ORIGINAL PAPER

DIGITAL RESOURCES DESIGNED FOR INCREASING THE ROMANIAN STUDENTS' INTEREST FOR NANOSCIENCE AND NANOTECHNOLOGY

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Abstract. *In this so-called Age of Knowledge, we should help the students, learners and productive members of the society to be informed on the latest news that appear in various fields. The practical experience proved that giving to the students such examples of how to use the new technologies and advanced materials in their daily life, we can convince them to valorize the importance of Science lessons in their acquisition of knowledge, and to increase their motivation for learning Science [1, 2]. More than that, from the teaching perspective, the Science lesson, through its particular didactics, represents a powerful facilitator for counseling and vocational guidance. In fact, as a first step, counseling the students in the area of Science, could be a feasible demarche for them, in order to promote a future career in scientific areas.*

Starting from abovementioned aspects, the partnership of the LLP KA3-ICT project no. 511787-LLP-1-2010-1-TR-KA3-KA3MP: "NTSE - Nano-Tech Science Education" designed the NTSE Virtual Laboratory as a main result, containing facilities and educational valences in order to help the teachers in their attempt to provide to young learners the necessary knowledge for helping them to understand the new scientific discoveries and technologies [3]. The Virtual Laboratory resources have been implemented at different students' level: from lower and upper secondary school to university students [4].

The paper includes the results of the case studies developed in several Romanian school settings, and emphasizes on the use of different facilities of NTSE Virtual Laboratory during the practical activities of students, university students (prospective Science teachers) and PhD students, who developed a variety of skills, some of them critical for their further formation/specialization.

Keywords: *nanoscience; career; nanotechnology; virtual resources; virtual laboratory; NTSE project.*

1. INTRODUCTION

The first decade of the 21st century brought a huge number of innovative solutions in the development of new technologies. There is a fierce battle between the manufacturing companies of different hardware and software products in order to obtain the market supremacy. As example, the implementing - in the last years - of nanomaterials and

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nanotechnologies led to more and more powerful products packed in a lower and lower dimension [5]. But for obtaining an efficient use of all those new products, we are forced to learn continuously how to manage and handle them.

It is obvious that the research of nanomaterials and nanotechnologies is a continuous, deep and complicated process which involves - now and in future decades - a huge number of high performance scientists. So, are the educational systems able to train so many scientists, very well prepared and willing to assume this important task for us? How can we increase the students' motivation for Science lessons? Is the *Didactics of Science* a powerful discipline able to raise the students' interest for the scientific fields? It seems that one of the best ways should be to present to students, attractive applications framed in digital formats that exploit the theoretical scientific concepts with implications in students' daily life. But, are our teachers trained and prepared to show and explain to students, the theoretical background, together with actual examples or new discoveries / modern technologies, providing so suitable connections with the current topics covered by the Science curriculum?

The answers to such questions are important, mostly taking into account that in Science disciplines, students are first exposed to a number of unusual terms they do not have their own motivation or life experience with, and the school often does not give to them the possibility to absorb the idea of the theory at all [6].

Trying to offer answers to abovementioned questions, Valahia University Targoviste, decided to participate together with other five institutions from five countries (*Private Doga Education Institutions, Turkey* - coordinator, *Fondazione Idis-Citta della Scienza, Naples, Italy, Sirma Media AD, Bulgaria, Foundation for Research and Technology-Hellas, Greece, Center for Creative Training Association, Sofia, Bulgaria*) to the project LLP KA3-ICT project no. 511787-LLP-1-2010-1-TR-KA3-KA3MP: "*NTSE - Nano-Tech Science Education*" (http://www.ntse-nanotech.eu/), implemented in the period 2011-2013, that aimed *to use ICTs as a tool to make the learning of Science topics more attractive and accessible for students*, mainly engaging in activities students from secondary education - between 13 and 18 years old.

2. THE NTSE VIRTUAL LABORATORY

Since actually the educational technological resources - like virtual instruments - come to help teachers and learners to introduce different theoretical concepts, in order to develop students' scientific knowledge and to practice different experiments without risks, the virtual laboratories developed in different scientific domains may support students to make connections between the theoretical background and practical issues, by using computers and specific software applications equipped with simulation capacities, as those met in real laboratories. In this sense, virtual laboratories offer a series of educational features, most of them producing knowledge building, modeling the reality, developing exploration skills and appealing students' creativity and imagination. Based on those aspects, a *Virtual Laboratory* has been set up as a main outcome in the frame of the NTSE project. The *NTSE Virtual Laboratory* (http://vlab.ntse-nanotech.eu/) was established to serve as a hub for science-learning including recorded appealing experiments, illustrated simulations and guidelines on Nanotechnology and Science education. As the main deliverable of the NTSE project, the Virtual Laboratory was designed as a platform for Science lessons, as a database of teaching materials and as a hub for Science-learning graphical aids, recorded and illustrated appealing experiments on Nano-Tech. Students and teachers can still use and refine the Virtual Lab, for lessons and sharing information, even the NTSE project finished since December 2013.

The *Virtual Laboratory* was designed to comprise several 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 [3].

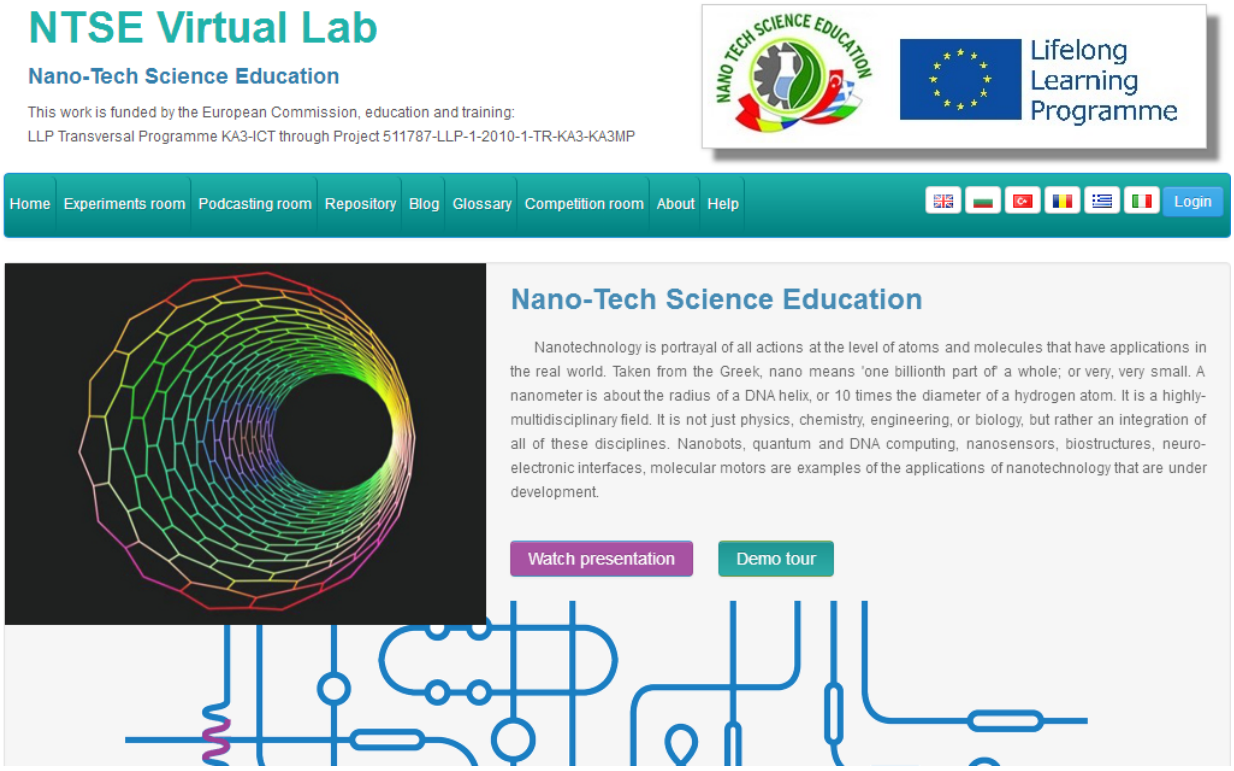

Figure 1. The main window of the NTSE Virtual Laboratory.

The *Home* section contain a short description with pictures regarding what *Nanotechnology* represents at this moment, together with a *PREZI* instrument. The *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 described experiment. The web page devoted to each experiment contains name and description of the experiment, a movie section, an area dedicated to interactions/simulations, several helpful documents (like student's guides, teacher's guides, assessment grids and procedures), links to the repository concerning the topic of the experiment, a section dedicated to other links and documents useful for the illustrated experiment and also a feedback section which is a space where each visitor can send his comments or questions.

Another important section of the Virtual Laboratory is the *Podcasting room* that comprises different 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 NTSE *Repository / Database* was developed as extra reading and reference related to Nanoscience and Nanotechnology papers, to be exploited 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.

In the *Blog* section, partners set up a portal system, to enable the implementers to share knowledge about the articles, but also implementations on project related issues. A

discussion space was created in the blog format, being used for making comments and submitting articles.

The *Glossary* section is in fact a vocabulary with definitions of different terms related to "*nano*" area.

The *Competition room* was specially designed to comprise presentations and information about *Nano competitions* organized in the frame of the project. It provided tools for uploading files, containing also gallery of posters developed by students from different countries involved in different stages of the *Nano competitions*.

In the *About* section, the partnership included a short description of the NTSE project.

3. METHODOLOGY

The *Virtual Laboratory* resources were implemented in all partner countries, at different students' level: from lower and upper secondary school to university students and teachers [4]. The Romanian partner developed four *Case Studies* in order to emphasize the use of different facilities of NTSE Virtual Laboratory during the practical activities of: (a) lower secondary school students; (b) upper secondary school students; (c) university students (prospective Science teachers); (d) PhD students.

All the Romanian case studies methodology followed the recommendation of Yin (1994), and had four stages:

- Designing the case study;
- Conducting the proposed activities stipulated in the case study;
- Analyzing the case study evidences;
- Drawing the conclusions, recommendations and implications.

Two of the case studies were developed during the implementation of two experiments described in the *Virtual Lab*, at the level of lower and upper secondary school students:

- *Nanotechnology and Nanobiomimicry* (*Lotus Effect* Experiment);
- *Allotropes of Carbon. Are there any Buckyballs?* (*Buckyball* Hands-on Demonstration).

The case study developed on the *Nanotechnology and Nanobiomimicry* was developed for the 11^{th} grade students. It sought to develop the knowledge, skills and attitudes of involved students, so that they can participate effectively in discussions on topical issues. It stressed the direct exchanges of ideas and experience, for students participated in the project, to take a clearer picture of the investigative approach in action. In this respect, the objectives are the following: (a) increasing the students' interest towards civic issues as well as to the scientific findings; (b) training the young people to express their views on various Science issues; (c) acquiring (by students) of investigative capacities and skills; (d) stimulating students' desire to deepen the understanding of the current problems of the actual society; (e) increasing the students' confidence and their self-esteem to be involved in the scientific discussions, on issues which can be found in ordinary and specialized newspapers.

The lesson activities allowed students to learn about the defined characteristics of: certain physical systems encountered in the wild; nanotechnology specific phenomena; possibilities of developing practical application related to theoretical knowledge of nanotechnology; determining causal relations; understanding the physical phenomena specific to nanotechnology; 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; explaining advantages and disadvantages of nanotechnology from the environmental perspective.

As procedural resources during the implementing of *Nanotechnology and Nanobiomimicry* in the classroom, teacher used the following methods and processes: SAC Method (Structured Academic Controversy), deliberations, conversation, observation, explanation, exercise, and discussion. The form of the activity organization was in groups and individual. Like material resources teacher used video-projector, flipcharts, media texts, PCs, Internet.

For finalizing the didactic approach, teacher set up a collection of questions. Students from each group had to express their personal opinions, answering to specific questions like: *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 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?*.

A similar case study was developed for the lesson *Allotropes of Carbon. Are there any Buckyballs?* designed for the 8th grade students. The set of the questions posed at the end of activity was the same as those mentioned in the above paragraph.

5. RESULTS AND DISCUSSIONS

Following the participation of the students in both activities (*Nanotechnology and Nanobiomimicry* and *Allotropes of Carbon. Are there any Buckyballs?*), their feedback was collected in relation to the questions mentioned in the above section. The students' answers are illustrated in Figs. 2-6.

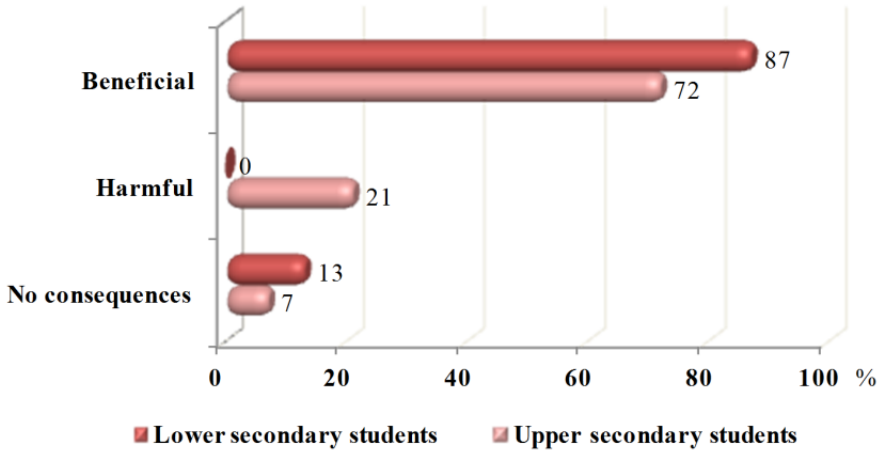

Figure 2. Students' feedback related to the question: "*Which are the consequences of using nanotechnology?*"

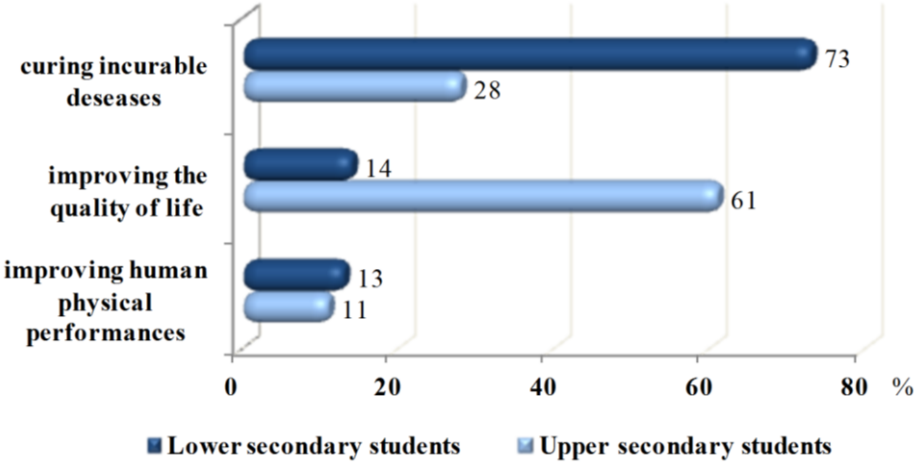

Figure 3. Students' feedback related to the question: "*Which were the most powerful pros arguments?*"

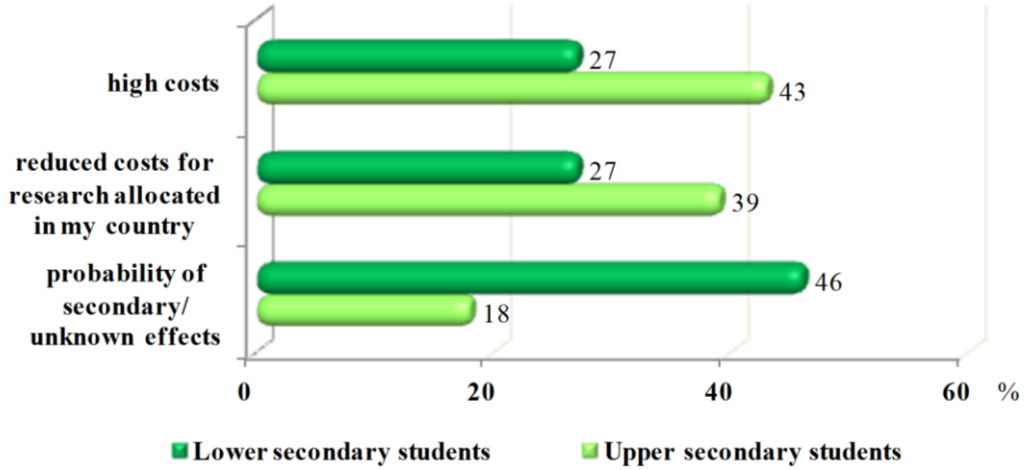

Figure 4. Students' feedback related to the question: "*Which were the most powerful cons arguments?*"

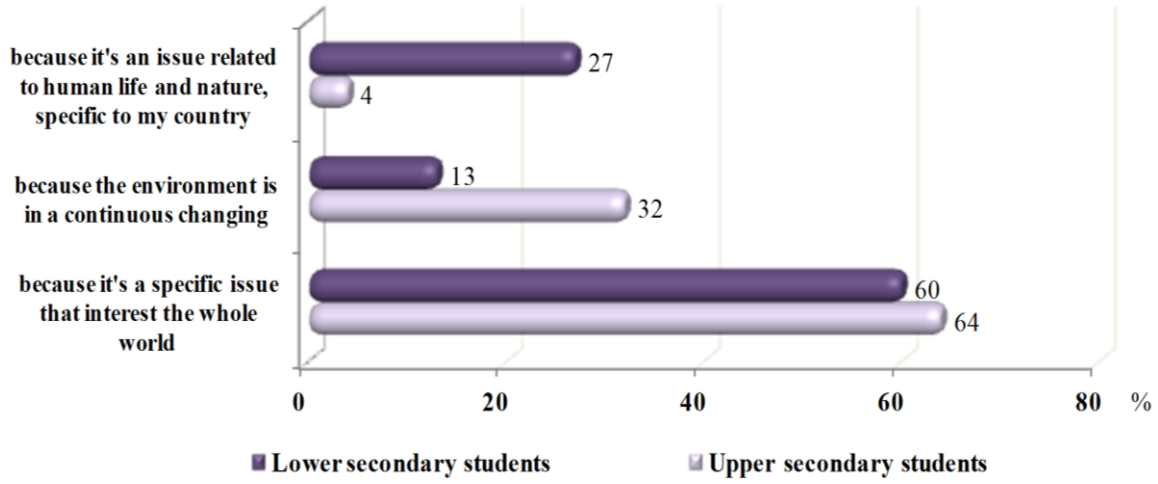

Figure 5. Students' feedback related to the question: "*Why Nanotechnology is important?*"

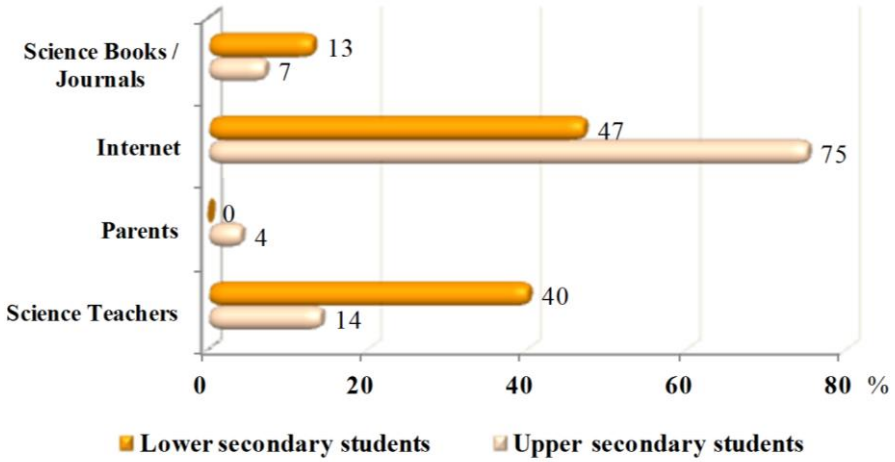

Figure 6. Students' feedback related to the question: "*What are the main sources for getting information about nanotechnology*?"

Analyzing the students' answers, teachers were happy to see that their students identified the fact that nanotechnology has beneficial consequences, but can be also harmful in some cases. This fact shows that students developed critical thinking in relation to this topic. They succeeded to identify the pros and cons arguments for using nanotechnology in their daily life. It was interesting to see that concerning the pros arguments of using nanotechnology, the lower secondary students appreciated more the use of nanotechnology for treating different incurable diseases, while the upper secondary students appreciated more the nanotechnology benefices for increasing the life quality. Another interesting aspect that can be emphasized is the focus of the upper secondary students to the level of costs involved in the processing of nanotechnology products, while the lower secondary students were more careful to the possible secondary or unknown effects that can appear during the production process.

Fig. 5 illustrates that all students identified nanotechnology as an important issue since it is a specific issue that interest the whole mankind. Moreover, the upper secondary students identified that since the environment is in a continuous changing we need nanotechnology to face easier and be prepared to those changes.

Fig. 6 shows that since the lower secondary students get the most information about nanotechnology from the teachers during the Science lessons, the upper secondary students read more information from Internet and complete their knowledge by using the information offered by the teachers with other printed/on-line resources.

6. CONCLUSIONS

During the proposed students' activities, they were asked to effectively participate in all the activity stages, through experimenting, discussing, direct exchanging of ideas and concluding. The students' feedback proves that they developed critical thinking related to the nanotechnology issue and succeeded to discern the pros and cons arguments for using nanotechnology in future.

From the teacher's point of view, the objectives of the activity were achieved, not just taking into account the scientific point of view related to the presence of nanotechnology in

the related activities, but also from the didactical / pedagogical perspective, contributing to the formation of the students, in order to make them to discern and take responsible decisions.

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