A CASE STUDY ON

Introduction to Nanotechnology – Nanoscale

in Experimental Gymnasium of Heraklion, Greece

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INTRODUCTION / BACKGROUND

Those Virtual Lab implementations took place in Experimental Gymnasium of Hereklion Crete, Greece during November 2013. The work was conducted in two classes (9th grade) with 51 students in total. Students had the opportunity to explore and understand the metric system, nanoscale, properties of nanoscale particles and what nanotechnology deals with.

KEYWORDS: Nanotechnology, nanotechnology applications, nanoscale, biomimicry

TARGET GROUP: 9th grade students

THE EDUCATIONAL SETTING

The Model Experimental Gymnasium of Heraklion is an elite school in Heraklion district. Students gain entry through an entrance exam that has recently been implemented. All classrooms are equipped with interactive whiteboards.

The lessons were carried out by a physics teacher, Ioannis Karadamoglou with the assistance of Yorgis Androulakis from FORTH. Ioannis, has five years of teaching experience and a great experience in using online resources in teaching and learning. According to data gathered from the school, the average score in physics of these two classes that took part in the VL implementation is 16.1/20.

PURPOSE

The aim of "Nanoscale and Nanotechnology" lesson was to introduce nanotechnology and nanoscale to the students by using the material provided in the Virtual Lab. By the end of this activity, students should have develop the ability to convert ordinary measurement scales into nano, visualize the nano scale, give examples of nanoscale objects and differentiate nanotech applications from the applications of conventional technology.

OBJECTIVES

The lessons' objectives were:

- ✓ To increase awareness about nanotechnology through nanotechnology applications
  - ✓ To comprehend nanoscale
  - ✓ To enhance the ability to convert units into nanometres
  - ✓ To comprehend how the surface/volume ratio affects the physical properties
  - ✓ To comprehend that nanotechnology imitate natures technology

LEARNING RESULTS

The proposed activities should allow students to:

- ✓ develop the ability to convert ordinary measurement scales into nano
- ✓ visualize the nano scale
- ✓ give examples of nanoscale objects
- ✓ differentiate nanotech applications from the applications of conventional technology
- ✓ understand why the material gain new properties when the particle size decreases to nano

BEFORE THE LESSON

The students were provided in advance with the "Student's Guidelines" booklet, available in the Documents section of Virtual Lab.

Students should already know the following terms that exists in the reading text:

- ✓ SI Units
- ✓ Ability to convert units
- ✓ Ability to calculate volumes and area of cubes and cuboids

The room was prepared to watch the PowerPoint presentation and the related videos / interactive application. Four sets of prebuild cubes and cuboids were arranged in the classroom. Nanorulers were available to all students.

CLASSROOM MANAGEMENT & SEQUENCE OF EVENTS

There were some deviations from the original lesson plan:

- The video "Powers of Ten" was not used due to time constraints. Emphasis was given to "Scale of the Universe II" interactive application.
- A PowerPoint presentation titled "Introduction to nanotechnology" was used.
- Two short videos showing nanotechnology applications (nano-coating), future materials (buckypaper) were used
- Two short videos showing differences in burning behavior between a conventional film-forming latex film and a polymer-silica nanocomposite film were also used.

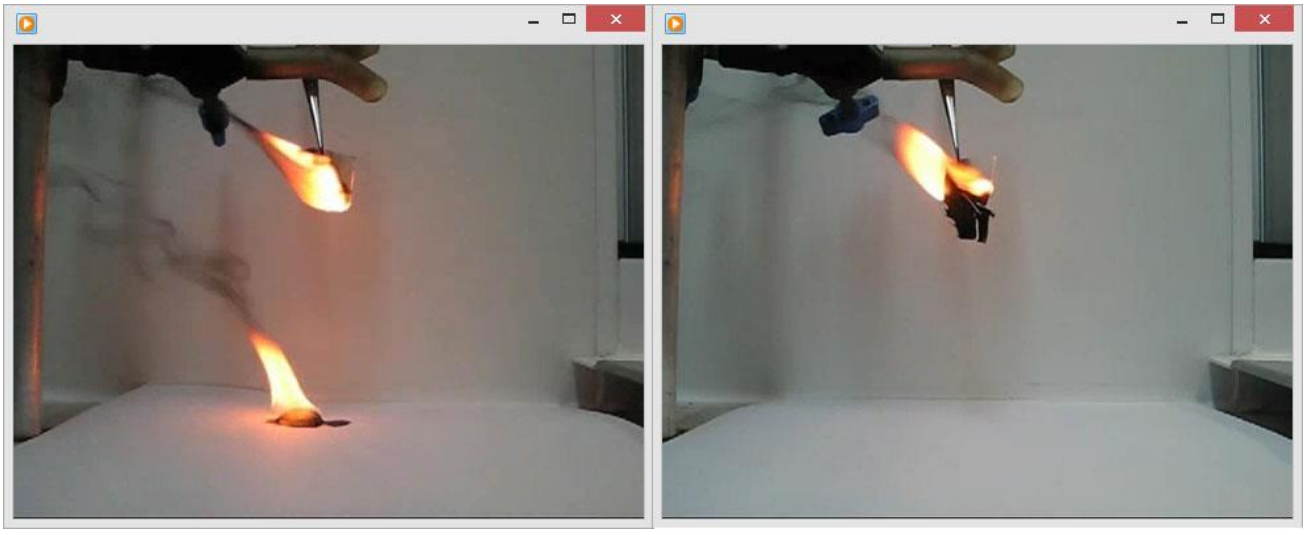


Figure: The 2 short videos on burning behavior of conventional film and a nanocomposite film

Introduction to Nanotechnology 13 minutes	A PowerPoint presentation introducing Nanoscience, nanotechnology applications, nanoscale and biomimicry.
Nanotechnology Applications 10 minutes	Two videos regarding today nanotech applications 1. Nano-coating http://www.dailymotion.com/video/x13jfyp_amazing-technology-with-nano-coating-2013_tech) 2. Future applications of buckypaper http://www.youtube.com/watch?v=nRMiQRiK5GY 3. Burning behaviour of a conventional forming latex film http://www.youtube.com/watch?v=D4vpztIZKKA 4. Burning behaviour of a polymer-silica nanocomposite film http://www.youtube.com/watch?v=27BFkl4grGM
The Scale of the Universe 12 minutes	Interactive application showing the scale of various objects. Focused in micro and nanoscale students were asked to identify objects and their sizes to compare sizes of different objects, to identify the smallest object visible to an optic microscope as well as to an electron microscope and also to point the largest /smallest scales.
Converting to nanoscale 3 minutes	Students were asked, by using their nanorulers, to convert in nano the sizes of some objects like books, pencils, rubbers etc.
Surface to volume ratio 7 minutes	Students were asked to compare the total surface areas that were pre-built of sugar cubes structures (one cube and 3 cuboids) all of the same volume and calculate the surface to volume ratio in each case.

The duration of the lessons was 45 minutes. At the end, all students and their teacher filled in questionnaires and assessment grids. The questionnaires aimed at evaluating and collecting information and suggestions on the content, usability and pedagogical effectiveness of the NTSE Project teaching materials (video, interactive animation, teacher guidelines, student guidelines).

IMPACT ON STUDENTS

Below are the results of the analysis of the students' questionnaires.

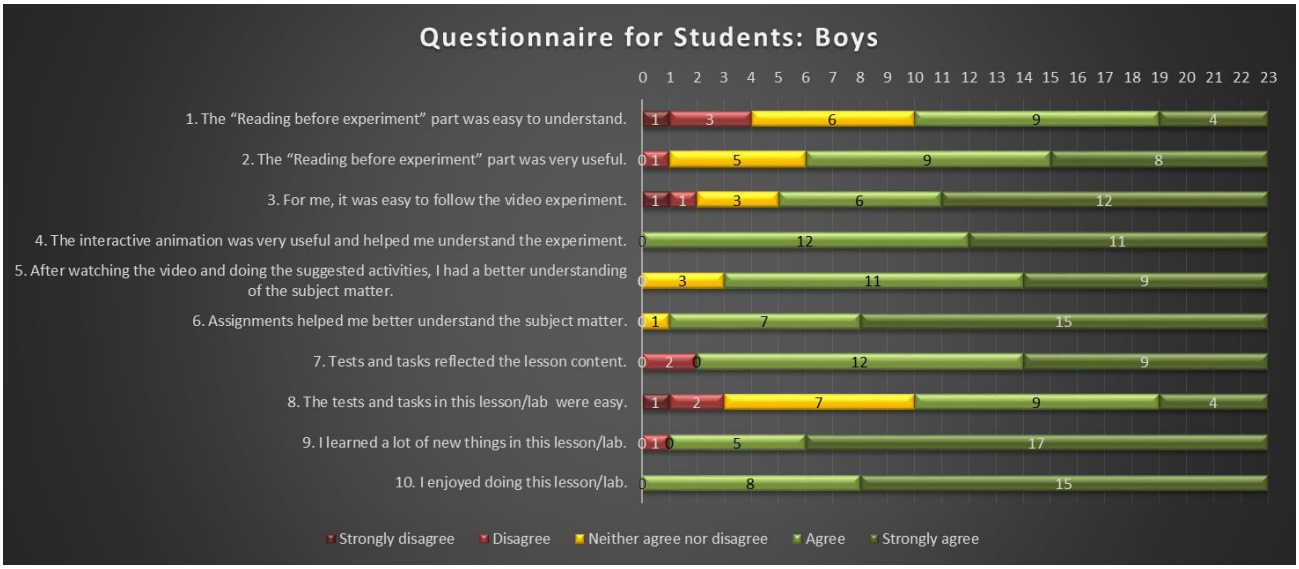


Figure 1: Questionnaire for students – Boys' responses (n=23)

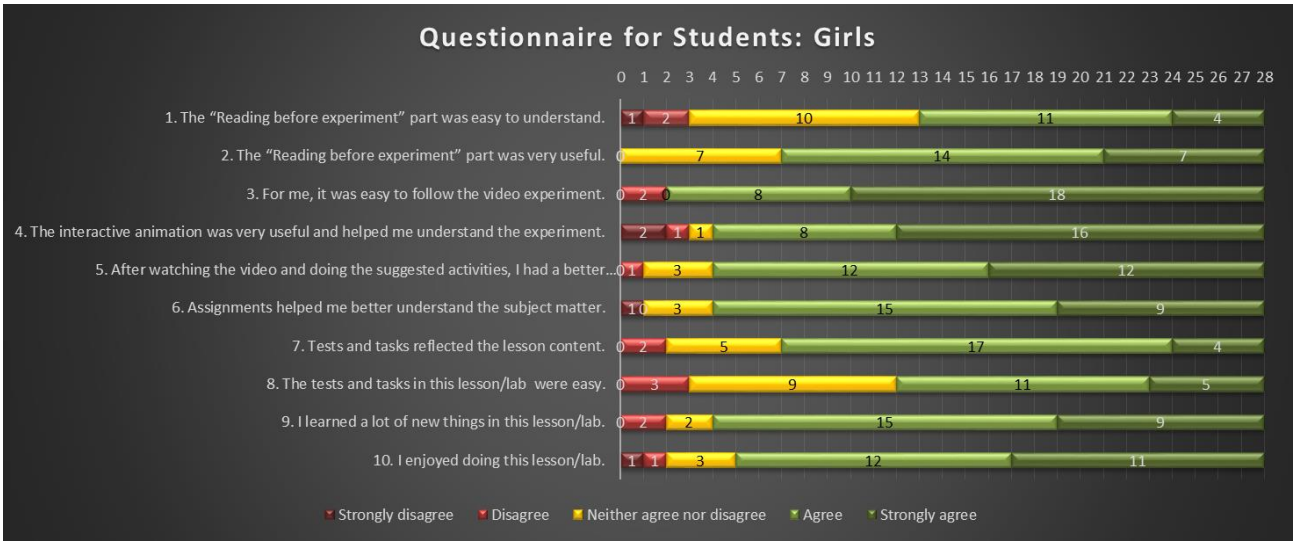


Figure 2: Questionnaire for students – Girls' responses (n=28)

High scores on all indicators regarding the lessons were observed. "Reading before the experiment" part and the tests caused difficulties for some students.

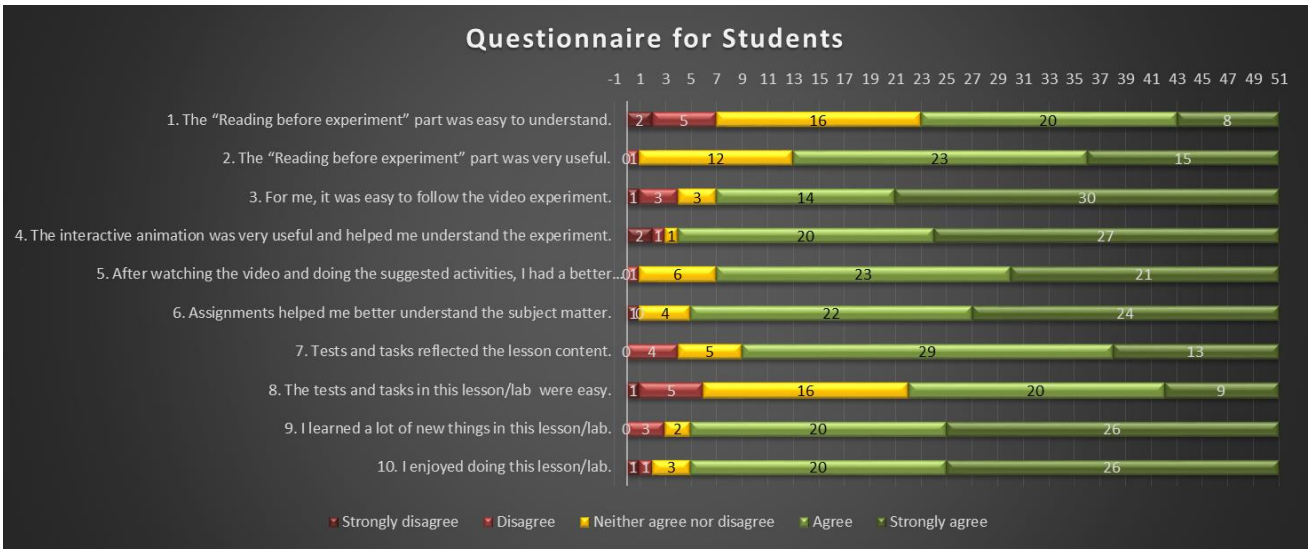


Figure 3: Questionnaire for students – Responses from all students (n=51).

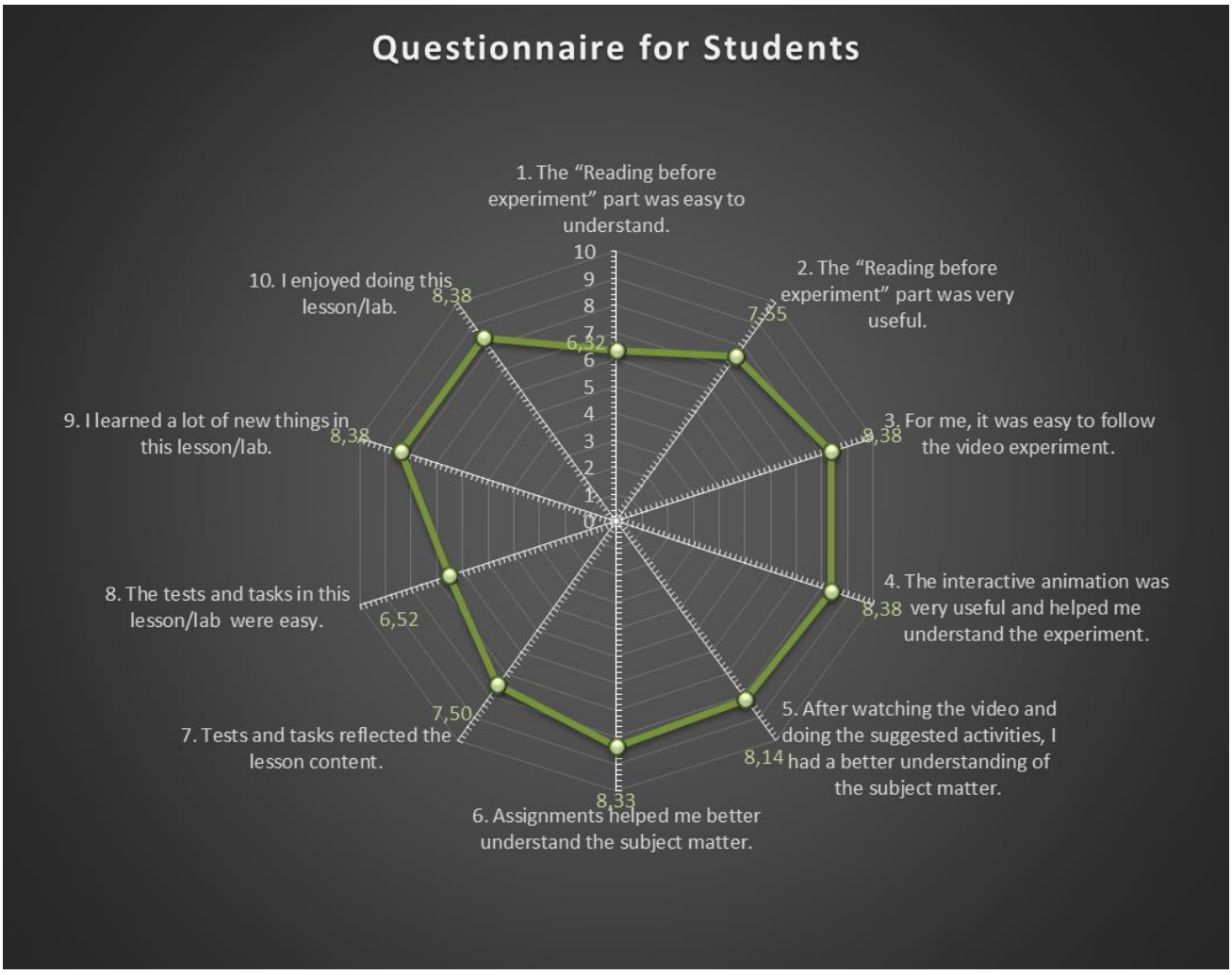


Figure 4: Questionnaire for students – Responses from all students (n=51), mean numbers

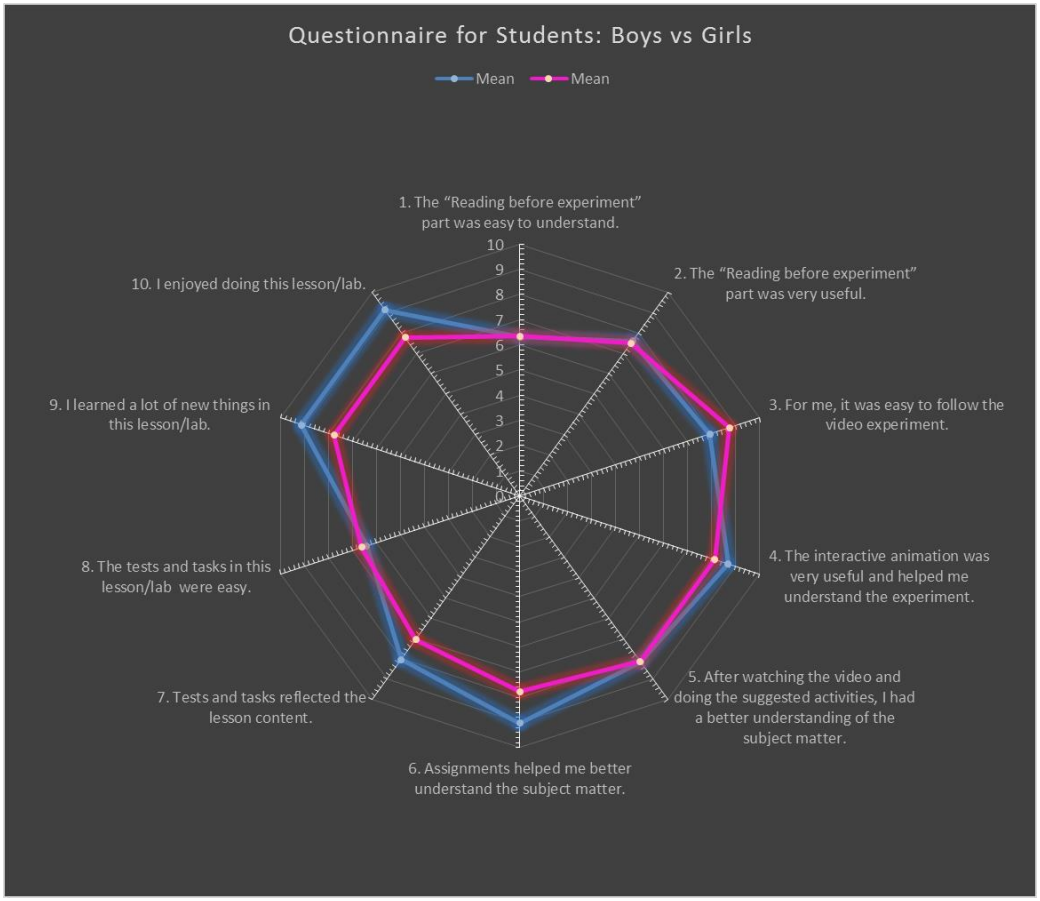


Figure 5: Questionnaire for students – Responses from all students (n=51), boys vs girls.

Students (especially boys) enjoyed the lesson and learned many new things. Four out of ten of them had difficulties with the tests but the assignments helped them understand the subject matter.

In general boys scored higher in most statements except the one regarding the video experiment.

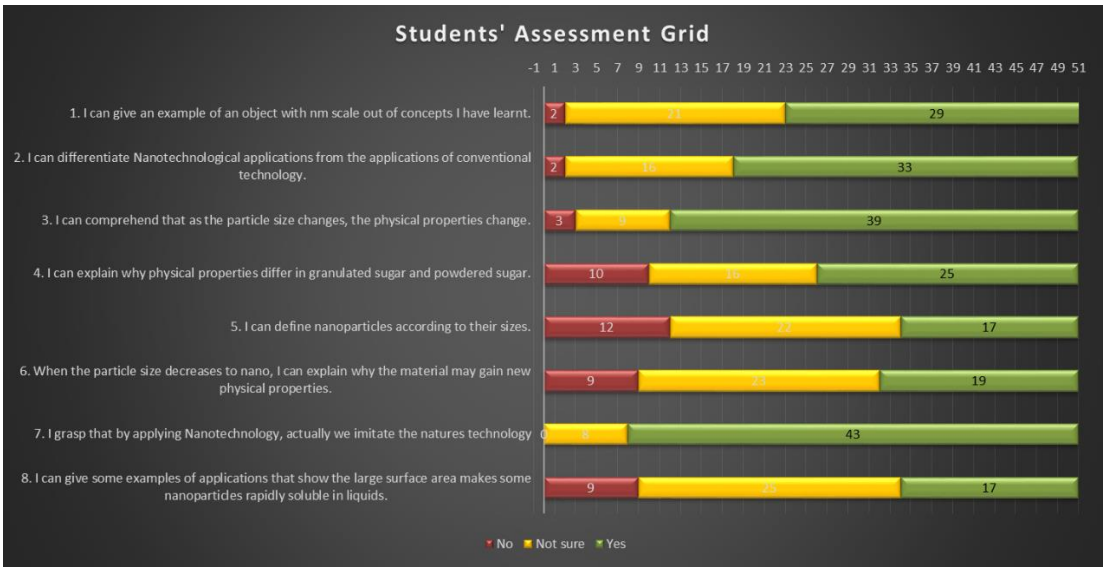


Figure 6: Assessment grid – Responses from all students (n=51)

The analysis of students' responses in assessment grids shows that generally students faced more difficulties in defining nanoparticles according to their size and, mostly the boys, in connecting physical properties to size of an object. Boys found it more difficult to explain why physical properties of granulated sugar differ from powered sugar and also to define nanoparticles according to their sizes but in all other statements boys showed a slightly better understanding than girls.

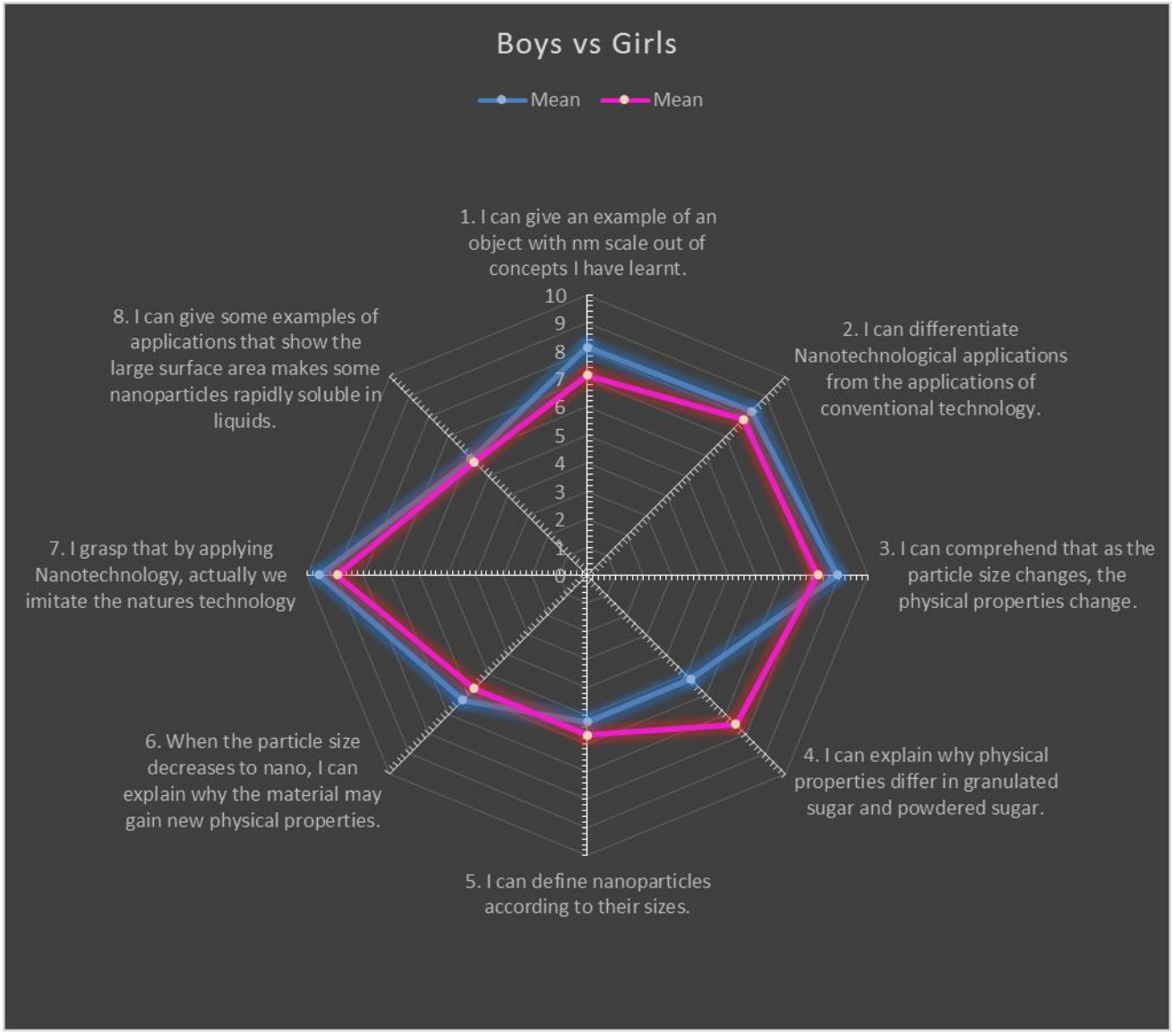


Figure 7: Assessment grid – Responses from all students (n=51), boys vs girls.

TEACHER'S REFLECTIONS

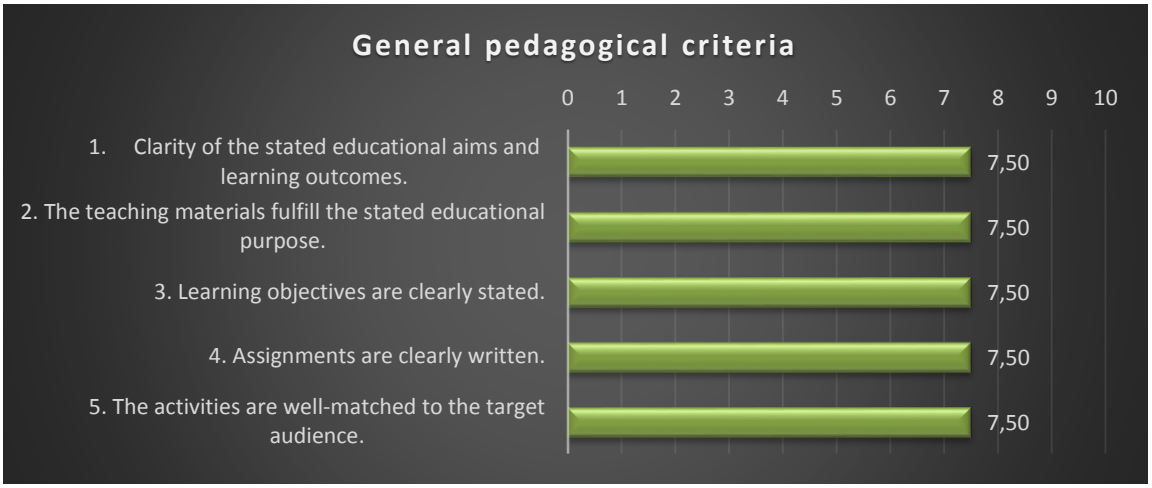
The following analysis is based on the teacher's views and suggestions regarding the content, usability and pedagogical effectiveness of the Virtual Lab.

Following the VL implementations, Ioannis Karadamoglou asked to fill in an evaluation questionnaire.

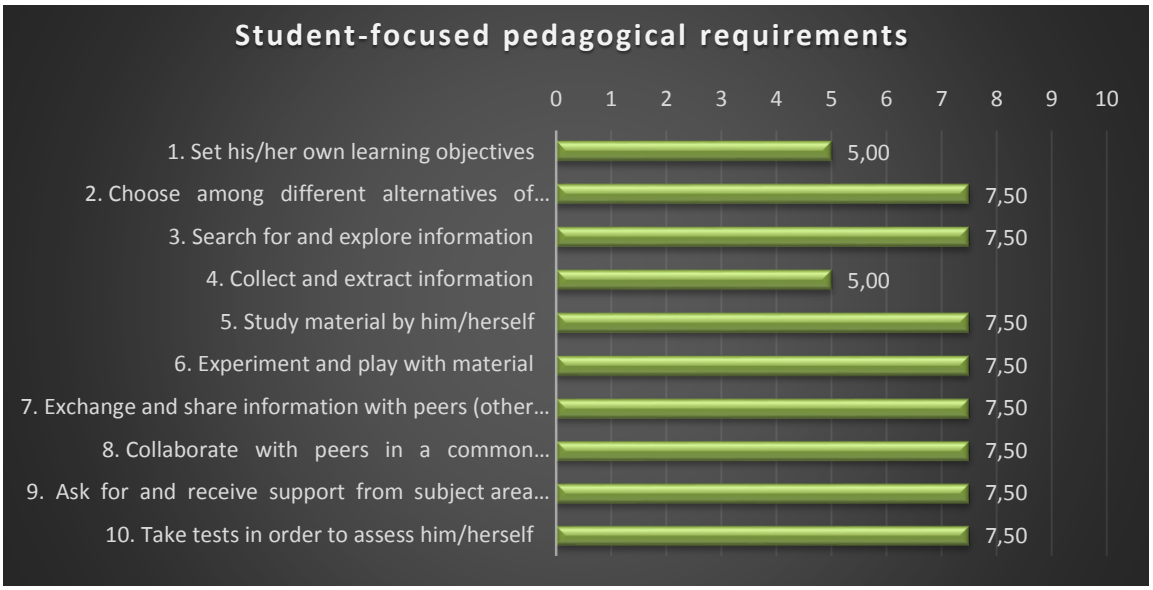
Pedagogical approach

The pedagogical effectiveness of the Virtual Lab educational materials was evaluated with three sets of questions regarding general pedagogical criteria, student-focus pedagogical requirements and teacher-focus pedagogical requirements.

The charts below show the teacher's responses:



The teacher believes that to a high degree the teaching materials fulfill the purposes of the Virtual Lab.



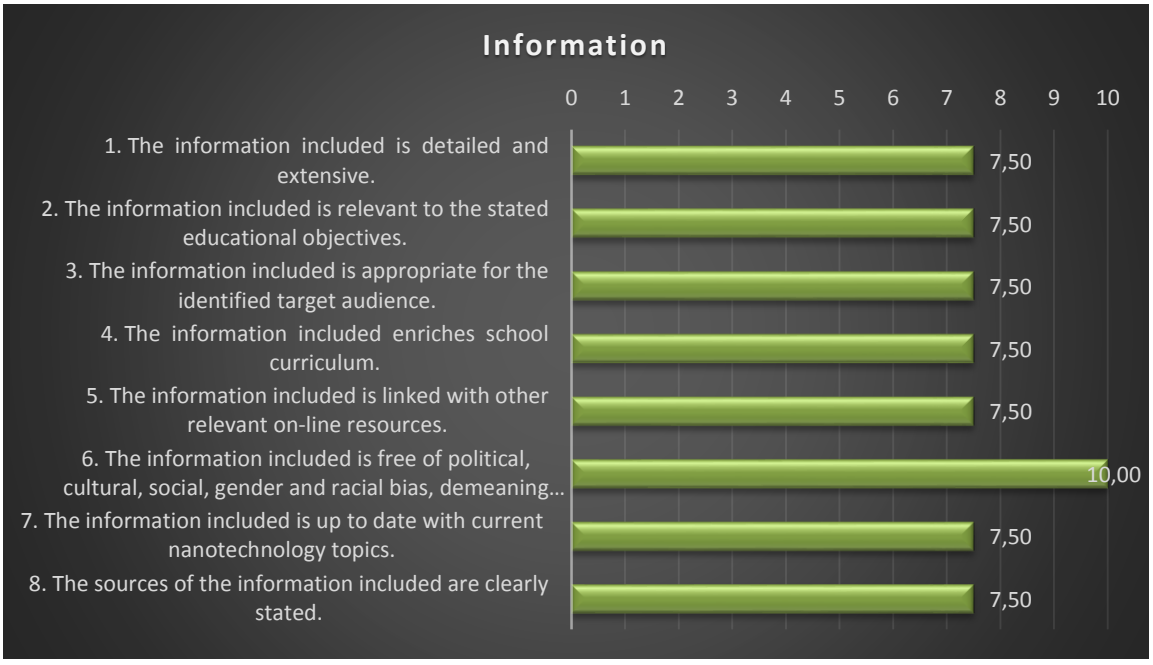
Regarding the students-focus pedagogical criteria the teacher also believes that the educational materials fulfill the purposes of the Virtual Lab. According to the teacher the VL allows the students to set his/her own learning objectives and collect / extract information in an average degree.

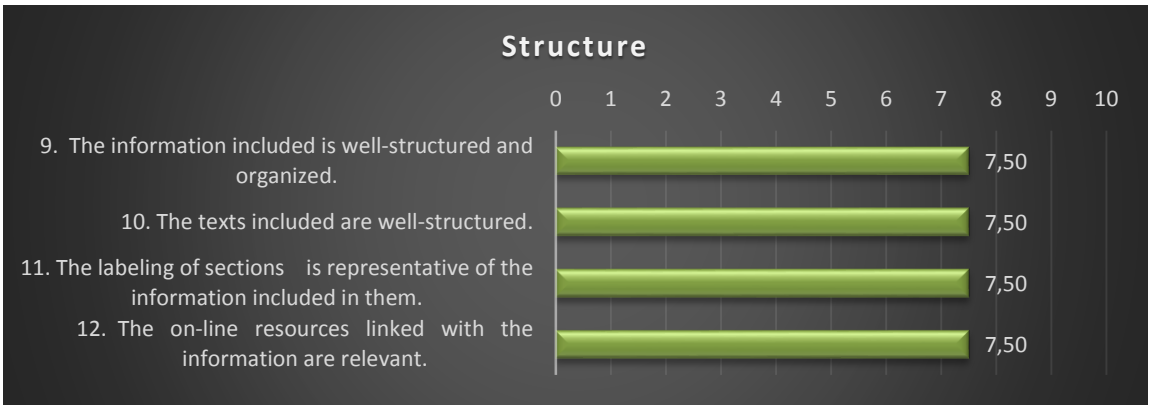
On the other hand, the educational materials provided let the teacher to a high degree to set his/her own learning objectives, have access to information and communicate with his/her students while asking and receiving professional support from nanotechnology experts doesn't seem so easy.

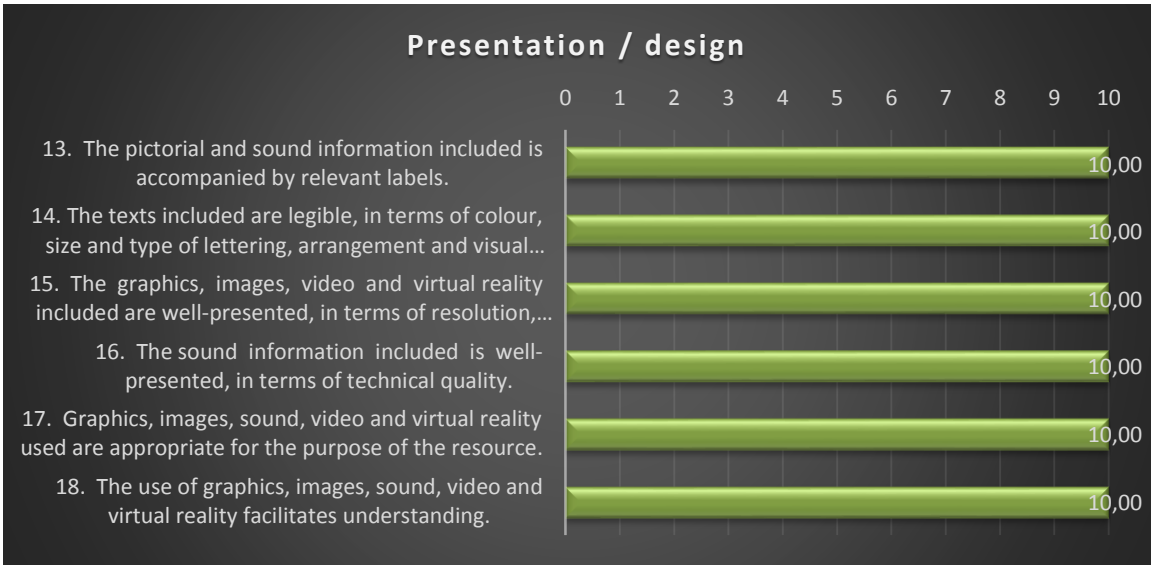
Content Efficiency

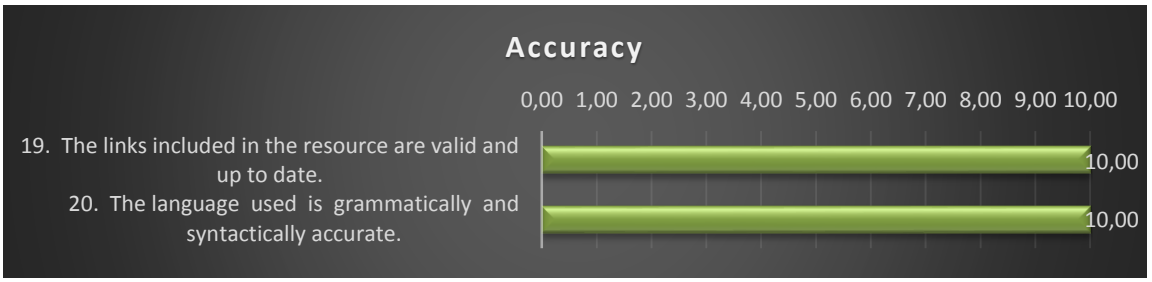
The content efficiency of the Virtual Lab was evaluated with four sets of questions aiming to extract information regarding the Information included, the structure, the presentation / design and the accuracy of the content

The charts below show the teacher's responses:









It's obvious that the teacher much appreciated the information included as per all different aspects, the structure, the presentation / design and the accuracy.

Teacher's Statements

"I spent more time in explaining student's observations. Students always want to learn why phenomena that they observe are happening"

"The hands-on experiment part went really well. Pupils like that and it is missing in the Greek curriculum"

"I would like to implement more Virtual Lab experiments with my students during this school year"

CONCLUSION

The lesson plan "Introduction to Nanotechnology – Nanoscale" let rise the students' interest regarding this science field and allowed them to contextualize some concepts regarding nanotechnology, size and scale and biomimicry.

The students enjoyed the lesson and learned many new things. Some of them had difficulties with the tests but in general, they seem to have a good grasp of the subject. No significant differences regarding girls and boys perceptions of the Nanotechnology concepts were observed. Boys scored slightly higher in most statements, while girls seen to comprehend better the relation between size and physical properties.

The teacher much appreciated the information included in the Virtual Lab as per all different aspects, like the pedagogical approach, the structure, the presentation / design and the accuracy of the content.

Figure 8: PowerPoint presentation screenshots

Figure 9: Implementing the "Nanoscale" Lesson Plan