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Procedia - Social and Behavioral Sciences 46 (2012) 4174 – 4180

Procedia
Social and Behavioral Sciences

WCES 2012

Teachers' perception related to the promotion of Nanotechnology concepts in Romanian Science Education

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Abstract

During the last years, a big number of researches illustrated a sharp decline in young people's interest for key Science studies. In order to increase the pupils', students' and teachers' interest to Science, Valahia University of Targoviste started to implement with other five institutions from Turkey, Bulgaria, Greece, Italy and Romania, the Project No. 511787-LLP-1-2010-1-TR-KA3-KA3MP entitled "Nano Technology for Science Education (NTSE)". Taking into account the issues proposed by the NTSE Project, the project partnership started to question the different target groups about the level of knowledge, implementation stage and the most effective ways to introduce the nanotechnology concepts during the Science lessons, in secondary education. The paper presents the analysis of teachers' answers related to their knowledge about nanotechnology, their opinions related to the possibility to adapt and implement the information concerning nanotechnologies in the frame of Science lessons, and which are the most effective ways to teach a particular scientific topic in a modern way. In addition, an analysis of the possible ways of using ICT tools for introducing nanotechnology concepts and related experiments to the students, will be also presented.

Keywords: teacher training; nanotechnology; Science education; educational use of ICT; KA3-ICT Project;

1. Introduction

Recent papers presented in different journals and international conferences shows that over the last decade, in many countries, the number of young people who enter in universities is increasing, but most of them are choosing fields other than Science ones. At the same time, the problems concerning our life and the environment where we live in are more and more complex and can be solved on the base of a deep knowledge in Science area.

We are immersed in a deep ocean of new knowledge in many domains, but a high level of scientific researches and discoveries has been developed in areas like Genetics, Biology, Physics or Chemistry. The technology is also developing with huge steps. Due to the big number of innovations brought to the technologies applied in different areas, specific lower and lower devices have been produced. In this way the technology evolves to the nanometric scale, many nanomaterials with vast applications in different areas like medicine, electronics, biomaterials or energy being produced through nanotechnologies (The Royal Society and Royal Academy of Engineering, "Nanoscience and nanotechnologies: opportunities and uncertainties", 2004). Many examples of different nanomaterials and the specific processes through these are produced are coming from the nature. Due to those examples, a huge number of

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doi:10.1016/j.sbspro.2012.06.221

studies have been focused on the development of new nanotechnologies (Treder, & Phoenix, 2006; Phoenix, 2004). In order to develop this kind of studies and researches, a high level of Science knowledge is requested. Consequently, the educational systems from all countries have to prepare policies and medium and long strategies for increasing the pupils' and students' motivation for learning Science and Technology. Ten years ago, the Educational Council of European Union presented to the European Council the report "The concrete future objectives of education and training systems". According to this report, one of the specific directions to be followed by the educational systems of the European countries represents the increasing of recruitments to scientific and technical studies. The report stipulated that, in many countries, the interest in Mathematics and Science studies is falling down or it is not under development as fast as it should. This problem can be emphasized even from the primary or lower secondary schools, when the uptake of Science subjects by pupils is much lower than it was some decades ago. The mentioned situation will have impact in the attitude of young people to those subjects and, later, in the level of their recruitment to research and related professions. In order to increase the young learners' interest for the Science studies, we need to improve the education and training for teachers. At the same time, we have to develop new pedagogical strategies, new teaching and learning methods and interesting and new generation valuable resources, produced by the use of ICT tools (Gorghiu et al., 2011; Gorghiu et al., 2010; Dumitrescu et al., 2009).

Following the European policies and strategies (The Educational Council of European Union Report, 2001) targeting on the increasing of pupils', students' and teachers' interest to Science, Valahia University of Targoviste has been involved in different projects financed by EU through different programmes like Socrates-Erasmus, Socrates-Comenius, Leonardo da Vinci or actual Lifelong Learning Programme. One of those projects is the project no. 511787-LLP-1-2010-1-TR-KA3-KA3MP entitled "Nano-Tech Science Education (NTSE)" (http://www.ntse-nanotech.eu). The NTSE Project is developed in the frame of LLP Transversal Programme KA3-ICT and aims to use ICT as a tool to make the learning of Science subjects more attractive and accessible. The project target groups are students from the general and vocational schools aged 13 to 18; teachers in Science subjects and college & university students attending Science education courses. Mainly, the project will establish a Virtual Lab, as an experimental virtual aid to Science learning. 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.

2. Description of the procedure

The NTSE Project tries to combine in an innovative way the scientific area of nanotechnology with ICT, in order to exploit and implement ICT in Science education and to disseminate good practices, educational content and services. At the same time, the project has in view to raise the students', prospective teachers' and teachers' knowledge, competences and skills which are not so reflected in the actual Science education. It is important to mention that the use of ICT will enhance the application in practice of inquiry-based methods, collaborative work, constructive knowledge acquisition and social learning.

Taking into account the issues proposed by the NTSE Project, the project partnership designed some evaluation questionnaires and started to question the different target groups from each country to the level of knowledge, implementation stage and the most effective ways to introduce the nanotechnology concepts during the Science lessons in secondary education. The questionnaires were aimed to identify the beneficiaries' opinions concerning several aspects of their activity, in order to better define the features of the Virtual Lab that will be developed in the project: scientific contents, educational methodologies and ICT integration in practical activities. Thus, three different questionnaires were applied in each country to three different target groups: students, prospective teachers with advance Sciences knowledge, and in-service Science teachers from lower and upper secondary schools. About 100 persons, framed in the mentioned target groups, have been selected in each country as people representatives of the main beneficiaries of the Virtual Lab, to fill in the questionnaires designed by the partnership. On the base of data analysis and reports prepared by each partner for each target group, a general need analysis study has been realized in the beginning of the project. This analysis helped us to define the pedagogical features required for ICT-

based Science teaching on nanotechnology. On the base of this need analysis study, a detailed concept for the features of Virtual Lab was produced.

In Romania, the questionnaires have been applied to 35 selected students from different Science classes, 31 prospective teachers with advance Sciences knowledge from different Science specializations and 35 in-service Science teachers selected from different lower and upper secondary schools. In the following parts, the paper presents the analysis of in-service teachers' answers related to their knowledge about nanotechnology, their opinions related to the possibility to adapt and implement information concerning nanotechnologies in the frame of Science lessons and which are the most effective ways to teach a particular scientific topic in a modern way. In addition, an analysis of the possible ways of using ICT tools for introducing nanotechnology concepts and related experiments to the students during Science lessons is also presented.

3. Results and discussions

The Questionnaire for in-service teachers about Science/Nanotechnologies teaching was structured in seventeen questions. The first question addressed to the teachers was: *Which kind of topics in science education would you consider to be more appealing for students?* On the base of the teachers' answers, there have been identified the topics presented in figure1.

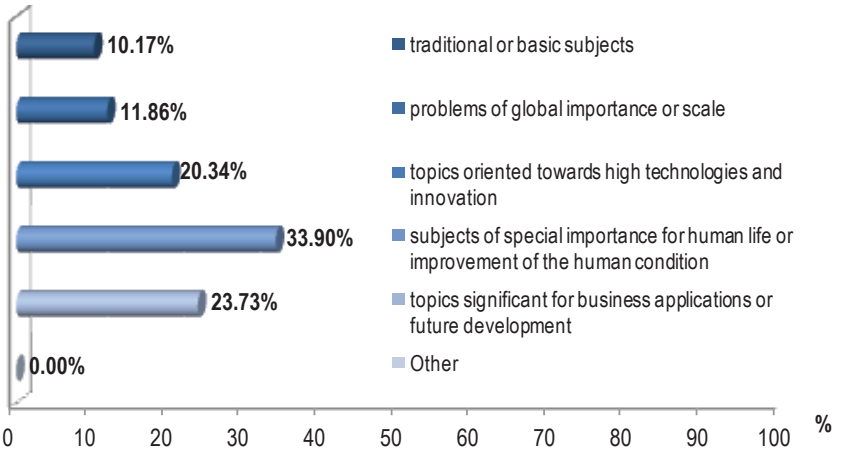

Figure 1. Topics in Science education considered by teachers to be more appealing for students

As can be seen in this figure, 33.90% 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 10.17% of teachers think that traditional / basic subjects are still attractive for students, and 11.86% of teachers emphasize that problems of global importance or scale are also appealing for students.

Another question addressed to the teachers about the Science contents was: *Which of the extracurricular topics should be integrated with Science topics?* Several topics have been presented as possibilities in the questionnaires. Figure 2 illustrates the teachers' opinions about the proposed extracurricular topics. The diagram emphasizes that 74.29% of teachers strongly agree that topics related to *how energy can be saved or used in a more effective way* should be integrated with Science topics; 60.00% of them strongly agree that topics related to *the ozone layer and how it may be affected by humans* should be integrated with Science topics, while only 20.00% of Science teachers strongly agree that *optical instruments and how they work* or *life, death and human soul* should be part of Science topics.

Related to the teachers' knowledge about the nanotechnology, only 77.14% of teachers declared they have a previous knowledge about it, while 22.86% of them recognized that they don't know many things related to this

concept. This emphasizes that, at this moment, a teacher training course - where different nanotechnologies and nanoproducts/devices applications in different areas should be presented - is absolutely necessary.

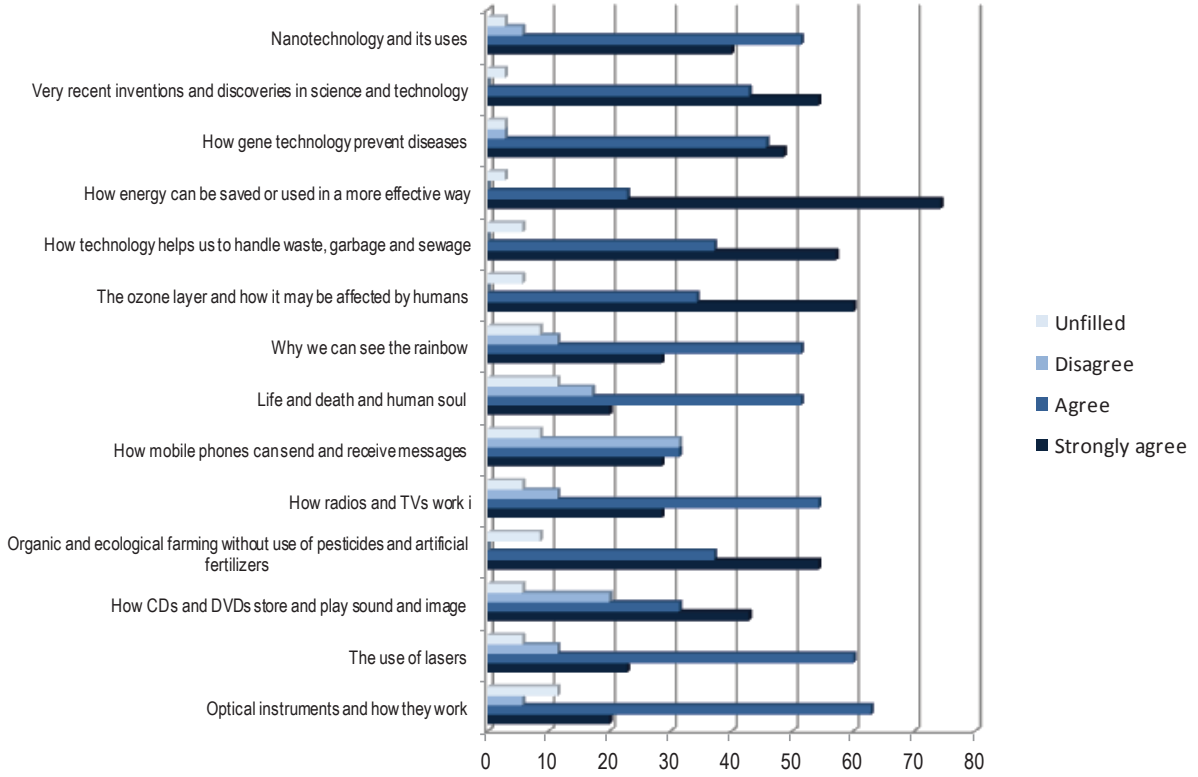

Figure 2. The teachers' opinions related to the extracurricular topics that should be integrated in Science lessons (in percentages)

Concerning the curriculum topics considered by the teachers to be related with Nanotechnology, 68.57% of Science teachers mentioned that *structure of DNA, genetic studies, heredity and how genes influence how we develop reproduction in humans* represent a topic suitable for Nanotechnology curricula. 65.71% of Science teachers mention that *atom, molecules and chemical bonding* can be also a topic suitable for Nanotechnology curricula and only 5.71% of Science teachers mention that *Structure of Earth and how the earthquakes are produced*, represent a topic connected with Nanotechnology.

To the question "*Which Science topics do you think that should be supported with experiments for a meaningful and permanent learning?"*, the analysis of teachers' answers emphasized that about 30.00% of them consider that subjects related to *Properties of Matters* should be supported with experiments for a meaningful and permanent learning. At the same time, 20.00% of teachers consider topics related to *Electricity* should be explained by practical activities while only 3.33% of them consider that subjects related to *Heat and Temperature* should be supported also with experiments.

Concerning to *what other aspects should be involved in Science Education*, 65.71% of Science teachers strongly agree that *making pupils aware of the unlimited aspects of Science* and *being able to demonstrate experiments* are topics needed to be involved in Science education. 62.86% of Science teachers strongly agree that *using Information Technology* is an important topic needed to be involved in Science education, while just 28.57% of Science teachers strongly agree that *offering short reports on modern achievements in Science at the micro- and nano-level to be added to every learning unit* is an important topic needed to be involved in Science education.

Trying to find the most effective ways selected by the teachers in order to teach a particular scientific topic, the obtained data - presented in figure 3 - illustrate that *direct experiments using measuring equipment* have been

selected by 71.43% of Science teachers as an effective way to teach a particular scientific topic. In addition, 62.86% of Science teachers strongly agree that *using interactive computer based tools* represent also an interesting way to teach a scientific topic and just 8.57% of Science teachers strongly agree that *reading text/books* represent a proper way to teach this kind of topics.

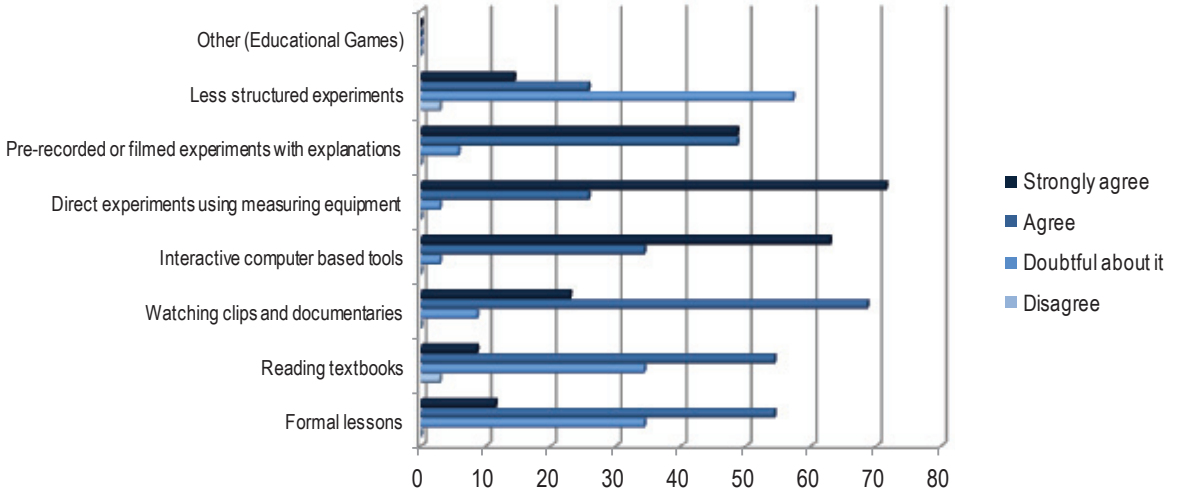

Figure 3. The teachers' opinions related to the most effective ways to teach a particular scientific topic in a modern way (in percentages)

Being interested to find out which are the important tools considered by the teachers to be part of an on-line Virtual Lab, according to figure 4, 68.57% of Science teachers strongly agree that *interactive simulations* are very important tools. At the same time, 62.86% of Science teachers think that *simulations* are also very important tools in an on-line Virtual Lab and just 11.43% of Science teachers consider that the *texts* could be important for an on-line Virtual Lab. These opinions can lead the partnership of the project for choosing different tools that will be included in the NTSE Virtual Lab.

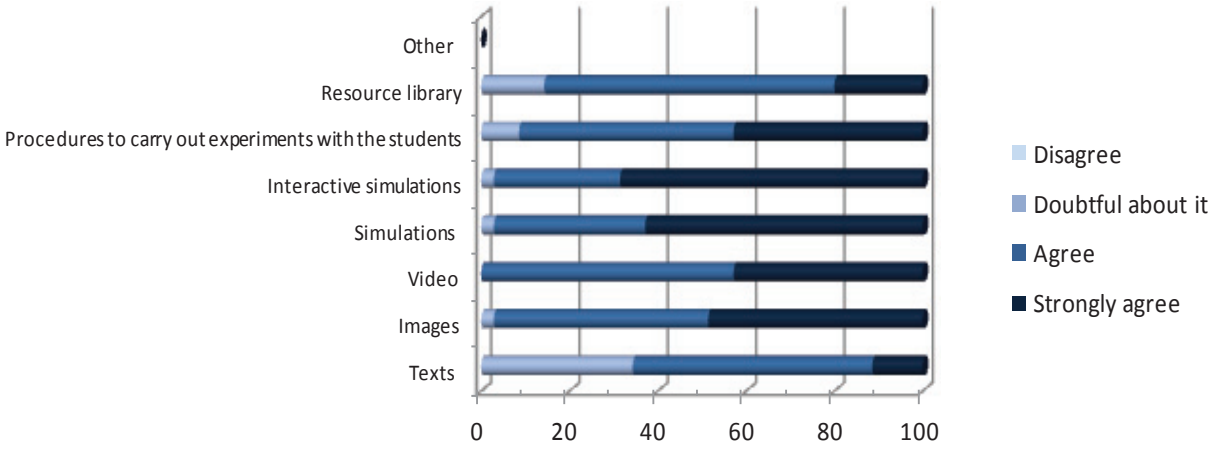

Figure 4. The teachers' opinions related to the most important tools to be part of an on-line Virtual Lab (in percentages)

Trying to obtain information related to which type of Lab approach is considered by the teachers that is better to be developed during the Science lessons, the answers obtained and illustrated in figure 5 emphasize that 40.00% of Science teachers strongly agree with *inquiry-based laboratory activities* (where students decide how to conduct the

activity, and have to explore them in order to figure out how the world works) which represent the best approach for an on-line Virtual Lab. Other 40.00% of Science teachers consider that *cook-book type laboratory activities* (step-by step instructions - to verify scientific facts) represent a proper option for an on-line Virtual Lab. These opinions are related to the students' abilities and skills. In this case, it is the role of the teacher to decide when they can use inquiry-based laboratory activities and when they have to use cook-book type laboratory activities, or how they split the students in groups in order to involve them in different kind of practical activities and approach, to develop the students' interest in Science, to raise their awareness related to the nanotechnology and to enable them to integrate the scientific/technological achievements with everyday lives and problems of global importance.

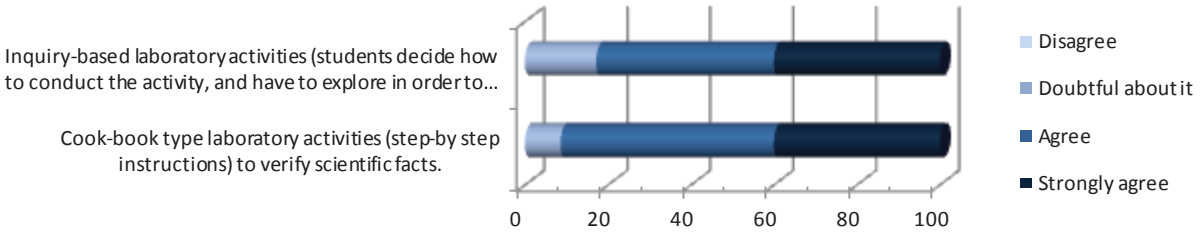

Figure 5. The teachers' opinions related to the most effective type of laboratory activities (in percentages)

Trying to find out different aspects related to the teachers' abilities to use the ICT tools and to manage the teaching Science topics by using ICT tools, the obtained data shown that generally, the results are balanced: 45.71% of Science teachers have a good level, 42.86% of teachers have a medium level while 5.71% of them have - on the one hand - poor expertise and - on the other hand - excellent expertise in managing on using ICT tools for teaching Science topics. In addition, 62.86% of Science teachers declare they implement sometimes ready-made ICT tools for teaching Science topics.

The teachers' answers to the question *"What kind(s) of ICT tools do you use for presenting Science/Nano-Tech experiments in your lessons?"* emphasized (in figure 6) that 40.30% of Science teachers intend to use *Virtual Experiments*, 28.36% of them intend to use *PowerPoint Presentation*, 17.91% intend to use *videoclips* and just 13.43% of the teachers intend to use *digital images* for presenting Nano-Tech experiments in the lessons.

Concerning the teachers' opinions about *how important are ICT tools to the promoting of inquiry based/creative learning about Science/Nano-Tech topics*, the data analysis showed that 62.86% of Science teachers appreciate (in a great extent) that ICT tools represent a channel for guiding students to explain scientific aspects and propose hypothesis for investigation, while 40.00% of Science teachers appreciate (in a great extent) that ICT tools represent a method to enhance creativity in teaching and learning process. In addition, considering the role of ICT tools for teaching Science/Nano-Tech topics, 77.14% of Science teachers appreciate that ICT tools represent a method to make learning content more attractive (by using virtual environments and multimedia tools) while 51.43% of teachers consider that ICT tools represent method to increase students' motivation.

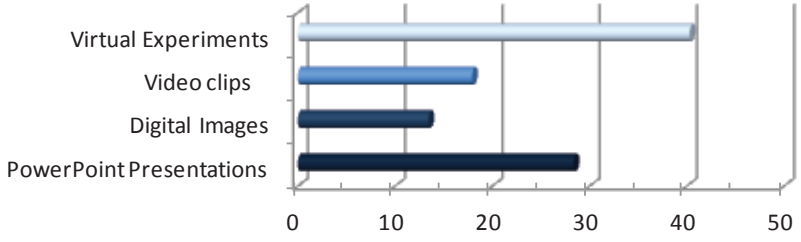

Figure 6. The teachers' answers related to the most effective ICT tools used for presenting experiments in Science lessons (in percentages)

4. Concluding remarks

The results presented above stress the importance of introducing in the national curriculum of different topics related to nanotechnology and nano-products/devices applicability in different areas. The study performed at the level of the Science teachers from Romanian lower and upper-secondary schools emphasized the teacher' needs to be involved in different training courses, where topics related to nanotechnology and its connection with the specific Science learning contexts have to be introduced.

On the other hand, different topics have been identified as possible to be introduced in Science lessons, mainly as extracurricular topics, defining what type of Lab activities are considered by the teachers being proper to be developed in the lessons.

Concerning the most effective ways selected by the teachers in order to teach a particular scientific topic, the results of the study emphasized that direct experiments using measuring equipment and interactive computer based tools represent powerful methods that would be mostly used by them in comparison with the traditional reading text/books method.

Related to the analysis of the possible ways of using ICT tools for introducing nanotechnology concepts and related experiments to the students, the obtained data showed that Virtual experiments, PowerPoint presentations and videoclips can be included in the Virtual Lab, since teachers identified those tools as powerful resources for presenting Nano-tech experiments in the lessons. In addition, the teachers agree that using the ICT tools bring an easier students' understanding, make the learning content more attractive and increase the students' motivation.

Acknowledgements

This work was funded through the of the KA3 ICT Multilateral European project no. 511787-LLP-1-2010-1-TR-KA3-KA3MP: "Nano-Tech Science Education" developed in the frame of Lifelong Learning Programme. The support offered by the European Commission and the Education, Audiovisual and Culture Executive Agency as responsible for the management of EU's programmes in the fields of education, culture and audiovisual, through the project mentioned above, is gratefully acknowledged.

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