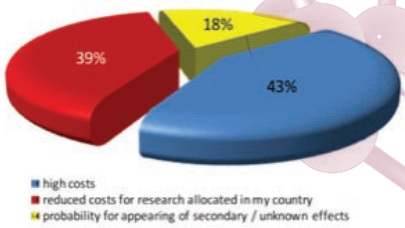


(b) Upper secondary students

Figure 4. Students' cons-arguments related to the developing and applying of Nanotechnology



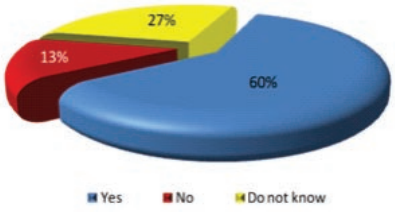
(a) Lower secondary Students



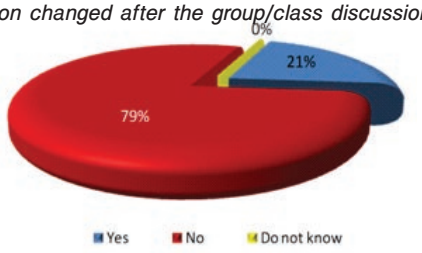
(b) Upper secondary students

Figure 5 illustrates the students' answers related to how their opinions about *Nanotechnology* had been changed after the group / class discussions. Here, it can be noted that most of the lower secondary students were influenced by the group / class discussions (60%). On the other hand, 79% of the upper secondary students expressed that the discussions did not change their initial ideas related to *Nanotechnology*.

Figure 5. Students' answers to the question: "Is your own opinion changed after the group/class discussion?"



(a) Lower secondary Students

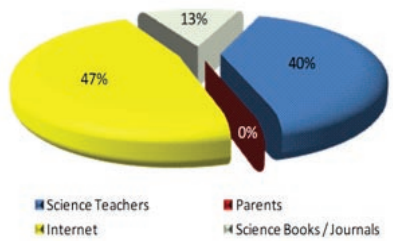


(b) Upper secondary students

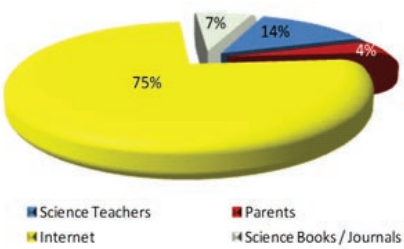
One of the most interesting questions was related to the sources of information accessed by the students for extending their knowledge about *Nanoscience* and *Nanotechnology*. In this respect, Figure 6 shows the important role played by Internet, as a valuable source of information. It is also the case of *Nano-Technology Science Education – NTSE* project, which provides its resources (including the *Virtual Lab*) in a dedicated space on Internet. But, it is clear that Science teachers need to be more involved and active at the moment when they make connections between real-life phenomena and *Nanoscience,* or when presenting physical or chemical processes which can be explained using specific *Nanotechnology* concepts. At the same time, teachers have to give more importance to the Science literature and ask the students to take more into account the articles published in scientific books or journals.

In many situations, teachers use case studies like teaching tools to show and evidence the application of a theory or a concept to real situations. In addition, they exploit case studies as specific didactic methodology which has the main role to develop the students' knowledge.

Figure 6. Students' feedback related to the question: "What are the main sources for getting information related to Nanoscience and Nanotechnology"?



(a) Lower secondary Students



(b) Upper secondary students

In the situation of both presented case studies, ICT represented a real support for understanding *Nanoscience* and *Nanotechnology* issues. In fact, learning *Nanoscience* and *Nanotechnology* by the use of ICT (through the designed resources included in the *Virtual Lab*), could be a feasible way for motivating the students, due to the wide possibilities for presenting related Nano concepts in multimedia formats (Gorghiu, & Gorghiu, 2012). On the other hand, at the student's level, the impact of such activities was major, maximizing the involvement in the proposed activities and multiplying the understanding of the real world. More, practical activities (like experimenting and modeling) made together with the colleagues inside the working group, offered an important social impact.

Concerning the implementations at the university level, there were three case-studies developed by the Romanian partner at the level of bachelor, master and PhD students.

The first case study entitled "Nanoparticles / Nanomaterials – Small things behind a stunning world" was realized by Teaching Assistant Radu Lucian Olteanu after the activity organized with bachelor students / prospective teachers with purpose to provide them a basically and advanced approach on to the NANO area. The students developed an essay which contained a virtual or real experiment that can be applied in laboratory. Having in view they were students from Science area (Physics-Chemistry) and moreover prospective teaches, they had to take care also to didactical and pedagogical aspects. Some of the selected information / examples made available to the students was from the NTSE Virtual Lab (teaching materials) and from NTSE database (Repository) under L Education (General) and Q Science (General) sections.

The second case study, entitled "Nanofibres" realized by Associate Professors Crinela Dumitrescu and Laura Gorghiu was based on the activity dedicated to familiarize master students / prospective teachers of science with important concepts related to nanofibers and their use in everyday life and the methodology followed during the implementation it was mainly the same as in the first implementation to the bachelor students. The activity designed for the *Chemistry master students (second year),* sought to develop the knowledge, skills and attitudes of students involved, so that they can participate effectively in discussions on topical issues. At the same time, it stressed the direct exchanges of ideas and experience, laboratory work, to take a clearer picture of the investigative approach in action.

For finalizing the didactic process, both bachelor students and master students were invited to fill in a questionnaire, in order to design a graphical feedback after processing their answers. "Questionnaire for master students / prospective science teachers" aimed at assessing and collecting information and suggestions on teaching effectiveness, content and usability of educational materials dedicated to teaching / learning Nanotechnologies created in the project Nano-Tech Science Education and uploaded in the NTSE Virtual Lab. The students had to express their personal opinions, answering to the following specific issues:

– Pedagogical approaches:
- General pedagogical criteria:
- The clarity of stated educational objectives and the expected results;
- If the teaching materials meet the stated educational purpose;
- The clarity of the learning objectives;
- Tasks are clearly described;
- If the activities are adapted to the target group.
- Pedagogical requirements focused on teacher:
  - > To set their own learning goals;
  - > To search and explore information;
  - > To collect and retrieve information;
  - > Communicate with students;
  - > To seek and receive support from experts in Nanotechnologies.

– Effectiveness of the content:

§ Information:
- > Information included are detailed and comprehensive;
- > Information included is relevant to the educational objectives set;
- > Information included are appropriate for the target group;
- > Information included helping to enrich the curriculum content;
- > Included information are related to relevant online resources;
- > Information included not contain labels or stereotypes political invoice / cultural / social / racial humiliation;
- > Information included are updated with current topics in the field of nanotechnology
- > Information sources are detailed.

§ Structure:
- > Information included are well structured and organized;
- > Included texts are well structured;

> Labels are suitable and representative sections for the information;
> Online resources related with information are relevant;

§ Presentation / Design:
> Images and sounds included are properly referenced;
> The texts are readable in terms of color, size, font type, arrangement and visual effects;
> Graphics, images and videos included are well presented in terms of resolution, color and size;
> Graphics, images, sound and video resources used are appropriate for the purpose;
> Using images, videos and audio facilitates understanding;

§ Accuracy:
> Links included in the proposed resources are appropriate and functional;
> The language used is correct syntactically and grammatically;
> Do you think there is a step that was omitted in the description of instructions or training materials?;

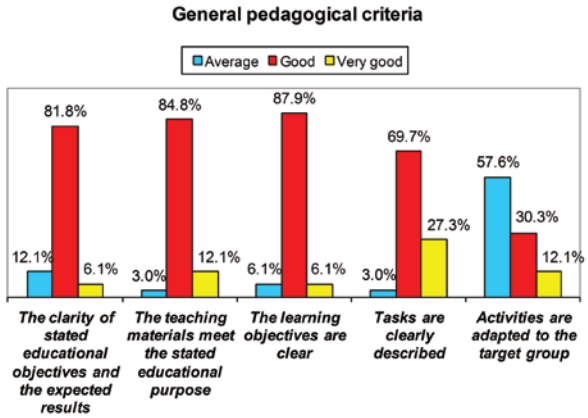
§ Designed tasks:
> The information provided was relevant and motivating for understanding topic task;
> Do you consider appropriate / interesting the introduction of laboratory work related to nanomaterials / nanotechnologies?;
> You find it useful to acquire additional knowledge about nanomaterials / nanotechnologies?

The comparative results obtained at the level of bachelor and master students are presented in the following figures. First of all, concerning the activity as a whole, the following ideas could be emphasized from the expressed feedback of both target groups:

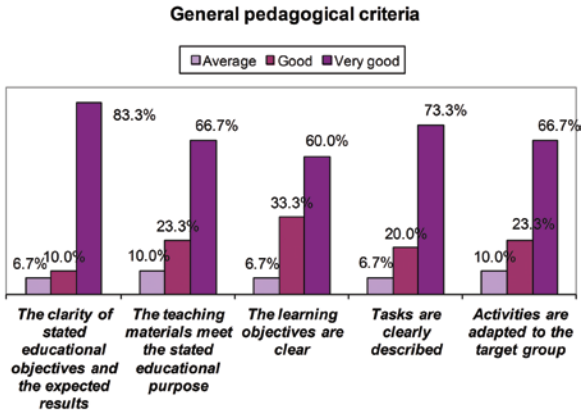
- real and actual issues have been discussed;
- opportunity to work in groups and know better the colleagues;
- possibility to express own opinion on certain issues;
- possibility to communicate without fear with the colleagues, and also with the teacher;
- proper frame to argument the own opinions, as well as listening patiently to others;
- opportunity to compile documents and find out things that otherwise are not so easy to know.

All students declared that they learn something new, interesting and actual during the activity. They were motivated and very interested to the presented / discussed subjects due to the fact that those topics aren't greatly deepened during university curricula.

– Pedagogical approaches:
§ General pedagogical criteria:



(a) Bachelor students / prospective teachers



(b) Master students / prospective teachers

> The clarity of stated educational objectives and the expected results;

Students' grade	Assessment grades		
	Average	Good	Very good
Bachelor students / Prospective teachers	12,1%	81,8%	6,1%
Master students / Prospective teachers	6,7%	10,0%	83,3%

> If the teaching materials meet the stated educational purpose;

Students' grade	Assessment grades		
	Average	Good	Very good
Bachelor students / Prospective teachers	3,0%	84,4%	12,1%
Master students / Prospective teachers	10,0%	23,3%	66,7%

> If the teaching materials meet the stated educational purpose;

Students' grade	Assessment grades		
	Average	Good	Very good
Bachelor students / Prospective teachers	3,0%	84,4%	12,1%
Master students / Prospective teachers	10,0%	23,3%	66,7%

> The clarity of the learning objectives;

Students' grade	Assessment grades		
	Average	Good	Very good
Bachelor students / Prospective teachers	6,1%	87,9%	6,1%
Master students / Prospective teachers	6,7%	33,3%	60,0%

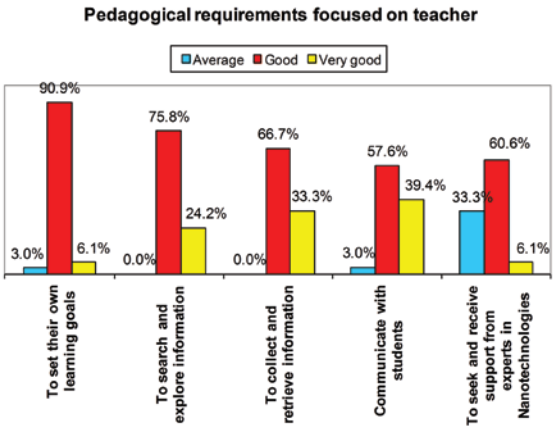
> Tasks are clearly described;

Students' grade	Assessment grades		
	Average	Good	Very good
Bachelor students / Prospective teachers	3,0%	69,87%	27,3%
Master students / Prospective teachers	6,7%	20,0%	73,3%

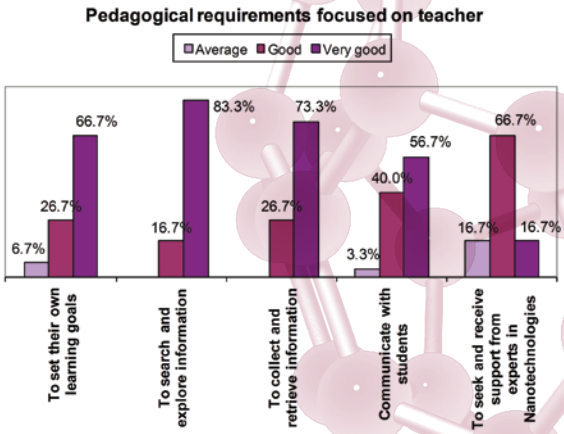
> If the activities are adapted to the target group.

Students' grade	Assessment grades		
	Average	Good	Very good
Bachelor students / Prospective teachers	57,6%	30,3%	12,1%
Master students / Prospective teachers	10,0%	23,3%	66,7%

§ Pedagogical requirements focused on teacher:



(a) University students / prospective teachers



(b) Master students / prospective teachers

> To set their own learning goals;

Students' grade	Assessment grades		
	Average	Good	Very good
Bachelor students / Prospective teachers	3,0%	90,9%	6,1%
Master students / Prospective teachers	6,7%	26,7%	66,7%

> To search and explore information;

Students' grade	Assessment grades		
	Average	Good	Very good
Bachelor students / Prospective teachers	0,0%	75,8%	24,2%
Master students / Prospective teachers	0,0%	16,7%	83,3%

> To collect and retrieve information;

Students' grade	Assessment grades		
	Average	Good	Very good
Bachelor students / Prospective teachers	0,0%	66,7%	33,3%
Master students / Prospective teachers	0,0%	26,7%	73,3%

> Communicate with students;

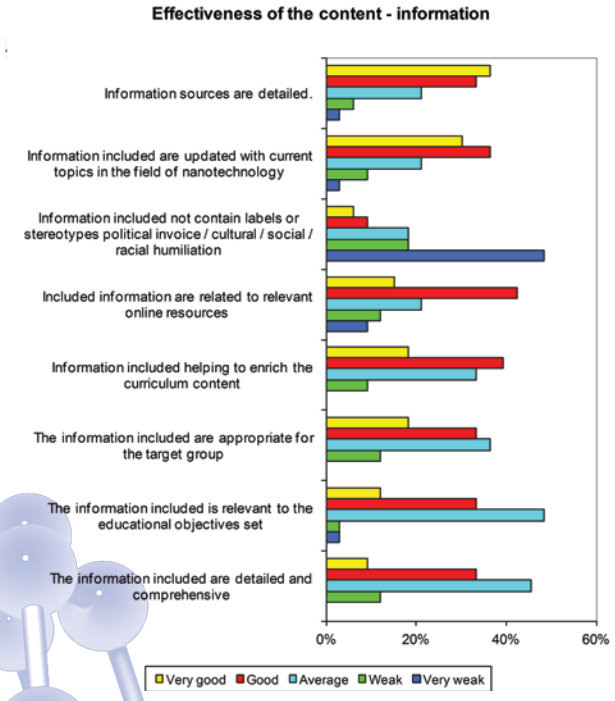
Students' grade	Assessment grades		
	Average	Good	Very good
Bachelor students / Prospective teachers	3,0%	57,6%	39,4%
Master students / Prospective teachers	3,3%	40,0%	56,7%

> To seek and receive support from experts in Nanotechnologies.

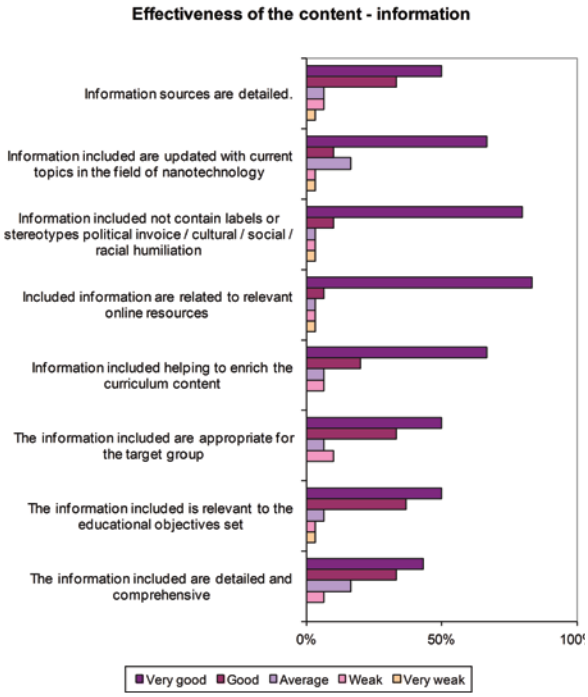
Students' grade	Assessment grades		
	Average	Good	Very good
Bachelor students / Prospective teachers	33,3%	60,6%	6,1%
Master students / Prospective teachers	16,7%	66,7%	16,7%

– Effectiveness of the content:

§ Information:



(a) University students / prospective teachers



(b) Master students / prospective teachers

> Information included are detailed and comprehensive;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	0,0%	12,1%	45,5%	33,3%	9,1%
Master students / Prospective teachers	0,0%	6,7%	16,7%	33,3%	43,3%

> Information included is relevant to the educational objectives set;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	3,0%	3,0%	48,5%	33,3%	12,1%
Master students / Prospective teachers	3,3%	3,3%	6,7%	36,7%	50,0%

> Information included are appropriate for the target group;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	0,0%	12,1%	36,4%	33,3%	18,2%
Master students / Prospective teachers	0,0%	10,0%	6,7%	36,3%	50,0%

> Information included helping to enrich the curriculum content;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	0,0%	9,1%	33,3%	39,4%	18,2%
Master students / Prospective teachers	0,0%	6,7%	6,7%	20,0%	66,7%

> Included information are related to relevant online resources;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	9,1%	12,1%	21,1%	42,4%	15,2%
Master students / Prospective teachers	3,3%	3,3%	3,3%	6,7%	83,3%

> Information included not contain labels or stereotypes political invoice/ cultural/ social/ racial humiliation;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	48,5%	18,2%	18,2%	9,1%	6,1%
Master students / Prospective teachers	3,3%	3,3%	3,3%	10,0%	80,0%

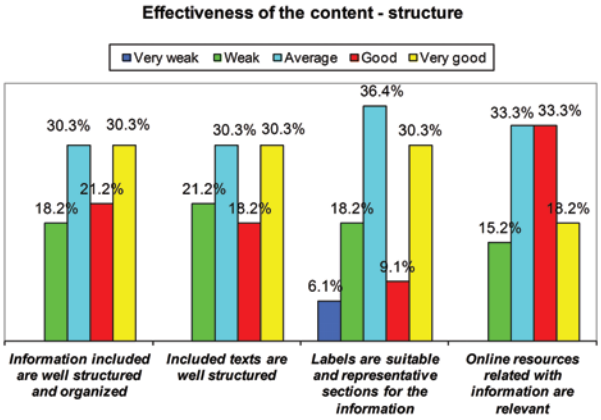
> Information included are updated with current topics in the field of nanotechnology;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	3,0%	9,1%	21,2%	36,4%	30,3%
Master students / Prospective teachers	3,3%	3,3%	16,7%	10,0%	66,7%

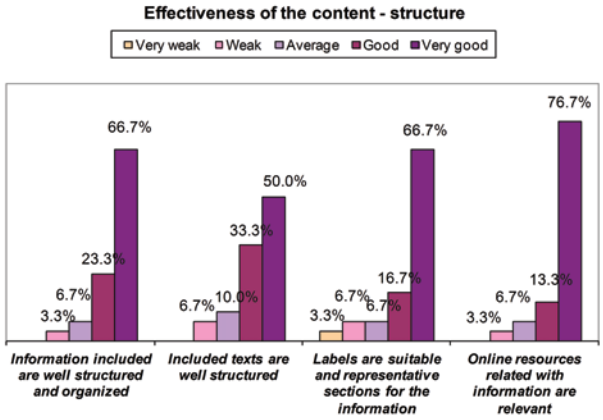
> Information sources are detailed;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	3,0%	6,1%	21,2%	33,3%	36,4%
Master students / Prospective teachers	3,3%	6,7%	6,7%	33,3%	50,0%

§ Structure:



(a) University students / prospective teachers



(b) Master students / prospective teachers

> Information included are well structured and organized;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	0,0%	18,2%	30,3%	21,2%	30,3%
Master students / Prospective teachers	0,0%	3,3%	6,7%	23,3%	66,7%

> Included texts are well structured;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	0,0%	21,2%	30,3%	18,2%	30,3%
Master students / Prospective teachers	0,0%	6,7%	10,0%	33,3%	50,0%

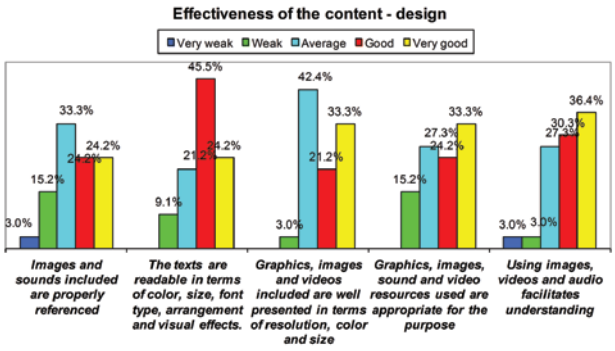
> Labels are suitable and representative sections for the information;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	6,1%	18,2%	36,4%	9,4%	30,3%
Master students / Prospective teachers	3,3%	6,7%	6,7	16,7%	66,7%

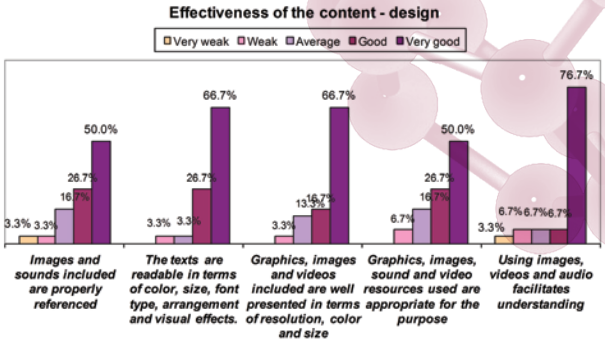
> Online resources related with information are relevant;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	0,0%	15,2%	33,3%	33,3%	18,2%
Master students / Prospective teachers	0,0%	3,3%	6,7%	13,3%	76,7%

§ Presentation / Design:



(a) University students / prospective teachers



(b) Master students / prospective teachers

> Images and sounds included are properly referenced;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	3,0%	15,2%	33,3%	24,2%	24,2%
Master students / Prospective teachers	3,3%	3,3%	16,7%	26,7%	50,2%

> The texts are readable in terms of color, size, font type, arrangement and visual effects;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	0,0%	9,1%	21,2%	45,5%	24,2%
Master students / Prospective teachers	0,0%	3,3%	3,3%	26,7%	66,7%

> Graphics, images and videos included are well presented in terms of resolution, color and size;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	0,0%	3,0%	42,4%	21,2%	33,3%
Master students / Prospective teachers	0,0%	3,3%	13,3%	16,7%	66,7%

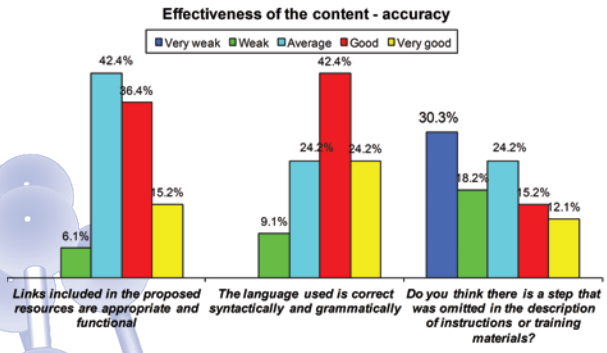
> Graphics, images, sound and video resources used are appropriate for the purpose;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	0,0%	15,2%	27,3%	24,2%	33,3%
Master students / Prospective teachers	0,0%	6,7%	16,7%	26,7%	50,0%

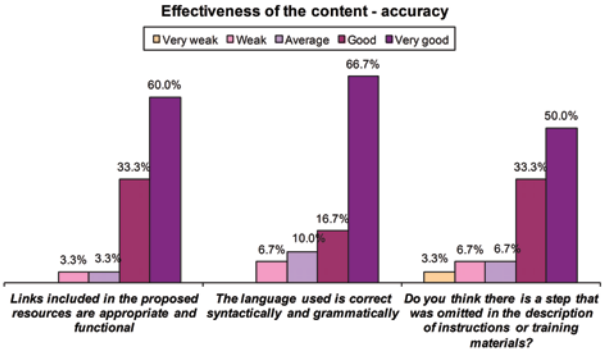
> Using images, videos and audio facilitates understanding;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	3,0%	3,0%	27,3%	30,3%	36,4%
Master students / Prospective teachers	3,3%	6,7%	6,7%	6,7%	76,7%

§ Accuracy:



(a) University students / prospective teachers



(b) Master students / prospective teachers

> Links included in the proposed resources are appropriate and functional;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	0,0%	6,1%	42,2%	36,4%	15,2%
Master students / Prospective teachers	0,0%	3,3%	3,3%	33,3%	60,0%

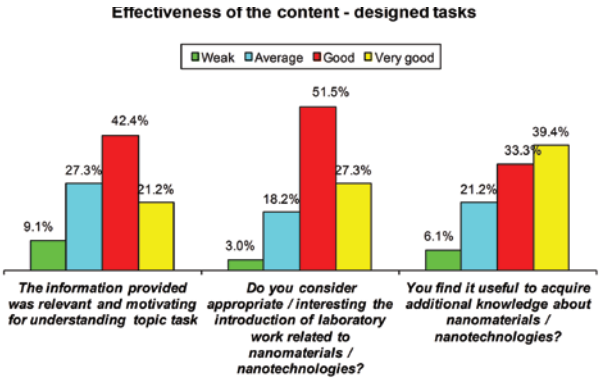
> The language used is correct syntactically and grammatically;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	0,0%	9,1%	24,2%	42,4%	24,2%
Master students / Prospective teachers	0,0%	6,7%	10,0%	16,7%	66,7%

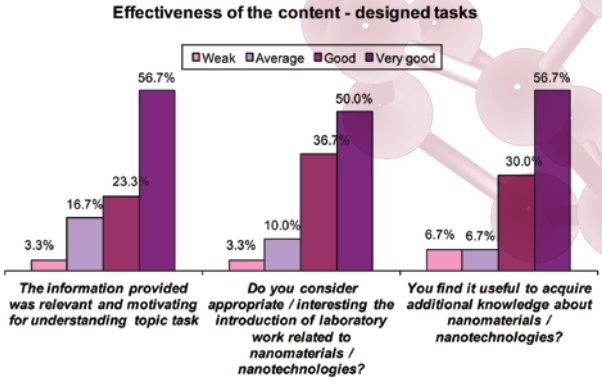
> Do you think there is a step that was omitted in the description of instructions or training materials?

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	3,0%	3,0%	27,3%	30,3%	36,4%
Master students / Prospective teachers	3,3%	6,7%	6,7%	6,7%	76,7%

§ Designed tasks:



(a) University students / prospective teachers



(b) Master students / prospective teachers

> The information provided was relevant and motivating for understanding topic task;

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	0,0%	9,1%	27,3%	42,4%	21,2%
Master students / Prospective teachers	0,0%	3,3%	16,7%	23,3%	56,7%

> Do you consider appropriate / interesting the introduction of laboratory work related to nanomaterials/ nanotechnologies?

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	0,0%	3,0%	18,2%	51,5%	27,3%
Master students / Prospective teachers	0,0%	3,3%	10,0%	36,7%	50,0%

> You find it useful to acquire additional knowledge about nanomaterials/ nanotechnologies?

Students' grade	Assessment grades				
	Very weak	Weak	Average	Good	Very good
Bachelor students / Prospective teachers	0,0%	6,1%	21,2%	33,3%	39,4%
Master students / Prospective teachers	0,0%	6,7%	6,7%	30,0%	56,7%

Important: the last part of the activity becomes very important, due to the fact that it represents a "debriefing" of everything the student has learned and lived during the whole process. The proposed questions dedicated to students substantiate in fact, the activity objectives.

Comparing the obtained results it can be observed that master students are more positive about the educational materials and features offered by the NTSE Virtual Lab than the bachelor students. This can be explained by the fact that after some implementations developed in each country, based on the feedback of the in-service and prospective teachers involved in the implementation stage, the partnership decided to improve the materials and making them more inquiry based learning. If we take into consideration that the activity developed with master students took place after the new educational materials were uploaded into the Virtual Lab, it can be emphasized an improvement of all the materials made available in the Virtual Lab. Based on these results, the Romanian partner has in view – in the context of the project exploitation – the development of new implementations of the educational materials prepared in the frame of the NTSE project for other classes of students.

The third case study made by PhD Student Andrei Chilian under the support of Professor Jipa Silviu was entitled "Deposition of TiO2 Nanoparticles on Optoelectronic Materials for Achieving Dye-Sensitized Solar Cells". The main reason of the activity developed at the PhD students level was to attract more PhD students to study NANO area. PhD students had to realize several laboratory experiments with nanoparticles. This activity was performed for PhD students involved in studying Engineering Sciences (1st and 2nd Year of study), because for developing the proposed experiments is requiring physics and chemistry knowledge.

Following this activity, the PhD students got several important capabilities:

- To work in groups;
- To interpret the obtained data;
- To improve their working mode;
- To implement new methods of working;
- Study the impact of various factors on the working method;
- To achieve good and real results;
- To learn new working methods;
- To learn to work with various tools of analysis;
- To make analysis of the surface of the materials;
- To interpret the SEM analysis, XRD (X-ray diffraction).

In the NANO area, PhD students learned more about: importance of nanoparticles in DSSC; how to obtain TiO2 nanoparticles; electronic transitions at the interface of TiO2 nanoparticles and dye; the advantages of using TiO2 nanoparticles compared with the use of particles of different sizes; the dyes with best photoelectric properties; electrolytes used for obtaining DSSC; the electrodes used for deposition of TiO_2 nanoparticles and using of other nanoparticles types in DSSC.

After retrieving the information and after the practical activities, PhD students are able:

- to make a report with the obtained results;
- to put into practice the knowledge about nanoparticles;
- to identify how nanoparticle size influences the efficiency of DSSC;
- to examine the advantages and disadvantages of this technology based on nanoparticles;
- to develop individual knowledge about NANO;
- to produce a scientific paper and present it at national or international conferences;
- to improve deposition techniques TiO_2 nanoparticles on optoelectronic materials.

Concerning the group management and sequence of events, all the activities started from the idea that TiO_2 nanoparticles are of high importance regarding their use as n-type element in dye sensitized solar cells (DSSC). Now, it is manifested an increased interest for technologies related to this type of photovoltaic cells. Therefore, the study of the properties and their deposition techniques require improvements.

Before starting the practical work, PhD students had studied the theoretical aspects related to methods of TiO2 nanoparticles deposition. Also, they received materials (scientific articles and books related to the deposition techniques).

To expand the horizon of knowledge in NANO, PhD students started to consult materials of *NTSE Virtual Lab Project* (http://vlab.ntse-nanotech.eu/NanoVirtualLab/) – especially dedicated to nanoparticles (see the video-clip *"Iron Nanoparticles"* from *Experiments Room*), and *NTSE Repository* (http://ntse.ssai.valahia.ro/), starting with the consultation of the article: *"The current state of public understanding of nanotechnology",* authors: Anna M. Waldron, Douglas Spencer and Carl A. Batt – uploaded in the NTSE Repository, at URI: http://ntse.ssai.valahia.ro/id/eprint/20, and of book specific paragraphs: Kenneth Kuno – *"Introduction to Nanoscience and Nanotechnology: A Workbook",* uploaded in the NTSE Repository, at URI: http://ntse.ssai.valahia.ro/id/eprint/35.

After the documentation stage, with the view to facilitate the assimilation of the Nano knowledge related to the studied Nano theme (*Deposition of TiO_2 nanoparticles on optoelectronic materials*), the work has been divided into several sections:

Section	Location	Activity
Section 1	Chemistry Lab (60 – 90 min)	The instructor does an introduction in the field of dye-sensitized solar cells (DSSC) and explains the importance of TiO_2 nanoparticles in them. PhD students are divided into groups (2 groups of 4 people) and receive work instructions for realization of experiments.
Section 2	Outside Lab	Consultation of materials and study of nanoparticle TiO_2 deposition methods
Section 3	Chemistry Lab (60 – 120 min)	The first group of PhD students begins the TiO_2 nanoparticles deposition by liquid phase deposition (LPD) (48 h). In parallel, the second group begins experiment of TiO_2 nanowires deposition by hydrothermal method (24 h).
Section 4	Outside Lab	Individual study related to deposit methods.
Section 5	Chemistry Lab (45 – 60 min)	Meeting with the second group after 24 h and finalization of TiO_2 nanowires deposition experiment by hydrothermal method and removing of FTO plates from chemical bath.
Section 6	Chemistry Lab (45 – 60 min)	Meeting with the first group after 48 h and finalization of TiO_2 nanoparticles submission experiment by liquid phase deposition (LPD).
Section 7	Outside Lab	PhD students study observed phenomena in experimental work and seek additional material.
Section 8	Chemistry Lab (60 – 120 min)	The first group of PhD students begins the experiment of TiO_2 nanowires deposition by hydrothermal method (24 h). In parallel, the second group starts the deposition of TiO_2 nanoparticles by liquid phase deposition (LPD) (48 h).
Section 9	Chemistry Lab (45 – 60 min)	Meeting with the first group after 24 h and finalization of experiment of TiO_2 nanowires deposition by hydrothermal method and removing of FTO plates from chemical bath.
Section 10	Chemistry Lab (45 – 60 min)	Meeting with the second group after 48 h and finalization of TiO_2 nanoparticles deposition experiment by liquid phase deposition (LPD).
Section 11	Chemistry Lab (45 – 60 min)	Evaluation and comparison of results. Presentation of research reports.

Additional references were also recommended to PhD students (e.g. the full articles can be downloaded from scientific databases.

Related to the procedural resources, the following methods and processes were used: research-based methods – experimenting, observing, data processing, analyzing, discussing, reporting. Both teams/groups and individual work was performed as form of organization. Like material resources and spaces, there were used instruments, reagents and utilities of Electrochemistry Laboratory, PCs, Internet access, video-projector, flipcharts etc.

For finalization of activity, PhD students had to express their personal opinions related to the experimental work, answering to a questionnaire with 20 questions that comprised the following sections: quality of expert' teaching; NANO activity; deposition method; method of deposition of TiO2 nanoparticles by liquid phase deposition (LPD); method of submission of TiO_2 nanoparticles by hydrothermal method; evaluation of the experimental activity.

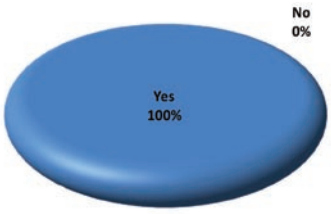
The impact on PhD students/Researchers at the end of activity emphasized the following aspects:

- Improvement of techniques for experimental work;
- Using theoretical concepts in solving practical problems;
- Better understanding and interpretation of the observed phenomena;
- Identification of the nanoparticles role in different areas.

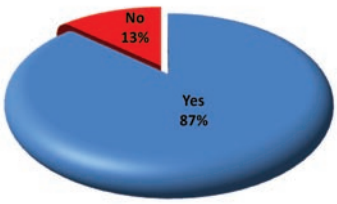
The following appreciations could be emphasized based on the expressed feedback of PhD students:

- Advantages of team work;
- Possibility of implementation / improvement of experimental techniques;
- Methods of deposition (advantages / disadvantages) have been discussed;
- Opportunity to consult scientific articles related to nanotechnologies and nanomaterials;
- Possibility of learning of something new.

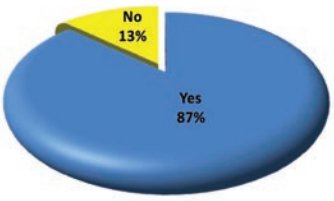
Below are some graphical outputs of PhD students' feedback:



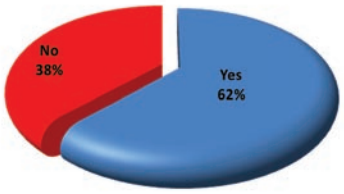
Has the instructor presented clearly the study materials?



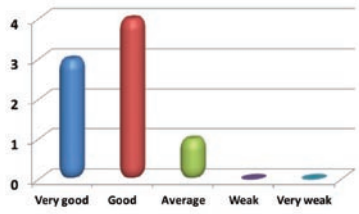
Have you had enough materials for study?



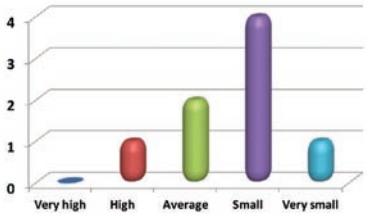
Were there any doubts during the experimental study of materials, in the related activity?



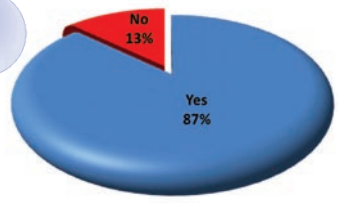
Is the performed experimental work useful for the chosen research topic?



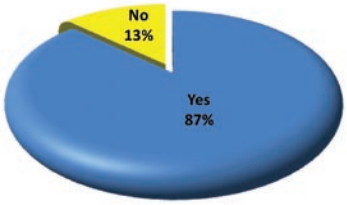
What is the degree of novelty for you of this experimental work?



Hardness of tasks for completion of work.

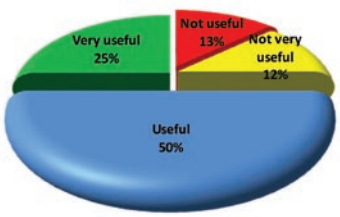


Would you also like to participate in such activities?



Have you changed your consideration about the importance of the NANO after carrying out this activity?

Will you study in the near future NANO-topics?



How useful is for your this experimental work?

CASE-STUDIES SUMMARY: BULGARIA

The case studies in Bulgaria were implemented by 5 teachers with 165 students from 8th grade (lower secondary school level) and from, 10th, 11th and 12th grades (upper secondary school level) in 4 different schools. The topics chosen by the teachers are:

1. "Nanoscale and Nanotechnology"
2. "Allotropes of carbon"
3. "Lotus effect"

Two of the teachers – Mrs. Evelina Vasileva and Mrs. Irina Kostadinova teach "Biology & Health education"; Mrs Rositsa Sotirova is a teacher in "Chemistry & Ecology"; Mrs. Kremena Dukadinova is a teacher in "Physics & Astronomy". Mrs. Vanya Gunova teaches two subjects – "English as a foreign language" and "Biology". Two of the schools where case studies have been carried out (the 'Akad. Emilian Stanev' Secondary school and the Second English Language High-School) work with a curriculum with intensive foreign language learning in English. This curriculum provides opportunities for "content and language integrated learning" (CLIL) where subject material is thought in a foreign language. The availability of the resources in English in the NTSE Virtual Lab allowed implementation of lessons in English.

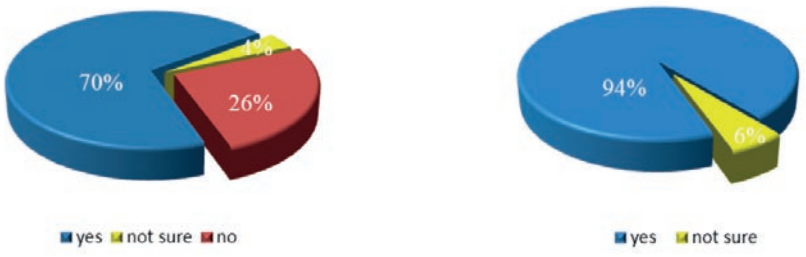
For her case study **Mrs. Evelina Vassileva** chose the **topic "Nanoscale and Nanotechnology"** and presented it in two different schools to students from 8th grade (in the National Professional High-school for Fine Mechanics and Optics "Michail Lomonosov") and, respectively, from 10th grade (in the 7th High-school in Sofia). The lesson with a duration of 90 min. is based on the use of the NTSE Virtual Lab resources on "Understanding Nanoscale". It provides the opportunity to explore and understand the metric system, nanoscale, properties of nanoscale particles and what nanotechnology deals with. Students have to develop the ability to convert ordinary measurement scales into nano and visualize the nano scale. For the implementation with the 8th graders the lesson was adapted in accordance to their level of scientific knowledge. The lessons with both groups were implemented in Bulgarian language.

They are involved in the subject by watching videos and presentations about nanoscale: "Nanotechnology" at http://www.youtube.com/watch?v=OKXwdG-Kk2Q, "The powers of ten" http://vlab.ntse-nanotech.eu/NanoVirtualLab/experimentroom/908f4cedc98349d0b57e781ae3ea29c4, The scale of The Universe: http://htwins.net/scale/, "A journey to the nanoworld", "A boy and his atom".

During the lesson the students execute four main activities, described in the Students' Guidelines (NTSE V-Lab Experiments room / Understanding nanoscale / Documents). They ask and answer the following questions about the text: *What is nanotechnology?, What is scale?, What is the largest scale shown in the video?, What is the smallest scale shown in the video?, How do you feel about travelling this long distances in empty space shown in the video?* They discuss the importance of nanotechnologies – their application in everyday life, as well as the beneficial or detrimental to health of the people in the future. They measure the objects in couples and convert the measurements into nanometer. They compare the sizes of different object: red blood cells and single hair; bacteria and virus; single water molecule and single gold atom; water molecules and Buckyball; cell, cell nucleus and carbon nanotube. Finally, they measure, calculate and compare the sizes of the figures they build with sugar cubes.

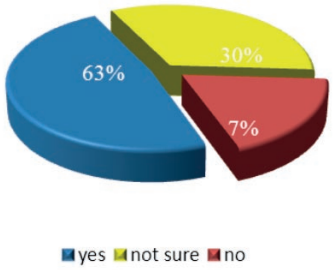
The students were mostly interested in the examples of application of nanotechnologies in the production of tissues, prostheses, alloys, etc. They faced difficulties in converting decimals into exponential units and vice versa. They also found it difficult to calculate volume and surface area of the geometrical shapes so only a small group of students tried to solve the problem.

At the end of the lesson, the students fill the standard self-evaluation questionnaire prepared as part of the set of NTSE V-Lab materials for this lesson. The answers of the students are presented below as diagrams in Figures 1–8. The parallel presentation of the data for the two age groups allows comparison of the level of understanding of the lesson's topic for the students from the lower secondary and upper secondary school level.

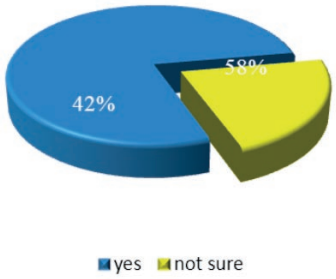


Lower secondary students *Lower secondary students*

Figure1. Answers to the statement *"I can give an example of an object with nm scale out of concepts I have learnt"* for both lower- and upper secondary students.

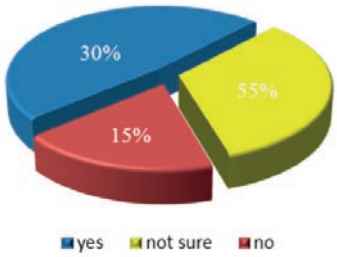


Lower secondary students

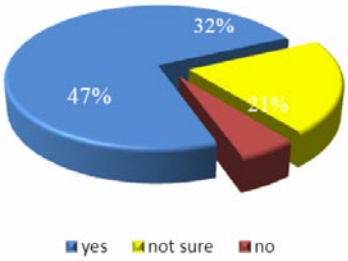


Lower secondary students

Figure 2. Answers to the statement *"I can differentiate Nanotechnological applications from the applications of conventional technology"*

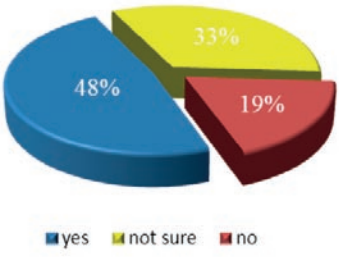


Lower secondary students

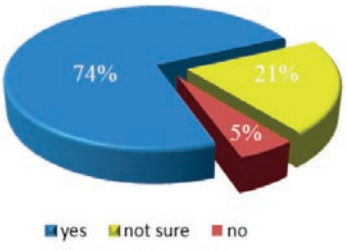


Lower secondary students

Figure 3. Answers to the statement *"I can comprehend that as the particle size changes, the physical properties change"*

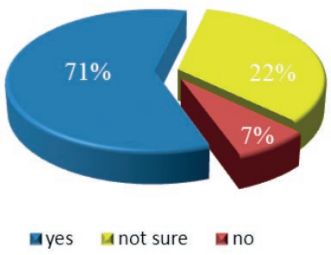


Lower secondary students

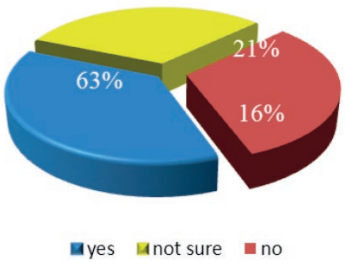


Lower secondary students

Figure 4. Answers to the statement *"I can explain why physical properties differ in granulated sugar and powdered sugar"*

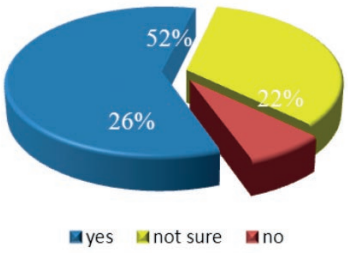


Lower secondary students

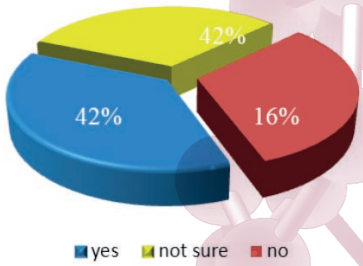


Lower secondary students

Figure 5. Answers to the statement *"I can define nanoparticles according to their sizes"*

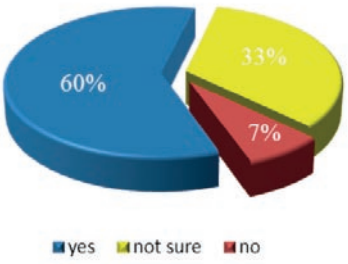


Lower secondary students

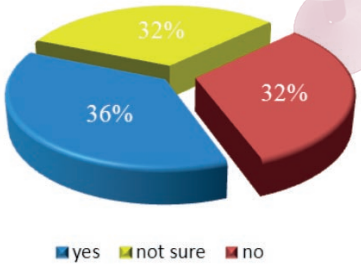


Lower secondary students

Figure 6. Answers to the statement *"When the particle size decreases to nano, I can explain why the material may gain new physical properties."*

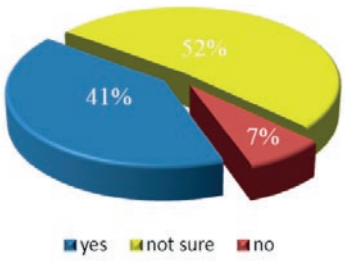


Lower secondary students

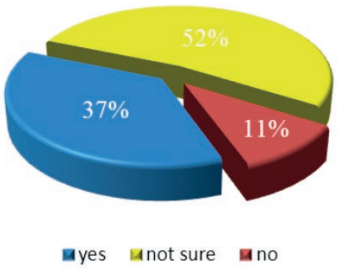


Lower secondary students

Figure 7. Pros and cons of the question *"I grasp that by applying Nanotechnology, actually we imitate the nature's technology."*



Lower secondary students



Lower secondary students

Figure 8. Answers to the statement *"I can give some examples of applications that show the large surface area makes some nanoparticles rapidly soluble in liquids"*

The topic "Allotropes of carbon" was presented in two different schools by two teachers – Mrs. Vanya Gunova in 'Akad. Emilian Stanev' Secondary school in Sofia and Mrs. Rositsa Sotirova in the Second English Language High-School in Sofia. The lesson includes scientific information for amorphous carbon, diamond, graphite, fullerenes and carbon nanotubes. During the lesson students learn notions as allotropes and allotropes of carbon; covalent bond; crystal structure of allotropes of carbon; structure of carbon nanotubes and buckyball (fullerenes); application areas of carbon allotropes etc. Both lessons utilize the resources of the NTSE Virtual Lab Experiments room – topic "Carbon Nanotubes".

The lesson implemented by **Mrs. Vanya Gunova** in "Akad. Emilian Stanev" Secondary school was aimed to help students visualize carbon nanotubes (hereinafter CNTs) which they cannot see by naked eye and to raise students' interest in both CNTs and nanotechnology. Students learn about different types of nanotubes, the production methods and a variety of application areas. The lesson was implemented in English and allowed mastering of scientific vocabulary in a foreign language.

Class preparations include designing the room to watch the experiment videos from the NTSE V-Lab and preparing a presentation (in Prezi) and the materials needed in the activities: students' guidelines, sheets of fence wire, microfiber cloth, ordinary cloth and two measurement containers with water.

During the lesson, the following activities are realized:

1. A brainstorming session attracting students' attention to the main topic.

2. The teacher asks questions preparing the students to watch the first video about spider silk explaining its properties. Then there is a discussion about the possible uses of technological replication of spider silk.

3. Students watch the video explaining the allotropes of carbon. They recognize carbon nanotubes as one of carbon allotropes and provide a definition.

4. Students watch the video explaining the production of carbon nanotubes and some of their uses.

5. The teacher shows pictures of different types of CNTs on the board and explains how to make their own CNTs' model out of the fence wire available on their desks. The teacher checks what type of nanotubes ("armchair", "zigzag" or "chiral") have been designed by the students.

6. Students are invited to read about CNTs properties from the Student's guidelines and fill in gapped sentences projected on the board.

7. Students watch an experiment video in the Virtual lab in order to recognize the water and oil absorption of materials made of CNTs. Then students discuss the amazing oil absorption property of CNTs and the possible application areas.

8. Students learn about other application areas of CNTs from teacher's presentation and the next animation video, explaining how they are used in computer circuits.

9. Finally students watch a video about space elevator and discuss the importance of carbon and its allotropes in technology of the future.

10. Evaluation.

At the beginning of the lesson implemented by **Mrs. Rositsa Sotirova** in the Second English Language High-School, the teacher made a brief historical introduction (in the form of PowerPoint presentation) about the reasons for Nanoscience appearance. She introduced also the main notions as Nanoscale, Nanotechnology etc. and the purpose of the activity – to teach the students about the structure and applications of carbon allotropes – diamond, graphite and fullerenes. The lesson was carried out in English language and allowed mastering of scientific vocabulary in a foreign language.

After that, the students are divided in 4 different groups for modeling origami of different structures – graphite, diamond, buckyball and nanotubes.

After completing the activities students are able to understand the reason as to why allotropes of carbon exist, to make connections between the "micro" and "macro" world linked to real-life applications, to understand the difference in the physical properties due to different arrangement of atoms in a crystal and to work cooperatively in a group setting. Students enjoyed working in groups and collaborating with classmates. They learned visually and managed to apply the knowledge in problem-solving activities (question session for discussion).

For getting students' feedback about the learning process and the level of difficulty of the topics was used the NTSE questionnaire for assessment of the Virtual lab implementations. The information from the questionnaires filled by the students after the lessons "Allotropes of carbon" is summarized and presented in Figures 9–18. Students answered to the questions giving feedback to what extent they agree or disagree with the statements where 1 means "Strongly disagree" and 5 means "Strongly agree".

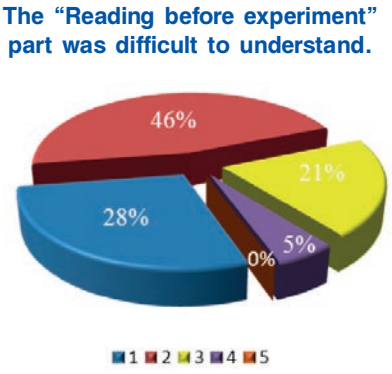


Figure 9.

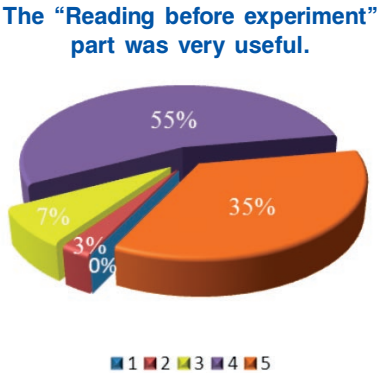


Figure 10.

For me, it was difficult to follow the video experiment.

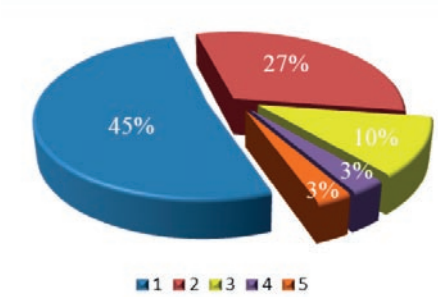


Figure 11.

The interactive animation was very useful and helped me understand the experiment.

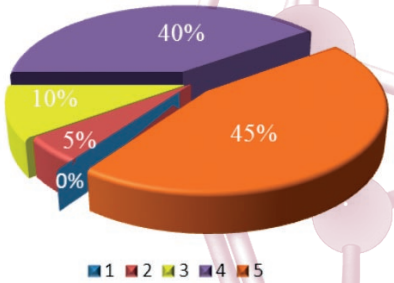


Figure 12.

After watching the video and doing the suggested activities, I had better understanding of the subject matter.

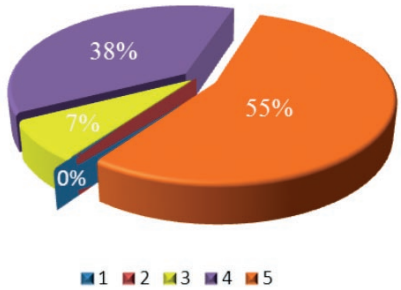


Figure 13.

Assignments helped me better understand the subject matter.

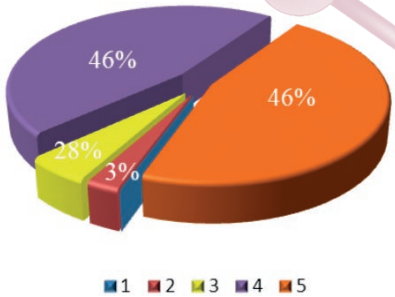


Figure 14.

Tests and tasks reflected the lesson content.

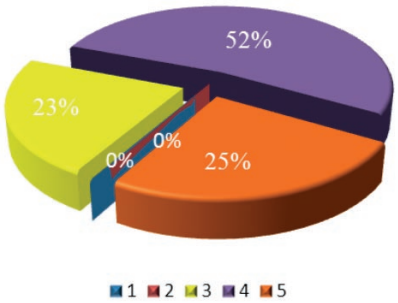


Figure 15.

The tests and tasks in this lesson/lab were difficult.

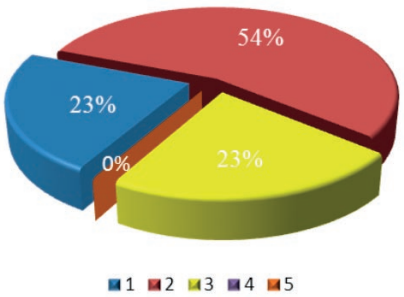


Figure 16.

I learned a lot of new things in this lesson/ lab.

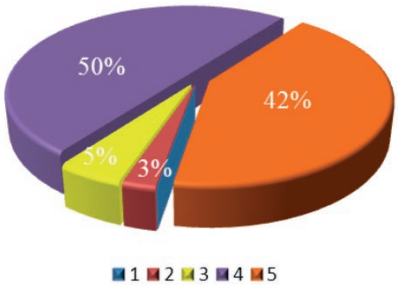


Figure 17.

I enjoyed doing this lesson/lab.

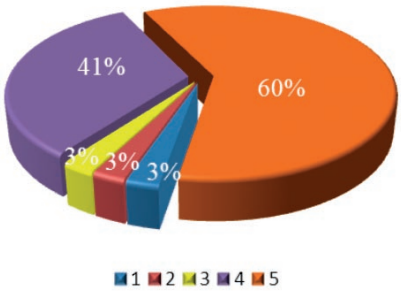


Figure 18.

The third case-study topic concerns the “Biomimicry” and especially the sub-theme “Lotus effect”. It is related with the notions as surface tension, capillary effects, wettability, hydrophobicity and hydrophilicity, molecular polarity, cohesive and adhesive forces, biomimicry. The topic was presented with the use of the resources of the NTSE

Virtual Lab Experiments room – topic "Lotus effect" by two teachers in two different schools – Mrs. Kremena Dukadinova in "Akad. Emilian Stanev" Secondary school in Sofia and Mrs. Irina Kostadinova in the Second English Language High-School in Sofia.

The main objectives of the lesson which **Mrs. Kremena Dukadinova** implemented in "Akad. Emilian Stanev" Secondary school were to demonstrate the properties of the lotus leaf and other plants, like cabbage, cauliflower, hazelbush, lettuce; to bring the observed effect of self-cleaning with the physical forces – cohesive and adhesive and their manifesting during the contact with water; to discuss about some applications of the nanotechnology based on the "lotus effect".

During the lesson the students read the "students guide" (NTSE Virtual Lab Experiments room/ "Lotus effect"/ Documents), watched videos, video-simulation and presentation on the topic. They made experiments with different kind of plant leaves available and discussed the observed phenomena. They made additional experiments with different surfaces and materials:

- glass plates with surface which is pure or treated with chemical (anti-fog, water repellent spray);
- paper (baking and writing),
- surfaces covered with water and oil.

Students explained the effect of the foam and detergents in the cleaning process.

At the very beginning of the lesson carried out by **Mrs. Irina Kostadinova** in the Second English Language High-School the students were informed about the main goals of project "Nano Technology Science Education" (NTSE) in the frame of which they receive the main information on the topic, summarized and available by the project site: http://www.ntse-nanotech.eu/. The lesson was implemented in English and allowed expanding of the students' scientific vocabulary in a foreign language. During the lesson the students read the text on "Lotus Effect" from the NTSE Virtual Lab Experiments room and try to answer the following questions related to the received information:

- Why lotus is so interesting plant for scientists?
- How the lotus surface is represented on the text?
- How to explain the structure of the lotus leaf in microscopic level?
- To understand better the physical phenomenon –lotus effect.
- What we already know about water-walking insects?

After that, the demonstration of floating needle is made and scientific explanation of the surface tension is done. Other demonstrations – of capillary action of water (cohesive/adhesive forces), of soap molecules action (hydrophilic and hydrophobic side of molecule) were presented.

- What happens when water is dropped on the lotus leaf?
- What applications might have been developed by engineers inspired by Lotus effect?
- Biomimicry – imitation of the nature.

The activity is focused on three main problems:

• Understand the lotus effect watching Videos 1 and 2. Discussing the structure of the leaves and their self-cleaning and hydrophobic properties.

• Examine (with the help of optical microscope) the surface of different leaves and their properties to repel water and mud.

• Observe the action of anti-fog and water repellent spray on glass

Finally, the students filled a questionnaire for evaluation of the content and usability of educational materials and learning Nanotechnologies, created in the project „NanoTechnology Science Education" in the NTSE Virtual Lab. The information from the questionnaires is processed and presented in Figures 19–28. Students answered to the questions giving feedback to what extent they agree or disagree with the statements where 1 means "Strongly disagree" and 5 means "Strongly agree".

The "Reading before experiment" part was difficult to understand.

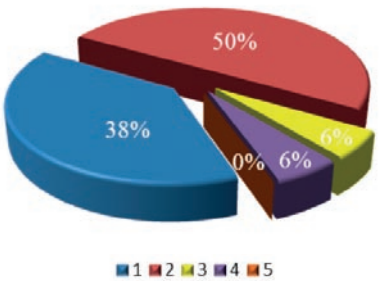


Figure 19.

The "Reading before experiment" part was very useful.

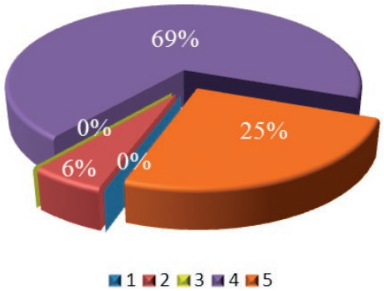


Figure 20.

For me, it was difficult to follow the video experiment.

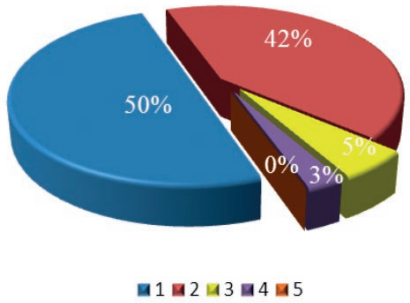


Figure 21.

The interactive animation was very useful and helped me understand the experiment.

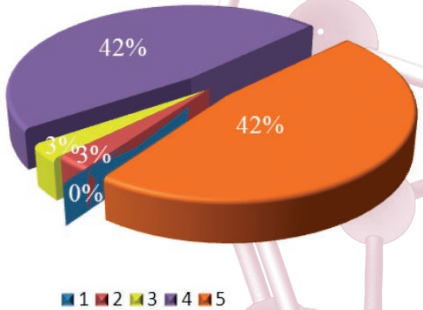


Figure 22.

After watching the video and doing the suggested activities, I had better understanding of the subject matter.

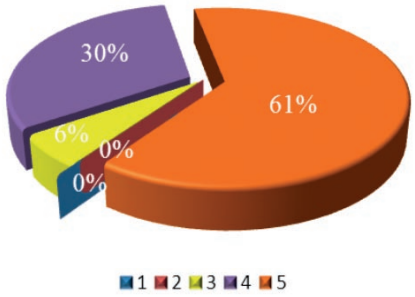


Figure 23.

Assignments helped me better understand the subject matter.

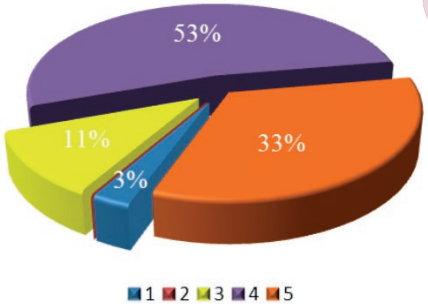


Figure 24.

Tests and tasks reflected the lesson content.

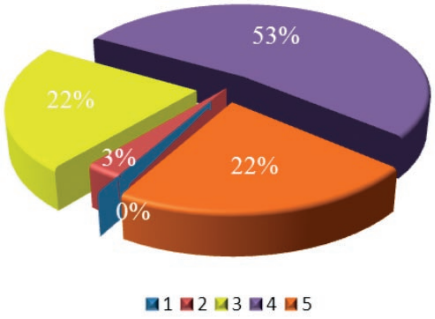


Figure 25.

The tests and tasks in this lesson/lab were difficult.

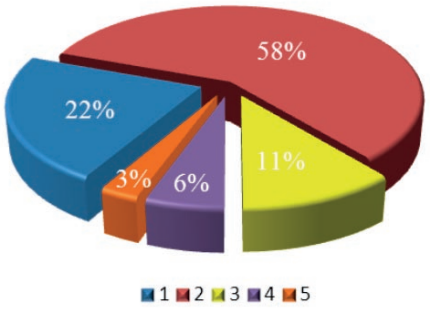


Figure 26.

I learned a lot of new things in this lesson/lab.

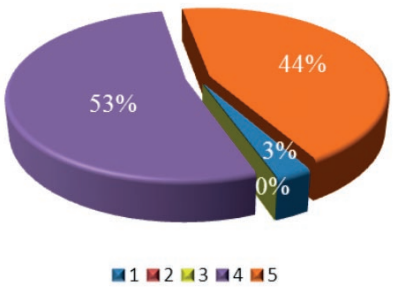


Figure 27.

I enjoyed doing this lesson/lab.

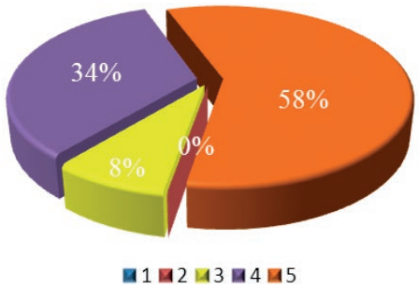
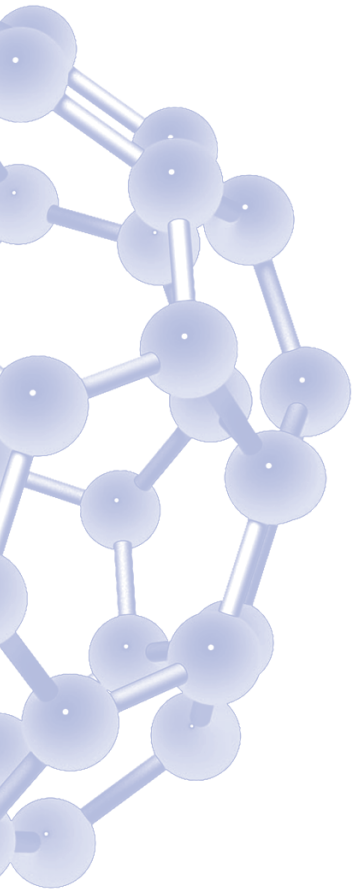


Figure 28.



VI. NANOCOMPETITION

NTSE Poster Competition aimed at encouraging the students (aged 14–18) to produce projects with regard to Nanotechnology. The participants had an opportunity to form their team with up to two friends. They selected a topic in nanotechnology about current and the possible future applications from given topics:

- Health (nanocosmetics)
- Environment (nanoparticles with antibacterial properties and nanoparticles used for purifying water and air)
- Nanotechnology used in Sport equipment
- Nanotechnology used in electronic devices

They made a first-class research and collected information, photos and images. The NTSE posters were designed about current applications in daily life and creative ideas/innovations for the future of nanotechnology in 300 words, A1 (59cm x 84cm) in size with a clear title. 145 posters were uploaded to Virtual Lab web site in six countries (BG, DE, EL, IT, RO & TR) until 15 March 2013. The statistics about the number, age range of the competitors in NTSE Poster Competition:

	BG	EL	IT	RO	TR
The students between 13-15	0	17	0	28	9
The students between 16-18	19	10	44	0	70
Number of the competitors	19	27	44	28	79
Number of the posters passing the content evaluation	12	13	9	15	51
Number of the posters in Antalya	7	6	6	6	14

The examination period was initiated on 16th April 2013 and finished on 19th April 2013. The aim of the evaluation is to ensure a fair assessment of the NTSE project posters produced by the students involved in the competition. All partners were in charge of poster evaluation and NTSE posters were evaluated in two steps by a committee comprised of international group of scientists with expertise in nanotechnology. First selection was done according to the criteria in the RUBRIC below.

Percentage distribution	Criteria	Points
60%	Clarity of Content	18
20%	Clarity of Design	6
20%	Online voting	6
1st SCORE		30
ANTALYA SCORE (EXTERNAL SCORE)		20
TOTAL SCORE		50

To be a finalist in APMAS 2013 Congress, 135 selected posters were voted online in the networks they are linked with (Facebook, twitter, google+, etc) and announced on our Virtual Lab.

Following the online voting 40 posters were exhibited in APMAS 2013 International Congress in Antalya (http://www.apmas2013.org/) and all posters were evaluated during the Congress by the scientists externally. All national winners chosen from partner countries were announced on our Virtual Lab and all winners were awarded to take part in the International nanoscience camp in the city Balchik, Bulgaria between 29th of June and 7th of July.

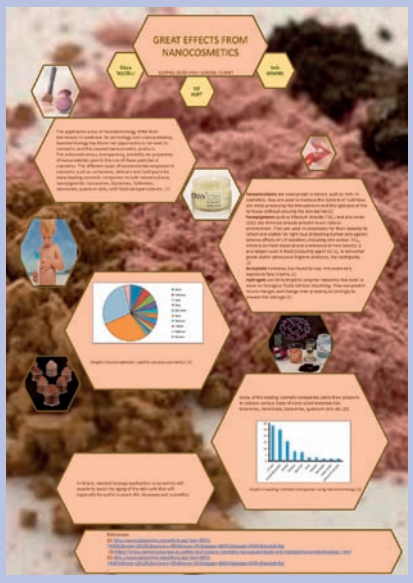
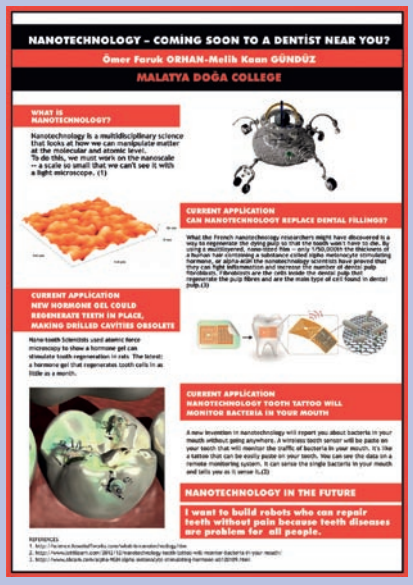
PROFILE OF TURKISH POSTER COMPETITORS

In total 79 students – 31 female and 48 male- attended NTSE Poster Competition from more than 20 different schools. 51 posters were successful in content evaluation and they were exhibited on our Virtual Laboratory to be voted online. 23 of these 51 posters were about health and nanocosmetics, 4 of them were about nanotechnology used in sport equipment, another 4 of them were about environment and 20 of them were about nanotechnology used in electronic devices and all other kinds of areas such as agriculture and textile. 14 posters passed the semi-final stage to go to Antalya Apmas, International Advances in Applied Physics and Material Science Congress, on 24 April 2013. These posters were also voted in Antalya and the winner of the poster competition is the 10th grade student from Acarkent Doga High School.

Table 1: 51 posters created by Turkish students and the name of their schools

No	Name-surname	School	Title
1	ABDULKADİR UZUN	SAKARYA DOĞA	NANO-TECH FILTER
2	AHMET ÖMER KADER, ARDA EGE ÖZTÜRK, MUHAMMED ÇİFTÇİ	DOGA COLLEGE	WHEN DREAMS MEET REALITY
3	ALİCAN TUNÇ, ÇAĞRI BOZKURT, DAMLA BUSE ÇAKIR	DOGA COLLEGE	NANOPARTICLES
4	ALİNDA EZGİ GERÇEKER	ATAŞEHİR DOĞA	NANOTECHNOLOGY IN FABRICS
5	ALPER ŞEKERCİ,MEHMET BERK SOFUGİL,DENİZ ŞAFAK ÇELİK	ACARKENT DOGA HIGH	NANOARMOR POSTER
6	ANILCAN ERCİYES	DOGA COLLEGE	NANOCLOTH
7	ARDA SU GÜRŞEN	BOSTANCI DOGA	THINK SMALL
8	ASYA KADIC	KARTAL DOGA HIGH SCHOOL	STRONGER NANOFIBERS
9	ATA MADENOĞLU	ÜSKÜDAR DOĞA HIGH	I'M SMALL BUT I CAN DO BIG WORKS
10	ATA YAĞIZ NART, BERA ERDENAY ALTUN	DÜZCE DOĞA	TITANIUMDIOXIDE NANOTUBES
11	ATAHAN VURAL	ACARKENT DOGA HIGH	NANOTUBES POSTER

12	AYŞE BERİL HERAL	ÇANKAYA DOGA	NANOTECHNOLOGY AND NANOMEDICINE
13	BATUHAN KOÇHAN, KAAN MERT, AYKUT CANER ALİ	DOGA COLLEGE	MOLECULAR NANOTECH
14	BEGÜM ÇINAR, CEYDA KÖSE	DOGA COLLEGE	NANO-MEDICINE
15	BERKAY SANDIKÇI	ÇEKİRGE DOĞA	NANOTECHNOLOGY IN MEDICINE WITH NANO-ROBOTS
16	BİRCE	HALKALİ DOGA	TEXTILE ENGINEERING
17	CEM KADIRGAN	ACARKENT DOGA HIGH	NANOTECHNOLOGY IN SPORT
18	CEREN İŞLEKLİ	DOGA COLLEGE	NANOTECHNOLOGY IN CANCER TREATMENT
19	CEYHUN PİRNAZ, YUSUF BERK CAN, YUSUF MERT ÖZTEKİN	DOGA COLLEGE	NANOTECH&CANCER
20	DENİZ TETİK	ATAŞEHİR DOĞA	NANO LIFE
21	DERİN AKYEL	ACARKENT DOGA HIGH	A BRIEF INTRODUCTION TO NANOTECHNOLOGY
22	EDA YASAN	30 AĞUSTOS KIZ TEKNİK VE MESLEK LİSESİ	NANO MUSCLE
23	EGE CUCUMAK	ÇEKİRGE DOĞA HİGH	NANOCOSMETICS
24	ELİF GÖKMAN	ÜSKÜDAR DOĞA HIGH	MY LITTLE NANO-HEALTH
25	ELİF KURT-BÜŞRA TAŞOĞLU-SELİN DEMİREL	ÇEKİRGE DOĞA HİGH	GREAT EFFECT FROM NANOCOSMETICS
26	ELİF PALACIOĞLU	SAKARYA DOĞA	COLOR CHANGING HAIR DYE
27	EMİNE ADIBELLİ	30 AĞUSTOS KIZ TEKNİK VE MESLEK LİSESİ	NANO MIRACLE
28	EMRE YÜCEL, GÖKTUĞ YALÇINTEPE, ONAT TAŞKIN	DOGA COLLEGE	NANOMATERIALS INSIDE OUT
29	FIRAT İPEKOĞLU	DOGA COLLEGE	TIMES OF CHANGE
30	FURKAN KARADENİZ, YİĞİT ATA TÜRK,	DOGA COLLEGE	NANO-FUTURE
31	FURKAN SATIŞ	ACARKENT DOGA HIGH	NANOMEDICINE
32	GÜLŞAH LİVATYALI	ÜSKÜDAR DOĞA HIGH	BEAUTIFYING NANOTECHNOLOGY
33	GÜN CELİL AKIN	ACARKENT DOGA HIGH	NANOTECHNOLOGY IN SPORT
34	GÜNEŞ BÜYÜKGÖNENÇ	DOGA COLLEGE	YOUR HEART IS SAFE WITH NANOTECHNOLOGY
35	HATİCE ÇANKAYA, YAĞMUR NİSA DURSUN	AYDIN DOĞA	THE ELIXIR OF YOUTH
36	ILKE BOLUKBAS & NIHAN AKCAN	USKUDAR DOGA	APPLICATION OF NANO TECHNOLOGY ON SPORTSWEAR
37	KAAN SAYIN	HACI RAHİME ULUSOY MARİTİME TECHNİCAL	BUCKY AIR CLEANER TUBES
38	MAZLUM DOGUKAN AKYOL	BEYKENT DOGA	NANO MEDICINE
39	MEHMET YILDIRIM	BOSTANCI DOGA	NANO TECHNOLOGY IS EVERY WHERE
40	MERYEM BÜYÜK	USKUDAR DOGA	21ST CENTURY HEALTH CARE REVOLUTİON
41	MUHSİN KÜREKÇİ	ÜMRANİYE ANADOLU IMAM HATİP LİSESİ	OPTIC TWEEZERS
42	ONDER CAKİOGLU	USKUDAR DOGA	NANO COSMETICS
43	ÖMER FARUK ORHAN	MALATYA DOGA	COMING SOON TO A DENTIST NEAR YOU
44	ROBIN YILMAZ	DOGA COLLEGE	NANOELECTRONIC
45	SEHER AKDAS	MALATYA DOGA	NANOTECHNOLOGY IS IN SPORT NOW!
46	SELCAN ÇINAR YILDIRIM	KURTKÖY DOĞA	NANOTECHNOLOGY APPLICATIONS
47	SELEN DEFNE DEMİRALP	HALKALİ DOGA	NANOBIOTECHNOLOGY
48	SELİN YILMAZ	SAKARYA DOĞA	SHILI
49	SEVVAL MELİS KOC	HALKALİ DOGA	NONLINEAR OPTICS
50	UMUT TAÇYILDIZ	SAKARYA DOĞA	SMART TOP
51	YİGİTHAN CAVUSOGLU	USKUDAR DOGA	NANO-DYE TECHNOLOGY

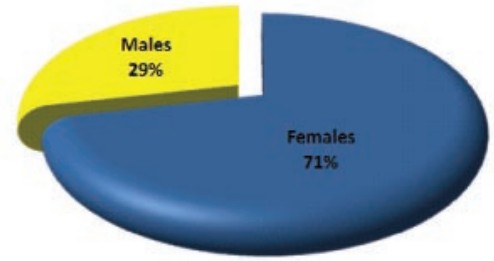
Name and surname	Title	Poster
FURKAN SATIŞ	*The Magic of Nanomedicine*	
ELIF KURT, BÜŞRA TAŞOĞLU & SELIN DEMIREL	*Great Effects from Nanocosmetics*	
ÖMER FARUK ORHAN & MELIH KAAN GÜNDÜZ	*Nanotechnology Coming Soon to a dentist near you?*	

Nanocompetition in Romania

The NTSE Romanian Team was involved in dissemination the Nanocompetition information and conditions at the level of schools from the south region of Romania. Different discussions with teachers and students took place in order to explain which are the minimal conditions of a poster in order to pass the national evaluation stage. In addition, the evaluation process of posters at international level was presented. The NTSE project dissemination materials have been spread at level of lower and upper secondary school from Dambovita County.

Profile of Romanian Poster Competitors

In total 28 Romanian students from the secondary school attended NTSE Poster Competition. The gender distribution of participants is presented below:



Concerning their age, all of the competitors were between 13 and 15 years old. After the national evaluation, 15 posters were successful regarding the content evaluation and they were uploaded and exhibited on the NTSE Virtual Laboratory to be voted online.

Table 1: Posters created by Romanian students and uploaded in the NTSE Virtual Lab

Poster no.	Name and surname	Title of poster	Organization/School
1	Dogaru Gabriela	*Nanotechnology in sports equipment*	Liceul de Arte "Bălaşa Doamna" Târgovişte
2	Dragomir Raluca; Mihai Raluca; Vancea Carmen	*A chance for life – A 3rd millennium miracle*	Şcoala "Vasile Cârlova" Târgovişte
3	Rotaru Mădălina Petruța; Mîinea Veronica Evelina	*Nanobots Applications*	Şcoala Gimnazială Gura-Şuții
4	Vlăduca Andreea Gabriela	*Nanotechnology and medicine*	Liceul de Arte "Bălaşa Doamna" Târgovişte
5	Căpraru Gabriela; Nănescu Ionela	*Do you know what hides behind perfection?*	Şcoala "Vasile Cârlova" Târgovişte
6	Sularia Andreea; Ştefani Diana	*Nano-technology in Medicine*	Şcoala "Vasile Cârlova" Târgovişte
7	Andrei Bianca; Chiricu Miruna	*Smart materials using Nanotechnology*	Şcoala "Vasile Cârlova" Târgovişte
8	Nănescu Mihail; Roşu Lavinia; Iordache Flavia	*Divinity vs. Nanotechnology*	Şcoala "Vasile Cârlova" Târgovişte
9	Călin Maria	*Nanorobotics – gate to future*	Liceul de Arte "Bălaşa Doamna" Târgovişte
10	Bălan Andreea	*Nanotechnology – health and cancer researches*	Liceul de Arte "Bălaşa Doamna" Târgovişte
11	Toma Adriana Maria; Nedelcu Adriana	*Nanorobotics*	Şcoala Gimnazială Gura-Şuții
12	Vişan Florentin Sebastian; Petre Robert Constantin	*Nanotechnology in medicine – nanorobots*	Şcoala Gimnazială Gura-Şuții
13	Avram George Laurențiu; Barbu Petrică Mirel	*Nanotechnology*	Şcoala Gimnazială Gura-Şuții
14	Veseliu Andrei Alexandru; Niță Alexandru	*Applications of carbon nanotubes*	Şcoala Gimnazială Gura-Şuții
15	Toma Adriana Maria; Toma Marian Cosmin	*Silicon Nanotubes*	Şcoala Gimnazială Gura-Şuții

The topics chosen by the Romanian students were related to application of nanotechnology in health, cosmetics, robotics, electronics and sports equipments. One of the interesting idea presented in a poster made by students from 8th grade from "Vasile Cârlova" School Târgovişte was the relation between Divinity and Nanotechnology. Six of the total 15 Romanian posters passed the national evaluation and the semi-final stage to go and be exhibited and evaluated by the scientists who participated to International Advances in Applied Physics and Material Science Congress, that took place in Antalya, on 24 April 2013.

After the vote process from Antalya the Romanian winner of the poster competition was Dogaru Gabriela, a 9th grade student from Liceul de Arte "Bălaşa Doamna" Târgovişte. In the following table the six posters that participated to the international evaluation in APMAS Congress are illustrated.

Name and surname	Title	Poster
Dragomir Raluca; Mihai Raluca; Vancea Carmen	*A chance for life – A 3rd millennium miracle*	
Căpraru Gabriela; Nănescu Ionela	*Do you know what hides behind perfection?*	
Sularia Andreea; Ştefani Diana	*Nano-technology in Medicine*	

Name and surname	Title	Poster
Dogaru Gabriela	*Nanotechnology in sports equipment*	
Rotaru Mădălina Petruța; Mîinea Veronica Evelina	*Nanobots Applications*	
Vlăduca Andreea Gabriela	*Nanotechnology and medicine*	

Table 2: Romanian Students' Posters selected for international evaluation by the APMAS Congress Participants in Antalya, Turkey

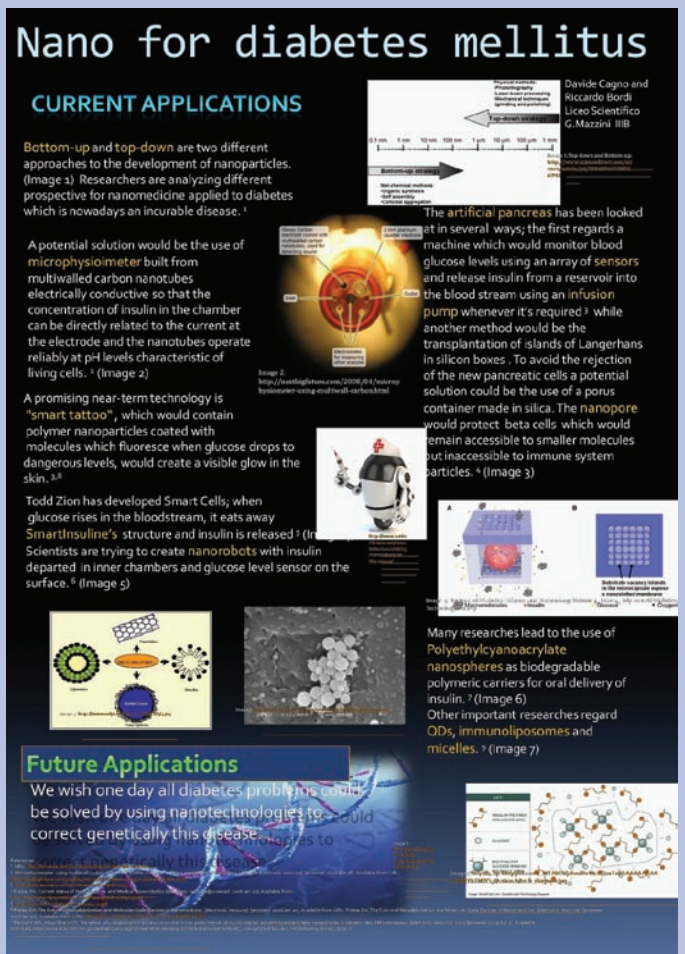
Nanocompetition in Italy

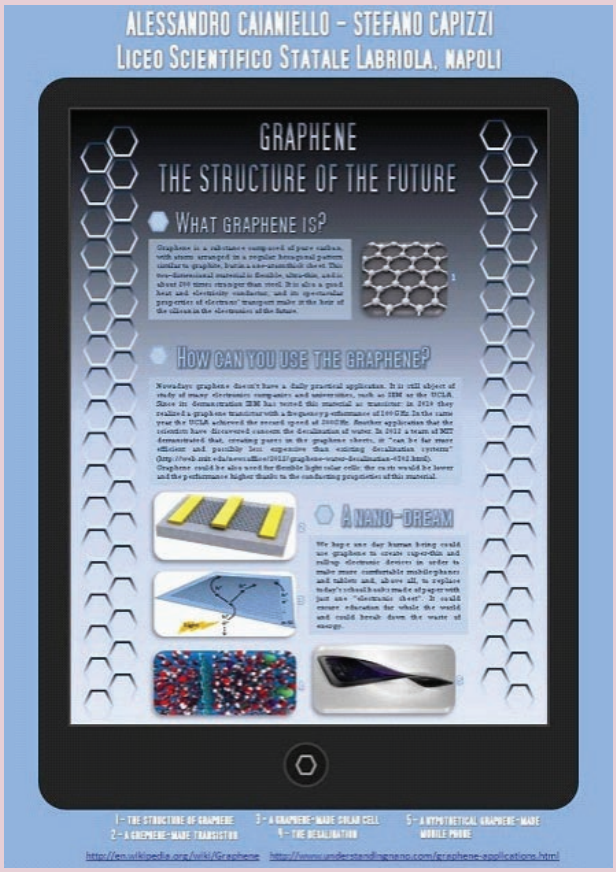
An important milestone of the project regarded the Poster Competition, in which high school students (13–18 y.o.) were invited to express their creativity in the production of a poster related to Nanotechnology. The poster should have addressed some common topics, like including scientific facts, the students' opinion and vision of a future use of that branch of nanotechnologies they selected. Also some graphic and layout standards were suggested. To launch the competition, Fondazione IDIS organized a training course for teachers, and 21 teachers for different high schools participated. 7 schools then decided to apply for the poster competition, and after the first contact, members of Fondazione IDIS went to the different schools to illustrate the rules of the competition.

Student chose application of Nanotechnologies in Health, Environment, Leisure and Sport, Electronic Devices and Human enhancement. 44 Students participated, with a first-class research and collection of information, photos and images. The posters were designed and written in 300 words, A1(59 cm x 84 cm) in size with a clear title. 22 posters were uploaded to Virtual Lab web site and were voted by general public through a social network until 15 March 2013. 9 posters were then selected considering the content, the graphic layout, the number of votes and the respect of the rules given. Out of these 9 posters, 7 were brought to Antalya for the final selection (2 posters were not given in the appropriate paper or digital form in the due time) and the best three posters from each Country were selected, by an international jury, to take part to the Nano Camp.

The students were very happy to take part to the competition, and expressed all their creativity and enthusiasm in spite of the fact that their teachers could not help much, due to the lack of information they had on the topic. Specifically one of the winning posters required a long and well structured work by the students, who, starting from a disease affecting a schoolmate, interviewed several doctors from the main hospitals in Naples and searched through scientific papers, how Nanotechnology could help curing the disease.

Table 1: Italian Students' Posters which were selected by the APMAS Congress Participants in Antalya, Turkey

Name and surname	Title	Poster
Davide Cagno e Riccardo Bordi	*Nano for diabetes mellitus*	

Name and surname	Title	Poster
Stefano Capizzi e Alessandro Caianiello	*Graphene, the structure of the future*	
Rosa Rapuano Lembo e Cristina Esposito	*How to limit addiction*	

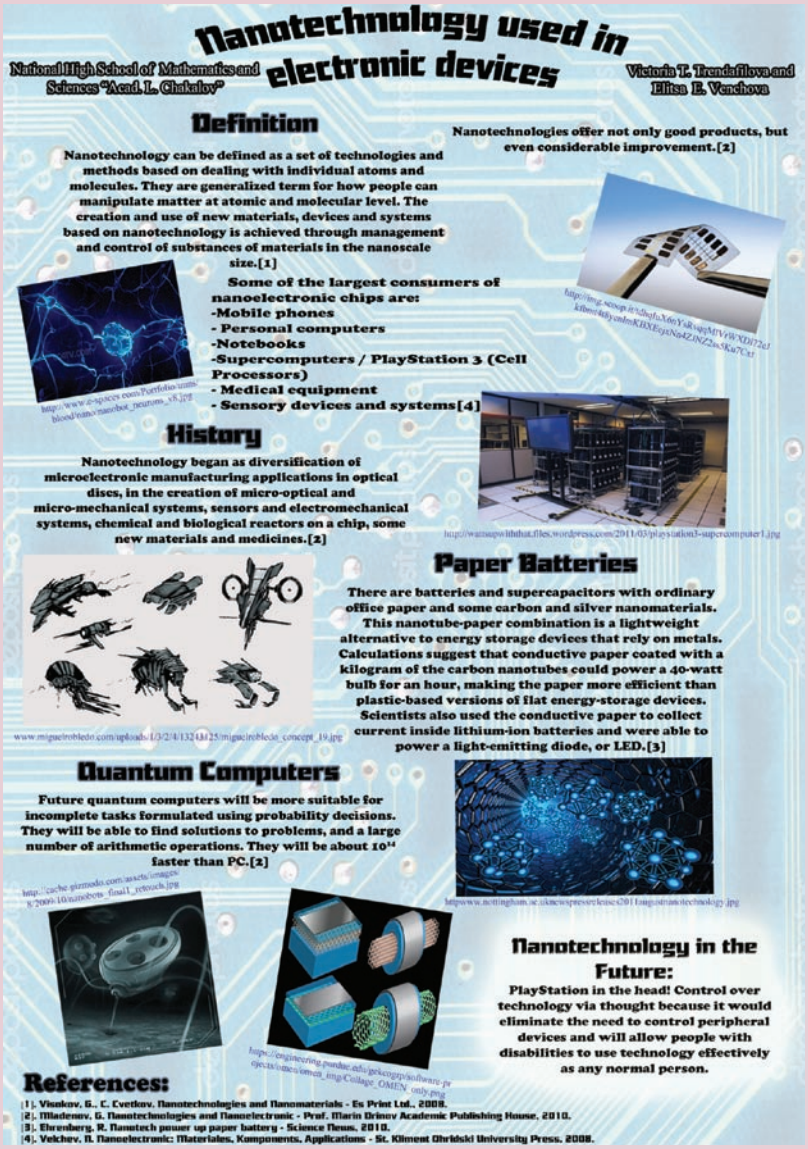
Nano-competition in Bulgaria

In Bulgaria the Nano-competition was announced in December 2012 with a deadline for submission of the posters 22 February 2013. Center for Creative Training Association distributed the call for the competition with priority to 77 science teachers from all over Bulgaria, who passed the invitation to their students, to all the Regional Inspectorates of Education and to its all relevant associated partners.

CCTA received 15 posters from 20 participants (some of them work in pairs). For the posters received before the deadline Alexander Angelov (CCTA) and Kichka Minkova (Sirma Media) offered feedback on what can be improved so that the posters answer to all criteria. Only two posters were disqualified because they weren't corresponding to the topic of the competition.

The posters went through two stages of evaluation – the first stage was concerning the technical specifications of the posters and correspondence to the criteria. The creators of the eligible posters were asked to send high-resolution versions of their posters, which were later printed and exhibited during the Nano Conference in Antalya in April 2013.

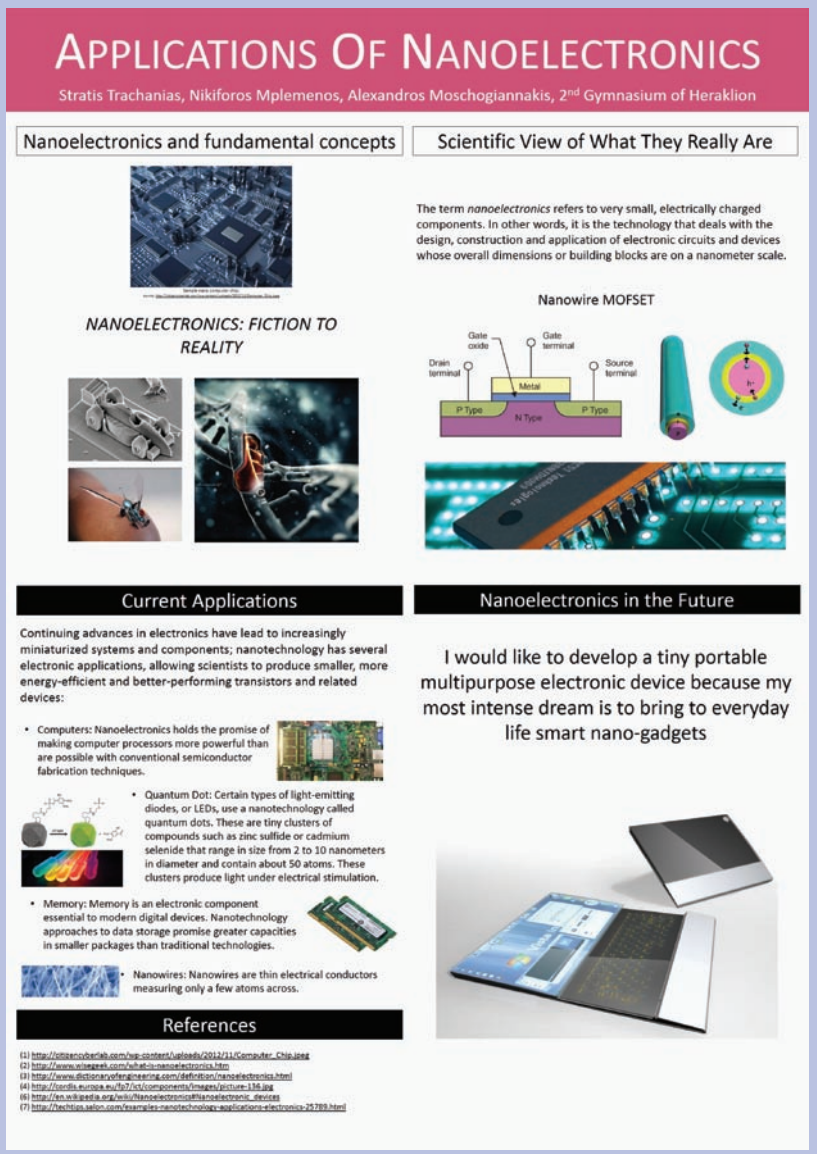
The best posters were chosen by independent nano-experts who were visiting the conference by anonymous voting system.

Name and surname	Title	Poster
Viktoria Trendafilova and Elitsa Venchova.	*Nanotechnology used in Electronic devises*	

Profile of Greek poster competitors

The NTSE Greek Team disseminated the related Nanocompetition information (procedures, rules and deadlines) through emails and promotional posters. Some discussions with teachers and students took place to clarify the suggested nano topics and competition rules.

In total 27 Greek students (13 boys and 14 girls) aged 14 to 17 attended NTSE Poster Competition. After the national evaluation, 13 posters met the criteria regarding the content and they were uploaded and exhibited on the NTSE Virtual Laboratory to be voted online.

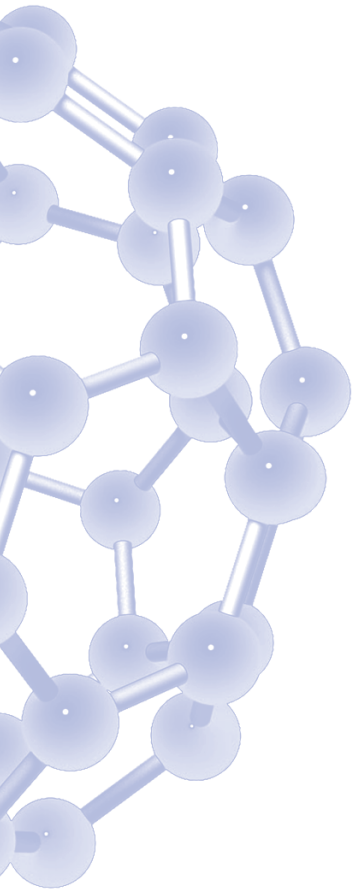
Name and surname	Title	Poster
Stratis Trachanias, Nikiforos Mplemenos, Alexandros Moschogiannakis	*Applications of Nanoelectronics*	

The topics chosen by the Greek students were related to application of nanotechnology in electronics, health, robotics and sports equipments. Six out of thirteen posters passed the national evaluation and the semi-final stage to go and be exhibited and evaluated by the scientists who participated to International Advances in Applied Physics and Material Science Congress, that took place in Antalya, on 24 April 2013. After the vote process from Antalya the Greek winners of the poster competition were a group of three students – Stratis Trachanias, Nikiforos Mplemenos and Alexandros Moschogiannakis – aged 14 to 15 from 2nd Gymnasium of Heraklion, Greece. The winning poster was entitled "Applications of Nanoelectronics".

Figure: The winning Greek Poster

Greek Students' Posters selected for international evaluation by the APMAS Congress Participants in Antalya, Turkey

Name and surname	School	Poster Title
Stratis Trachanias, Nikiforos Mplemenos, Alexandros Moschogiannakis	2nd Gymnasium of Heraklion, Greece	*Applications of Nanoelectronics*
Serena Tzortzaki, Ilektra Malefitsaki, Pinelopi Liparaki	2nd Gymnasium of Heraklion, Greece	*D3O in our lives*
Maria Stavraki, Christina Katsafarou, Konstantinos Katsogridakis	2nd Gymnasium of Heraklion, Greece	*Graphene – Meaning and Properties*
Pantelis Fragkiadakis, Katerina Apolithianaki, Aggeliki Dympaoya	Episkopi High School, Rethymnon, Greece	*Buckminsterfullerene*
Marilena Bougoulia, Konstantinos Vasos	3rd Lyceum of Mitilini, Greece	*Nano-microchip*
Vladislav	Episkopi High School, Rethymnon, Greece	*Nanorobots*



VII. NANOCAMP

1. Overview

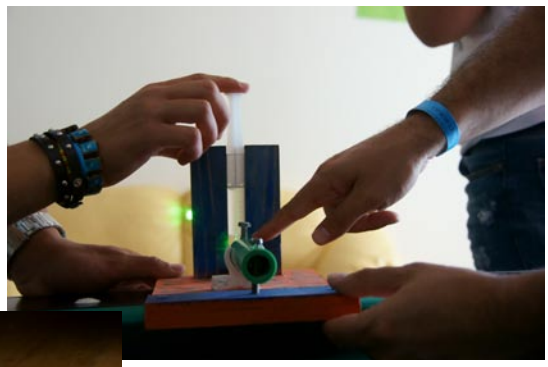
The Nano-Science Camp for teenage researchers is a key event in the process of the approbation of the main outcomes produced by the NTSE partnership.

The Nano-Science Camp participants were selected through a poster competition in which 145 school students from 5 countries at the age of 13-18 years took part. The teenage authors of the best posters, selected through voting of international committee got together for the week-long Nano-Science Camp in Bulgaria, hosted by the Center for Creative Training Association from 30 June to 7 July 2013 at the "White Lagoon" Resort near Balchik.

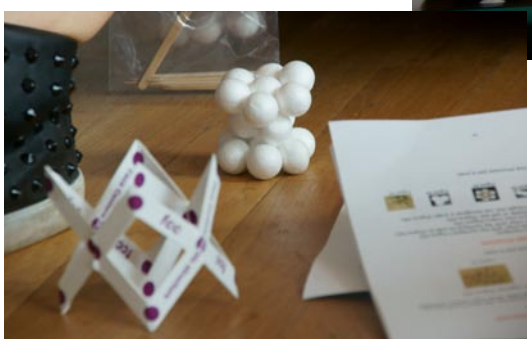
The agenda of the camp involved work with the NTSE Virtual Laboratory, hands-on research activities in the field of nano-sciences, as well as exercises related to the self-presentation and professional orientation of the youngsters.

2. Agenda

The participants in the Nano-science camp were divided into 4 international teams and were assigned a team leader, whose task was to ensure the cooperation between team-members (icebreaking, team-work activities, warm-up, etc.), to guide the team to the different experiment rooms and to supervise them during activities, which require independent work.



When planning the Nano-science camp, Center for Creative Training Association's team focused on building a balanced and engaging agenda for the young learners. The main building blocks of the agenda were the activities, which science teachers and experts from the partner countries designed especially for the event: Measuring nano-gelatin (Bulgaria), Non-Newton liquid (Bulgaria), Tea to silver, AFM activity (Greece). Some of the activities were based on the use of the content of the NTSE Virtual Lab and the students had to opportunity to work with the the laboratory with the supervision of an expert. Among these activities were: Iron nanoparticles, Lotus effect, Buckyball, Carbon nano-tubes, Nanoscale, etc.



Short movies with some of the scientific experiments can be seen at:

http://www.youtube.com/watch?v=OPidbRQ6yAI
Modelling lotus effect

http://www.youtube.com/watch?v=6TEw0grK63g
Non-newton fluid

http://www.youtube.com/watch?v=B7EGfj9bllg
AFM effect

http://www.youtube.com/watch?v=UmpW9Bar4n4
Milk and gelatin

Apart from the strictly science-oriented activities, the experts also dedicated time for self-evaluation, career-orientation, team-building and team-work. Each team of young scientists had the task to work on a team diary (activity: My own guinness). On this activity youngsters worked together with their team leader. Diaries were filled in by each team each day and facilitated the final summary and evaluation of the camp during the last day. Also, the participants were involved in a treasure-hunt game (activity: My way to success), which had a strong focus on both career-orientation and team-building.

During the one-week camp, the students had the chance to participate in two educational trips. The first one was a visit to the Institute of Oceanology at the Bulgarian Academy of Sciences in Varna (Bulgaria) where they attended a lecture for the Institute's research activities, including in the field of nano-sciences and had the chance to board on a real submarine with nano-technology equipment. The second trip was to Cape Kaliakra and the Botanical Garden in Balchik, Bulgaria.

To ensure the intercultural aspect of the Nano-Science camp, as a part of the agenda, CCTA's team included an international evening, for which the participants from each country were informed in advance. During the international evening the participants were presented to national clothing, music, dances, food and drinks, and other national tokens.

The agenda also included ice-breaking activities for the participants (with the whole group and then in each separate team), which aimed at building better teams and to ensure the smooth intercultural communication. Also, each day of the week-long camp, there were specific times dedicated to warm-up activities, including short physical or brainstorming activities, with the aim to set the mood for active learning and to prepare the students for the upcoming lessons.

Since the venue was set on the sea-side, the participants had some time to visit the beach and enjoy the Bulgarian seaside.

3. Lecturers

ZUHAL YILMAZ DOGAN – The NTSE project coordinator Zuhal Yılmaz Dogan has gained experience in managing projects at Doga Schools. She contributed to the development of on-line courses and coordinated project activities in schools in the Comenius Projects www.bsiproject.com and www.sustain-project.eu.

She has extended experience as a teacher trainer of MoNE to train the language teachers on current methodologies and programs. She had studies about the applicability of "A CEF-R for Languages" in public schools during her master education and currently as a PhD student at Yıldız Technical University of Program Design and Development Department. Courses that she gives as trainer are INTEL TAO program and educational projects in formal schools.

She is currently working as the local coordinator of TC4PI (Teacher Competences for Plurilingual Integration with the Education) 526596-LLP-1-2012-1-ES-COMENIUS-CMP, KEYS (Key Methodology to Successful Competence Based Learning) 539401-LLP-1-2013-1-BG-COMENIUS-CAM and TTT NET (Teamwork, Training, and Technology Network, COMENIUS Multilateral Networks) 540029-LLP-1-2013-1-IT-COMENIUS-CNW Projects.

Yavuz Oral (Turkey) – His research interest was in the sol-gel fabrication of ferroelectric thin films in the context of his graduate work at New York State University. He had an opportunity to further develop his experience in the same area with the emphasis on characterization of thin films with electron microscopy during my Ph.D. study at UC Irvine. He has built his professional career around the same periphery; He has worked in three different countries including US, Singapore, and Turkey and pursued several broad lines of research in the area of electron microscopy, thin films, and nano-powder synthesis. He has involved in teaching in the area of nanotechnology and biomaterials.

Idil Akcay (Turkey) – Idil Akcay has been working in Doga Schools as Chemistry Teacher of Çekirge Doğa High School. She has worked as an expert and implementer in the NTSE project. Since the secondary stage initiates the academic learning process for the construction of the science education, she aims to enhance the pupils learning period through following the modern science education via integrating the ICT. She is the project coordinator of Comenius School Partnerships called 2012-1-TR1-COM06-36512 1 "Effective Science Learning with Senses" in order to improve her teaching skills and to exchange the good practices with her colleagues. Hence she tries to construct the science education programme through use of ICT tools in her science department. In her institution she has already took the ICT courses to use the smart boards and transferring of the ICT games and activities.

DR. DIDEM SÜNBÜL – Dr. Didem Sünbül received B.Sc. in Physics, İstanbul University, 1995; M.Sc., and Ph.D. in Physics Engineering, Istanbul Technical University, 2000, and 2007, respectively. Since 1995, she has been working as a physics teacher at MoNE. She has conducted many national and international projects. She is working as the expert of NTSE project. Her research interests are polymerization kinetics, applied mathematics, simulation and modelling of copolymers.

Ercan Tatlı (Turkey)
B.A.: Faculty of Education Science – Pamukkkale University
M.A.: Institue of Education Sciences – Süleyman Demirel University
Ph.D.: Institue of Education Sciences – Marmara University (continues)

Ercan Tatlı works as a researcher at the Faculty of Education at Marmara University, while continuing his Ph.D. at the Institue of Education Sciences of Marmara University, studying mainly on current methods and innovations in science education. Courses that he gives as co-instructor are research projects on science education, learning theories, and teaching practice. He contributes to the educational material development, workshop designs and assessment of the project. He was involved in different studies and projects including a project at national and international level, where recent publications related to the domain of the project are:

> Robot Vertical Tail Model (TUBITAK Science Project)
> Identified Flying Objects (National Agency)
> Burdur Lakers (National Agency)
> Creative Leadership Mechanism (National Agency)

Interview with Ercan Tatlı – http://www.youtube.com/watch?v=lmtedbqj4ho

Luigi Cerri (Italy) – Luigi Cerri, science communicator and project manager at Città della Scienza. He got a degree in Geology at the University of Naples Federico II. He is expert in Seismology and Geophisics. At the Science Centre he is in charge of the Educational Department and takes care of all the activities in Seismic and Quality of Environment. He took part to the design and realization of the Science Centre in 2001.

Interview with Luigi Cerri – http://www.youtube.com/watch?v=xbGdA03gQ5U

Ioannis Sgouros (Greece) – Ioannis (sgouros@sch.gr) is a high school teacher of physics in Western Crete, Greece and PHD student in the Pedagogical department of University of Crete, Greece, specialized in Introducing Nanotechnology in Secondary Education.

Yorgis Androulakis (Greece) – studied physics in University of Athens. His interests are focused in the areas of networks (setup, administration), authoring of educational software, e-learning environments. Since 1993 he is a member of ERE group of IACM / FORTH, working as technical scientist.

Leonidas Manou (Greece) – Leonidas (lmanou1@gmail.com) is a school teacher of physics in Northern Greece and phd student in the Pedagogical department of University of Western Macedonia, Greece specialized in Introducing Nanotechnology in Primary Education.

Radu Lucian Olteanu (Romania) – Radu (raduolteanu110@yahoo.com) works as a lecturer in the Science Department, Faculty of Sciences and Arts, Valahia University Targoviste. He leads laboratory work, seminars and projects in the field of Applied Chemistry, Chemical Technology and Physical-Chemistry. At the same time, Radu carries out research and publishing. He thinks that one of his main quality is *teamworking.* The teamwork experience has been gained in the various contracts / projects carried out, in which he served as a member of the working team.

Milena Gosheva (Bulgaria) – Milena graduated Sofia University and has a Master's degree in physics and pedagogy. She has qualifications in both pedagogy and physics. Milena works in Sofia Professional Highschool for Electronics "John Atanassov" as a senior teacher. She has been incorporating in the school curriculum theories and practices linked to nano-technology since many years. She is also an author of articles about methodology of physics.

Interview with Milena Gosheva – http://www.youtube.com/watch?v=lZ6O4m9EKbw

Nasko Stamenov (Bulgaria) – Nasko is studying Chemistry in the Faculty of chemistry and pharmacy, Sofia University. He works in the Laboratory of nanotechnology and nanomaterials. He synthesises metal and semiconductor nanoparticles and test their properties. Nasko also is studying module 'Chemistry teacher' where he participates in teaching Chemistry in high school.

Interviews with Nasko Stamenov:
http://www.youtube.com/watch?v=5WHg2lmZtuU
http://www.youtube.com/watch?v=pLXHEyT_9ag

4. Outcomes – video, interviews, portfolios

During the nano-camp, CCTA's team took pictures of each activity, as well as videos of the experiments and interviews with the experts (for link see previous chapter).

The activity "My personal guinness" aimed at focused and systematic recording of the experiences and knowledge, gathered through each day of the nano-camp. Each team produced its own portfolio

Portfolios of the teams:

TURBO ORANGE BRAINS

"Think BIG – make nano"

SELF PRESENTATION:

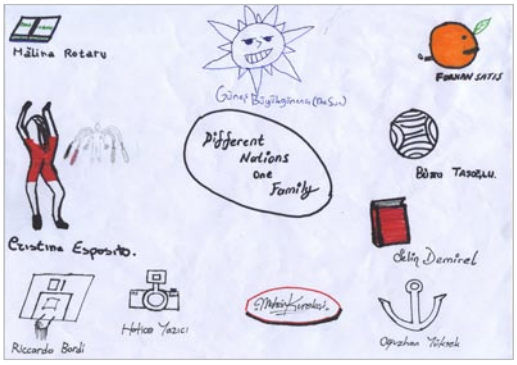
1. I am Muhsin. I'm from Turkey. My school name is Umraniye Anadolu Imam Hatip high school. I live in Istanbul. I'm 17 years old. My favourite sport is football. I'm a soccer player. I'm so happy to be here because I want to be nanotechnology engineer.

2. I'm Oguzhan. I'm from Turkey. My school name is is HRU Maritiem Technical and Vocational High school. I'm 16 years old. I like to play basketball because it's very exciting and funny. My favourite team is Boston Celtics and favourite player is Kevin Garnett. I hate watching TV because it's very boring. In the future I want to be shipmaster.

3. I am Malina Rotaru. I like music and the nature. I live in Romania. I'm 14 years old teenager who is in search of her own identity trying to discover the most hidden secrets of life.

4. I am Dimitar Linov. I like computer games and physics. I live in Varna, Bulgaria. I'm 16 years old. In my free time I like playing computer games and watching funny videos. I want to... have god-like powers. (The GOD)

5. I'm Hatice Yazici. I live in Turkey, Istanbul. I'm 17 years old. I'm in technical high school for girls. I like to listen to music and I hate writery. My favourite team is Besiktas.



6. I'm Selin Demirel. I'm in Doga Collage. I'm studying science – math. I like reading book and watching movies in my free time.

7. I'm Bursa Tasoglu. I'm In Doga Collage. I'm studying science – math. I have no siblings. I like play volleyball and swimming. I want to be an architect in the future.

8. I'm Gunes Buyukgnena. My birthday date is 6.06.1998 so my lucky number is 6. As I told before, I'm 15 years old. My school is Doga Koleji and it's a private school. I love computer games that are only on my computer, I don't know why. My favourite subject is chemistry. My favourite sport is basketball. I hate sleeping. I know it is very important for our health but when I sleep I feel like I'm wasting my time. And I'm happy with my life.

9. My name is Furkan Satis. I'm from Turkey. I'm 17 years old. My school is Doga College and I am a student in science and math department. I do like sports very much. If you want a powerful brain, your body should be powerful.

10. Hello, I'm Riccardo. I come from Naples, Italy. My favourite sport is basketball. I also like football because I support my team "Napoli". I'm happy about these experiences.

11. My name is Cristina Esposito. I live in Sarno, Italy. I have one brother and sister older than me. I attend the school from Sorno and I'm at 4 year. My favourite sport is dance, because is my passion, my life. I have a dance school where I teach with my brothers.

I LEARNED

In this camp we did a lot of things. We learned about buckyball, carbon nanotubes allotropes, ferrofluids.

We did a lot of experiments like magic sand, we did an atomic force microscopes with toys.

We thought and learned cultural games.

We learned national dances and songs, and we tasted national foods.

But at the end we learned to think as a team.

CREATIVITY

Since we came here we learned that we have to think like a team.

Because of this, many ideas took place and as this happens we learned thinking in different ways. When we try to find something is unknown, in experiments, we all produced our ideas and this was a kind of creativity.

As an example, we tried to understand about an unknown substance and we had used our imagination with some materials, of course. and it was kind of a subject which is increasing the level of creativity.

As the creativity level of us increased, we solved the problems faster and in a easier way. It will help us in our whole life, even in our daily life.

Creativity is very important for our life and this place helped us to improve it.

I LEARNED, I TAUGHT

In this nanocamp, we learned a lot of things that we can't write all of them. We learned how to make experiments, we learned a lot of about nano things. We learned turkish, we learned bulgarian, we learned romanian and also we improved our english level. In the same time, we learned things about life. It has rules, you have to know how to live good. Our teachers taught that to us. And what we taught is, as I said before, we taught about our languages to other guys. After experiments, we taught how to do it to each other. The camp was fantastic, amazing and perfect.

I wish it would be longer.

OUR TRIPS

Our trips started when we meet as a team and it will not finish on saturday. We first have visited the "White Lagoon" near the Balchik, a beautiful place, immersed in the nature and next to the sea. Monday after we went to visited the city "Varna" to visited a submaring and a special labarotory that studies Black Sea. Today after we went to visited to wins of Kaliakra in fact Kaliakra ploide an important rule during all the ages in Bulgaria, Kaliakra is a beautiful old settlement situated in a long and narrow head land. This place is also a natural riserve for animals like delgin, pinnipeds. After during the someday we went to visited botanical garden and place of Balchik. The Palace and first part of garden were bird by the Queen

Marie of Romany. New day the Botanical garden with all his plants are synonym of the Bulgarian love for nature

The garden was well organized in fact there were a different areas composed by plants coming from over the world.

The Royal Palace was very different by common Royal Palaces because it was more simple.

Almost like an "estate" this was our trip.

MY SPORTS

We tried to do yoga – it was so different.

We swimmed in the pool together.

We played beach volleyball.

So we climbed the stairs which are about 94 steps in a minute!

MY GUINNESS

We climbed 94 stairs in 1 minute!

We are the only team that has 7 Turkish guys.

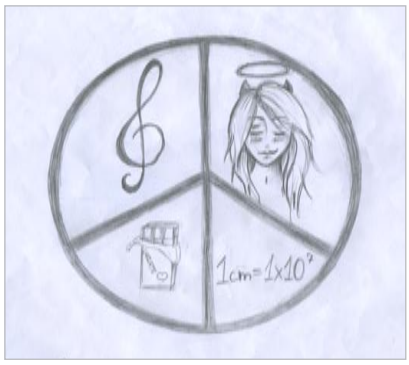
We have the youngest team-leader of the camp!

We have four basketball players in the team! (Riccardo, Furkan, Gunes, Oguzhan)

I'm the only romanian girl who learned what is the international family alone.

PINK TEAM

"We are for science and science is for us!"



SELF PRESENTATION

1. I'm Emine Adibelli. I live in Turkey, Istanbul. I'm 17 years old. I'm in technical high school for girls. I like to listen to music and I hate writing.

2. I'm Blagovest Papagalski and I'm living in the capital of Bulgaria – Sofia. I'm 19 years old and I have already finished school and I'm preparing for university. I like meeting new people and one of my hobbies is photography.

3. I'm Kaan Sayin from Turkey. I live in Istanbul, Kadikoy. I want to be captain one day. I'm 16 and I'm a student in a Maritime Vocational school. I like drawing but I'm not professional. I like to listen metal and hard rock and eating meat. I met a lot of good people during Nano-science camp and I love this camp.

4. My name is Vera. I am 15 years old. I'm from Romania. I live in Targovishte. I have to say a lot of things about me. About my physical qualities I can say I'm tall with brown eyes.

About my moral qualities I have to say that I'm optimistic and a friendly nature. I have a lot of friends because I'm sociable.

5. My name is Raya and I am 16 years old. I come from Bulgaria. I am a student at the National High School of Mathematics and Science. What I would like to say about myself is that I have a passion for science and I am looking forward to work with it in the future.

6. My name is Sofia. I am from Bulgaria and I'm 15 years old. I'm a student is 31 high school "Ivan Vazov". I'm friendly and I like having fun.

7. Hi everybody! I'm Lora Tsvetkova from Bulgaria, Sofia. Something interesting for me is that I'm drawing very well and I'm learning to draw by myself. I don't like when somebody helps me doing something. But in future I don't think to be an artist. May be at home I will draw for pleasure but I'm thinking of being a vet.

8. Hi! I'm Gabi (Gabriela Capraru) I'm from Romania. I like listening music – almost any kind of music, making new friends and learning something new. I love my friends and my family.

9. I am Dimitar – Delyan and the science camp was great, being able to consult with experts in the field of nano tech was really helpful.

10. I am Vladimir and I liked the camp. Thanks for the fun!

I'm LEARNING

– nanoparticles in our daily life
– working in a team
– respecting the different ones
– how to develop professionally
– different languages
– strange yoga exercises
– new and funny games
– how to make experiments
– different cultures
– to express myself
– new legends
– how to get up early
– how to climb 95 stairs
– survive without Internet

– how to sleep two hours per day
– that teamwork is very important

MY ADVENTURE

MY MUSIC

– Pink panter
http://www.youtube.com/watch?v=HhHwnrlZRus

MY GUINNESS

– staying up all night
– our team won "My way to success" game
– two people from our team won individual prices
– climbing stairs easily without getting tired
– being more social
– exploring unknown places

MY SPORT

Our team's favourite sports are waterball, volleyball, yoga.

CREATIVITY

I LEARNED

– seismic waves
– how to make a difference between non-newton liquids and newton liquids
– how to make a silver mirror
– about different nationalities
– how to dance Gangnam style
– lotus effect
– how to make a carbon nanotube
– how to move like a tiger
– how to negotiate

NANORMOUS

"Great potentials – small dimensions"

SELF PRESENTATION

1. Name: Stefani Diana
Age: 15 years old
Country: Romania, Targoviste
Class/school: I finished eighth grade
What I like: vacation, pizza, chocolate, walking, interesting books, music, sea, purple colour, gym, jokes clothes
What I don't like: spiders, snakes, bad jokes, green eyes
Career: I want to become a doctor
Favourite quote: "Everything happens for a reason"

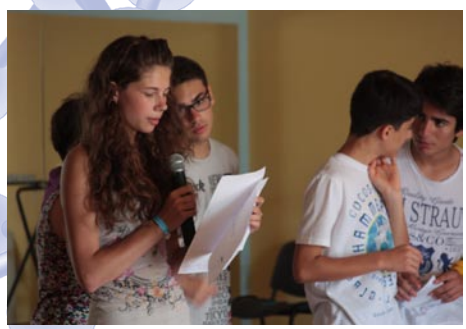
2. My name is Alessandro Caianiello. I come from Naples, in Italy and I am eighteen years old. I swim, but not at agonistic level because of the school. When I was young I was a little champion, I also won some medals. People usually ask me what I am going to do at university, but I really don't know the answer. Some years ago I believed that I would have attended the aerospace engineering courses, but now I am a little bit confused. In fact I would like to do something of artistic such as music, films...By the way I think I will attend the university and than I will learn other things.

3. My name is Vasil Vasilev Ivanov. I was born in Svishtov and my birthdate is 10.03.1998. Currently I live in Veliko Tarnovo.

I study in the High School of Mathematics and natural sciences "Vasil Drumev" and after the summer holiday ends I'll be 9th grade. Year 2 in high school!

There are 5 things that I enjoy – photography, programming, graphical design (photoshop stuff), chemistry and basketball. As you can see from my hobbies I'm not not a person who's really into sports and physical activities.

During the camp I enjoyed all the experiments a lot. That's probably because of the experts/teachers who showed everyone that science can be fun.



Even though I liked the whole experience in general, there are a thing or two that I didn't like – the food at the restaurant was kinda bad and we had to take 5-6 times a day 95 steps so we could get to our rooms.

To seem up the nanocamp was a valuable experience that somehow changed my way of thinking.

4. My name is Andreea Vladuca, I am 15 years old. I come from Romania. I'm in an Art high school, I study architecture. I dream of being a great architect. I like drawing , travelling and animals.

5. My name is Victoria Trendafilova and I am 18 years old. I live in Dragoman. It is a small town which is located 40 km. away from Sofia (the capital of Bulgaria). I like to go out with my friends, to listen music and to watch movies. I love

chocolate and ice cream. I want to become a teacher because I love the kids. I study maths in National School of Mathematic and Science "Academic Lubomir Chakalov". This school is very nice and the teachers are pretty awesome. I heard about NTSE project from my IT-teacher and I was really interested in it. I made a poster with one girl from my class and we were chosen to participate in Nano-Science Camp. The camp was really fun and I learned a lot of interesting things. Also I made a lot of friendships. This is my first science camp and I will remember it forever.

I LEARNED

On Monday we performed some outstanding experiments about natural nanomaterials and the properties of their structure. We found out about things called non-newton liquids and that the cheese contains nanoparticles.

On Tuesday we learned about seismic waves and we made buckyballs by ourselves. Nasko showed us how to recognise the size of the nanoparticles by the color of the solution.

On Thursday we learned how to analyze materials without physical contact with them. More precisely we used magnets to track metallic objects and a laser beam was showing their location. We also learned that the ferrofluids are suspensions of small particles with a mean diameter of about 10nm in proper carrier liquids. They have many uses (decrease friction, from powerful seals in electronic devices, sound performances etc).

On Friday we found out that the water on lotus leaves is disposed to form droplets as a result of surface tension. Water droplets are in contact with lotus leaves and air. Papilla retain the water droplets in higher energy by reducing the contact area between the solid and liquid. Furthermore, the waxy surface makes the leaves hydrophobic and the roughness makes them water-repellent.

MY SPORT

We loved physical activities such as beach-volleyball. Via that game we learned to co-operate. We also taught yoga exercises to the other.

CREATIVITY

We made team symbol and created a team's name.

MY ADVENTURE

On Monday we have learned some very valuable and interesting things. Our day started with an amazing trip to Varna. We expected it to be a very common trip but it come out to be significantly better than we thought. Coming in a contact with a submarine for the first time was really exciting. We learned about the history, the basic parts of a small submarine and then we met the extraordinary creatures of the ocean world.

On Wednesday we had a trip to Kaliakra and Balchik. It was really fun because we saw a lot of amazing plants in Botanical garden.

On Friday we had 3 hours to go shopping in Varna.

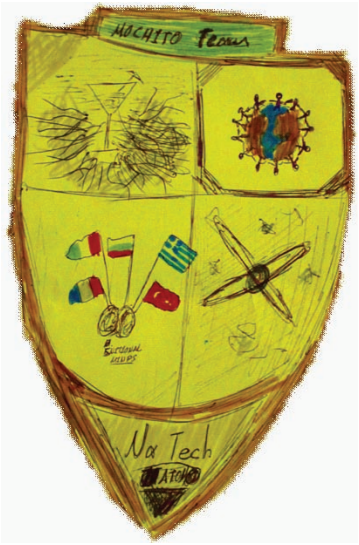
MY MUSIC

The yoga dance really enjoyed to us and because of this our team song is "Alpha Blondy – Sebe Allah".
http://www.youtube.com/watch?v=L6M4cvn5lXU

MOCHITO TEAM

"The best green team ever!"

MY ART AND CREATIVITY:



MY MUSIC:

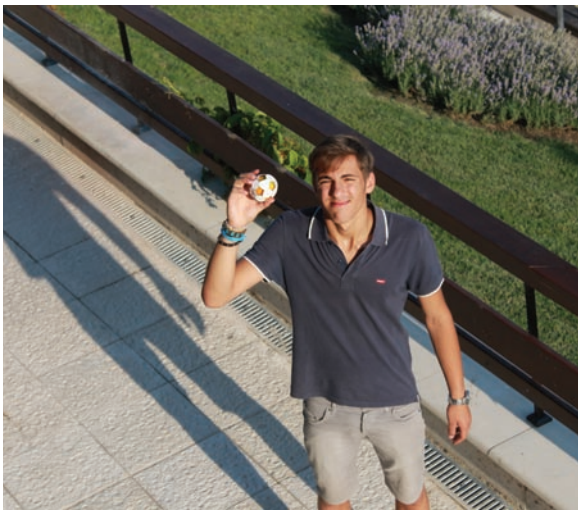
WHAT I LEARNED:

- Definition of nanoparticles
- Non Newtonian liquids
- The application of nanotechnology in our everyday life
- Flat cup
- Lotus effect
- Ferrofluids
- AFM activity
- Carbon nanotubes …
- How to work in a team
- Intercultural exchange
- To appreciate others' different points of view
- The Yoga dance!!!
- How to throw people successfully in the swimming pool

TOO MUCH YOGHURT IS NOT GOOD FOR YOUR HEALTH!!!

MY SPORT AND MY BODY:

MY TRAVELS:



I am my own GUINESS:

The presentations of the portfolios can be found here:

https://drive.google.com/a/cct.bg/file/d/0B4jsByCSVH14UXRMbzZlRXJmUHM/edit?usp=sharing

https://drive.google.com/a/cct.bg/file/d/0B4jsByCSVH14M05ZRjBDVnptbWc/edit?usp=sharing
https://drive.google.com/a/cct.bg/file/d/0B4jsByCSVH14OTJVTVVQVTBhV2M/edit?usp=sharing
https://drive.google.com/a/cct.bg/file/d/0B4jsByCSVH14MUdYbjFqaWpZcTQ/edit?usp=sharing

"Nature works to maximum achievement at minimum effort. We have much to learn."
(http://www.cbid.gatech.edu/univ_labs.html)

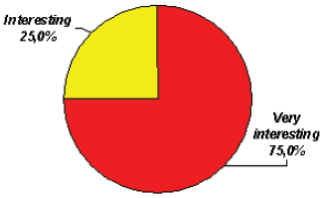
PROCESSED FEEDBACK
(relevant issues and statistics) – Results related to the feedback of Nanocamp participants

Those results are based on the answers of Nanocamp participants. Both children, teachers and experts were invited to fill in a questionnaire, in order to design a graphical feedback after processing their answers. "Questionnaire for Nanocamp participants" aimed at assessing and collecting information and suggestions related to NTSE Virtual Lab and Nanocamp. The main sections of the questionnaire aimed the main following issues:

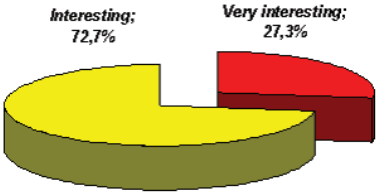
- The level of the presentations offered during the Nanocamp;
- The level of the real and virtual experiments performed during the Nanocamp;
- The scientific activities in which participants were involved during the Nanocamp;
- The strengths and weaknesses of the Nanocamp:
- Opinions related to the usefulness of Nanocamp activities.

- ***The level of the presentations offered during the Nanocamp***

The participants were invited to rate the level of the presentations based on the following Likert scale: very interesting – interesting – less interesting – non-interesting – boring. The following two figures illustrate their opinion related to this topic.



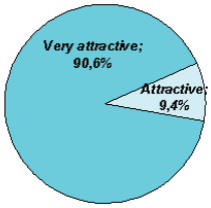
(a) Children



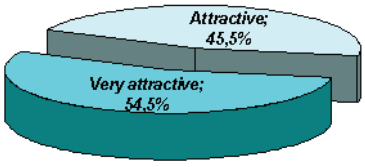
(b) Experts and teachers

- ***The level of the real experiments performed during the Nanocamp***

For rating level of the real experiments the following Likert scale was used:: very attractive – attractive – less attractive – non-attractive – boring. The analysis of children, teachers and experts' opinions is shown in the following images.



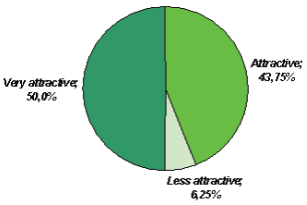
(a) Children



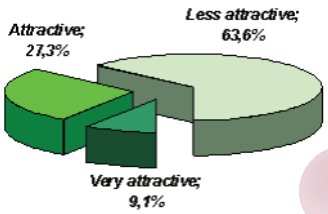
(b) Experts and teachers

- ***The level of the virtual experiments performed during the Nanocamp***

Being interested on how the virtual experiments performed during the Nanocamp are rated, a special question related to this topic was introduced in the feedback questionnaire. The Likert scale steps for the rating of this topic were: very attractive – attractive – less attractive – non-attractive – boring. THe children and the teachers and experts' opinions are presented in comparison in the following two figures.



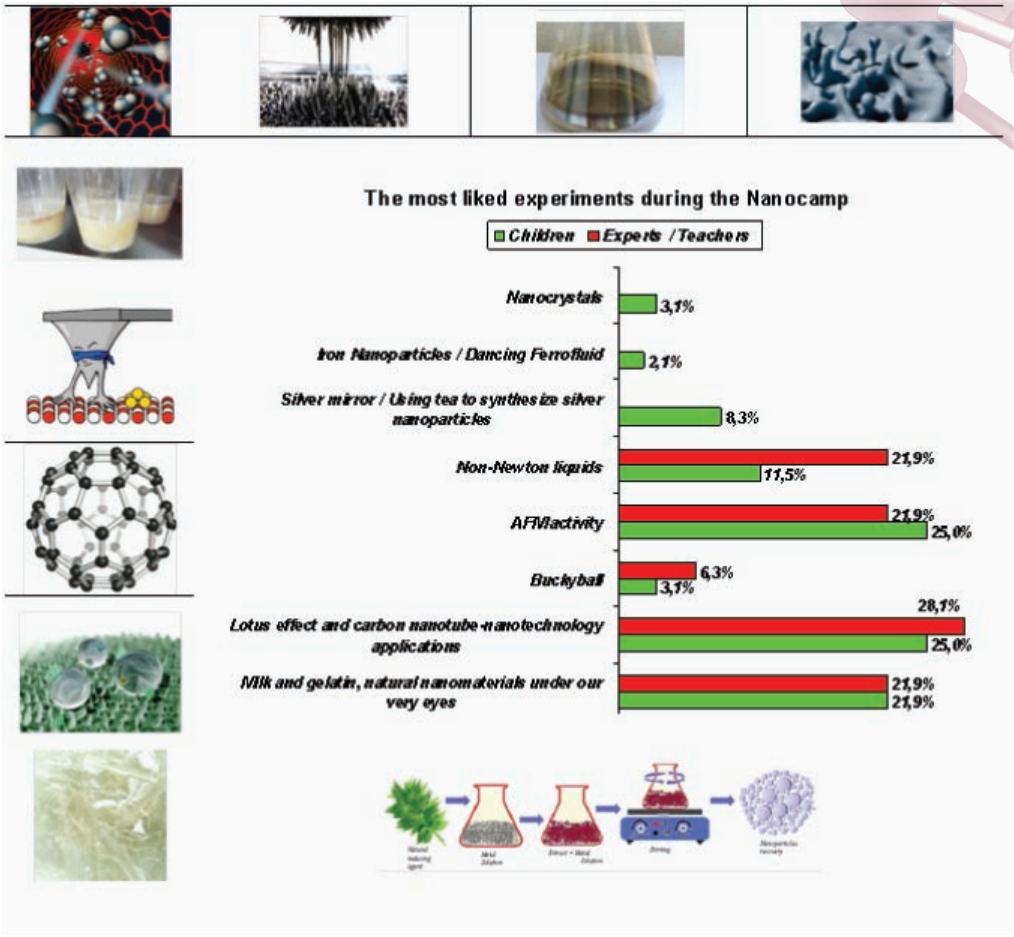
(a) Children



(b) Experts and teachers

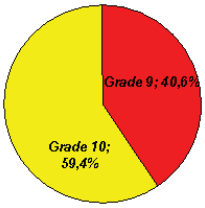
- ***The most liked experiments performed during the Nanocamp***

The participants were invited to mention 3 experiments which they liked most during the Nanocamp. The obtained results are illustrated in the following picture.

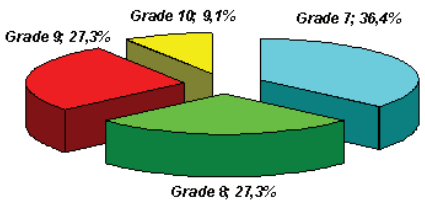


- ***The scientific activities (as overall) in which participants were involved during the Nanocamp***

Being asked to give a mark (from 1 to 10) to the scientific activities in which they were involved, the two target groups (children and respectively teachers and experts) rated the activities in conformity with the following two graphics.



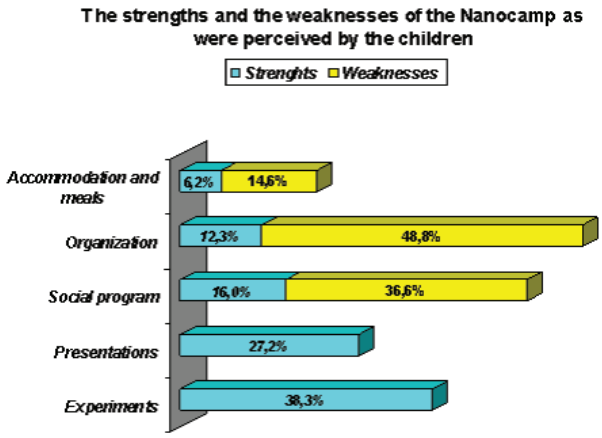
(a) Children

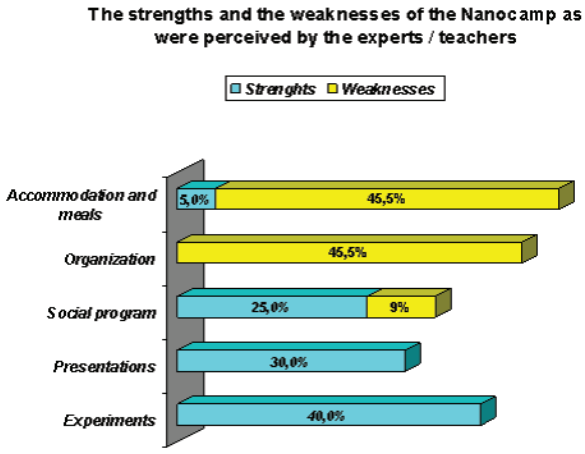


(b) Experts and teachers

- ***The strengths and the weaknesses of the Nanocamp***

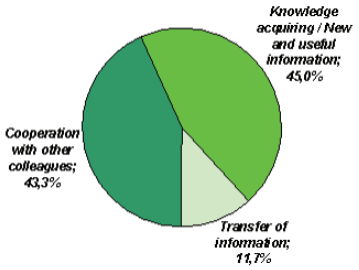
Being asked to mention the strengths and the weaknesses of the Nanocamp, as those were perceived by them (organization, provided activities, social program, accommodation and meals etc.), the participants expressed their opinion related on these aspects. The obtained results are presented in the following two pictures:



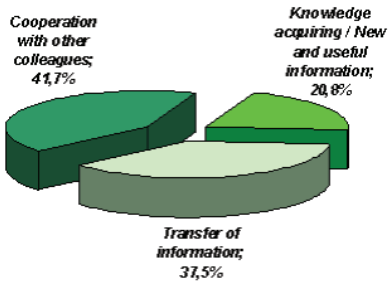


- ***Opinions related to the usefulness of Nanocamp activities***

The participants were invited to express their opinions related to the usefulness of Nanocamp activities, from the perspective of: knowledge acquiring, transfer of information, cooperation with other colleagues, future personal development. The data analysis is shown in the following graphics:



(a) Children



(b) Experts and teachers

VIII. DISSEMINATION & EXPLOITATION

8.1. Dissemination Activities and Results

8.1.1. Dissemination Activities of Doğa

On 17.03.2011, 22 upper elementary students from Beykoz Doga School and 6 female high school students from Kartal Doga School were ***invited to Yakacık Doga Nanobiotech Lab*** to test the nanotech experiments in order to initiate the experiments of the Virtual Lab.

At APMAS – ***International Advances in Applied Physics and Material Science Congress,*** on 02.05.2011 in Antalya-TURKEY, NTSE project was presented to 300 participants whom were prospective teachers, university students and academicians of universities.

On 06.09.2011, thirteen teachers chosen from Doğa Schools attended to the ***Teachers' Training Course of Nanotechnology*** between 6th and 8th September, 2011 in Yakacık Nanobiotechnology Laboratory, İstanbul. The teachers are working as Science, Physics, Chemistry and Biology teachers both at upper elementary and secondary schools of Doğa Schools.

On 05.09.2012, the ***local workshop to Group Leaders of science teachers*** was organized. Ten science teachers (at upper-elementary and secondary school levels) of Doga Schools from different campuses in Turkey attended in İstanbul on 05.09.2012.

On 05.03.2013, ***vocational school visit for Hacı Rahime Maritime Vocational High School students*** (20) was organized. Students visited Yakacık Doga Nanobiotech Lab and they worked on nano kits and was informed about the poster competition.

On 08.03.2013, ***the project experts visited the 30 Ağustos Female Technical and Vocational High School*** (50 students) in order to introduce virtual lab and announce the poster competition. Between October and November, ***6 lessons on nanotechnology was given to 30 Ağustos Female Technical and Vocational High School students*** (26) in three school visits.

On 08.06.2013, ***the conference, Joy of Sharing International Projects and Good Practices,*** was organized in İstanbul. The Project was presented to 200 participants consisting of EU Project partners and coordinators, "Sustaining Development In Early School Education" Project experts, EACEA and Turkish National Agency representatives, students, teachers and parents of different target groups, decision makers, Governorship and partners of centralized and decentralized EU Projects.

At APMAS – ***International Advances in Applied Physics and Material Science Congress,*** on 24.04.2013, the participants of Nano-Tech Competition were voted by the scientific jury in the semi-finals. There were 400 participants at the event.

On 15–16 November 2013, ***"International Nano Technology Science Education Congress:*** "INT-NTSE" Congress took place in Istanbul (TURKEY). The aim of the congress has been to promote the sharing of good practices and transnational cooperation in the field of the application of Nano Technology and ICT in Science Education learning and training. In two days, approximately 200 people (mostly students and teachers) attended the congress.

NTSE project is announced at oxygen press in Doğa Schools. Target audience were teachers, students parents and managers of Doğa Schools.

All the news published in visual and print media about the project can be reached at http://www.dogaabprojeleri.com/basinda-biz.

Dissemination Seminar in İstanbul, Turkey will be held on December, 13 2013.

8.1.2. Dissemination activities of Fondazione Idis-Città della Scienza

Presentation of the project in 3GIORNIPERLASCUOLA, Smart Education & Technology Days 2012

3GIORNIPERLASCUOLA is an annual national convention held from 2003 in Città della Scienza, Naples, and dedicated to school and education issues, as the promotion of new learning technologies. The 10th edition has been held from 10 to 12 October 2012. In particular on October 10th, NTSE was presented in the framework of the session Nella scuola dei nativi digitali. Esperienze e traiettorie in Italia e in Europa.

Presentation of the project in 3GIORNIPERLASCUOLA, Smart Education & Technology Days 2013

The 11th edition of 3GIORNIPERLASCUOLA (see above) has been held from 9 to 11 October 2013. Several thousands teachers and other stakeholders engaged in educational issues attended the event. In particular on October 9th a special session has been held in order to present and promote the activities carried out in the framework of NTSE. A sample of students who attended both the Nanocompetition and the Nanocamp took part in the session talking to the public about their experiences presenting some of the scientific issues they learned during the camp. Several teachers attended the session.

Presentation of the project in ASTC Annual Conference 2013

The annual conference of Association of Science – Technology Centers has been held on 19–22 October 2013 in Albuquerque, New Mexico, USA.

A representative of Fondazione Idis-Città della Scienza attended the conference presenting the activities of the Foundation. Also the activities carried out in the framework of NTSE have been presented among the others developed by Idis.

Presentation of the project in Toy Expo 2013

The Toy Expo is a science fair annually held in Potenza, southern Italy, aiming to involve young students in scientific laboratory activities. Fondazione Idis-Città della Scienza took part at the 2013 edition – from 16 to 22 December – presenting some nano related activities developed in the framework of NTSE. About 3.000 students attended the event.

Presentation of the project in P.O.N. F3 Andare a scuola, perché?

On November 27th and December 4th in ISIS Europa of Pomigliano D'Arco, district of Naples, the lesson plans of NTSE have been presented to groups of students involved in the national educational programme P.O.N. F3 Andare a scuola, perché?

8.1.3. Dissemination activities of Valahia University Targoviste

Presentation of the paper: „Teachers' perception related to the promotion of Nanotechnology concepts in Romanian Science Education" (Authors: Gorghiu L. M., Gorghiu G.) concerning the Romanian teachers' feedback based on the questionnaires applied in the beginning of the NTSE project – to the **4th World Conference on Educational Sciences (WCES 2012)** – Barcelona, SPAIN, February 2nd–5th, 2012. Approximately 500 participants from secondary education, higher education, adult education, regional and national authority (as teachers, head teachers, inspectors, initial and in-service teacher educators, academic staff, scientific researchers, prospective teachers, students, etc.) attended the conference.

Presentation of the paper: "Teachers' and Students' Feedback Concerning the Use of ICT Tools in Learning Science through Nanotechnology" (Authors: Gorghiu L. M., Gorghiu G.) to the **11th WSEAS International Conference on Applied Computer and Applied Computational Science** (ACACOS'12) – Rovaniemi, FINLAND, April

18th–20th, 2012. Approximately 300 participants from Secondary Education, Higher Education, Adult Education, Regional and National Authority (as teachers, head teachers, inspectors, initial and in-service teacher educators, academic staff, scientific researchers, prospective teachers, students, etc.) attended the conference.

Presentation of the paper: "Considerations on the introduction of nanoscience specific topics in preuniversity and academic Romanian educational system" (Authors: Gorghiu L. M., Gorghiu G., Dumitrescu C., Olteanu R. L., Bizoi M.) to the **Yearly Scientific Seminar of the Faculty of Science and Arts,** with national participation organized in the frame of **"Valahia University Days"** – Targoviste, ROMANIA, May 24th, 2012. Approximately 100 participants from Education environment (teachers, head teachers, inspectors, initial and in-service teacher educators, academic staff, scientific researchers, prospective teachers, students, etc.) attended the seminar.

Publication of paper: "Teachers' and Students' Feedback Concerning the Use of ICT Tools in Learning Science through Nanotechnology" (Authors: Gorghiu L. M., Gorghiu G.) in **Recent Researches in Applied Computers and Computational Science (Proceedings of 11th WSEAS International Conference on Applied Computer and Applied Computational Science),** ISBN: 978-1-61804-084-8, pp. 194–199, which is indexed by Association for Computing Machinery (ACM) International Databases and assure a worldwide dissemination to the level of scientific researchers, academic staff, in-service teachers / educators from secondary education, higher education, adult education, regional and national authorities members, prospective teachers, students, and general public.

Publication of paper: "Teachers' perception related to the promotion of Nanotechnology concepts in Romanian Science Education" (Authors: Gorghiu L. M., Gorghiu G.) ***by Elsevier*** in **Procedia – Social and Behavioral Sciences,** vol. 46, 2012, pp. 4174–4180 – which is indexed by the following International Databases: ScienceDirect, Scopus and Thomson Reuters Conference Proceedings Citation Index (ISI Web of Science) and assure a worldwide dissemination to the level of scientific researchers, academic staff, in-service teachers / educators from secondary education, higher education, adult education, regional and national authorities members, prospective teachers, students, and general public.

Presentation of the paper: "Promoting the Nanotechnology Concepts in Secondary Science Education through ICT Tools – the Romanian and Turkish Teachers' Perception" (Authors: Gorghiu L. M., Gorghiu G., Yilmaz Doğan Z., Gerçeker P.) to the **3rd World Conference on Information Technology 2012 (WCIT 2012)** – Barcelona, SPAIN, November 14th–17th, 2012. Approximately 500 participants from secondary education, higher education, adult education, regional and national authority (as teachers, head teachers, inspectors, initial and in-service teacher educators, academic staff, scientific researchers, prospective teachers, students, etc.) attended the conference.

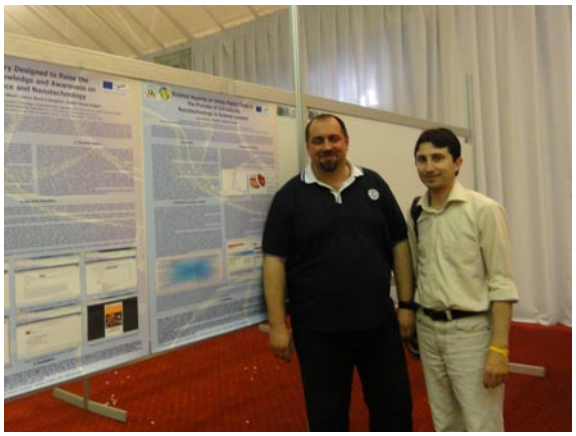
Publication of paper: "Promoting the Nanotechnology Concepts in Secondary Science Education through ICT Tools – the Romanian and Turkish Teachers' Perception" (Authors: Gorghiu L. M., Gorghiu G.. Yilmaz Doğan Z., Gerçeker P.) in **Global Journal on Technology,** Vol 3 (2013) **(Proceedings of 3rd World Conference on Information Technology (WCIT-2012)),** ISSN: 2147-5369 that assure a worldwide dissemination to the level of scientific researchers, academic staff, in-service teachers / educators from secondary education, higher education, adult education, regional and national authorities members, prospective teachers, students, and general public.

Presentation of two posters: 1. "Related Aspects on Using Digital Tools in the Process of Introducing Nanotechnology in Science Lessons" (Authors: Gorghiu L. M., Gorghiu G.) ***and 2. "A Repository Designed to Raise the Students' Knowledge and Awareness on Nanoscience and Nanotechnology"*** (Authors: Gorghiu G., Bîzoi M., Gorghiu L. M., Yilmaz Doğan Z.) (Authors: Authors: Gorghiu L. M., Gorghiu G., Yilmaz Doğan Z., Gerçeker P.) to the **3rd International Advances in Applied Physics and Materials Science Congress (APMAS 2013)** – Antalya, TURKEY, April 24th–28th, 2013. Approximately 500 participants from secondary education, higher education, adult education, regional and national authority (as teachers, head teachers, inspectors, initial and in-service teacher educators, academic staff, scientific researchers, prospective teachers, students, etc.) attended the congress.

Presentation of NTSE project: "NTSE – Nano-Tech in Science Education" (Authors: Gorghiu L. M.) to the **4th International Conference on Baltic and Nordic Studies in Romania: Empire-building and Region-building in the Baltic, North and Black Sea Areas 2013** – Constanta, ROMANIA, May 24th – 26th, 2013. Approximately 100 participants from secondary education, higher education, adult education, regional and national authority (as teachers, head teachers, inspectors, initial and in-service teacher educators, academic staff, scientific researchers, prospective teachers, students, etc.) attended the conference.

Presentation of the paper: „Utilizarea experimentelor virtuale în predarea nanotehnologiilor. Experiența proiectului NTSE (The use of virtual experiments in teaching nanotechnologies. The NTSE project experience)" (Authors: Gorghiu L. M., Gorghiu G., Olteanu R. L., Dumitrescu C.) to the **Yearly Scientific Seminar of the Faculty of Science and Arts,** with national participation organized in the frame of **"Valahia University Days"** – Targoviste, ROMANIA, June 15th, 2013. Approximately 100 participants from Education environment (teachers, head teachers, inspectors, initial and in-service teacher educators, academic staff, scientific researchers, prospective teachers, students, etc.) attended the seminar.

Selecting as a Key Research Article and indexing of the paper: "Teachers' Perception Related to the Promotion of Nanotechnology Concepts in Romanian Science Education" (Authors: Gorghiu L, Gorghiu, G.) by **Psychology Progress Ltd. – Center for Top Research in Psychology** – July, 2013. Key research papers are selected by Psychology Progress Ltd. – Center for Top Research in Psychology from a wide variety of peer reviewed journals and are judged to be of major importance in their respective fields. That improved the worldwide dissemination to the level of scientific researchers, academic staff, in-service teachers / educators from secondary education, higher education, adult education, regional and national authorities members, prospective teachers, students, and general public.



Publication of paper: "A Repository Designed to Raise the Students' Knowledge and Awareness on Nanoscience and Nanotechnology" (Authors: Gorghiu G., Bîzoi M., Gorghiu L. M., Yilmaz Doğan Z.) in **Journal of Science and Arts,** 3(24), pp. 319–325, 2013, ISSN 1844-9581. The journal is indexed by a big number of International Databases: Index Copernicus Journals Master List, Directory of Open Access Journals, Google Academic, Journal Seek, Open J-Gate, Summon Serials Solutions, Zentralblatt MATH, ProQuest products: ProQuest Technology Collection; ProQuest SciTech Collection; ProQuest Materials Science Journals; ProQuest Engineering Journals; ProQuest Advanced Technology & Aerospace Journals; ProQuest Engineering Journals; ProQuest High Technology & Aerospace Journals; ProQuest Natural Science Journals, Academic Journals Database, University of Zurich, WorldCat, Wageningen UR, E-Library, Center for Teaching and Learning Resources in Central Taiwan, CORE (COnnecting REpositories), EBSCO Host. This assures a worldwide dissemination to the level of scientific researchers, academic staff, in-service teachers / educators from secondary education, higher education, adult education, regional and national authorities members, prospective teachers, students, and general public.

Organization of the First Dissemination Seminar in Romania and dissemination of NTSE project results. The seminar took place on September 11th, 2013, in Targoviste, ROMANIA. During the seminar the educational features of the NTSE Virtual Lab were presented and different materials related to the NTSE project results (leaflets, bookmarks, posters) were spread. A number of 60 participants from Dambovita County education environment (secondary and higher education, regional authority), like teachers, head teachers, inspectors, initial and in-service teacher educators, academic staff, students, etc. were attended the seminar.

Presentation of NTSE project: Nano-Tech Science Education – A European KA3-ICT Project that Promotes Science Education through Virtual Experimentation (Authors: Gorghiu G., Gorghiu l. M., Bîzoi M., Yilmaz Doğan Z.) to the **International Organization for Science and Technology Education Eurasian Regional Symposium & Brokerage Event Horizon 2020 (IOSTE 2013)** – October 30th – November 1st, 2013, Antalya, TURKEY. About 80 participants as educators, academic staff, scientific researchers, PhD students, etc. attended the symposium.

Publication of the abstract: „Nano-Tech Science Education – A European KA3-ICT Project that Promotes Science Education through Virtual Experimentation" (Authors: Gorghiu G., Gorghiu l. M., Bîzoi M., Yilmaz Doğan Z.) – in **Abstract and Programme Book of The International Organization for Science and Technology Education Eurasian Regional Symposium & Brokerage Event Horizon 2020 (IOSTE 2013)** – October 30th – November 1st, 2013, Antalya, TURKEY. That assures the worldwide dissemination to the level of scientific researchers, academic staff, in-service teachers / educators from secondary education, higher education, adult education, regional and national authorities members, prospective teachers, students, and general public.

Organization of the Second Dissemination Seminar in Romania and dissemination of NTSE project results. The seminar took place on November 6th, 2013, in Targoviste, ROMANIA. During the seminar the educational features of the NTSE Virtual Lab were presented and different materials related to the NTSE project results (leaflets, bookmarks, posters) were spread. A number of other 20 participants from Dambovita County education environment (secondary and higher education, regional authority), like teachers, head teachers, inspectors, initial and in-service teacher educators, academic staff, students, etc. were attended the seminar.

Organization of the Third Dissemination Seminar in Romania and dissemination of NTSE project results. The seminar took place on November 8th, 2013, in Cluj-Napoca, ROMANIA. During the seminar the educational features of the NTSE Virtual Lab were presented and different materials related to the NTSE project results (leaflets, bookmarks, posters) were spread. A number of 40 Participants from Cluj County Education Environment: Secondary and Higher Education (as teachers, teacher educators, academic staff, prospective teachers and students) were attended the seminar.

Presentation of the study: Virtual Resources Developed in NTSE Project for Raising the Interest of Romanian Students' and Teachers' for Nanoscience and Nanotechnology (Authors: Gorghiu L. M., Gorghiu G., Olteanu R. L., Dumitrescu C., Chilian A.) to the **International Nano-Tech Science Education Congress 2013** – November 15th – 16th, 2013, Istanbul, TURKEY. Approximately 150 participants from education environment (secondary and higher education, regional and national authority) as teachers, head teachers, inspectors, initial and in-service teacher educators, academic staff, students were attended the congress.

Presentation of two papers: 1. Using Various NTSE Virtual Laboratory Resources for Developing the Students' Knowledge Related to Nanoscience and Nanotechnology (Authors: Gorghiu L. M., Gorghiu G., Olteanu R. L., Dumitrescu C.) and ***2. Educational Case studies Related to Promote Nanoscience and Nanotechnology Issues in Science Education, Based on ICT Tools*** (Authors: Gorghiu G., Gorghiu L. M., Antonescu C., Badoiu N.) to the **4th World Conference on Information Technology 2013 (WCIT 2013)** – November 26th – 28th, 2013, Brussels, BELGIUM. Approximately 500 Participants from the Education Environment: (secondary education, higher education, adult education) as teachers, head teachers, inspectors, initial and in-service teacher educators, academic staff, scientific researchers, prospective teachers, students were attended the conference.

Organization of the Final Dissemination Seminar in Romania and dissemination of NTSE project results. The seminar took place on December 4th, 2013, in Targoviste, ROMANIA. A presentation of the NTSE Virtual Lab was sustained by the VUT team and different materials realized in the frame of the NTSE project were disseminated to the participants.

Participating with university students and experts to the NTSE Webinar sessions on December 9th and 16th, 2013. Approximately 35 participants from Valahia University Targoviste were attended the webinar sessions (as teachers, academic staff, researchers and students).

Publication of paper: "Publication of the paper: "Related Aspects on Using Digital Tools in the Process of Introducing Nanotechnology in Science Lessons" (Authors: Gorghiu L. M., Gorghiu G.) in **Acta Physica Polonica,** ISSN: 1898-794X, 2014. The paper was accepted for publication and is in press. Since the journal is indexed by Thomson Reuters Conference Proceedings Citation Index (ISI Web of Science), this will assure the worldwide dissemination to the level of scientific researchers, academic staff, in-service teachers / educators from secondary education, higher education, adult education, regional and national authorities members, prospective teachers, students, and general public.

Publication of papers: "Using Various NTSE Virtual Laboratory Resources for Developing the Students' Knowledge Related to Nanoscience and Nanotechnology" (Authors: Gorghiu L. M., Gorghiu G., Olteanu R. L., Dumitrescu C.) and ***"Educational Case studies Related to Promote Nanoscience and Nanotechnology Issues in Science Education, Based on ICT Tools"*** (Authors: Gorghiu G., Gorghiu L. M., Antonescu C., Badoiu N.) in **Global Journal on Technology, 2014 (Proceedings of 4th World Conference on Information Technology (WCIT-2013)),** ISSN: 2147-5369. The papers were accepted for publication and are in press. Starting with the moment of publishing, they will contribute to the worldwide dissemination of NTSE project results to the level of scientific researchers, academic staff, in-service teachers / educators from secondary education, higher education, adult education, regional and national authorities members, prospective teachers, students, and general public.

Mass-media Dissemination (in Romanian):

– Article in "Gazeta Dâmboviței" Journal (3 April 2013):
http://www.gazetadambovitei.ro/educatie/elevii-targoviteni-viitori-pionieri-in-domeniul-nanotiinelor/;

– Flash news in "Columna TV" News Journal (3 April 2013):
http://www.youtube.com/watch?v=A61fnmlUT8o

8.1.4. Dissemination activities of FORTH

Presentation of NTSE Project to science teachers

On April 4th 2012, the NTSE Project was presented to the science teachers of Experimental High School of Heraklion. FORTH has a formal collaboration with the set of Pilot / Experimental Schools of Greece (15 in Upper Secondary level and 15 in Lower Secondary level). The head of the school, two physics teachers, two chemistry teachers and one biology teacher were present.

Newsletter to science teachers

On June 1st 2012, a newsletter in the form of e-mail was send to "Science Teachers" (including the project's leaflet in pdf format) introducing the project to them. Three National Unions of Scientists. (Teachers of Physics, Chemistry and Biology) were targeted.

Submission of the project in STENCIL Catalogue

On June 24th 2012, the NTSE Project was submitted in STENCIL Catalogue (http://www.stencil-science.eu/). The Science Teaching European Network for Creativity and Innovation in Learning (STENCIL) offers to science teachers and practitioners in science education from all over Europe a platform to encourage joint reflection and European co-operation, to contribute to the improvement of science teaching.

Presentation of NTSE Project to science teachers

On November 23rd 2012, the NTSE Project and the Virtual Lab were presented to the science teachers of the 2nd Gymnasium of Heraklion. Nine teachers participated in the meeting (Head of school, five physics teachers, two chemistry teachers and one biology teacher.

Newsletter to science teachers

On January 31st 2013, a newsletter in the form of e-mail was send to all EKFE (Laboratory Centers for Science Education) around Greece, including the project's leaflet and the nanocompetition poster in pdf format. EKFE operates under the Ministry of Education.

80 Laboratory Centers for Science Education (and through those centers all science teachers in secondary education) were targeted. After that email there were more than ten articles / references about NTSE in Greek educational portals, blogs, school sites and newspapers.

Newsletter to science teachers

On March 11th 2013, another newsletter in the form of e-mail was send to all EKFE (Laboratory Centers for Science Education) around Greece, including updated information regarding the nano poster competition.

Poster in "The Onassis Foundation Science Lecture Series 2013"

The Onassis Foundation Science Lecture Series 2013 that took place in Heraklion, Crete from July 15th to July 19th 2013 were centered on the topics of Nanoscience and Nanotechnology. The lectures were given by highly reputated

international scientific personalities: Phaedon Avouris, Andrea Ferrari, C. Galiotis. Konstantin Novoselov, Paul Stephan Roche, Christian Thomsen, S. Weiss, and Hua Zhang. Academics and science students (35 Greek and 15 international) were targeted.

Poster in the poster session of Scientific Retreat at FORTH

The Scientific Retreat took place at FORTH, Heraklion on July 12th – 13th 2013. The aim of the Retreat was to inform the members of our scientific community about the current research activities, placing emphasis on interdisciplinary activities. Academics, researchers, policy makers and science students were targeted.

Newsletter to science teachers

On October 7th 2013 an information letter (in Greek) in the form of email was send to all EKFE (Laboratory Centers for Science Education) around Greece, including information regarding the upcoming NTSE conference (call for papers, poster and deadlines).

Information letter to STENCIL Network.

On October 8th 2013 an information letter (in English) in the form of email was send to ˜30 Stencil Network stakeholders (Policy makers, academics, practitioners) including information regarding the upcoming NTSE conference (call for papers, poster and deadlines).

First dissemination workshop

On December 4th 2013, the first dissemination workshop took place in Vamos, Western Crete. A presentation of the NTSE Virtual Lab was sustained by the FORTH team and different materials realized in the frame of the NTSE project were disseminated to the participants. A discussion on teaching nanoscience in Secondary education followed. 35 in total science teachers and educational inspectors / consultants from Wester Crete region were present.

Second dissemination workshop

On December 19th 2013, the second dissemination workshop took place in Heraklion, Crete. Again, a presentation of the NTSE Virtual Lab was sustained by the FORTH team and different materials realized in the frame of the NTSE project were disseminated to the participants. A discussion on teaching nanoscience in Secondary education followed. 27 in total science teachers and educational inspectors / consultants from Eastern Crete region were present.

8.1.5. Dissemination activities of CCTA

Center for Creative Training Association has a wide network of partner schools and develops activities focused mainly on the teachers, but also performed a strategy for dissemination through students and stakeholders. Out of the NTSE project target groups CCTA works actively with teachers in science subjects (and their students), school headmasters and decision makers in education (such as Regional Inspectorates of Education, municipal educational authorities, different departments of the Bulgarian Academy of Sciences and others).

As a whole, the project reached more than 600 teachers directly, and many more indirectly – through dissemination materials, invitations and notifications for events, electronic publications and invitations through the network of the Regional Inspectorates of Education.

Since the beginning of the project, CCTA's team reached to the a wide group of teachers in sciences from all over Bulgaria – along with the 1st questionnaire, concerning their needs, the teachers received information about the project, its aims and objectives and the foreseen activities. 42 teachers participated in the survey.

During the Final meeting and project conference (22–23.09.2011) for the project KeyTTT (504605-LLP-1-2009-1-BG-COMENIUS-CMP) in Stara Zagora (Bulgaria) was held a poster dissemination of the NTSE project. 86 Bulgarian teachers, representatives from the Bulgarian Ministry of Education, and from regional stakeholders took part in the conference.

The Festival „Science on Stage" took place on the 27th and 28th of October 2012 in Sevlievo, Bulgaria with the participation of 150 students and 90 teachers, MoE representatives and officials. The NTSE project was disseminated on a stand, for one and a half days during this event. Visitors were able to observe interviews, vlab experiments and to do hands on nano-related activities and received printed materials about the project and its forthcoming activities.

On 23rd and the 24th November 2013 the NTSE VLAB and project results were disseminated to an audience from Smolyan, Bulgaria (Science and IT teachers). Every participant had the opportunity to try the translated and uploaded experiments in Bulgarian, also to try the other resources available on the NTSE web-site and the virtual lab. 34 teachers took part in the event. They were informed about the event with the assistance of the Regional Inspectorate of Education – Smolyan region. The inspectorate supports the NTSE dissemination in the region.

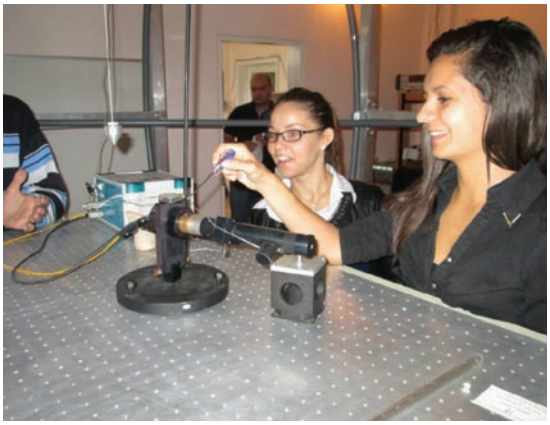
On 06.12. 2013 in Sofia, Bulgaria was held NTSE project dissemination seminar 17 registered participants (teachers, university students and Bulgarian Academy of Sciences reps.) from Sofia and the region took part in one-day practical dissemination seminar.

On 13.12.2013 Blagoevgrad, Bulgaria was held a half-day dissemination seminar entitled „Technologically supported education – the Use of Virtual Lab". The CCTA team involved in the NTSE project 40 teachers and the IT expert from the Regional Inspectorate of Education – Blagoevgrad. About 10 participants in this seminar stated they will try the Vlab and the project outputs in their classes.

The CCTA dissemination strategy facilitated the outreach of approx. 300 students through direct communication and even more through the teachers from associated partner institutions and electronic announcements – approx. 3000 students were reached as a whole. The students, directly involved in project activities took part in test-implementation processes (implementation of lessons in school), nano-competition, Nano-science camp, study visits at research institutions and other sites where nano-technologies are applied. During the educational study visits, the students had the opportunity to meet with scientists, and talk with them about their career choices and development.

On 21.12.2012 9 students from "John Atanasoff" VET high school and Mrs. Milena Gosheva, physics teachers travelled to Botevgrad to meet the founders and owners of AMG technology Ltd. Students were able to observe a real Bulgarian business built on nanotech products. AMG technology staff answered questions, conducted demonstrations and experiments for two hours in their facility and production plant. A short video-film was recorded about this visit and is now available at the podcasting room in the Virtual Lab at NTSE website: http://vlab.ntse-nanotech.eu/NanoVirtualLab/podcastingroom/2b43263387b443f2bb3223ffb803aeaf

On 27.06.2013 4 students visited the Institute of Electronics in the Bulgarian Academy of Sciences. 50th Anniversary Day of open door to scientific knowledge "My day in the Institute of Electronics: Open door to Bulgarian and Global scientific knowledge". 11th grader Hristina Metodieva wrote a report and essay about the day spent in the academy.



Apart from the communication between scientists and students, the scientists were involved in direct project activities, such as working in close contact and consulting the project experts ensuring the quality of the content and the materials. CCTA's team organized work meetings with representatives of the Bulgarian academy of sciences (BAS) and disseminated electronic information materials about the project to institutes and laboratories from the BAS.

The scientists also took part in the construction and development of the agenda of the Nano-science camp, as well as its implementation. The scientists consulted the experts, helped them develop activities and ensured that they are scientifically correct.

Nanotechnology and Education national conference took place on 25th and 26th of November 2011 in Sofia, Bulgaria with the participation of 120 participants from Bulgaria, 10 international. The project was presented by poster and poster session. The Project paper was prepared by assoc. prof. Mladen Matev.

Between the 21st and 23rd november 2013 was held 15th International Workshop on Nanoscience & Nanotechnology: The event is organized by The Bulgarian Academy of Sciences, the Technical University of Sofia and AQUACHIM JSC, Bulgaria.During the conference there was a plenary, poster session and business-education workshops. CCTA representatives took part in the plenary and established working contacts with more nanotech experts from Bulgaria and EU.

Exploitation:

The project will be presented during the International Conference "Educational Policies in the 21st century" which will take place between 12th and 14th March 2014. The Conference is the culminative event of the project "Educational Policies in the XXI century" (Lifelong learning programme, centralized, EACEA/20/2012) and is organized by Center for Creative Training Association, Sofia, Department for information and In-service Teacher Training in The Trakia University in Stara Zagora, Bulgaria and The Regional Inspectorate of Education – Sofia-City.

The Key conference topics will be policies supporting the EU Education and Training 2020 Strategy, vocational education and training, non-formal and informal learning, technology supported education.

Website of the project: http://edu21project.eu/

The Scientix Project Ambassador meeting (FP7 Managed by the European Schoolnet, with the support of the EACEA Science Team) took place between 29 November – 1 December 2013. CCTA expert Alexander Angelov is currently engaged as Scientix deputy-ambassador for Bulgaria. He agreed with the Scientix team to include NTSE project in the Scientix database and to use the Scientix tools and events to disseminate widely the NTSE materials and products. The project was presented to 88 Scientix ambassadors (mostly science teachers) from all EU countries (+Norway and Israel).

About Scientix: Scientix promotes and supports a Europe-wide collaboration among STEM (science, technology, engineering and maths) teachers, education researchers, policymakers and other STEM education professionals.

In its first stage (2009–2012), the project built an online portal to collect and present European STEM education projects and their results, and organised several teacher workshops. The main networking event was the Scientix conference, held in May 2011 in Brussels.

The goal of the second phase (2013–2015) is to expand to the national level. Through the network of the National Contact Points (NCPs), Scientix aims to reach out to national teacher communities, and contribute to the development of national strategies for wider uptake of inquiry-based and other innovative approaches to science and maths education.

8.1.5. Dissemination activities by Sirma Media

Sırma Media (P3) conducted 4 workshops between 2011–2012 to present the effective use of Virtual Lab in the classes for science education.

On 30 October – 1 December 2011, Sirma Media conducted workshop "IT tools in education" with 60 participants from the following cities: Vraca, Vidinand Montana/teachers, head teachers, primary and secondary school teachers, school heads.

On 12 – 14 January 2012, 150 participants/teachers, schools IT administrators, IT in education specialists and consultants were participated to the workshops in London, UK (participation in best practices organized by INTEL).

In new school term, 2012–2013 with the revision and development of the educational materials on Virtual Lab. Sirma Media conduced new 9 workshops to present the functionality of the virtual lab (Sept.2012, October 2012, March 2013,May 2013,October 2013,November 20139) and reached about 366 participants /primary teachers, secondary teachers, head teachers, school principals, representatives of the regional inspectorates of education in Seminars "Classroom of the future" in Kustendil, Varna,Bourgas, Stara Zagora, Sofia, Plovdiv and Blagoevgrad, Bulgaria

8.2. Exploitation Activities and Results

8.2.1. Exploitation strategy and specific Exploitation channels provided by the NTSE Project

The *Exploitation strategy* took into consideration the following aspects:
a) *measures* for exploitation of results during and beyond the lifetime of the project;
b) *timing;*
c) *target groups* (final end-users).

The *Strategy* clearly stipulated also that it was defined and carried out in a very close relation with the *Dissemination activities,* and in this respect, the exploitation results must be seen in a deeply correlation with the *Evaluation and Dissemination process.* More, the *Mainstreaming* and the *Multiplication actions* play an important role for further development of the project outputs and offer a real guarantee that the benefits of the project will endure beyond the lifetime of the project.

The main channel for exploitation of project results – as indicated in the Project proposal (page 102) – was/is offered by the use of the *NTSE Virtual Laboratory* (designed and set up in the frame of the project), as an *educational testing environment,* in-time but also beyond the lifetime of the project. Practically, beginning with the second half of the project, the Virtual Laboratory was introduced to the educational stakeholders and decision-makers in the frame of various seminars or through mass-media. More, the NTSE *Virtual Laboratory* Guidelines Book makes broadly known the NTSE Virtual Laboratory to the educational environment.

But first, the NTSE Project partners had as an important task to exploit the *Virtual Laboratory* in their own institution, within the existed *teaching programs,* planned workshops and/or Science events. More, the NTSE Project partners made efforts to encourage educational institutions / organizations and/or individual learners to apply the *Virtual Laboratory* in different educational settings.

The other important channel for exploitation of project results is represented by the Nano-Tech Annual for Nano-Tech Readers – a printed volume that records, highlights and illustrates the main results of the project, including also the main project facts and several statistics. The volume (printed in English version) is sent and dispatched to schools, directorates, public libraries, teacher training centers and research institutions. A special launching and presentation of the project (and of the volume) will be organized with the occasion of the *4th International Advances in Applied Physics and Materials Science Congress & Exhibition (APMAS 2014)* and *1st International Congress & Exhibition on Current Trends on Science Technology Education (SCITEED 2014),* both of them being held on April 24th–27th, 2014 in Fethiye, Muğla, Turkey, and proposing special sections dedicated to *Nanoscience* and *Nanotechnology*.

As a clear *NTSE Exploitation Event,* it has to be mentioned that in the frame of the *1st International Congress & Exhibition on Current Trends on Science Technology Education (SCITEED 2014),* a special Workshop dedicated to Nanotechnology will be organized: *1st Workshop on Nanotechnology in Everyday Life.* The workshop welcomes submissions covering aspects of using Nanotechnology in various areas relative to our everyday life (as below), but not limited just to those ones:

- *Nanotechnology in Medicine*
- *Nanotechnology in Food Preparation and Refrigeration*
- *Nanotechnology in Cosmetics and Skin Care*
- *Nanotechnology in Clothes and Related Accessories*
- *Nanotechnology in Computer Equipment*
- *Nanotechnology in Electronic Devices*
- *Nanotechnology in Photography and Film*
- *Nanotechnology in Renewable Energy*
- *Nanotechnology in the Treatment of Surfaces*
- *Nanotechnology in the Renewable Energy Area*
- *Nanotechnology in Robotics*
- *Nanotechnology Issues in Education*
- *Miscellaneous*

At the same time, the *Workshop Scientific Committee* is defined as the same one that supervised the (INT-NTSE), held on November 15th – 16th 2013, in Avcılar, Istanbul, being formed by active participants and members of NTSE project. The project partnership intention is to make permanent the *Workshop on Nanotechnology in Everyday Life,* future editions being proposed to be organized in conjunction with important Conferences or Congresses.

A very successful NTSE project action and event was the Nano Science Camp (July 2013), hosted at *"The White Lagoon",* Balchik, Bulgaria, between July 1st – 6th 2013, where 25 teachers / experts from partner countries (Bulgaria, Greece, Italy, Romania and Turkey) and 45 secondary school students participated to *Nano* presentations, demonstrations, implementations, hands-on activities and cultural tours, including interactive sessions using the *NTSE Virtual Laboratory.* It is also in the intention of the project partnership to organize the *Nano Science Camp* yearly, by exploiting the *NTSE project results* (especially the *NTSE Virtual Laboratory*), after the end of the project. In this sense, two proposals for its organization have been already expressed (one from Turkish partner – DOGA, and one from Bulgarian partner – CCTA).

Beside the *Nano Science Camp,* another successful event was represented by the *Nano Poster Competition* for the students between 14 and 18 years old, having as main theme: *Nanoscience* and *Nanotechnology*. The competition was held in the countries participating in the NTSE project: Bulgaria, Greece, Italy, Romania and Turkey, and the winners were selected by an *international jury* at the *3rd International Advances in Applied Physics and Materials Science Congress & Exhibition (APMAS 2013),* in Antalya, Turkey. The NTSE project partnership express the willingness to exploit the success of this competition and to continue to organize another edition of the *Nano Poster Competition,* in order to encourage the young students to extend their knowledge and to meditate on the topic related to *Nanoscience* and *Nanotechnology*, by imaging different *Nano-applications* in various areas. Local winners from each country will be rewarded with the opportunity to participate in the *International Nano Science Camp,* in 2014.

A remarkable project result, with *a huge potential of exploitation on a large scale,* is offered by the realization and production of the *NTSE Nano Kit,* designed by *DOĞA* experts. The *NTSE Nano Kit* comprises of nine experiments similar to those ones included in the *NTSE Virtual Laboratory* that serves for *hands-on activities* related to *Nanoscience* and *Nanotechnology* and Science teaching. With the help of the materials provided in the *NTSE Nano Kit,* acvitivities concerning Nanoscale, Buckyball, Lotus Effect, Nanocrystals, Ferrofluids and Leds can be taught to students. Thousands of young students (from NTSE project partner countries, but not only!) will benefit of *NTSE Nano Kit,* during the scholar activities, in the following years. The *NTSE Nano Kit* can be easier implemented in the Science curricula and offers sufficient strong points to be adopted by the Science teachers for practicing and developing Nano experiments in the classrooms.

An important channel for exploitation of NTSE project results is offered by the participation of project teammembers to various national / international conferences, seminars, workshops which have *Nanoscience* and *Nanotechnology* as topic. Representatives from each partner country will participate and present the main results and outcomes of the project: *NTSE Virtual Laboratory, NTSE Virtual Laboratory Guidelines Book, Nano-Tech Annual for Nano-Tech Readers, Nano Poster Competition, Nano Science Camp, NTSE Case Studies Results etc.* One of the main objectives for participating to national / international conferences is to increase the impact of the project, to ensure the project sustainability and to create awareness related to the NTSE project within the scholar and academic actors, researchers, but also general public.

A clear result comes especially on continuing the *NTSE project activities* and exploiting them by *setting up of a new proposal.* In this respect, preliminary discussions with some European partners have been already established with the occasion of *IOSTE Eurasia Regional Symposium & Brokerage Event Horizon 2020 – EU Framework Programme for Research and Innovation* (October 30th – November 1st 2013, Antalya, Turkey), where the *NTSE – Nano-Tech in Science Education project* was presented *(Nano-Tech Science Education – A European KA3-ICT Project that Promotes Science Education through Virtual Experimentation* – authors: Gabriel Gorghiu, Laura Monica Gorghiu, Mihai Bîzoi and Zuhal Yılmaz Dogan).

Last but not least, the *Exploitation of the NTSE project* results takes into account the on-line channels, being concretized in practice by the *NTSE project website* (http://ntse-nanotech.eu/). The website represents the mirror of the project which people can visit it and consult it for having a project overview, but also to use the project results. The website ensures the NTSE project sustainability and includes also the main events, even after the project ending.

8.2.2. Specific Exploitation results from NTSE project partners

The main results obtained in the frame of the *exploitation activities,* carried out by the *NTSE project partnership,* have been registered as follows:

– ***Valahia University Targoviste (VUT)*** was the partner institution which coordinated and monitored the *Exploitation Work Package* and reported its results.

As results, the *NTSE Virtual Laboratory* was integrated in specific training activities for 50 *Chemistry* students (Year I and III of studies) and *Physics* students (Year II of study), in the frame of disciplines: *Physical Chemistry, Colloidal Chemistry, Inorganic Chemistry, Organic Chemistry and Didactic of Chemistry/Physics.* During the disciplines laboratory/seminar activities, there have been exploited teaching materials, multimedia features and resources (articles) from the NTSE Virtual Laboratory / Repository related to: synthesis of nanoparticles, specific properties of nanoparticles, application of nanoparticles in different areas. Different topics have been approached and discussed such as: physical and chemical methods for obtaining nanoparticles *(Nanocrystal Fabrication materials),* structure and properties of nanomaterials *(Making Origami Buckyball and Lotus Effect materials),* magnetic properties of magnetite *(Iron Nanoparticles and Ferro-fluids and Waves and Dancing Ferrofluid materials).*

At the same time, master students / prospective Science teachers – 30 Master students from *Physico-Chemical Methods of Analysis for Life and Environment Quality* specialization – studied specific properties of nano-fibers and nanotubes (using *Carbon Nanotubes* and *Waveguide Fabrication* by Sol-Gel materials from the *NTSE Virtual Laboratory / Repository*).

In addition, 25 students from the *Faculty of Electrical Engineering, Electronics and Information Technology* (Year III of study) were involved in analyzing the way of making the simulations and producing the movies included in the *NTSE Virtual Laboratory interactions: Nanocrystal Fabrication and Iron Nanoparticles and Ferro-fluids).*

Future teachers were also familiarized with the modelling and simulation concepts designed for educational purposes. In the actual education, the role of modelling and simulation in understanding dynamic processes is extended to secondary education. Computer modelling and simulation have an important potential to improve the quality, especially of the secondary Science education. In this respect, 35 students enrolled in the related studies proposed by the Teacher Training Department have been trained concerning the use of *NTSE Virtual Laboratory / Repository* in teaching and learning. *Movies, Interactions, Repository and Documents (Student's Guide, Teacher's Guide and Assess-*

ment Grids) sub-sections were presented and debated as important issues that embrace and complete the *simulation concept.* As examples, the Romanian Case Studies were also introduced and explained.

All the presented results will be multiplied in the following university years. In addition, the *Nano Kit* was presented during the Seminars held with Science teachers, those ones being very interested to use the *Nano Kit* with the secondary students, in the classrooms.

UVT has also planned to exploit the *NTSE Virtual Laboratory Platform* and the *NTSE Virtual Laboratory Guidelines Book* in the frame of the meetings with Romanian Science teachers. In this sense, half-yearly meetings are foreseen to be organized with the occasion of the traditional Science teachers' methodological meetings, in which particular outcomes of the NTSE project *(Classroom implementations, Video-conference implementation sessions and Case Studies conclusions)* will be analyzed. In addition, *the Nano-Tech Annual for Nano-Tech Readers* – distributed to more than 250 Romanian educational actors – has the role to make known the NTSE project and its results, but also to increase the importance of Nanoscience and Nanotechnology in the formation of young students.

– **Doğa Schools (DOĞA)** – the NTSE project coordinator – exploited the NTSE project results in several various national and international events (*Workshops* and *Webinars*), by organizing them to provide basic information on how to effectively use the *NTSE Virtual Laboratory* in the classroom for Science and Prospective Science teachers.

Created initially as a *Dissemination event,* the first edition of the *Webinar* provided an important exploitation feature, through *mainstreaming* – several educational stakeholders (Science teachers, students, master students, university staff) participating to the event (www.ntse-nanotech.eu/webinar). Within Doğa Schools, 131 Science teachers from secondary schools and 60 Physics, 48 Chemistry and 48 Biology teachers from high schools participated in the Webinar. During the first session of the Webinar (December, the 9th 2013), the NTSE project was presented, but also the basic information about Nanotechnology was provided to participants. More, during the second session of the Webinar (December, the 16th 2013), the NTSE Virtual Laboratory was presented and how it should be used and exploited, but also the NTSE Nano Kit was introduced and discussed.

The European School Net (www.europeanschoolnet.org) supports the dissemination of the Webinar in order to be able to maximize the number of participants. In this sense, more on-line sessions are planned for the following period, after the ending of the project, in order to address over 100 Science teachers in Europe.

Having a big exploitation potential, the NTSE Nano Kit and the related 9 experiments provided by the NTSE Virtual Laboratory will be included in next years' Science curriculum, in Doğa Schools, starting from the lower secondary education level and expanding to other levels, gradually. It is estimated that during the 2014–2015 school year, the NTSE Nano Kit and the NTSE Virtual Laboratory will be used by 4000 students from lower secondary and 3700 students from upper secondary schools.

As NTSE project coordinator, Doğa presented the project in Berlin, at Online Educa 2013, December 4th–6th, 2013, a three-days International conference on technology supported learning & training. The NTSE project and its outputs were presented during the event organized by EACEA within the main conference. It must be specified that proposed by EACEA, the NTSE project has been chosen to be included in the publication that includes project descriptions and outcomes of several KA3 projects from the period 2007–2011. The publication gathers the information related to coordinating organization, consortium and grant details and relevant pictures from the project activities, a paragraph describing the project and a part that introducing the project outcomes.

– **Fondazione Idis-Città della Scienza (FONDAZIONE)** – Fondazione IDIS exploited the NTSE results and steps of the project in several meetings and events with teachers and educators. Since Fondazione had a Science Centre (for half of the length of the project), the section devoted to Nanotechnologies and Nanosciences was the place where educators and teachers could experiment and be updated about the projects. Apart the annual event for schools, Smart Education and Technology days, in which – both in 2012 (10–12 October) and in 2013 (9–11 October) – thousands of teachers could be informed about the project and also try some experiments from the Virtual lab, other smaller events for teachers were held during the project's time span.

Since the burning of the Science Centre, the Nanotechnology section was also the place where the explainers (educators who deal with the school students and the general public) were trained every month and informed about the virtual and real tools available and on how to use them with the public. Virtual lab was one of the topics that was chosen and 35 educators attended to the training courses held in October 2012.

In February 2012 a special training course for science teachers (Primary and secondary schools) was held at Città della scienza in cooperation with the Italian Ministery for University and Reasearch (MIUR). 25 teachers from all over Italy attended the course, and one of the lessons was about Nanotechnology and regarded the use of the virtual lab. A similar course will be held in February 2014.

In March 2013 (8th and 15th) two special training course with science teachers of secondary schools were held by Guglielmo Maglio (13 teachers and 8 teachers respectively attended the meetings) on the NTSE project and how to apply for the Poster competition. Other meetings in 9 secondary schools of Naples were held by the staff of the Project to clarify the rules of the poster competition and to invite students to use the virtual Lab.

Finally, it is estimated that the Nano-Tech Annual for Nanop-Tech readers will be distributed to 30 Policy Makers and Managers responsible for Local School Autorities and 50 selected teachers.

– Foundation for Research and Technology-Hellas (FORTH) undertakes to exploit the NTSE project results of: NTSE Virtual Laboratory Platform, NTSE Virtual Laboratory Guidelines Book and Nano-Tech Annual for Nano-Tech Readers.

It is foreseen that the NTSE Virtual Laboratory Guidelines Book was/is about to be distributed (in electronic format) to approx. 5000 Science teachers, in the context of Greece. This is to be achieved via FORTH's collaboration with the Hellenic Institute of Educational Policy (http://www.iep.edu.gr/site/index.php/en) which is the responsible Agency for curriculum development.

A Workshop entitled "Teaching Nanoscience in Secondary Education" will be organized during March 2014 in Heraklion, Crete, addressing Science teachers from the region of Crete. The Workshop will be supported by the local educational authorities and its main goal will be to integrate experiments from NTSE Virtual Laboratory into the curriculum and introduce the students to the new field of Nanoscience, but also exciting them about Science, in general.

In addition, the regional inspectors / consultants of Science Education in the fields of Physics, Chemistry and Biology will support the engagement of teachers in the NTSE Virtual Laboratory. A minimum of 300 teachers will participate in this task. The results of the NTSE Virtual Laboratory implementations will be conveyed to the regional inspectors and through a dedicated Workshop jointly organized between FORTH and the Institution of Educational Policy (IEP) – the NTSE "messages" will be conveyed to the policy level.

Finally, the Nano-Tech Annual for Nano-Tech Readers is distributed to a not less than 120 policy makers (approx. 100 inspectors and 20 curriculum development specialists of the IEP).

– Sirma Media (SIRMA) planned to exploit actively the NTSE project results of: NTSE Virtual Laboratory Platform, NTSE Virtual Laboratory Guidelines Book and Nano-Tech Annual for Nano-Tech Readers. The Bulgarian institution has already placed an advertise banner of the NTSE project on the National Educational Web-Portal of the Ministry of Education (http://resursi.e-edu.bg). This portal is being visited by several thousand people daily (teachers, students, MoE administrators and representatives of the regional inspectorates of education). This banner will bring serious traffic to the NTSE Virtual Laboratory and hopefully the majority of the visitors will start returning to the Virtual Lab occasionally. This will greatly enhance the future exploitation and direct implementation of the NTSE Virtual Laboratory experiments and materials, in the everyday learning activities.

Sirma Media is acting as Regional Training Agency under the Intel Teach program for Bulgaria. Among Sirma Media, main responsibilities are the coordination of the senior and master trainers under the program, and the provisioning of useful examples of good educational practices that can be shared with the teachers during the training sessions. With all this in mind, Sirma Media plans to represent the NTSE Virtual Laboratory as useful tool for Science based lessons, especially with the following Intel Teach courses: Project-based approaches, Inquiry based learning in the Science classroom.

It is also planned that the NTSE Virtual Laboratory Guidelines Book will be distributed (in electronic format) to approx. 500 educational institutions across Bulgaria. This is to be achieved via Sirma Media network of active partners/clients.

In addition, the Regional inspectors of education and especially the Science education experts (covering the disciplines: Physics, Chemistry and Biology) will support the direct implementation of the NTSE Virtual Laboratory experiments and materials by the Science teachers, across the country. It is envisaged the inclusion of approximately 280–300 teachers from the 28 Regional Inspectorates in the country.

Finally, it is estimated that the Nano-Tech Annual for Nano-Tech Readers is distributed to approx. 30 policy makers, but also to educational NGO activists, young scientists and prospective teachers.

– Center for Creative Training Association (CCTA) exploited and plan to exploit the project results at different levels, as follows:

a) Exploitation of the project results in the frame of the Nanocamp Event:

CCTA is committed to have the Nanocamp as annual event, beyond the project lifetime. CCTA had organized the NTSE Nanocamp in Balchik, Bulgaria, and up to early 2014 is planning the second edition of the Nanocamp, taking part in Kyustendul, Bulgaria, with the support of the Kyustendil Municipality. The Bulgarian Nanocamp team leaders and scientists had committed contribution for the second edition in 2014.

The Nanocamp is presented as science-camp, taking part in Bulgaria, open for any national or international team of participants from EU or partner countries. Every team participates on tuition basis, for every participant, as the cost of the team-leader (teacher) is covered by CCTA.

b) Exploitation by adding the NTSE activities to the general curriculum, at local level:

The Sofia-city Regional Inspectorate of Education is supporting four schools in Sofia City to freely experiment the integration of the NTSE activities in the general curriculum:

- 2nd English Language School "Thomas Jefferson";
- 2 Comprehensive School "Acad. Emiliyan Stanev";
- "John Atanassov" VET High School of Electronics;
- National VET school of precise equipment, electronics and optics "M.B. Lomonosov".

All above-mentioned schools had taken part in all the project stages, staring with the questionnaires to teachers, up to the NTSE Congress in Istanbul, in November 2013. Videos of the recorded lessons are available in the NTSE Virtual Lab – Podcasting Room.

The curriculum integration is not time-limited result, since the involved teachers teach

c) Exploitation by involving the Bulgarian Academy of Sciences and the Technical University of Sofia, through participating in the Annual Nanotechnology conference:

CCTA participated in the 15th International Workshop on Nanoscience & Nanotechnology, where a special section was dedicated for illustrating the NTSE findings and results. In this respect, the CCTA team was invited to share the Virtual Lab learning materials to the conference organizers and audience.

d) Exploitation via the FP7 Scientix 2 project:

CCTA had reached an agreement with the Scientix project team, in order to integrate the NTSE Virtual Lab activities in the Scientix database, and therefore to make it available to more than 2000 registered members, all STEM teachers from EU28 and partner countries, and to add the NTSE Project in the SCIENTIX project community funded STEM-related projects, making so NTSE accessible via the Scientix search engine. By that way, the users will enter directly to the NTSE Website and Virtual Lab, redirected by the Scientix portal.

8.2.3. Conclusions

Generally, through Exploitation process, the NTSE project outputs are available so that they become replicable and usable by others. From the partnership point of view, it is considered that the exploitation results lead to a qualitative process of ensuring the project sustainability and answer to the expectations proposed in the exploitation strategy. In this respect, the project partnership will make continuously efforts to promote the NTSE project results and outputs through different educational, professional, and school / academic networks of which the partners are members.

IX. CONCLUSIONS

During the project it was not easy to design the products addressing for the different target groups who are students from the general and vocational schools aged 13 to 18; teachers in science subject; and college & university students attending science education courses. The Virtual Lab is the milestone of the project that serves as a platform for science lessons, as a database of teaching materials, and as a hub for science learning-related experiments on Nanotechnology. Our project experts have been using the content of Virtual Lab and hands-on activities with nano kits for students at workshops. To be able to share the outputs and make more teachers and students be aware of the project number of dissemination activities were organized both in Turkey and in the partner countries. One and most important of those activities was the two-day long International Nano Technology Science Education Congress. During the congress the project was presented and key note speakers gave speeches on nanoscience, nanotechnology and workshops dedicated to different themes and topics in nanoscience were held.

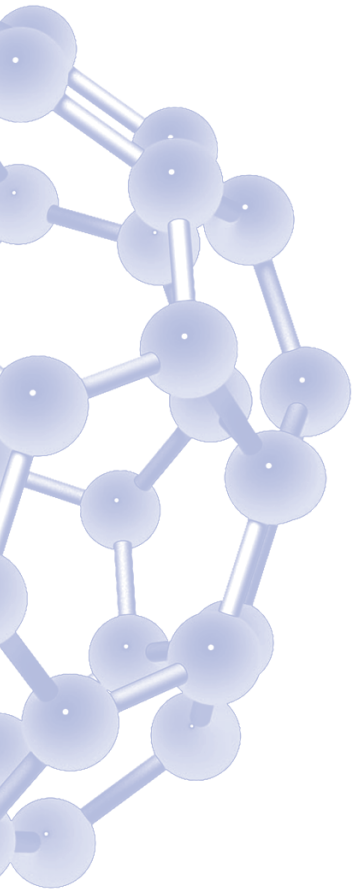
Besides, webinar sessions http://www.ntse-nanotech.eu/webinar.asp

were held to provide basic information on how to effectively use the virtual lab in the classroom to reach more and more users to include the Nano-Science Center, presenting to learners and their in-service or future teachers the miracles of the nanotechnologies. A program for a week Science Camp training including hands-on experiments and demonstrations will be developed and delivered through the VL, this is a good step as an approbation of the contents and functionalities of the virtual lab. We should increase the numbers of webinar sections in order to reach more teachers; via webinars through given tasks; teachers learn how to use ICTs more effectively when they see the technologies not as generic and decontextualized tools but as tools for teaching, that is, for motivating, managing, facilitating, enhancing, and evaluating learning. When teachers perceive ICT as a tool to meet curricular goals they are more likely to integrate ICT in their lessons.

The NTSE project aimed to support the acquisition of key competencies through making all levels of education and training more attractive and efficient. in line with the strategic objectives of the Education and Training 2020" (ET 2020). The project deliverables aspired to support mostly basic competences in science and technology through providing adequate equipment and educational software and encouraging the teachers for the best use of teaching and learning techniques based on ICT. The NTSE project by prioritizing these goals focused on the young students as well as their teachers and has been searching to diversify teaching equipment and ICT tools to help people to gain science and digital competence.

The products of the project was tested, refined and developed in three years. The educational materials in virtual laboratory were redesigned and modified according to the needs, levels and interests of our target groups. They are being enriched as they are used and shared. In each chapter, it was how the products were processed and developed through presenting the numbers, statistics and facts about the projects. When you read this annual you can not only find the numbers and facts of the project but also recognize the roads that we took, the obstacles that we overcome and successes that we achieved.

Even though our project has being finalized, the project partners put great efforts to sustain, share and cascade the good practices, trainings and all virtual learning tools. It is not the end for the project, the project is being born today will be grown when it was used and shared.



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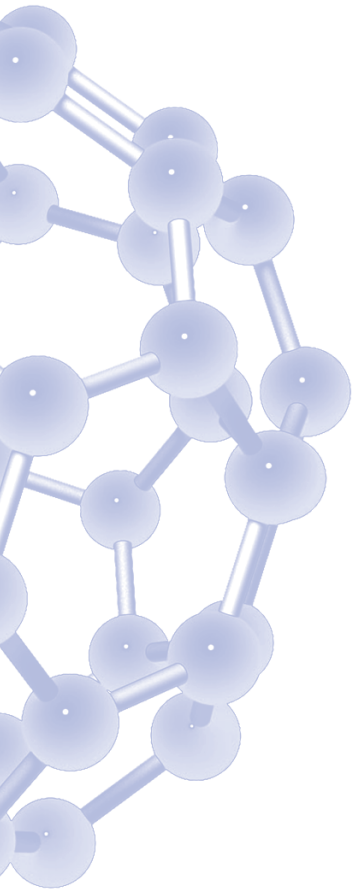

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