Chapter 17
A View on High School Students' Knowledge About Nanotechnology

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Abstract Nowadays, almost each member of this society, not just high school students, uses cutting edge technology, whether those devices are used for fun or work. Technological evolution registered in different fields of knowledge imposes challenging technological situations for all of them, proposing learning situations that belong to informal education, which sometimes do not cover the real scientific facts.

17.1 Introduction

Interacting with freshly gained scientific knowledge could become a big problem, these interactions suggesting various learning situations, each developing a specific set of cognitive links based as well on previous interactions with technology. This informal learning leads to the development of cognitive structures which sometimes do not cover the real scientific facts, while through formal education students would be able to form cognitive connections that reflect scientific reality. The main problem in this situation is that school curriculum does not contain updated information regarding scientific progress, information that could become the foundation for a coherent understanding (Stabback 2016). The adaptation of education can be achieved by changing the structure of contents and skills taught in the classrooms or transferred in extracurricular activities so that it reflects current society requirements (Darling-Hammond et al. 2019).

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17.2 Experimental Framework

Following this hypothesis we conducted a study whose purpose was to determine the level of knowledge that high school students have about nanotechnologies and their applications (Srinivas 2014). The instrument used in this study was a questionnaire containing 12 items referring to various aspects regarding nanotechnologies and some peculiar addressing the knowledge about magnetic materials applications.

17.2.1 Developing the Analysis Tool

The questionnaires used were focused on three main issues: magnetism, fluid state, and nanotechnologies. Some questions wanted to determine the quantity and quality of knowledge obtained in formal education in the classrooms, and others were built to probe students' interest on nanotechnologies and knowledge obtained during informal education sequences. Through this study, we managed to determine the level of knowledge and interest that high school students manifest toward the field of nanotechnology (Sebastian and Gimenez 2016). Addressing a representative sample of schools/pupils proved to be a difficult task for our educational research. To ensure that the sample resembles as much as the population from which it was extracted, this survey included both pupils of schools with high ranked results and those with difficulties in improving scholars' performances, both urban and rural areas and representatives of both sexes. The questionnaires were applied between February and March 2016 on a sample of 650 pupils from 7 high schools in the southern part of Vaslui county, 4 from urban areas and 3 from rural areas.

17.2.2 The Questionnaire

Including too many questions could create a certain level of boredom among pupils, while too few wouldn't have gathered enough information. This being said, we chose 12 questions that most of the respondents could answer. The sentences were built using carefully chosen words, in order to keep them as short and as pointed as one can be. Each question referred to a piece of the puzzle, some of the questions were open format so that pupils could respond as they felt at that moment.

17.2.3 Centralizing Responses

The first two questions allow the readers (respondents) to familiarize with survey, referring to simple aspects such as the usefulness of studying physics and identifying

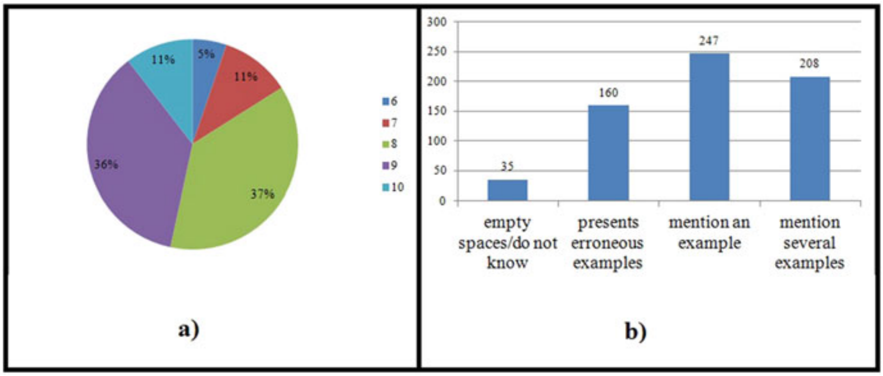

Fig. 17.1 (**a**) Grades given by the students to the how important is Physics in their life. (**b**) Number of the respondents answers regarding the contribution of physics to the revolutioning of society

areas revolutionized by it. The answer options for the first question were grades 1 to 10, 1 marking the uselessness of Physics, and 10 its importance. A small number of students awarded notes near the middle of the scale presented in the questionnaire, while 478 of those questioned giving grades 8 and 9. To the second question, 70% of the questioned students are able to present a correct example of a fields revolutionized by the knowledge gained within the borders of progress of science. The answers provided by students include medicine, robotics, astronomy, computing, acoustics, various types of engineering, optics, or telecommunication (Fig. 17.1).

Questions 3, 4 and 7 allowed a quantitative determination of the knowledge that students have about basics of magnetism, fluids, and nano-sized materials (Sederberg and Bryan 2006; Guisasol et al. 2004; Li and Singh 2016). The knowledge scrutinized by these three questions could be found in school curricula. The third question conceived as an open-ended item asks the students to described some properties of the magnets. The students had had a variety of ways to formulate the answer. The most often given answer of 86.2% of the students expressed the property of the magnet to have two poles. The second answer with a frequency of 73.5% of the respondents was about the interaction in between magnets repelling or attracting. The majority of the answers given by students was incomplete presenting only part of the aspects taught in the classroom and provided by the curriculum. The fourth question, also an open-ended item moved the focus on fluids and asked the students to provide some properties of the fluids (Besson 2004), with the aim to predict if students can explain why fluid can behave different in magnetic field. Only 27.5% of the students defined correctly the properties of fluids while 45.8% left the space blank or answered "do not know." At least one correct example of a fluid was provided by 56.9% of the students.

The presentation of correct examples correlated with the inability to present the properties of the fluids indicates the existence of loopholes that lead to the impossibility of a coherent expression of the concept. Surprisingly, as can be seen from

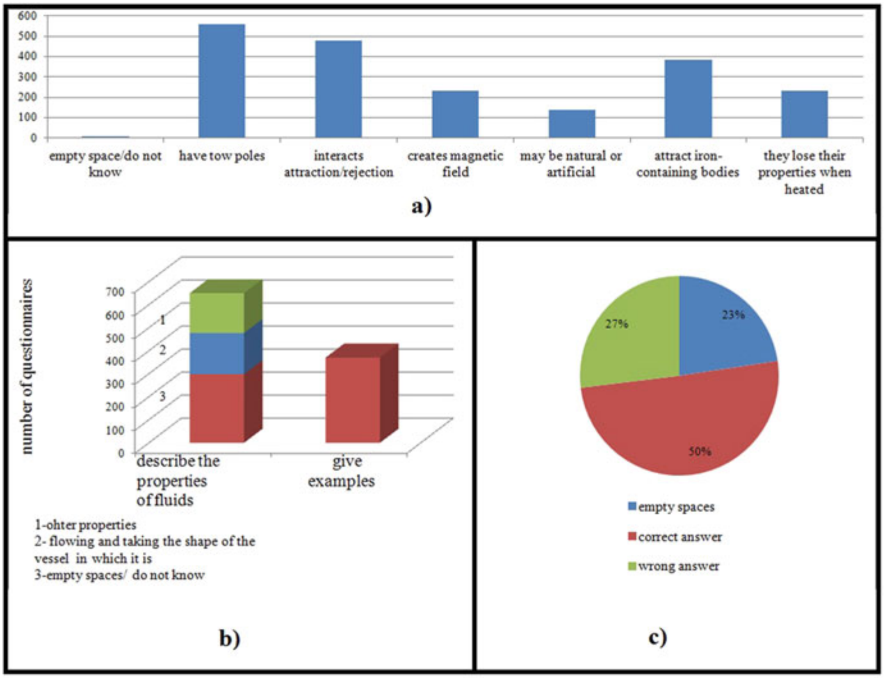

Fig. 17.2 (**a**) Distribution of the answers of students to the open-ended item on magnets. (**b**) Distribution of the answers on fluids' properties. (**c**) Distribution of the open-ended item on ferrofluid or magnetic fluid

Fig. 17.2c, half of the respondents managed to describe a ferrofluid and some properties even in the school curricula ferrofluids are not mentioned. The survey targeted both rural and urban schools. The majority of the correct answers in describing magnetic liquids came from the students from urban area. The justification for such high percentage is the exposure of these students to the informal activities.

The questions 5, 6, and 8 concern information that is not part of the curriculum implemented in Romania nowadays. In order to answer these questions correctly, it would have been necessary to have information about this field from other sources as informal experiences outreach activities, science fairs, science night, science center, etc. The fifth item addressed the complex concept of Ferrofluids that is not taught in Romanian high school. This explains why 48% of the respondent left blank spaces. Only 4% of the respondents had correctly defined the concept and only six students imagined application for ferrofluid. The number of those who considering appreciate that these "substances" interact with magnets is significantly higher than those who provide a correct definition, possibly the "name" of the substance suggested the "behavior." To the sixth question, 76.5% of the respondents failed to provide an answer, 20% presented the definition of the concept, and only about half of them

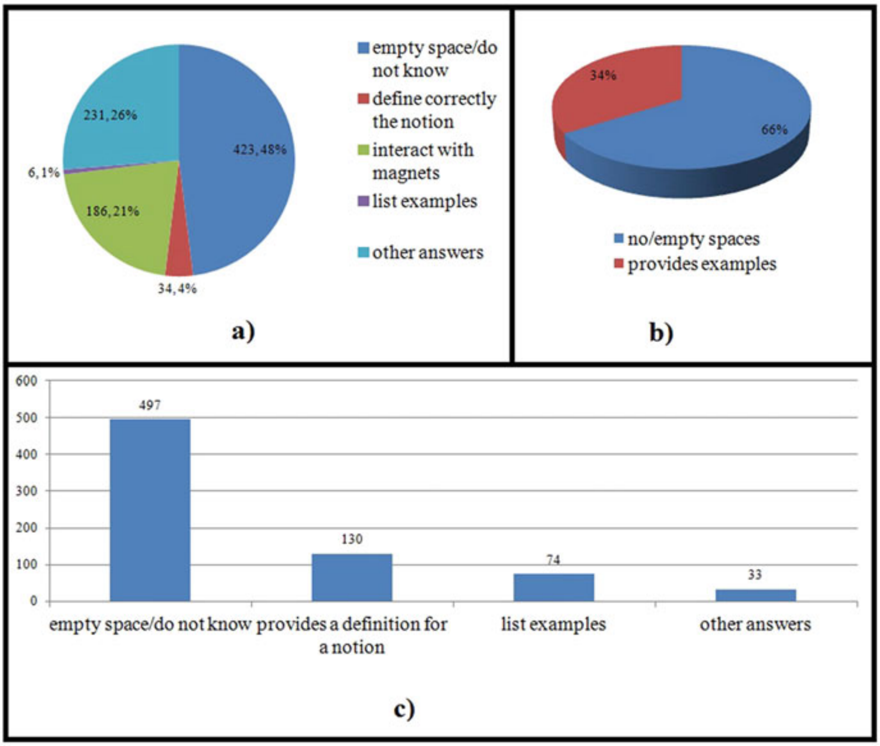

Fig. 17.3 (**a**) Distribution of the answers providing a definition of ferrofluid; (**b**) distribution of the answers describing the interaction in between magnets and ferrofluid; (**c**) students providing examples for ferrofluids' application

gave at least an example. Students who provided other answers mentioned that they had heard about this notion on TV/film, but did not look for more information. Many of the students surveyed fail to present practical applications of nanotechnologies, although it can be said that each of them uses a mobile phone at least. The motivation to study a certain amount of information is the most difficult to achieve, making a correlation between this information and everyday life could be a bridge that could underpin this motivation (Fig. 17.3).

Questions 9 and 10 relate to the pupils' interest in "new technologies" a term that is in the day by day life used to describe the last progresses in science and industry. The students can have a vague idea of the concept and only few of them have read systematic on this topic. The item nine intended to qualitatively mirroring the students' interest to observe/understand/practice something with and for new technologies. For 67% of the students, participating in a laboratory activity of hands on ferrofluids, implicit in new technologies, as suggested by question 9 would be interesting. The majority of students following the questionnaire realized that ferrofluids must have practical applications and 61% of them think that application can exist but they have no idea where and how.

La last item of the survey was designed to measure the interest of students in understanding how a device or gadget is working and about their readiness to participate in informal activities based on nanotechnology topics. About 70% of the students are interested in practicing for understanding how their smart phone or tablet is working.

17.3 Conclusions

The research has been carried out in order to identify the level of knowledge as well as the interest of high school students toward the field of new technologies and nanoscience. Based on the answers given to the first questions it can be stated that the students consider physics a particularly important science and have clear ideas of fields and activities that was revolutionized by the progress of Physics as applied science. Most of the examples that they provided represent big advancement in the humanity history showing that in the classroom the teachers are used to give significant example. The teachers do not use examples from new technologies and nanoscience probably because in their initial training did not became familiar with such topics. All the items related to the contents and concept familiar for the students from the formal education got expected god answers underlining once more the importance of formal education in achieving desired scientific key competence the fundament for social and professional insertion. The items related to the new technologies and students' opinion demonstrate that students are not familiarized with basic concepts in the field but they manifest high interest in hands on activities using devices or gadgets incorporating these new technologies. The students' answers emphasize the students need in knowing more about science progresses and the necessity of introducing more and more formal and informal activities for and with new technologies.

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