Teachers' and Students' Feedback Concerning the Use of ICT Tools in Learning Science through Nanotechnology

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Abstract: - In the last decades many researches underlined the alarming decline in young people's interest for key Mathematics and Science studies. In this respect, several efforts are still to be made for attracting the students to learn Science and to be interested by the recent innovations and discoveries in Science and Technology. As part of Science education, learning Nano-science and Nanotechnology by the use of ICT could be a solution for motivating the students due to the wide possibilities for presenting related Science/Technology concepts in multimedia formats. In this sense, the objectives of the LLP KA3-ICT project no. 511787-LLP-1-2010-1-TR-KA3-KA3MP: "*Nano-Tech Science Education*" are oriented on searching the most effective ways to introduce the Nanotechnology concepts in Science lessons, in secondary education. The paper illustrates an analysis on the particular data collected from different target groups with the view to identify the most suitable instruments for setting up a specific *NanoTech Virtual Lab*.

Key-Words: - Science education, ICT tools, NTSE Project, teachers' feedback, students' feedback, Lifelong Learning Programme

1 Introduction

In the recent past years, many studies were elaborated related to the participation of young people in Mathematics and Science studies. Raising a warning - in a very serious way -, almost all of them emphasized on the alarming decline in young people's interest for key Mathematics and Science studies. At the same time, despite of many implemented projects that aimed to reverse the mentioned 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 [1]. But, without any doubts, as the actual society is dependent on the use of knowledge, the acquisition of skills is crucial in all walks of life.

In education, a series of researches illustrated different ways in which the Science concepts are promoted and experimented [2]. As example, even the laboratory work is generally considered as the most common activity, students found science boring - largely because -, although they prefer to work in groups [3], they mostly follow the *whole-class teaching* model. It is noticed that for a productive group work, it is not always needed to involve equipment, but engaging students in considering alternative ways of explaining events, planning investigations, or working out how to interpret data from others' experiments is very important [4].

In addition, using technology in Science and Mathematics class may promote learning activities in which students can work in small groups rather than in a whole class demonstration. But the technologies used in the classroom are not those designed explicitly to teach basic skills, but rather are real-world applications that support research, design, analysis, composition, and communication [5].

During the past years it was continuously observed that the introduction of Information and Communication Technology in Education led to improved learning results changes in practices, with a positive effect on learning [6]. In this respect, ICT is 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 ICT is fully exploited, it 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

socioeconomic barriers. Not the least - innovative science education requires motivated, skilled teachers, capable of exploiting ICT creatively to enhance the acquisition of competencies, skills and knowledge required for life in the 21st century. However, even with the help of ICT tools, most of the teachers - as is happened in eastern European countries, and not only - are still emphasizing on Science facts and concepts, rather than critical thinking and problem solving.

Anyway, with the effective help of ICT tools, various pedagogical methods were proposed for Science education, with the view to promote active learning, increase students' motivation, improve their communication and collaboration. In this respect, at the European level, several projects were implemented - under the former Socrates (and actual Lifelong Learning Programme) - which pointed to the educational use of ICT in Science education [7].

2 The NTSE Project

Learning Science through Nanotechnology (and by the use of ICT) is a new concept. It is known that *nano* is effectively only a unit of measure, but *Nano-science* occurs across a wide range of disciplines (Physics, Chemistry, Biology, Materials science) and *Nanotechnology* is applicable across a wide range of sectors (energy, transport, medicine, textiles, communications). Despite this diversity, the reason for delineating *Nanoscale sciences* and technologies as something distinct is that at the *nanoscale*, objects can express different properties from those observed for the same material at larger scales [8]. ICT support *Nanotech education* in the countries leading in nanotechnology. In this respect, in USA, it was designed an educational portal containing specific information, training courses, seminars or presentations that can be accessed on-line [9]. In Europe, the *Nanoforum* website provides access to recent publications, lectures, training materials, list of academic centers on nanotechnology [10].

Having in view the above mentioned facts, the project entitled "*Nano-Tech Science Education*" (started in January 2011) gathers 6 institutions from 5 countries (*Private Doga Education Institutions*, Turkey; *Valahia University Targoviste*, Romania; *Center for Creative Training Association, Sofia*, Bulgaria; *Sirma Media AD*, Bulgaria; *Foundation for Research and Technology-Hellas*, Greece; *Fondazione Idis-Citta della Scienza, Naples*, Italy) and aims to use ICTs as a tool to make the learning of Science subjects more attractive and accessible. It is addressed especially to students from the general and vocational schools, university students who attend Science education courses, pre-service and in-service Science teachers.

The project tries to establish a special *virtual space* which serves as a web-platform for Science lessons, equipped with a multimedia database of teaching materials - especially experiments related to Nanotechnology.

The project seeks to integrate well established but currently independent technological developments, within creative and motivating teaching materials and virtual learning spaces. This comes in order to use the added value that emerges for different target groups: in-service and pre-service Science teachers, university students, secondary students. Specifically, the project is aimed to create a user-friendly virtual learning area that may raise interest in learning Sciences (in general) and Nanotechnologies (in particular).

The main project objectives are oriented on [11]:

(a) to encourage students to learn about Sciences / Nanotechnologies and to be engaged in explorative and amusing Science learning through experiments and activities. By using various resources and proactive methods, students' curiosity is entertained, their knowledge about Science / Nanotechnologies deepened and their imagination stimulated by digital materials for personal online-learning. They are encouraged to connect their learning to the nature and real life, which help them to learn faster and more effectively. Via the design of materials, books and multimedia channels, they start promoting Nanotechnologies; they make Science education more appealing and motivating.

(b) to make Science teachers (in general), but also vocational education more enthusiastic and capable of using ICT in the ordinary classes. In this way, the teachers are encouraged for raising their creativity and using the innovative cognitive tools in order to propose Science classes more enjoyable for the young learners.

(c) to encourage the university students (future Science teachers) to promote the Science knowledge with the support of ICT and to enrich the enthusiasm for learning Science together with their future young learners.

Of course, ICT really helps the educational approach, but - in particular -, in order to prepare students to solve *Nanotechnological challenges*, the education in this area should be incorporated into the mainstream undergraduate science curriculum by [12]:

(a) integrating nanotechnology within traditional and modern science courses;

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(b) developing new multidisciplinary courses that complement the traditional ones;

(c) equipping the laboratories with the necessary infrastructure and advanced facilities for supporting learning;

(d) developing interdisciplinary research opportunities and educational collaborations;

(e) disseminating the best practices.

The key points (a), (d) and (e) - mentioned above - are clearly targeted in the NTSE project whose intended impact will be a new model that integrates the knowledge about Nanotechnology through ICT, into the mainstream curricula of Science.

3 Results and Discussions

In order to fulfill the main objectives of the NTSE project, one of the first activities that took place 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. Thus, the partnership of the project designed an evaluation questionnaire for three different target groups formed by students, prospective teachers with advanced Science knowledge and in-service teachers from lower and upper secondary education. The questionnaires have been applied in each partner country. Figure 1 illustrates the distribution of the interviewees from all the target groups, as it was recorded in Romania.

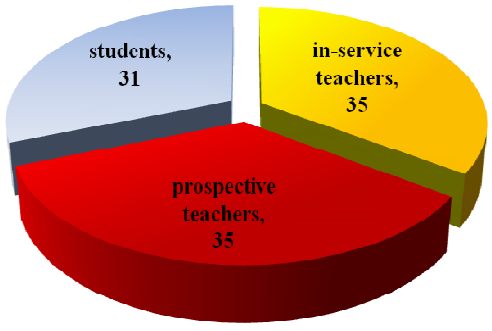

Fig. 1 Repartition of the interviewees people in the three Romanian target groups

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 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. In this way, while 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. Figures 2 and 3 illustrate the in-service and prospective teachers' ideas related to the effective ways to introduce different Science and Nanotechnology topics in actual education.

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

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are capable to identify and appreciate the advantages of those new teaching methods developed in the last period.

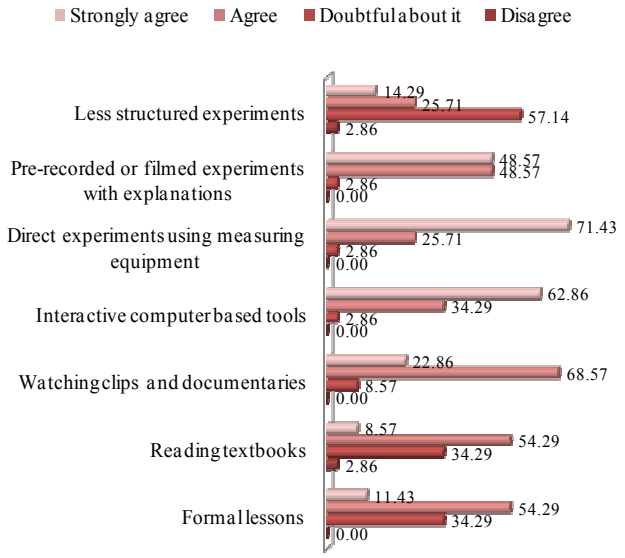

Fig. 2 In-service teachers' perspective concerning the effective ways to introduce specific topics during the Science lessons

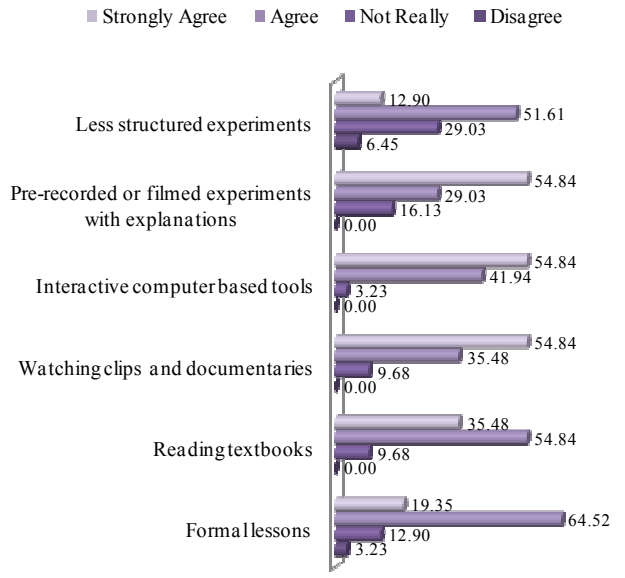

Fig. 3 Prospective teachers' perspective concerning the effective ways to introduce specific topics during the Science lessons

At the same time, the students' opinions related to the good ways to learn more about Science and Technology are shown in Figure 4 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.

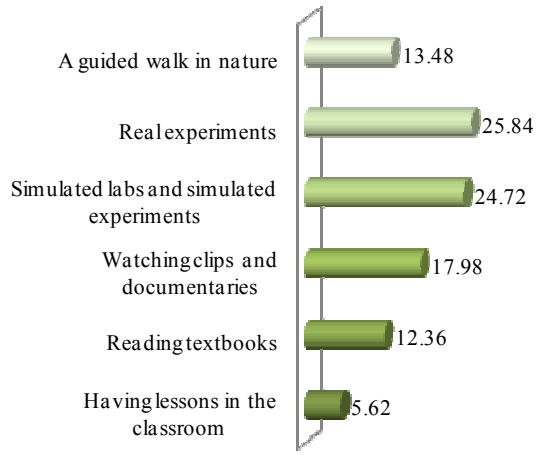

Fig. 4 Students opinions related to best ways to learn different Science and Technology contents

These aspects proved us that if a virtual lab would be developed in the frame of the NTSE project, it will be very well received by all the target groups to be used during the Science lessons.

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. Figures 5 and 6 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 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

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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.

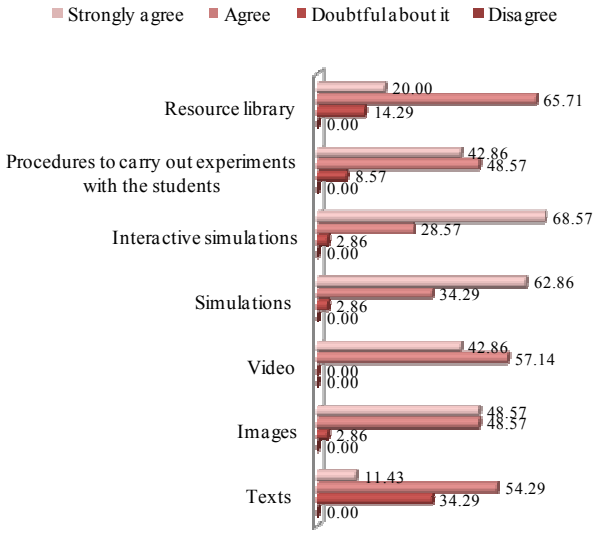

Fig. 5 In-service teachers' perspective concerning the important tools to be included into an online virtual lab

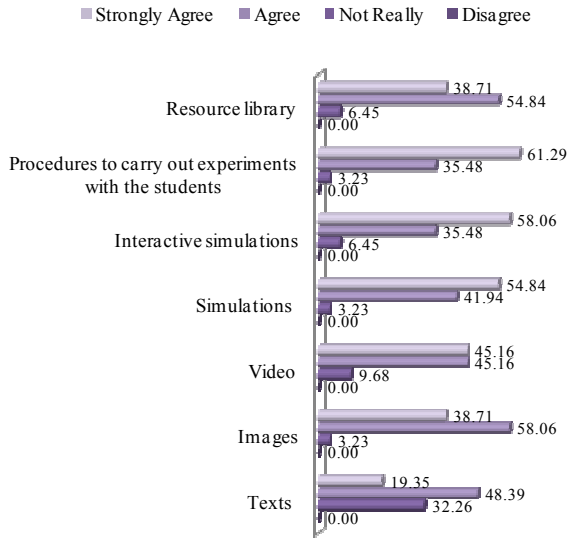

Fig. 6 Prospective teachers' perspective concerning the important tools to be included into an online virtual lab

The data collected are illustrated in figure 7 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.

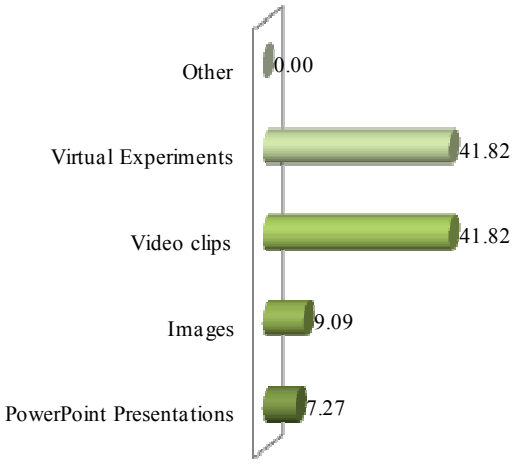

Fig. 7 Specific ICT tools preferred by the students to discover and learn aspects related to Science topics

The data analysis of the answers provided by the interviewees from all the three target groups 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. At present the NTSE partners are in the process of designing the NTSE *Virtual Lab* dedicated to illustrate specific Science and Nanotechnology topics.

4 Conclusions

The results presented above emphasized on the most suitable pedagogical strategies and teaching methods that can be used to teach a particular scientific topic - in our case, *Nano-science and Nanotechnology*. Most of them include ICT tools and enhance the students' motivation, their learning skills, the collaborative work and the constructive knowledge acquisition which allow at the same time the premises for social learning.

Related to the ICT instruments that could be used for teaching Science and Nanotechnology concepts, the assessment performed in the NTSE project, proved that virtual experiments, Powerpoint presentations and educational videoclips can be powerful resources for presenting NanoTech experiments suitable to be included in the proposed NTSE *Virtual Lab*.

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