



A CASE STUDY ON Lotus Effect

By

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INTRODUCTION/BACKGROUND

The intervention has been focused on a high school in Naples offering several kinds of course of studies: in scientific, linguistic and socio-psycho-pedagogical area (Liceo Statale "G. Mazzini").

The work was carried out with a high school class (Classe IV Sezione B, 12° Grade), whose students attend a course of study in scientific area. The work concerned two issues: experiment a lesson plan chosen among the ones available in the Virtual Lab of the NTSE Project (Lotus Effect) and integrate the lesson plan with an activity (Creating a model of the Lotus Effect) proposed in the Nano Camp in Bahlchik (Bulgaria).

The activities were carried out on October 8th 2013 by a science teacher, Prof. Chiara Schettini, who took part to the Nano Camp together with two students of the class, Riccardo Bordi and Davide Cagno, whose poster (Nano for diabetes mellitus) was one of the winners of the Nano Competition.

The class involved is characterized by the high average in level of scientific skills of its members (28 students) and in that period hosted a science teacher trainee, Dr. Sara Fiorentino, who was involved in the intervention.

(DEFINITIONS/NOTIONS/TERMINOLOGY)

Nanotechnology:

Lotus Effect:

Superhydrophobicity

Biomimicry

PURPOSE

The main task of the activities has been to introduce the students to the properties of hydrophobic surfaces through IBSE methodologies. Then the student will have to work in a cooperative way to solve a problem proposed by the teacher.

OBJECTIVES

The lesson activities are designed for *students* from the 8th to the 13th grade.

The objectives are:



- Learn about properties of lotus leaves, comparing them with other plants leaves
- Learn about application of nanotechnology in the contest of Lotus effect
- Learn to develop hypothesis and experimentation
- Realize impact of technology in everyday things

The proposed activities allow students to:

- Describe the behavior of water on superhydrophobic surfaces.
- Define "lotus effect" and describe its water-repellent and self-cleaning properties.
- While conducting investigations, use the science themes to develop explanations of physical and chemical interactions and energy exchanges
- Identify questions they can investigate using resources and equipment they have available

LEARNING RESULTS

- Describe the behavior of water on superhydrophobic surfaces.
- Define "lotus effect" and describe its water-repellent and self-cleaning properties.
- Describe situations in which a superhydrophobic lotus-effect surface would be useful.
- Use models and explanations to predict actions and events in the natural world

CLASSROOM MANAGEMENT & SEQUENCE OF EVENTS

Before the activity started in the classroom, students should have read on their own the text on Lotus effect available in the Documents Room of the Virtual Lab.

Then the activity was split in 4 steps-

Introduction and Activity 1 (VL)	The whole class watches the videos 1 and 2 on the Lotus effect available in the Virtual Lab. Students split into small groups (4 persons) discuss the structure of the leaves and their self-cleaning and hydrophobic properties.
Activity 2 (VL): Examining the hydrophobic property of the leaves of different plants	Each group tests the leaves of different plants, some who exhibit the Lotus effect and others who don't, following the worksheet provided by the teacher. Then the students draw and describe a sketch which would explain the different behavior.
Activity 3 (Nanocamp): A model of the Lotus Leaf's property	Each group recreates the leaf surface in a way which will explain the Lotus leaf property using the materials provided by the teacher. They describe briefly the model to the other students.
Activity 4 (Nanocamp):	Each group repeats the Activity 1 , using a piece of hydrophobic



Hydrophobic Textile	fabric.
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RESOURCES

http://www.teachengineering.org/view_activity.php?url=collection/duk_/activities/duk_surfacetensionunit_activities/duk_surfacetensionunit_act4.xml

http://www.teachengineering.org/view_lesson.php?url=collection/duk_/lessons/duk_surfacetensionunit_lessons/duk_surfacetensionunit_les4.xml

http://www.nisenet.org/catalog/media/zoom_lotus_leaf_video

ASSESSMENT SUGGESTIONS

Pre-Activity Assessment

Pre-Lab Questions: After the introductory talk, but before conducting the lab, students should write on note cards their answers to the following questions.

1. How are hydrophobic and hydrophilic different?
2. What is the lotus effect?
3. How is the lotus flower's importance in Asian religions related to this effect?

Activity Embedded Assessment

Worksheet Observations: Circulate throughout the classroom, checking each student's observations, as recorded on the worksheet. Ask questions about student answers to gauge their comprehension, and help them gain clearer pictures of the concepts in the lab and their extensions to real-world engineering problems and products (such as self-cleaning, stain-repellent garments)

Lesson Summary Assessment

Three-Minute Writing: Hand each student a note card. Instruct them to write down — in three minutes — everything they learned in today's lesson. It doesn't matter if the information is out of order. Small diagrams or drawings are fine. Encourage students to try to fill the note card front and back in the time given. Require that they do this from memory — they may *not* refer to their notes.

IMPACT ON STUDENTS

Students showed a real interest for the lesson and its contents.

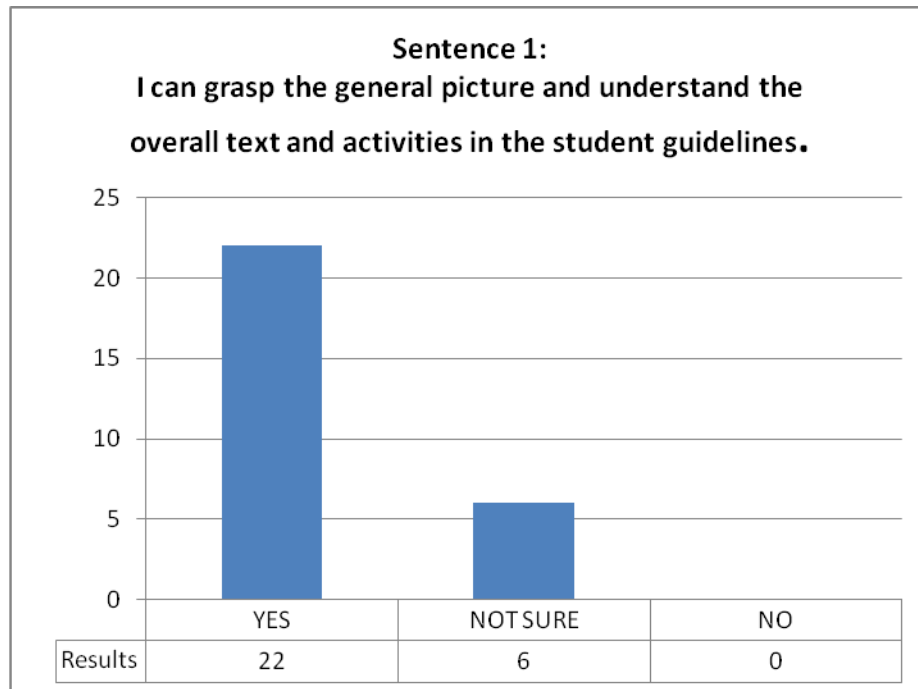


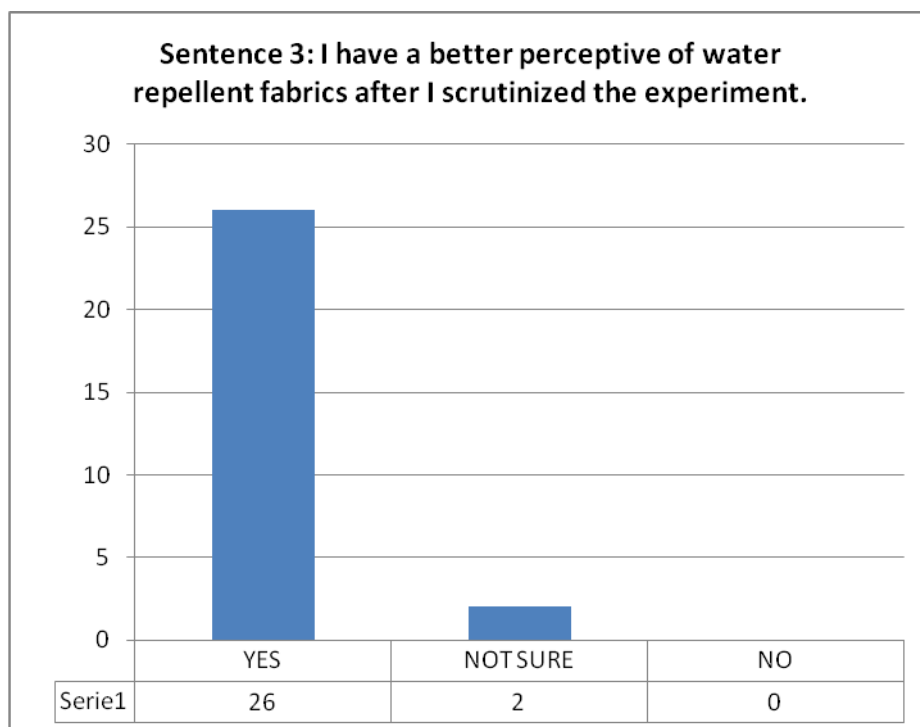
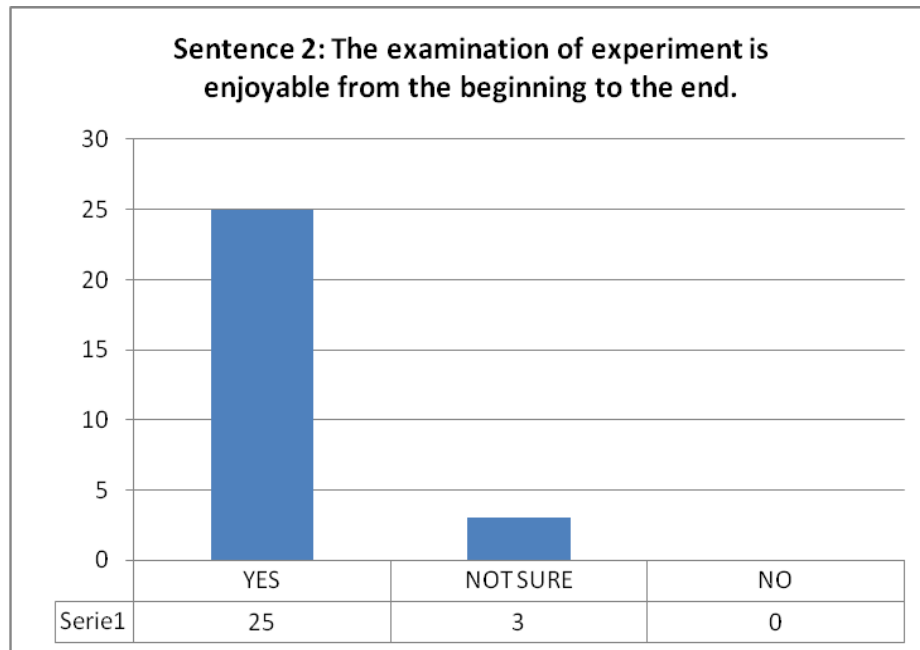
Each group of student built a macroscopic model of surface's structure of lotus leaf. A video showing the different steps of this experience has been realized.

STUDENTS' FEEDBACK

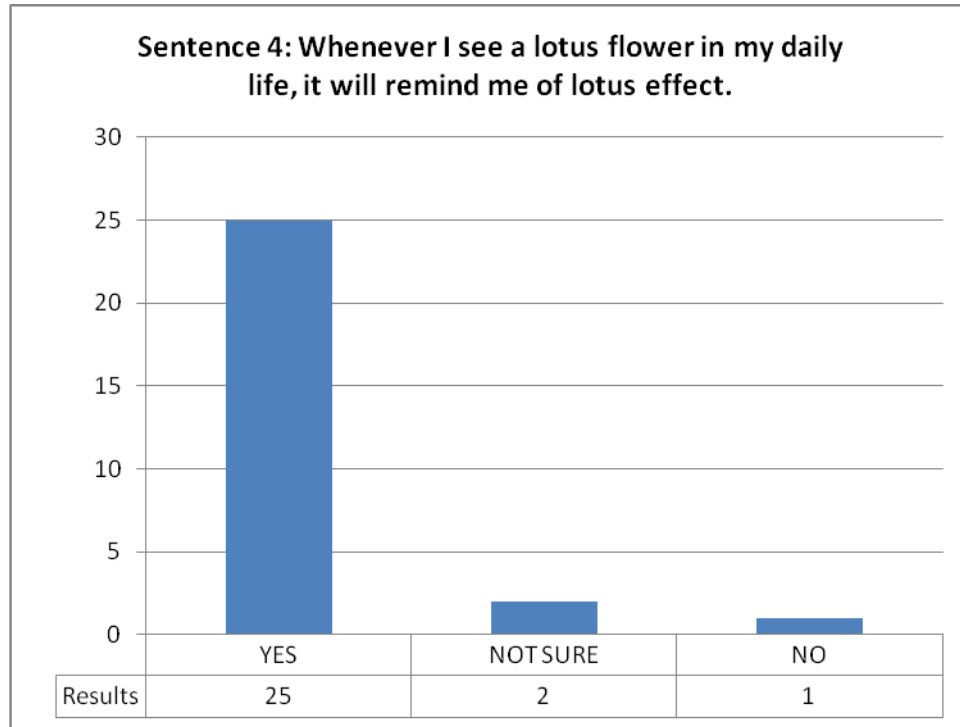
Processed feedback (graphical results):

After the activity the teacher asked the students to fill in the assessment grid and then she received 28 completed examples. The results gathered from the assessment grid are reported below and show a general appreciation expressed by the students.





The large majority of the students agree with the first three statements. These results can be explained considering the previous skills of the students.



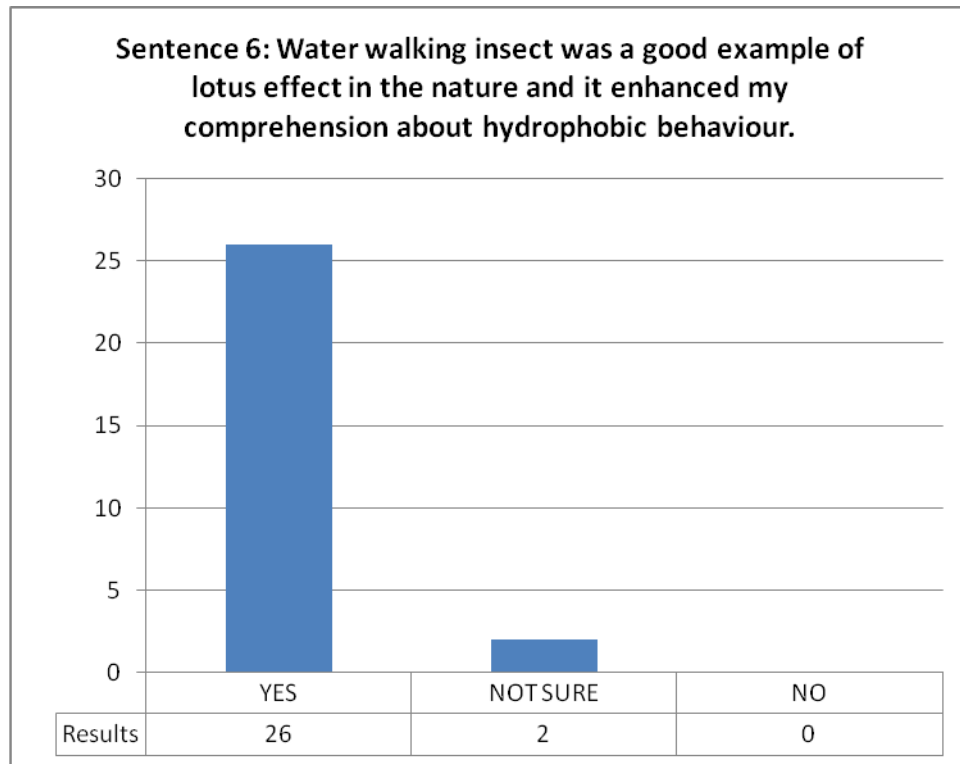
Also in this case we can see a very large majority of the students agreeing with the statement. Anyway we have to consider that the statement concerns an hypothetical future experience the students could deal, therefore not everybody is sure to see a lotus flower in the future.



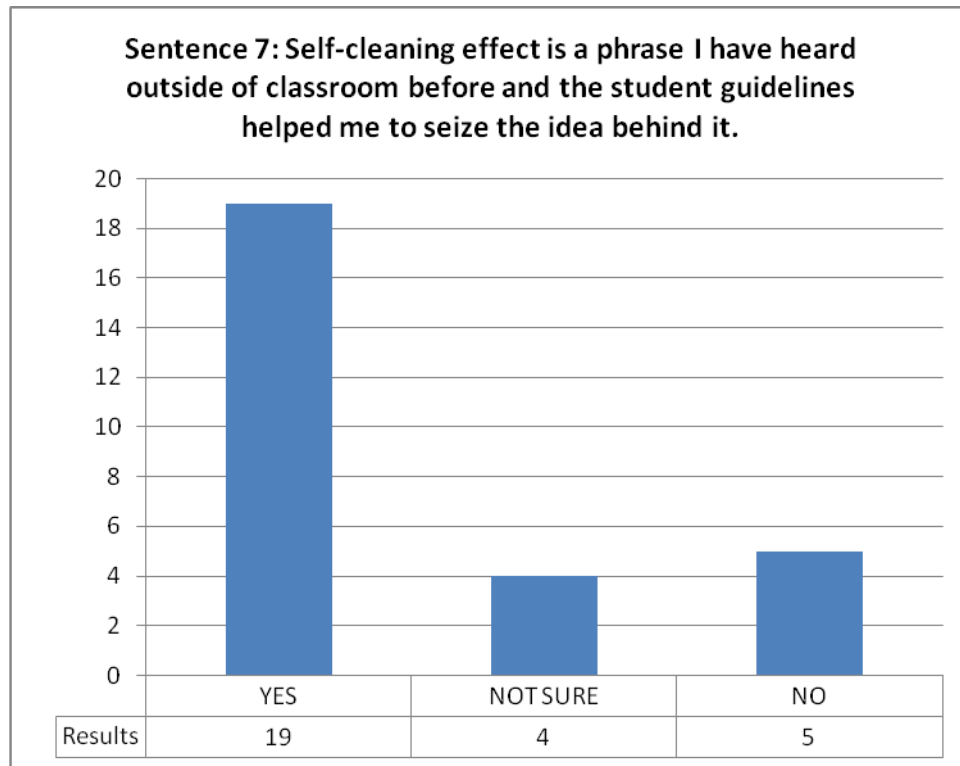
Sentence 5: I would like to takepart in the experiment if our teacher makes the experiment in which hydrophobic paper is painted by watercolors during our science laboratory.



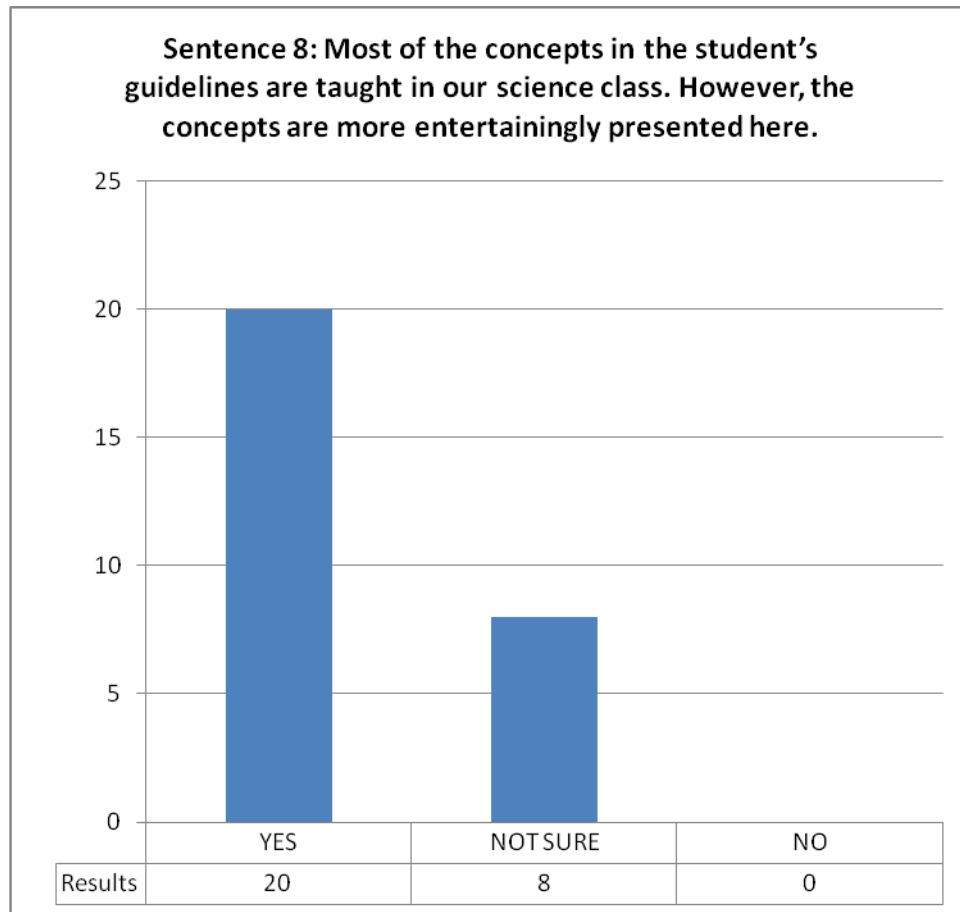
The experience quoted in the statement hasn't be accomplished by the students, for this reason they didn't give a response.



The students just got information about the subject of this statement from the Student’s Guidelines, however the large majority of them agree with the statement.



The results of this statements are more heterogeneous. Notice that the whole sentence contains two different statements, this could explain the resulting uncertainty.



As for the previous, also this sentence could be split in two different statements with different meanings. Anyway the majority of the interviewed students agree with the sentence.

CONCLUSION

The lesson plan about lotus effect lets rise the interest of the students in the study and the applications of nanotechnologies and it allowed them to contextualize some concepts (e.g.; hydrophobic; hydrophilic) previously understood just on a theoretical level.



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The employment of multimedia - provided by the VL or found by the teacher in the web - has been very effective.

The students appreciated particularly the building of the model of lotus leaf. This activity has been carried out as a problem solving activity in a cooperative way.

Finally we consider very interesting the contribution provided by a trainee perspective teacher who attended all the steps of the activity providing the teacher with a useful feedback.

References

Links

<http://vlab.ntse-nanotech.eu/NanoVirtualLab/>

<http://www.nanoyou.eu/>

<http://www.timefornano.eu/>

Images taken during the activity/project/lesson(s)





