Nanotechnology Applications in everyday life: Junior High School students' views

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Abstract
Within the framework of teaching modern concepts of Nanotechnology in Junior High School classes, this paper describes the experiential research we conducted to identify Year 3-Junior High School students' views regarding Nanotechnology applications in everyday life. I.M.Panagiotopoulos School students who took part in the research attended appropriately designed teaching sessions and undertook projects while the research data resulted from the comments made by the instructors who realised the teaching sessions as well as the students' answers to questionnaires given to them at the beginning, during and at the end of the project. Data processing proved that students have a positive attitude towards Nanotechnology applications in everyday life, but they also accept them with certain reservations regarding specific issues.

Keywords: Nanotechnology, students' views, secondary education, project

JEL classifications: O30, O10, L70

Introduction

According to the European Commission (2004), Nanotechnology refers to the science and technological applications developed on nanoscale, that is, on a scale ranging from 1 to 100nm. On nanoscale level, material often appears to have different qualities from those on larger scales. Smaller, lighter, faster and more efficient materials that Nanotechnology offers makes it possible in order solutions to be given regarding many current problems as far as both science and everyday life are concerned (Schulenburg, 2007). For example, Nanotechnology has already been implemented on fields of medicine,

such as biomedical materials and tools, medicine, development of contrast material in medical imaging, remediation or development of artificial tissues etc. The field of Nanoelectronics has contributed in faster communication, new and exceptionally powerful systems of saving information, smaller sizes of computer systems etc. Nanotechnology applications have also been important regarding energy production via photovoltaic elements or hydrogen cells, energy storage (i.e. rechargeable batteries) as well as energy saving (i.e. development of more efficient insulation and lighting systems). There are also nanocomposites which offer new perspectives in car industry, aeronautics and aerospace engineering as well as everyday items such as appliances, clothes, cosmetics, sports equipment etc. (Schulenburg, 2007; Nouailhat, 2008; Foundation for Research and Technology, 2012; 2013).

Nanotechnology has been used for many of the appliances students are nowadays familiar to, such as computers, mobile phones and portable media players (iPods), while the manufacture of even more products is going to be based on Nanotechnology in the future. Thus, bringing Nanotechnology to classroom, students get in touch with the current developments of science and technology (Filipponi and Sutherland, 2010), while they also acquire a kind of nano-literacy in order to become citizens who perceive important scientific issues which are related to everyday life and society (Laherto, 2010).

During the last fifteen years, a great number of studies and proposals have been made regarding the introduction of Nanotechnology concepts in Science school programmes both in primary and secondary education by several organisations and research institutes all over the world that work on Nanoscience and Nanotechnology. A typical example of this effort is the NANOYOU (NANO for YOUTH) programme. Funded by the European Commission, it started in 2009 and aimed at the increase of young people's basic knowledge on Nanotechnology and raising awareness so that they participate in a dialogue regarding the moral, legal and social implications of its applications (Hochgerner et al., 2010; Nikou, 2010). The results of the research carried out within the framework of NANOYOU for young people from 11 to 25 years old showed that young people have heard about Nanotechnology applications and known about several of its products. In addition, young people believe that Nanotechnology will improve our lives in the future but they also accept with certain reservations the possible negative effects of its applications (Hochgerner et al., 2010). In other words, their views were similar to the ones already described as being the results of other researches (Sahin & Ekli, 2013; Murcia, 2013).

Within academic year 2015-16 and being the result of the experimental teaching of modern concepts of Science and Nanotechnology in secondary education, Year 3 students of I.M.Panagiotopoulos Junior High School carried out a research project on the topic "Nanotechnology-Nanocomputers. Studying Today ... the applications of Tomorrow". During the realisation of the above project, there was a research carried out which is described within the present paper aiming at recording students' views regarding the benefits and dangers of Nanotechnology applications. Students' views were recorded at the beginning, during as well as after the completion of the project. We believe that the research results will contribute in further and systematically planning the teaching of modern concepts of Nanotechnology in secondary education. More specifically, the following research questions were explored:

1. Which Nanotechnology products did students know and use at the beginning of the project?
2. Which Nanotechnology applications did students wish or did not wish to get in touch with in the future at the beginning of the project?
3. Which are the views students formed during the project regarding the funding of Nanotechnology applications, the benefits and dangers that can result from their use?
4. Which of the students' views regarding the benefits and dangers of Nanotechnology applications did change after the end of the project?

Research activities

A) Bibliographical research:

Bibliographical research was carried out focusing on accounts within Greek and international bibliography regarding Nanotechnology and its applications in everyday life, such as appliances, medicine, manufacturing industry etc. The approach of the above accounts took place in terms of quality as the processing of difficult mathematical concepts that describe both Nanotechnology phenomena and applications may lead students to giving up the effort to understand them further.

B) Educational material:

i) Text slides were made in order students to be presented with how material behaves at nanodimension level and corresponding applications in everyday life products.
ii) Videos from the Internet that refer to the qualitative description of Nanotechnology applications were chosen.
iii) Material concerning Nanotechnology applications addressing to a wider audience interested in them was utilised.
iv) Internet sources that put emphasis on Nanotechnology applications and modern information technology systems were chosen.

C) Teaching activities:

Within the framework of the project, Science and IT Departments instructors presented students with Nanotechnology and its applications in everyday life. During the above presentations, teachers made use of the slides prepared and the material chosen from the Internet. In addition, the instructors explained to students the concepts that the science of Nanonotechnology uses as far as the description and interpretation of phenomena at nanodimensional level and their implementation in everyday life products are concerned. Moreover, during the presentations they thoroughly discussed the views that students expressed on the advantages and dangers regarding the use of nanotechnology products.

D) Students' activities:

The activities students carried out were: (a) essay writing, (b) slides creation and (c) script writing regarding the video they created to present their approach to Nanotechnology field and its products.

More specifically, acting as journalists, students created their own video to present their view on the Nanotechnology products they know or use in their everyday life as well as the Nanotechnology applications they would like to get in touch with in the future. The video included: i) narration regarding Nanotechnology basic concepts; the already existing applications of Nanotechnology as well as the ones which are about to come; the activities of Glonatech-ONEX Company Group, a company that innovates on high technology industry, ii) interview with the Researcher and BD Manager and a senior researcher of the company mentioned above whose Department of Research and Development has been at Leukippos Institute, at the premises of National Center for Scientific Research "Demokritos", since 2009, iii) music and photographic material (copyright free) which supports students' presentation of the project. It should be noted that the students who participated in the creation of this video won the first award in the European competition "What kind of Nanotechnology do we want to have?" organised by NanoDiodeProject (under the auspices of the European Union) and the European Union of Science Journalists' Associations (EUSJA).

Picture 1. Video snapshots: Students interviewing researchers of nanomaterials and nanomaterials use for fighting environmental pollution

Methodology of research

Research characteristics

Forty-five Year 3-Junior High School students participated in the research carried out. The first of the submitting authors of this paper focused on the selection, design and creation of the teaching material. The second and third of the submitting authors dealt with the processing of research data. The fourth one organised the construction of the questionnaires and supported the research by electronic means. The fifth one carried out the bibliographical research while all the above submitting authors – in cooperation with the last one – got involved in the presentation and the final paper of the research.

Research data collection

Research data was collected from the students' answers to the questionnaires created aiming at describing their views on

Nanotechnology applications as well as from the instructors' remarks after the activities they carried out. Three questionnaires were made in order to serve the research and were given to students at the beginning, during and at the end of the project. The method of critical content analysis was used in order data that resulted from the students' remarks and answers to be processed (Holsti, 1969).

Research results

I) Twenty-three students answered the questionnaire given at the beginning of the project. The rest of the students did not answer it because – according to the instructors participating in the project – they were not sure then whether they would get involved in the realisation of the project. The results from the students' answers regarding Nanotechnology applications in everyday life showed that:

a) In relation to the kind of Nanotechnology products students knew (see Figure 1), 39% of them knew Nanotechnology products related to computers; 39% of them knew Nanotechnology products related to waterproofing materials and 22% of them knew Nanotechnology materials related to clothing, body care and hygiene products etc.

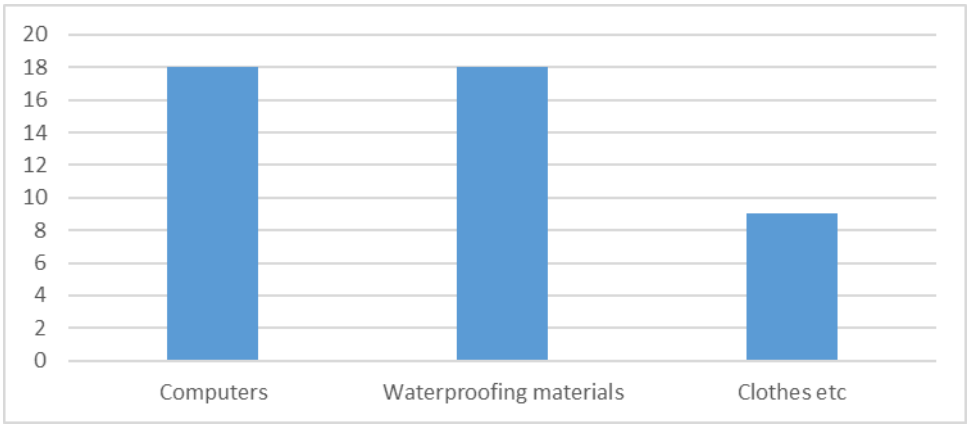

Figure 1. Numerical distribution of students' knowledge on Nanotechnology products

b) As far as the use of Nanotechnology products are concerned (see Figure 2), 39% of the students use Nanotechnology products related to the operation of computers more often; 27% of the students use them for the cleaning and protection of other products; 13% of the students use Nanotechnology products related to sports and 4% of the students use them in relation to various other products. A proportion of 17% of the students did not answer.

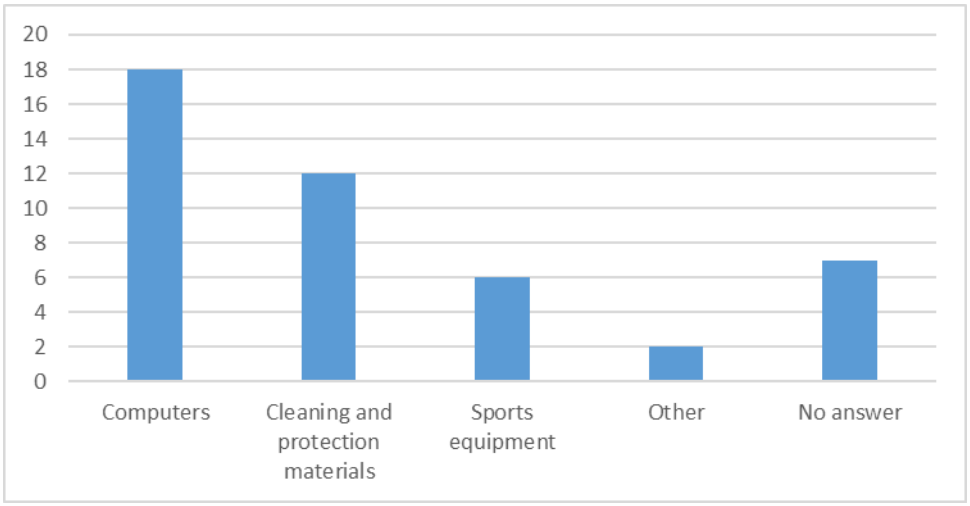

Figure 2. Numerical distribution of students' usage of Nanotechnology products

c) In relation to students' answers regarding applications they would like to be developed in the future (see Figure 3), most of them, that is 57%, referred to medicine issues, 26% to appliances issues, 13% to environmental issues and 4% to other applications.

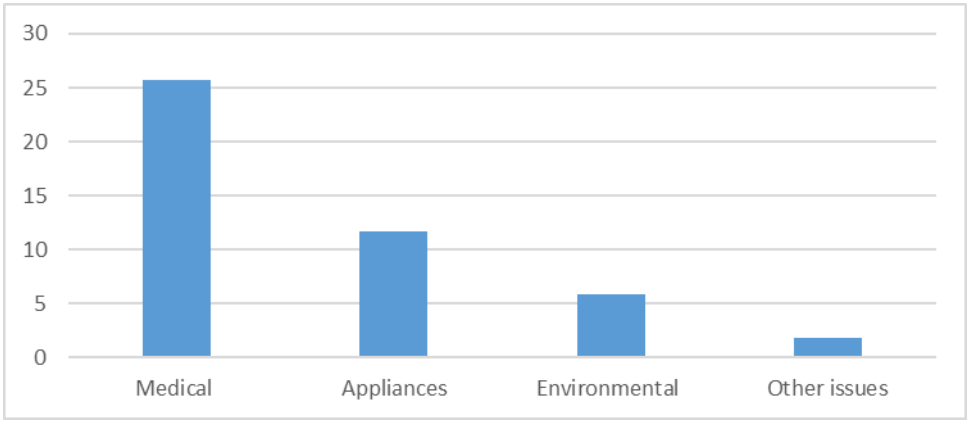

Figure 3. Numerical distribution of students' preference in future Nanotechnology applications

d) Regarding Nanotechnology applications they would not like to be developed in the future (see Figure 4), 23% of the students referred to armament, 13% to the autonomy of robotic mechanisms, 9% to dietary issues and 25% to various applications while 30% did not answer.

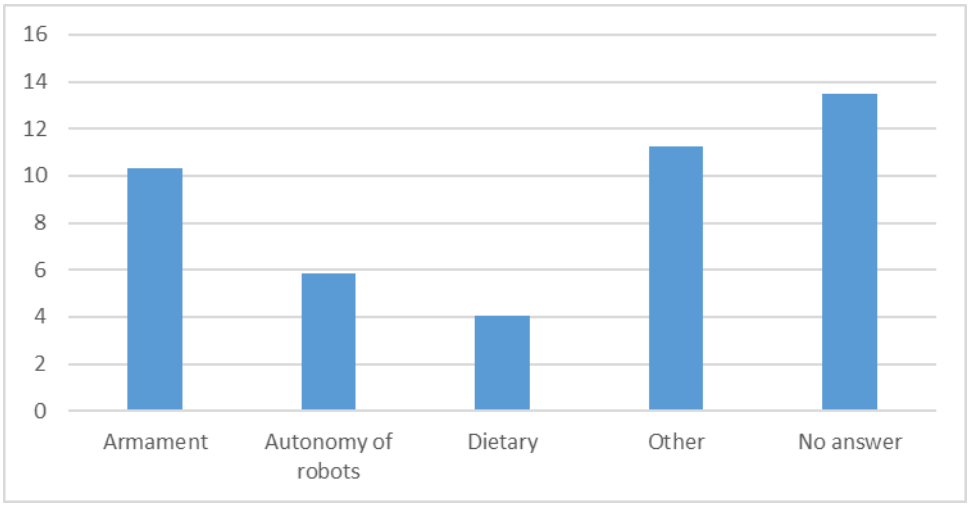

Figure 4. Numerical distribution of students' undesirable Nanotechnology applications in the future

II) Forty-five students answered the questionnaire given to them during the project. The processing of students' answers regarding their views on funding Nanotechnology applications, the benefits and dangers that may result from their use led us to the following results:

a) Regarding Nanotechnology applications funding, 95% of the students expressed the view that research is necessary to be continued as far as computer systems are concerned and 84% of the students expressed the view that, despite the economic difficulties our country is currently facing, a considerable amount of money should be invested in Nanotechnology research (see Figure 1). According to students' answers, 89% believes that, although this is a period of economic crisis, science should be developing owing to the fact that - according to 33% of the students - new products, new posts etc may arise in order economy to be helped, while according to 36% of them, science development is taken for granted.

b) Regarding the results related to the use of Nanotechnology applications products, 84% of the students express the view that the already existing products should be banned from the market until there is a thorough exploration on the absence of possible dangers – scientific research has not spotted whether their use is harmful regarding people's health yet. However, 81% of the students support that the development of Nanotechnology applications should carry on although the danger of nanoparticles for human health is still under examination. Regarding environmental issues, 70% of the students express the view that benefits from the development of Nanotechnology applications in the field of environment are more than dangers that can affect human health (see Figure 5).

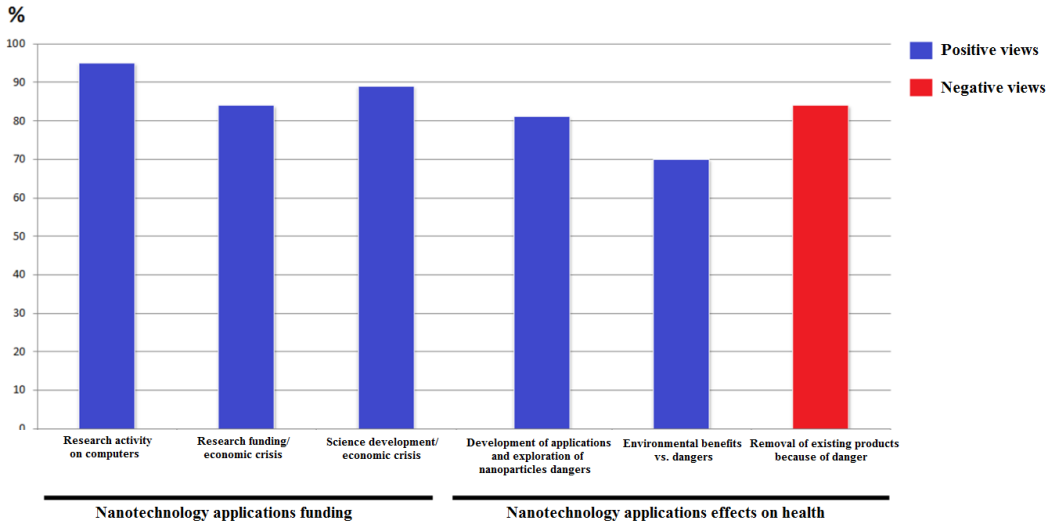

Figure 5. Percentage distribution of the positive and negative students' views for Nanotechnology applications

III) A third questionnaire was given to students at the end of the project. The processing of students' answers regarding the alteration of the views they had formed on nanotechnology applications during the project showed that changes were only few. More specifically, there was only one student who, in contrast to his initial view, stated that Nanotechnology development should be abandoned supporting the view that nanoparticles could severely damage people's health. In addition, two students changed their initial view and stated that the benefits from the use of nanomaterials may be less than dangers as Nanotechnology has not made safe conclusions regarding whether their use is harmless or not. Moreover, a student changed his mind regarding the contribution of nanomaterials in the quality of people's life and expressed the view that their use in everyday life could improve it. It should be noted that regarding the financial support for the development of Nanotechnology during the economic crisis period, there were only two students who changed their views and thought that the development of Nanotechnology should not be a priority for the improvement of our country's economic situation.

IV) The analysis of remarks that the instructors recorded after the teaching sessions they realised made them conclude that the level of students' interest in Nanotechnology applications remained high during the project. More specifically, the instructors think that the video making procedure and their participation in the European Competition helped most of the students to actively participate in all of the project stages. Moreover, taking advantage of the experience they acquired from teaching modern concepts of Nanotechnology, the instructors proposed that in case a similar project is carried out from other instructors in the future, the teaching sessions could be separate designed regarding the main fields of Nanotechnology applications such as, Nanoelectronics, health issues etc. In addition, the instructors expressed the view that productive collaboration between them contributed in the successful completion of the project, too.

Discussion

At the beginning of the project and according to the research results, most of the students knew about Nanotechnology products related to computers and the process of making products waterproof. Regarding Nanotechnology applications students would like to be developed in the future, most of them referred to the fields of medicine and environment. As far as Nanotechnology applications they would not like to be developed in the future are concerned, they referred to the fields of armament and autonomy of robotic mechanisms. During the project, the view students formed regarding the benefits and dangers that can result from the exploitation of Nanotechnology was that Nanotechnology applications can contribute in the economic growth of our country despite the economic crisis. In addition, most of the students expressed the view that research should be continued regarding further development of Nanotechnology. Referring to health issues and despite the fact that research related to nanoparticles dangers is still in progress, most of the students expressed the view that Nanotechnology development should be continued and products which may have harmful effects on health should be banned from the market. Regarding Nanotechnology applications related to environmental issues, students have second thoughts as far as their possible benefits are concerned. According to the results of the research at the end of the project, most of the students maintained the views they had regarding Nanotechnology implications in everyday life.

We believe that students' positive views on Nanotechnology applications in combination with their reservations about specific issues which have to do with their safe exploitation in everyday life (see Hochgerner et al., 2010) are encouraging regarding further exploring the possibility to teach students about them in secondary education. In addition, the prospect of teaching sessions designed taking into consideration the different fields of Nanotechnology applications, i.e. Science, ICT etc. can be further studied always keeping in mind that collaboration among instructors from different fields can contribute in an effective teaching approach.

Acknowledgements

We wish to acknowledge the help provided by Mrs. Zefi Tressou, the philologist who edited the Greek version of the paper, Mrs. Eva Kaliskami for translating the paper from Greek into English and Ms. Efi Alexandri for the secretarial support.

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