A CASE STUDY ON

Introduction to Nanotechnology – Nanoscale

in Argiroupoli High School, Rethymnon, Greece

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INTRODUCTION / BACKGROUND

This Virtual Lab implementation took place in Argiroupoli High School, Rethymnon, Greece in October 2013. The work was conducted in one 10th grade class with 16 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: 10th grade students

THE EDUCATIONAL SETTING

Argiroupoli is a village in an agricultural area in Rethymnon prefecture, Western Crete. Students from this high school participated in the nano poster competition and the school was represented with two posters during the final phase of Nanotechnology poster competition in Antalya, Turkey in April 2013.

The physics' teacher that conducted the implementation, **Ioannis Sgouros**, participated – as an expert- in the nano science camp in Baltchic, Bulgaria in July 2013 camp where he implemented the "Atomic Force Microscope" activity. Ioannis is a PhD student (Teaching nanoscience in Secondary Education, Pedagogical Department, University of Crete), has four years of teaching experience and a great experience in using online resources in teaching and learning.

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 related video and 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 no deviations from the original lesson plan:

Figure: Screenshot from the documentary "Powers of Ten"

Introduction to Nanotechnology 10 minutes	Short Description of the Activity and Short Theoretical Background Nanotechnology Applications
Powers of Ten 15 minutes	A short documentary on the relative scale of the Universe according to an order of magnitude (or logarithmic scale) based on a factor of ten, first expanding out from the Earth until the entire universe is surveyed, then reducing inward until a single atom and its quarks are observed. Questions on the video
The Scale of the Universe 10 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. Comparison of objects
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 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.

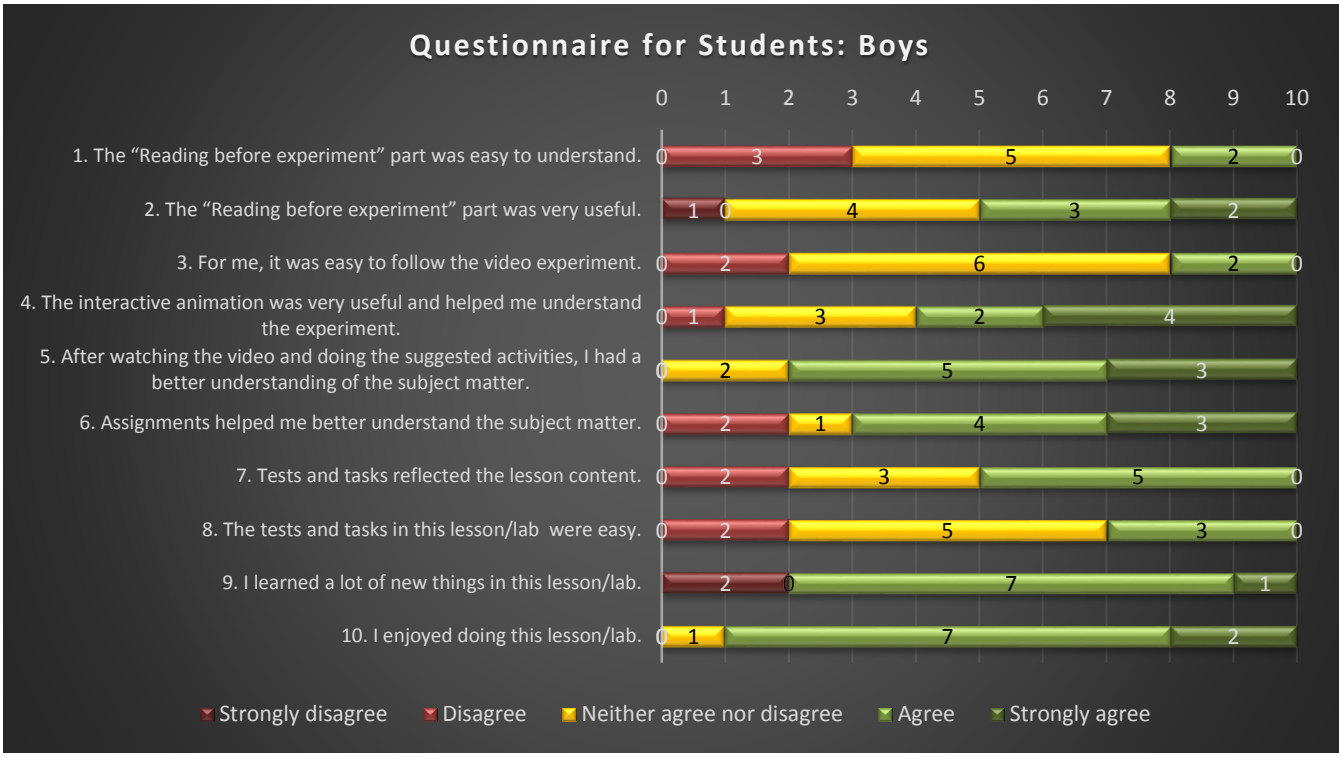

Figure 1: Questionnaire for students – Boys' responses (n=10)

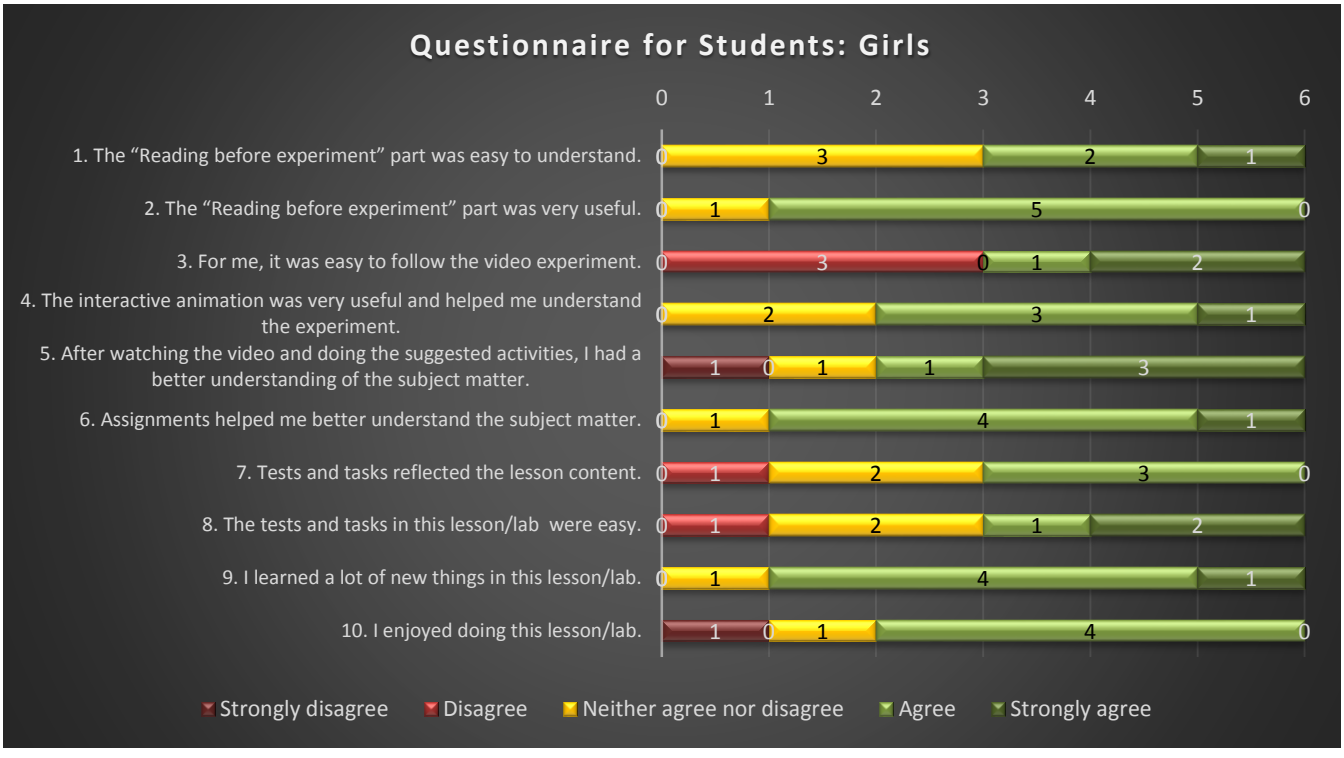

Figure 2: Questionnaire for students – Girls' responses (n=6)

According to students' views, they enjoyed the lesson and learned many new things. The video as well as the assignments, helped them understand the nanoscale. On the other hand, they did not find the "Reading before experiment" part easy and many students (particularly girls) found it difficult to follow the video, probably due to language issues since the video was in English. Despite that, the video and the assignments helped them to understand the subject matter.

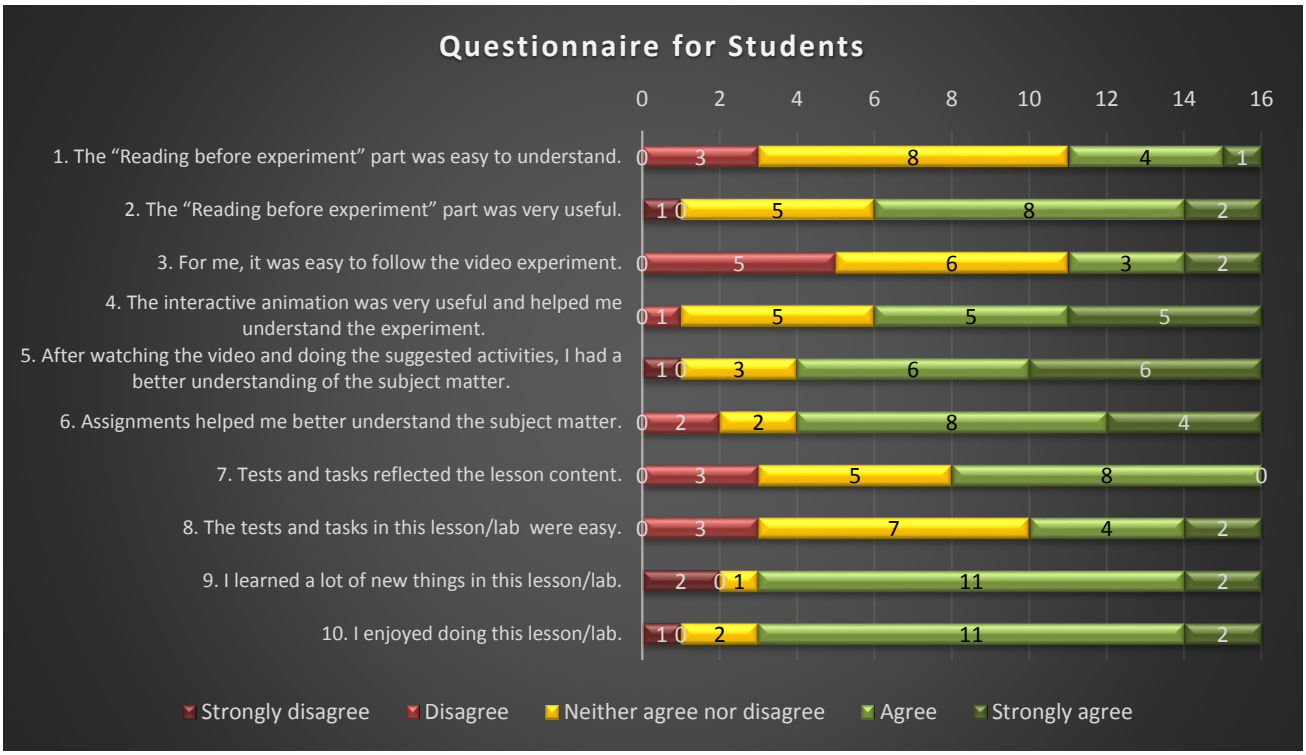

Figure 3: Questionnaire for students – Responses from all students (n=16).

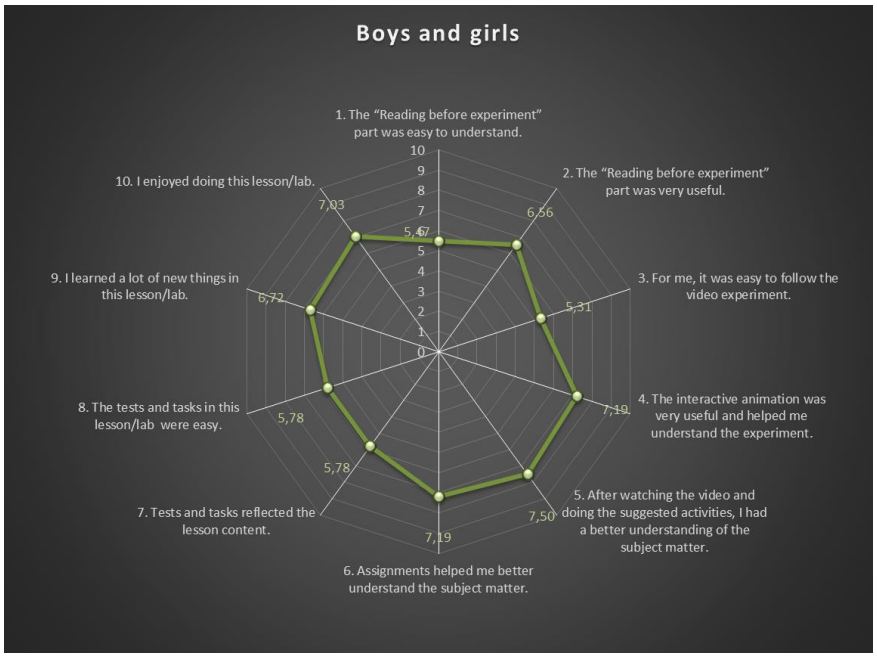

Figure 4: Questionnaire for students – Responses from all students (n=16), mean numbers

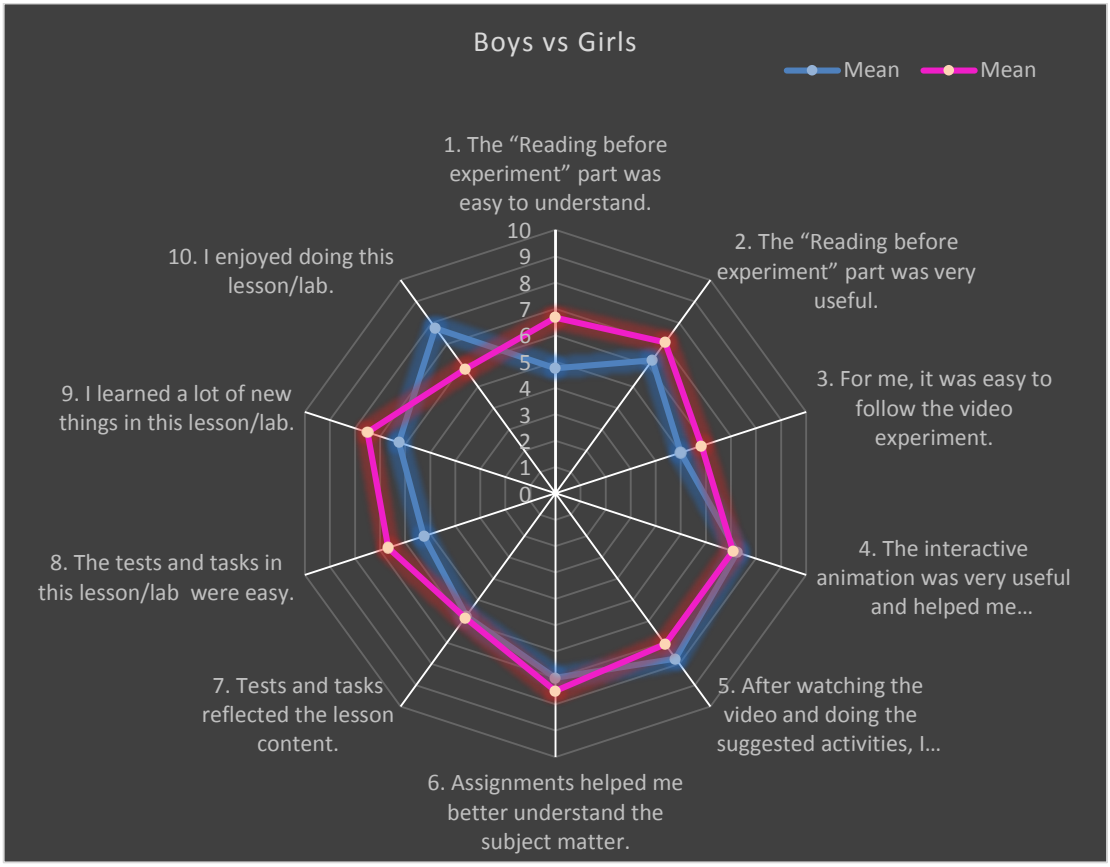

Figure 5: Questionnaire for students – Responses from all students (n=51), boys vs girls.

There are no significant differences in views between boys and girls. The boys seemed to enjoy the lesson more while the girls found the "Reading before experiment" part and the tests easier. In general boys scored higher in most statements except the one regarding the video experiment.

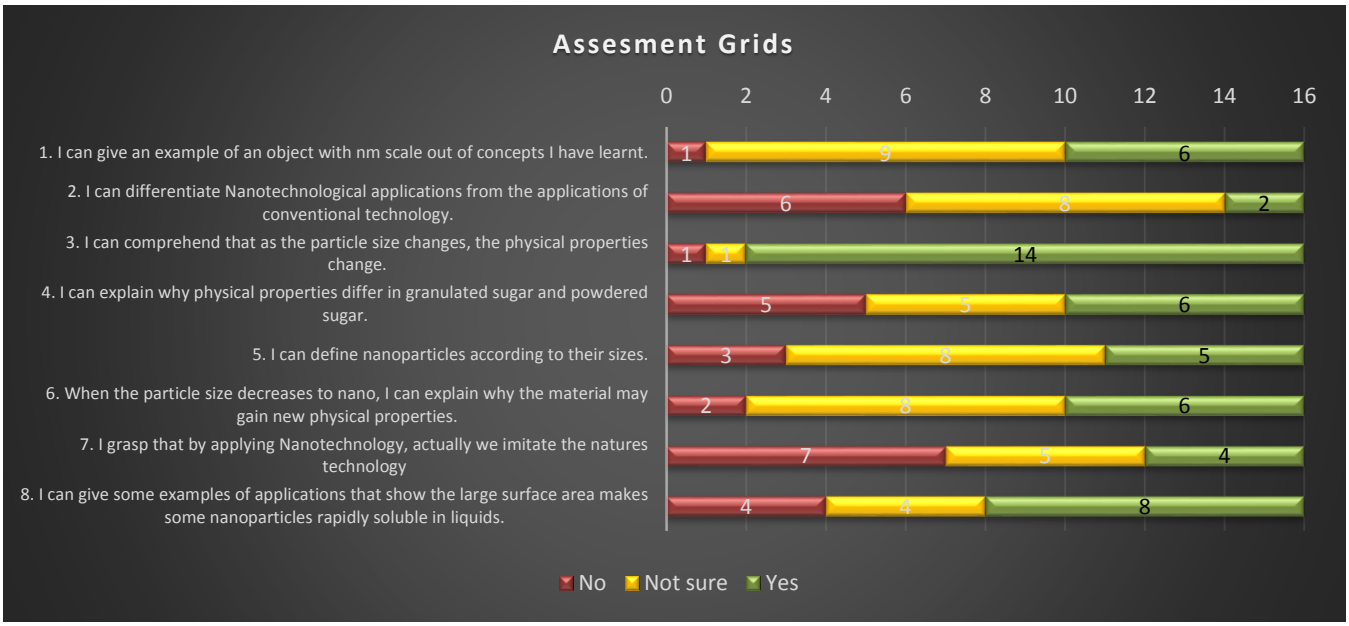

Figure 6: Assessment grid – Responses from all students (n=16)

The analysis of students' responses in assessment grids shows that they comprehended in a high degree the relation between particle size – physical properties. They experienced difficulties in differentiating nano apllications from conventional technology applications.

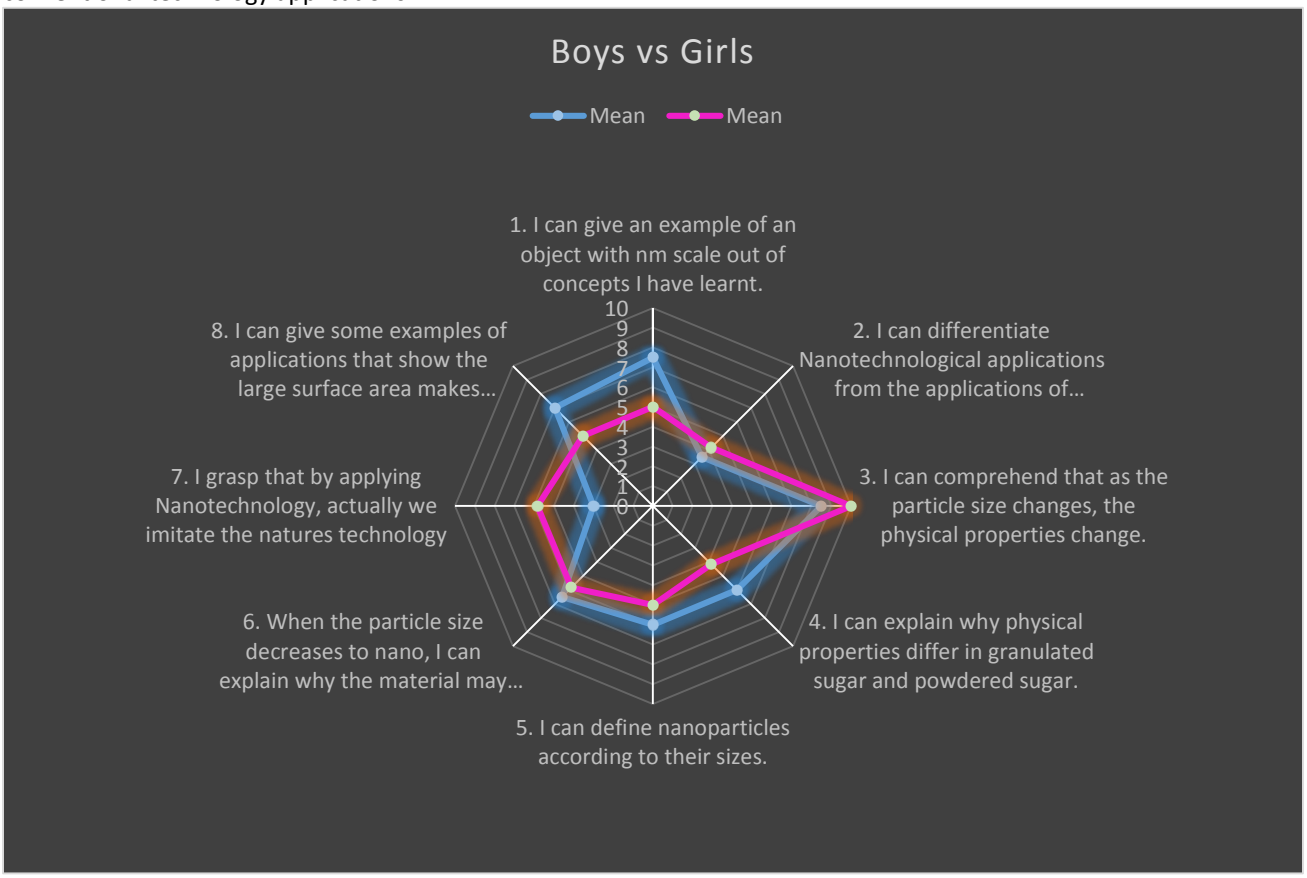

Figure 7: Assessment grid – Responses from all students (n=16), boys vs girls.

Boys found it easier to give examples of objects on the nanoscale and nano applications related to size/volume ratio. On the other hand, girls had a better grasp of the idea of biomimicry. According to the teacher not much attention was given in the biomimicry concept during this lesson.

TEACHER'S STATEMENTS

"Understanding Nanoscale went really well. The educational objectives linked to students' pre-knowledge" (10th grade students)

"The educational material should be updated regularly"

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.

The students enjoyed the lesson and especially the girls learned many new things. The video as well as the assignments, helped the students to understand the nanoscale, despite the fact that many students (particularly girls) found it difficult to follow the video, probably due to language issues. Boys and girls experienced difficulties in differentiating nano applications from conventional technology applications. Boys found it easier than girls to give examples of objects in nanoscale or nanotechnology applications and made the connection easier between size and physical properties of objects. On the other hand girls got a better idea of biomimicry.