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Related Aspects on Using Digital Tools in the Process of Introducing Nanotechnology in Science Lessons

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It is known that in the last decade, a sharp decrease of students' interest and motivation for learning science was registered. Taking this fact into account, new ways for raising the students' interest and motivation should be promoted, mostly based on using digital tools in the teaching/learning process. In this sense, if we are thinking that nanoscience and nanotechnology are new areas of science which come with a lot of interesting applications in different areas, the topics related to the nanoscience and nanotechnology introduced in the science lessons — at the students' knowledge level — can lead to the effective raise of students' interest for science. Starting from those premises, Valahia University Targoviste participates as partner with other five institutions from Turkey, Bulgaria, Greece, and Italy to the LLP KA3-ICT project no. 511787-LLP-1-2010-1-TR-KA3-KA3MP: "Nano-Tech Science Education" oriented on searching the most effective ways to introduce the nanotechnology concepts in science lessons, in the secondary education. In this respect, this paper presents a study based on the data collected from different target groups of the project, with the view to identify the suitable features for setting up a specific NanoTech Virtual Lab.

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1. Introduction

Many studies published in the last decades in the scientific literacy emphasize the sharp decrease of students' interest and motivation to learn science. Most of them presented this fact with the lack of connection between the scientific content introduced in the science lessons and related applications in practice. Due to this fact, the students cannot understand the meaning of science and its application in all areas of our daily life. One potential action that can be developed for attracting the student to learn science will be the presentation of the recent innovations and discoveries in science and technology that will clearly emphasize the connection of theory and practice. In addition, other several studies proved the high students' interest for the use of digital tools in the learning process [1].

As examples, there can be listed useful and easy digital tools for creating mathematics and science virtual experiments, with an important impact on the teaching process, at different levels of education [2]: GeoGebra — a dynamic mathematics software that joins arithmetic, geometry, algebra, and calculus [3]; Cabri Geometry — an educational software which supports the development of a dynamic, investigative and exploratory approach to the teaching and learning of geometry [4]; or LabVIEW — a tool for developing interactive applications as simulated experiments, from very simple ones (like phenomena demonstration) to advanced experiments based on electronic instrumentation [5].

Having just those digital tools as suitable examples designed for mathematics and science classes, it is evident that the introduction of information and communication technology (ICT) in education led to improved learning results changes in practices, with a positive effect on learning [6]. In this respect, ICT represents a proper channel to be used for developing knowledge acquisition, to change structures of classroom activities, to increase students' control over their own learning, and to enhance motivation in science classes.

If digital tools are fully exploited, they can offer innovation in teaching and also ways to increase the attractiveness of learning. It was clearly demonstrated that ICT facilitates wider access to innovative resources, regardless of geographical or socio-economic barriers. In fact, ICT represents the core of a new paradigm of borderless education which is proposed to be implemented with the view of providing innovative ideas and even possibilities for reforming education in different parts of the world [7].

2. Nanoscience in partner countries

One of the first activities that took place in the "Nano-Tech Science Education" project was to develop a need analysis study for defining the pedagogical features required to the ICT-based science teaching on nanotechnology, for different target groups. In order to develop the required analysis, the educational settings for a generic document (called Concept Paper) have been established by organizing meetings and workshops with the involved

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target groups where different questionnaires have been applied.

Taking into account that nanoscience and nanotechnology are complex topics, the partnership of the project tried to fit those ones with other basic science subjects presented in the curricula of the partner countries. Thus, a systematic analysis of science curricula (physics, chemistry, biology) for lower and upper secondary school has been performed by all the partners. This study emphasized the basic science topics that assure the proper scientific knowledge necessary to understand the *nano* related issues.

Table presents some nano topics identified to be related with general scientific subjects existing in the curricula of partner countries.

TABLE

Basic science topics which exist in the curricula of NTSE partner countries and different related nano topics.

Basic science topics	Nanoscience/ nanotechnology topics
basic skills, the nature of physics	size and scale
heat, temperature, and phase changes	preparation of a cholesterol ester liquid crystal thermometer
properties of matter	lotus effect activity
waves and sounds	NiTi shape memory alloy springs
electrostatic, electric current and effects of electricity	periodic properties and light emitting diodes
enlightenment	preparation of an organic light emitting diode
general and organic chemistry	X-ray diffraction and scanning probe microscopy, citrate synthesis of gold nanoparticles
general chemistry, mineralogy	amorphous metal activity
botany and zoology	nanowire sensor slides
genetics	DNA optical transform kit, DNA barcode slides

Beside the analysis of curricula and the identification of possible nano topics for being introduced in science lessons, the project partners designed specific evaluation questionnaires for three different target groups, each of them being composed of distinguish personnel: (a) students, (b) prospective teachers with advanced science knowledge, (c) in-service teachers from lower and upper secondary education. The purpose of the questionnaires was 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 questions presented in the questionnaires were oriented on three thematic areas: (a) scientific contents, (b) educational methodology, (c) ICT tools for teaching science. Based on the answers collected from the respondents, the partnership could better define the features of the virtual lab that has to be developed in the NTSE project.

The questionnaires have been designed in English and translated in all the partners' national languages, in order to be applied in each partner country.

3. Results and discussions

The results of those questionnaires lead to an interesting comparative study about the needs and the opinions of the main stakeholders of the educational system of the partner countries [8]. Figure 1 illustrates the distribution of the interviewers from all the target groups, as it was recorded in Romania.

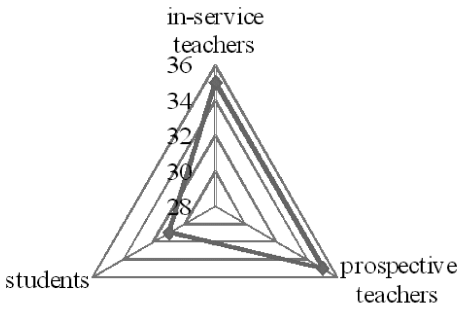

Fig. 1. Repartition of the interviewers along the proposed Romanian target groups.

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 in 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.

Figure 2 illustrates the teachers' suggestions related to which kinds of topics in science education are considered to be more appealing for students.

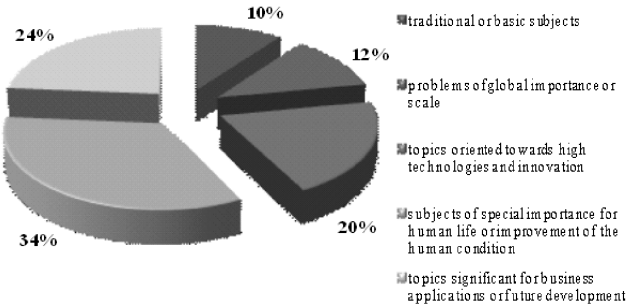

Fig. 2. Science education topics identified by the Romanian in-service teachers to be appealing for students.

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%) as topics that should be integrated in the science lessons, the most interesting subjects from the students' perspective were: "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' expectations. This can be considered as an aspect which possibly explains the decrease 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 clearly during the science lessons.

The analysis of the answers provided by the interviewers from all the three target groups helps 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. As a result of the analysis, the project partnership established to introduce in NTSE virtual lab video clips and interactive simulations that show/simulate real experiments which will be introduced in the science lessons, being connected with nanoscience or nanotechnology topics.

In addition, as illustrated in Figs. 3 and 4, a lack of knowledge related to the nano topics has been identified to the level of in-service and prospective teachers.

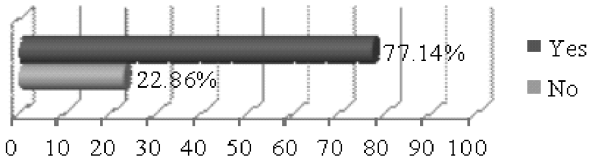

Fig. 3. In-service teachers' level of knowledge related to nanotechnology.

Due to the reason that 23.86% of in-service teachers do not have knowledge about nanotechnology, 29.03% of prospective teachers know only what nanotechnology is, but do not have any further knowledge and other 19.35% have just heard about nanotechnology, the NTSE partnership decided that a resource library (NTSE 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 repository are completed with other multimedia products useful not only

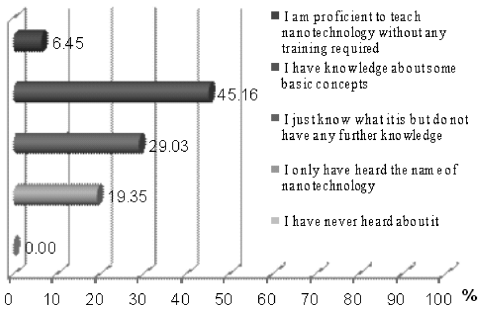

Fig. 4. Prospective teachers' level of knowledge related to nanotechnology.

for the teachers and prospective teachers, but also for 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 the broadcasting of photos from various conferences, seminars, 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 Fig. 5 shows — the students enjoy to use e-platforms dedicated for this purpose. This lead the project partnership to the idea of creating of a blog where different articles related to nanotechnology are about to be introduced and group discussions are undertaken between the members of all target groups.

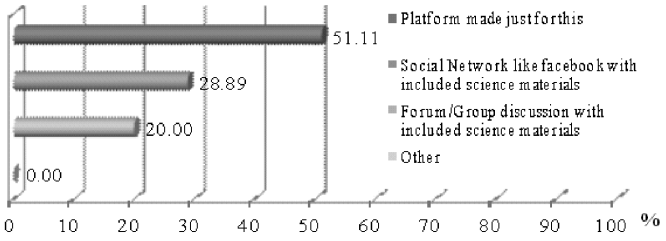

Fig. 5. Specific IT environments preferred by students to be used for introducing nanotechnology topics.

At present, the NTSE project partners are in the process of finalizing the virtual lab dedicated to illustrate specific science and nanotechnology topics. More, a program for one week science camp training, including hands-on experiments and demonstrations, will be developed and delivered through the virtual lab, during the last year of the project.

4. Conclusions

Trying to analyze the interviewers' opinions related to which are the most appealing topics for students during the science lessons, the data analysis proved that Romanian in-service teachers identified between their students' preferences, topics with special importance for human life

or for improving the human conditions, topics significant for business applications or future development, and topics oriented towards high technologies and innovation. In addition, analyzing the proposals of extracurricular subjects that can be introduced during the science lessons, it was identified the existence of a gap between the teachers ideas about what have to be taught and the students' expectations. This aspect can explain the decrease of the students' interest to science lessons.

The data collected from the interviewers' answers have been used by the project partnership not only to identify the lack of knowledge related to nanotechnology, but also to define and design the most suitable features of the virtual lab developed in the frame of NTSE project. Most of the used features include digital tools in order to enhance the students' motivation, their learning skills, the collaborative work and the constructive knowledge acquisition.

From all types of ICT tools that can be used for teaching science and nanotechnology concepts, the analysis performed in the frame of NTSE project, led to conclusion that virtual experiments, interactive simulations and educational video clips are powerful resources for presenting nano-tech experiments and should be included in the virtual lab [1]. On the one hand, those resources can raise the students' interest and motivation to study science in general, and nanotechnology in particular. On the other hand, they enhance creativity in teaching and learning process, considering the importance of ICT tools for promoting of inquiry based/creative learning in strong relation to science/nano-tech topics.

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