Promoting the Nano - Technology Concepts in secondary Science Education Through ICT Tools – the Romanian and Turkish teachers' Perception

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Abstract

The paper presents a study developed in the frame of LLP KA3-ICT project no. 511787-LLP-1-2010-1-TR-KA3-KA3MP: "Nano-Tech Science Education" that aims to use ICTs as a tool to make the learning of science subjects more attractive and accessible. Trying to increase the learners' motivation in science studies (The Educational Council of European Union Report, 2001), teachers and students were asked about how to introduce the new scientific concepts related to nano-materials and nano-technologies in the classroom, to be easy and better understood. The paper includes only the analysis of the science teachers' answers from the Turkish and Romanian secondary education in order to identify the most suitable tools for introducing the nano-materials and nano-technologies in science lessons. Based on their feedback, the partnership decided to set up a specific Nanotech Virtual Lab and use the proper ICT tools during the project.

Keywords: Science education, ICT tools, NTSE project, teachers' feedback, Lifelong Learning Programme;

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1. Introduction

We are living in an era when huge steps are covered in Science and Information Technology areas. A lot of scientists are involved in the effort to discover new materials and compounds with amazing properties, new technologies (The Royal Society and Royal Academy of Engineering Report, 2004) which will make our life easier or new sources of renewable energy, in order to reduce the imbalances that we have produced in the last century. It is obvious that the research of all those aspects is a continuous, deep and complicated process which will involve in future decades a huge number of high performance scientists. Are the educational systems able to form so many scientists, very well trained and willing to assume this important task for us? How can we manage and annihilate the major decrease of students' interest for science areas, registered in the last decades, and reported in many articles from different European countries? How can we increase the students' motivation for science lessons? The best way it would be to show them all the applications of the theoretical scientific concepts in their daily life. But, are our teachers trained and prepared to show and explain all those new discoveries or technologies, and make the suitable connections with the current topics covered by the science curriculum?

Starting from all those questions, the partnership of the LLP KA3-ICT project no. 511787-LLP-1-2010-1-TR-KA3-KA3MP: "NTSE - Nano-Tech Science Education", coordinated by Doga Schools (Turkey) and formed by five institutions from Turkey, Romania, Bulgaria, Greece and Italy, is trying to find and produce some interesting tools to help teachers in their attempt to provide to young learners the necessary knowledge for helping them to understand the new scientific discoveries and technologies. In order to fulfil this goal, the project objectives are focused on searching the most effective ways to introduce the Nanotechnology concepts in science lessons, for secondary education. In this paper, a comparative analysis of the science teachers' answers from the Turkish and Romanian secondary education is presented, in order to identify the most suitable tools for introducing the nano-materials and nano-technologies in science lessons. Their feedback was very important in the setting-up process of the Nanotech Virtual Lab and deciding the most proper ICT tools used in the frame of this Lab.

2. Methods

One of the most important objectives of the NTSE project is to identify the most suitable ICTs tools to make the learning of science subjects more attractive and accessible (Gorghiu & Gorghiu, 2012). The target groups involved in the project included: students from general and vocational schools aged 13 to 18; in-service science teachers; university students attending science education courses (prospective school teachers in sciences).

One of the outputs of the NTSE project is the NTSE Virtual Lab, an on-line educational laboratory that aims to support in their learning or working activities the beneficiaries of the project. In the beginning of the designing process of the NTSE Virtual Lab, a concept paper aimed to describe the general features of the virtual lab was prepared by the partnership. More than its technical issues, this concept paper intended to focus on the educational methodology adopted in the development of the virtual lab. The NTSE partnership took into account that nano-materials and nano-technologies are quite complex topics considering their relationships with many different basic science subjects, therefore they require quite articulate basic science skills. Before designing of NTSE Virtual Lab, the efforts of the NTSE partners were focused on making a systematic analysis of the science curricula (Physics, Chemistry and Biology) in their own countries. By means of this analysis, it has been possible to identify those basic science topics that could represent the previous scientific knowledge necessary to face some "nano" related issues. Besides the analysis of the curricula, with the view to identify the possibilities to increase the interest of young learners about the science topics, another activity developed in the NTSE project was to raise students', prospective teachers' and teachers' reflection, concerning 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. For obtaining their feedback,

the NTSE partnership designed evaluation questionnaires for each of the three different target groups. The questionnaires were applied in each partner country, being aimed to gather the beneficiaries' opinions on three main thematic areas, in order to better define the features the NTSE Virtual Lab: ICT-based, scientific content and educational methodology.

3. Results and Discussions

The analysis developed in the frame of the NTSE project represented a tool for the development of the project, but also an interesting compared study about the needs and the opinions of the main stakeholders of the educational system in different countries. In the following part of the paper, the most relevant issues emerged from the analysis of the Romanian and Turkish science teachers' answers are briefly described. The in-service science teachers target groups that fulfil the questionnaire were formed by 35 persons in Romania and 111 persons in Turkey.

The first part of the teachers' evaluation questionnaire was focused on finding out which kind of topics in science education are considered from the teachers point of view, to be more appealing for students, like 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, or other topics. The comparative opinion of Romanian and Turkish science teachers is emphasized in Figure 1.
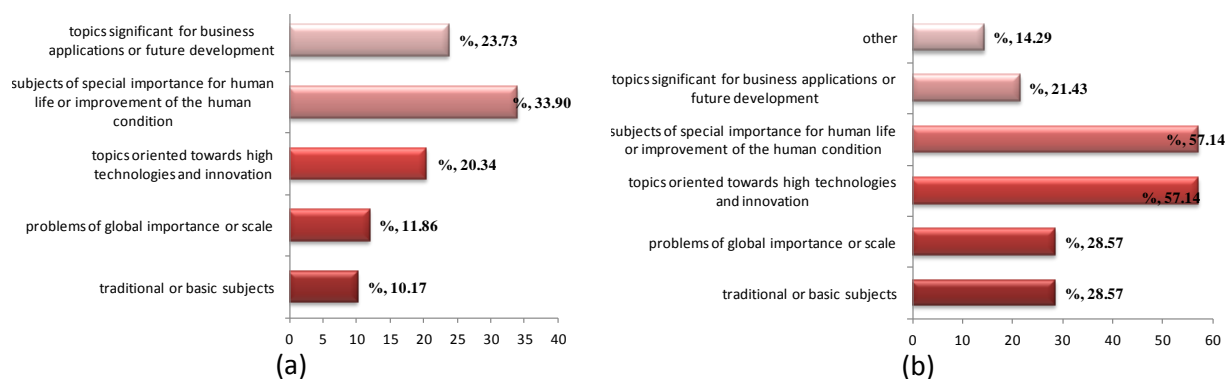

Figure 1. Romanian (a) and Turkish (b) teachers' opinion concerning the topics in science education more appealing for students

Analyzing the data presented in Figure 1, it is obvious that the majority of Romanian and Turkish teachers consider the topics related to the improvement of human life - under the point of both the health and the new technologies in daily life - as the most appealing for the students. However, it is interesting to emphasize that Turkish teachers had a higher appreciation than Romanian ones for topics oriented towards high technologies and innovation. This aspect can lead us to the conclusion that topics related to innovation would be more interesting for them, but also for Turkish students.

Concerning which extracurricular topics should be integrated in science lessons or what kind of extracurricular subjects are considered to be important and/or innovative in teaching science, the Romanian and Turkish science teachers were more articulated. Among them, we can mention environmental topics (organic and ecological farming without the use of pesticides and artificial

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fertilizers, energy saving, ozone layer, how technology helps us to handle waste, garbage and sewage), human health related topics (how gene technology prevent diseases), new technologies (how mobile phones can send and receive messages, nano-technology and its uses) and so on.

Asking the teachers if they have any knowledge about nanotechnology, the answers were also different for the Romanian and Turkish target groups. Thus, since only 77.14% of Romanian teachers declared that they have knowledge about nano-technology, all the Turkish teachers have expressed that they know that nano-technology is related mostly with: chemicals, their properties and how they react; parts of human body and how the systems work; structure of DNA, genetic studies, heredity and how genes influence how we develop reproduction in humans; how plants and animals grow and reproduce; atom, molecules and chemical bonding; the structure of cell, mitosis and meiosis etc.

Trying 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, the NTSE partners offered to teachers 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. Figure 2 illustrates the teachers' opinion concerning the effective ways to introduce different Science and Nanotechnology topics in actual education. A more careful analysis of the results presented in this figure, proved that both Romanian and Turkish target groups highly appreciated: the use of interactive computer based tools, watching clips and documentaries, direct experiments using measuring equipment or pre-recorded or filmed experiments with explanations.
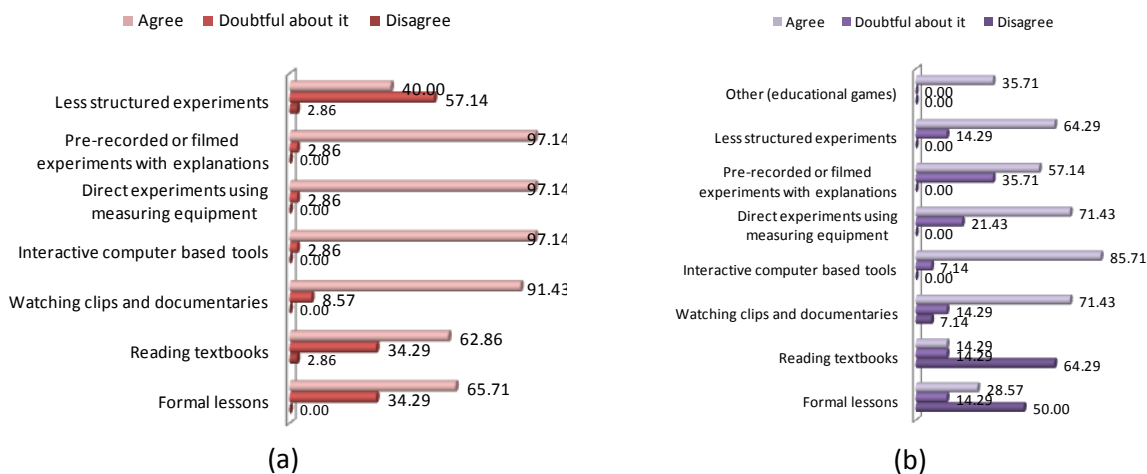

(a)   (b)

Figure 2. Romanian (a) and Turkish (b) teachers' opinion concerning the effective ways to introduce specific topics during the science lessons (in percentages)

However, the target groups from both countries have different opinion about using less structured experiments, reading textbooks and formal lessons. While Romanian teachers agreed that formal lessons and reading texts can be ways to introduce different concepts and phenomena during the science lessons, the Turkish teachers are against to use those kinds of methods and appreciate that the less structured experiments and educational games can be more effective ways for a meaningful and permanent learning. Ways like study visits to laboratories and institutions which implement scientific experiments, hands-on activities, educational games and inside and outside classroom activities, collaborative students' group-work, were also additionally mentioned by Turkish teachers.

Asking the teachers which are the important tools for an online virtual lab (Figure 3), most of the teachers appreciated that videos, simulations, interactive simulations, procedures to carry out

experiments and images are very important tools. Due to the fact that resource library and texts were also mentioned in different percentages by both target groups, the NTSE partnership decided to include also a repository inside the virtual lab. In addition, some of the Turkish teachers mentioned that for the blind students who have auditory intelligence, the directions of the virtual lab should be audible.
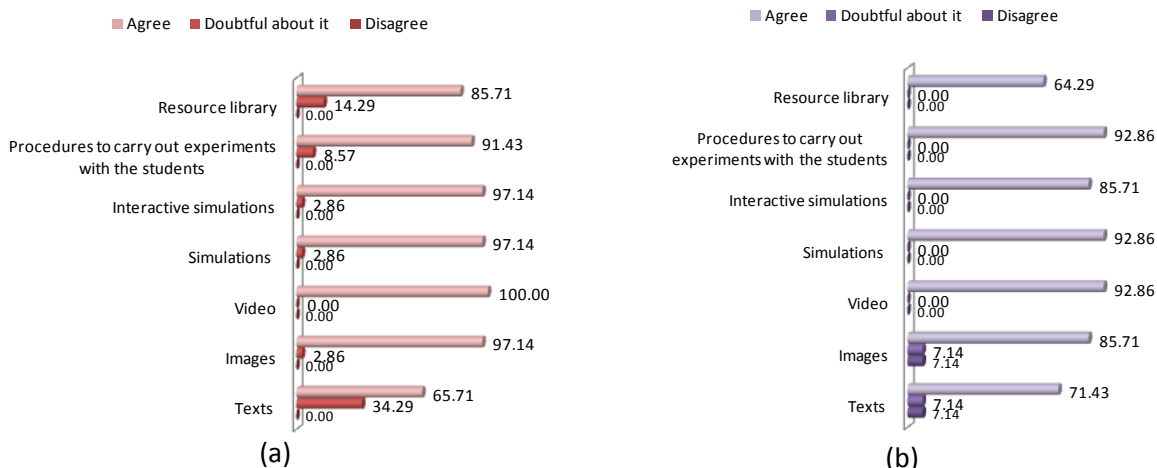

Figure 3. Romanian (a) and Turkish (b) teachers' opinion concerning the important tools for an on-line virtual lab (in percentages)

Trying to identify which are the specific tools that teachers would like to use in the on-line virtual lab in order to discover and learn aspects related to science topics, a specific question was introduced in the questionnaire. Figure 4 shows the teachers' opinion from both countries.
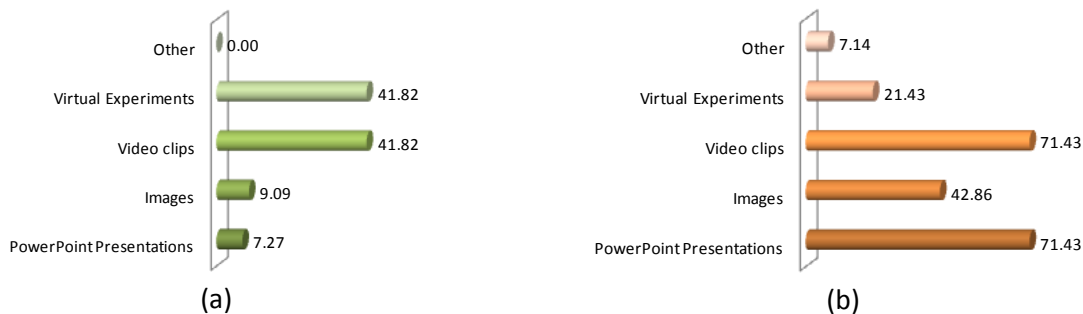

Figure 4. Romanian (a) and Turkish (b) teachers' opinion concerning the tools that they would like to use in the on-line virtual lab (in percentages)

As Figure 4 illustrates, while most of the Turkish teachers prefer to use more PowerPoint Presentations and video clips for presenting Science/Nano-Tech experiments in their lessons, the Romanian teachers appreciate more the virtual experiments and video clips than images and PowerPoint Presentations.

Trying to find out the level of teachers' skills to use ICT tools, a special question like "*How well are you able to manage with using ICT tools for teaching Science topics?*" was included into the questionnaire. The teachers' answers (illustrated in Figure 5) proved that both Romanian and Turkish teachers are able to manage different ICT tools, but the Turkish teachers are more confident in their skills.
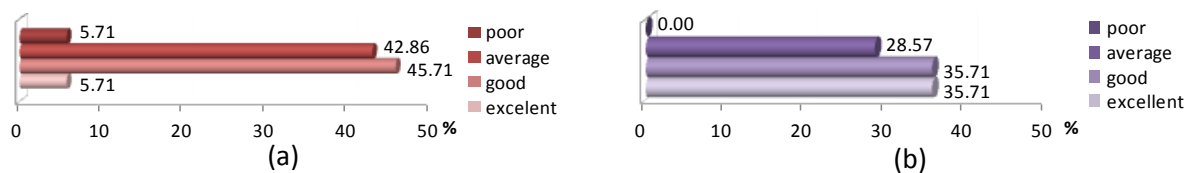
Figure 5. Romanian (a) and Turkish (b) teachers' answers concerning their ability to manage the ICT tools for teaching Science topics (in percentages)

4. Conclusions

Based on the Romanian and Turkish science teachers' opinions presented above, the NTSE partnership identified the most suitable topics in science education that are considered from the teachers point of view, to be more appealing for students, which other extracurricular topics should be integrated with science lessons and what kind of extracurricular subjects are considered to be important and/or innovative in teaching science. In addition, the analysis of teachers' answers emphasized to NTSE partners which are the most suitable pedagogical strategies and teaching methods to be used during science lessons. They highly appreciated the use of ICT tools during the introduction of problematic topics related to nano-materials and nano-technologies in science lessons, having in view the impossibility to develop real experiments that can emphasize the processes that take place on such low level of matter dimensions.

The assessment of Romanian and Turkish science teachers emphasized that most of the teachers consider collaboration using ICT for teaching Science/Nano-Tech topics as a method to increase students' motivation, a method to make learning content more attractive (by using virtual environments and multimedia tools), a way to make students more emotional (by connecting them) and a method to promote creativity based on collaborative work.

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