



## CASE STUDY

### Lotus effect

Implemented by

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#### BASIC INFORMATION:

Kremena Dukadinova is a physics teacher at 2<sup>nd</sup> school “Emilian Stanev” in Sofia, Bulgaria. The lesson “Lotus effect” was implemented with 11<sup>th</sup> grade students from the same school. The school is in the capital city of Bulgaria – Sofia.

#### PRELIMINARY INFORMATION AND INTRODUCTION:

Nano  $10^{-9}$ , comparative characterization of the sizes with familiar objects, provoking of interest towards self-purifying of the lotus leaf.

#### (DEFINITIONS/UNITS/TERMINOLOGY)

Surface tension, capillary phenomena, wetting, hydrophobicity and hydrophilicity, polarity of the molecules, полярност на молекулите, cohesive and adhesive forces, bio mimicry

#### PURPOSE OF THE LESSON

Examination of nature’s hydrophobia and its imitation from science in life through nanostructure of the surface of lotus leaf /in the lesson-cabbage leaf/, the students participates and rationalizes hydrophobic features by using practical experiments and demonstrations.

#### OBJECTIVES OF THE LESSON

The lesson and its activities are adapted for students from 11<sup>th</sup> grade and are implemented in physics class.

The objectives of the lesson are:

To show the feature of the lotus/cabbage leaf; connecting the self-purifying process with science-cohesive and adhesive forces and their manifestation with water

Application of nanotechnologies based on the lotus effect

The suggested activities give the students opportunities to...

Observe and study nature’s mechanism and the lotus effect.



Formation of drops depends on the surface tension and the surface impact on the shape of the drop; wetting is possible only on some /which?/ surfaces.

Understanding the mechanism of self-purifying and its connection with the surface tension.

To understand bio mimicry and its use in nanotechnology.

### **RESULTS (THE STUDENTS LEARNED MORE ABOUT)**

The interaction between the constructive particles of water-surface;

Surface tension, wetting, nano structure of surfaces with hydrophobic features;

Bio mimicry- applications of nanotechnologies;

### **USED PROCEDURES FOR MANAGEMENT OF THE CLASSROOM AND CLASS AND SEQUENCE OF THE LESSON DEVELOPMENT**

**1. video 1, 2**

**2. science information from the Student guide**

**3. presentation with video and video simulations**

**4. discussion**

**5. experiments with leafs from cabbage, hazelnut, cauliflower, salad-and powdered with flour: self-purifying**

**6. experiments with glass plates-clean and processed with waterproof spray, household paper for baking and sheet of notebook paper-powdered with flour for observing hydrophobic and hydrophilic surfaces /with water and oil/**

**8. washing with soap- I depended on the students' experience and I explained the mechanism of the cleaning**

**7. demonstration of wetting with water a pair of cotton gloves- the one processed with waterproof spray**

### **USED RESOURCES**

<http://www.lotus-effect.de/index.php>

<http://vbox7.com>

<http://www.youtube.com/>

And the links from the used literature from the lesson

<http://wthielicke.gmxhome.de/bionik/pageengl/videos.htm>



### **SHORT DESCRIPTION OF THE LEARNING PROCESS**

Because of the big amount of experiments, interest was awakened towards the observed occurrences.

### **HOMEWORK SUGGESTIONS:**

Video <http://vbox7.com/play:fde50f32> and classification of the applications in the practice. According to them which is more significant-can they define?

### **IMPACT ON THE STUDENTS:**

The lesson provoked interest towards the micro world through observation, experiment and analyses of the effect of the lotus leaf and some applications of the nanotechnologies.

### **CONCLUSION:**

Both boys and girls are interested towards micro and nano world of the technology applications and of bio mimicry in the science education, especially in the explanations. But only one lesson is not sufficient for the course of education.

**RECCOMENDATION** – to be explained the dangers from the incorrect use and application of nanotechnology

### **LINKS:**

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

<http://ntse.ssai.valahia.ro/>

### **ADDITIONAL INFORMATION:**

On the preparation of the activity- I looked at the elaboration the lesson LOTUS EFFECT, which is part of the project/ of course after I've seen the provided ones- my English is not very good and from the two lessons in Bulgarian I decided that this one is more attractive and interesting for the kids. Because for the students is much more memorable the practical experience of the knowledge.



For the students I prepared text from 1 page, for awareness of the order  $10^{-9}$ m through comparing the scales of some everyday objects with the purpose to draw attention and to provoke interest towards modern science.

I practically viewed and tried on different sheets how to illustrate the effect and where the painting looks more attractive. It was hard for me to find fresh leaves- autumn time, fall of the leaves, little time to implement the lesson. As a result I chose leaves from white and red cabbage, broccoli- for the effect and hazelnut leaf and leaves from salad for natural surface, exhibiting hydrophilic properties.

I drew the attention of the students towards the dew-drops or after rain on leaves, grasses- different surfaces. I shortly explained about the lotus leaf as ancient symbol of pureness and I put the problem-why does it purify itself? Could this occurrence be used for making our lives easier?

For demonstrations I prepared flour, spray-bottle with water, pair of cotton gloves-one of them was partly processed with waterproof spray, pan with water. I found in internet simulations of the self-purifying- I could download some.

Because of the fact that the students don't have the habit to observe and study the world around us, I prepared for every team, from three or four students, leaves with hydrophilic and hydrophobic features; white sheet of paper and notebook sheet; two glass plates- the one proceeded with waterproof spray; a glass with water and pipette. The purpose- lotus effect or how nanotechnology applies the perfect natural design in the physics lesson- through experiencing the knowledge "alive".

I relied on the students' experience for cleaning with soap and water and I simply explained technologically how it happens on nano level. I didn't explain which soaps are antibacterial.

During the lesson-interest towards the experiments; comments on the check of the gained human experience.

It was hard for me- good internet, the movie clips from the lesson can be used only online.

Probably it would be good if the nanotechnology lessons are implemented at the end of the science course-there will be more possibilities for making comments on the applications, based on the basic needed knowledge.



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