



A CASE STUDY ON

LOTUS EFFECT

by

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BASIC INFORMATION:

Irina Kostadinova is a teacher in Second English Language School "Thomas Jefferson". The lesson "Lotus effect" was implemented with students from the 12th grade in the same school. The school is in the capital city of Bulgaria – Sofia.

INTRODUCTION/BACKGROUND

"Nanotechnology is manufacturing with atoms"

William Powell

Nanotechnology is the manipulation of matter on an atomic and molecular level of substances (from 1 to 100 nm or $1 \cdot 10^{-9}$). Because of their huge applications in human life nanotechnology in nowadays are very modern and progressive branch of science.

Scientists often take inspiration from the nature in order to create different materials, devices, systems and human made products that imitate the properties of living organisms. Biological imitation of nano and macro scale structure and processes is called nanobiomimicry. Lotus plant (*Nelumbonucifera*) is an example of organism which can clean itself and the explanation of this natural phenomenon is the structure of the lotus leaf.

(DEFINITIONS/NOTIONS/TERMINOLOGY)

nanotechnology, nanoscale, papillae, hydrophilic/hydrophobic, surface tension, capillary action of water, adhesive/cohesive forces, biomimicry, self-cleaning effect, anty-fog, water repellent,

PURPOSE

The "Lotus effect" lesson explores the nanostructure of the lotus plant, how this plant creates



and uses hydrophobic surfaces in nature and how engineers have created human-made products that mimic the properties of these natural surfaces
Students are introduced to hydrophobic surfaces by participating in hands-on activities.

OBJECTIVES

1. To learn about properties of lotus leaves
2. To link science lessons with the process of self-cleaning
3. To learn about applications of nanotechnology in the context of lotus effect
4. To describe cohesive and adhesive forces and their effect on water

The proposed activities allow students to:

- To understand what is this nanotechnology.
- To understand how big nanoparticles are.
- To understand how the Lotuss effect is connected to the very high water repellence or superhydrophobicity of the lotus leaf.
- To understand the natural mechanism of the Lotus Effect
- To understand the term “biomimicry” and its relation with nanotechnological applications
- To understand that surface tension of water is the reason for forming droplets and the properties of the contact surface causes the extension of deformation in the spherical shape of the droplets.
- To comprehend that water is the liquid that wets only certain solids
- To understand the natural mechanism of self-cleaning-
- To comprehend the relationship between surface properties and self-cleaning

LEARNING RESULTS

After this lesson my students know more about:

- Nanostructure of the lotus plant;
- How this palnt creates and uses hydrophobic structure in nature
- How engineers created human-made products that are similar to the properties of these natural surfaces



CLASSROOM MANAGEMENT & SEQUENCE OF EVENTS

Target Group Students in 12 grade (18 years old)

Duration 90 minutes

Subject Areas Biology and Health Education

Class Preparations:

Preparing the materials needed in activities .

Designing the room to watch the experiment videos.

Form of organization: groups, individual (frontal)

Methods: conversation, explanation, discussion, observation, experiments -exercise

Introduction - Students were informed of the main goals of project - Nano Technology Science Education /NTSE/

1. Providing the students the text on “Lotus Effect” in their folders and asking them to read it.
2. Asking the following question about the text.
 - Why Lotus is so interesting plant for scientists?
 - How the lotus surface is represented on the text?
 - Can you explain the structure of the lotus leaf in microscopic level?
 - To understand better the physical phenomenon –lotus effect- lets remember What we already know about water-walking insects?
3. Demonstration of floating needle.
4. Scientific explanation of surface tension.
5. Demonstration of capillary action of water (cohesive/adhesive forces)
6. Demonstration of soap molecules action (hydrophilic and hydrophobic side of molecule)
7. What happens when water is dropped on the lotus leaf?
8. What applications might have been developed by engineers inspired by Lotus effect?
9. Biomimicry – imitation of the nature.

Activity 1

Watching Videos 1 and 2 in order students to understand the lotus effect. Discussing the structure of the leaves and their self-cleaning and hydrophobic properties

Activity 2

Examination (with the help of optical microscope) of the surface of different leaves and their properties to repel water and mud.



Activity 3.

Observation of the action of anti-fog and water repellent spray on glass

MATERIALS and RESOURCES

- Folder for each working place with Students` Guidelines in it;
- Activity materials: –
 - different types of leaves;
 - glasses with water and oil;
 - needles,
 - capillaries (glass tubes);
 - plastic cups with soil and flour;
 - pipettes and droppers;
 - paper towels;
 - microscope;
 - anti-fog and water repellent spray
- Experiment videos

ASSESSMENT SUGESTIONS

- Student worksheet
- Student quiz

name.....class.....№.....

Biology and Health Education – 12.Grade

WORKSHEET

Lotus effect

EVALUATION

Task: Fill in the blanks with appropriate expressions. (5 minutes)

- molecules tend to be non-polar and, thus, prefer other neutral molecules and non-polar solvents.
- is the imitation of the nature.
- One of the remarkable organisms which can clean itself is.....



d. If carefully placed on the surface, a small needle can be made to on the surface of the water even though it is several times as as water.

e. When the capillary is immersed into wetting liquids like water, the water in the capillary.

IMPACT ON STUDENTS

The students were really excited to participate in the lesson that introduces them to complex scientific knowledge about nanotechnology, presented in an interesting and entertaining way.

STUDENTS' FEEDBACK

Expressed feedback:

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Processed feedback (graphical results):

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(Diagrams/Graphs)

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CONCLUSION

After the approbation of the lesson “Lotus effect” I see the location of this lesson in Bulgarian curriculum in 9 Grade (respectively in Grade 10 for language schools) during the study of the water as abiotic ecological factor. In this way the knowledges of students for water like leaving environment and ecological factor will be enriched and they will get an idea of the practical application of natural phenomena in human life(self-cleaning effect and biomimicry).

References

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NANO TECHNOLOGY SCIENCE EDUCATION (NTSE)
Project No: 511787-LLP-1-2010-1-TR-KA3-KA3MP



Videos

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Links

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

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

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