NANO TECHNOLOGY FOR SCIENCE EDUCATION (NTSE) TEACHERS' REPORT – Bulgaria
Created by Center for Creative Training Association (P6, CCTA)

CONTENT:

Introducing NTSE to teachers in Bulgaria

In the first project phase (September 2011) CCTA had started parallel initiatives to involve teachers from Bulgarian public and private schools into NTSE project activities. One of the first contacts was the Teachers' questionnaire, spread out from top to bottom:
CCTA experts contacted all 28 regional inspectorates of Education in Bulgaria, targeting the experts, responsible for science education. Starting there, experts were granted questionnaires template that was sent to all science teachers in the specific region. The project team also got access to the names, e-mail addresses and schools of the interested teachers.

The questionnaires show some interesting results, like:

- All of the responders say that would like to have updates in their curriculum
- Teachers desire more content and activities in the field of environment education (like ozone layer, energy efficiency) and are less willing to have new content and activities in topics like optics, radio waves, medicine (life, death and human soul).
- 94% of teachers believe that more time should be dedicated to science education, in all of its aspects (practice, experiments, discussions, self-preparation, etc.)
- 95% say they know about Nanotechnology
- For all teachers Nanotechnology is something different, and its application is not clear
- Most of teachers say they are good in ICT, while 7% say they are poor ICT users, 8% say they are excellent in ICT. 7% say they have average skills in using ICT.

Testing preliminary NTSE activities in classrooms

In John Atanassov High School of Electronics, Sofia, Bulgaria, teachers used an interesting approach:
Students were left with a Nanotech educational kit and instructions in English. The task was to discover the contents of the kit, to shoot videos, upload in Youtube™ and to explain what is observed in those videos to their class and school-mates. The process was managed by Mrs. Milena Gosheva, physics teacher in the school.
Milena Gosheva: "For students was unnatural to discover and then present learning content by themselves. The frustration rapidly grew in excitement, while having real technology (nano)

examples in your hands was 100 times more effective than having a textbook. Students showed me new sources of information, when searching for scientific explanations of what is in their hands. I am proud of them. Later Nanotechnology was part of every lesson and discussion".

Youtube videos, on Nanotechnology created by students, as homework (all unlisted, not public):
Si Sand - http://youtu.be/QNQbhN1tMQY
Ferrofluids - http://youtu.be/Nb3nzGcL4Xo
Magnetic Strip - http://youtu.be/2RagVP7Jk08
Impregnated textile - http://youtu.be/8HiH3Fvaxkw

Mrs. Milena Gosheva hosted three video-conferences with different classes in the very same school and involved more than 100 students in the field of Nanotechnology.

More about the video conferences:
Four videoconferences were conducted with Bulgarian school participation. Three of them took place in John Atanassov High School of Electronics, Sofia, Bulgaria. Project expert from Bulgaria was present during the conferences.

Topics of the video-conferences were: "Nanocrystal Fabrication"/ Toothpick Activity, Led (Light Emitting Diodes), Making Origami Buckyball, Understanding Nanoscale

One videoconference took place in 2nd English Language School "Thomas Jefferson" with 12th grade students and a PhD researcher from Forth, Yorgis Androulakis and Alexander Angelov took part in the video-conference to ensure the smooth implementation. The students from Bulgaria had prepared in advance a set of questions for Eleni Papananou (PhD student) and the participants conducted a Q&A session about nanocomposites.

Testing preliminary NTSE activities in classrooms CASE STUDIES DONE BY BULGARIAN TEACHERS:

The case studies in Bulgaria were implemented by 5 teachers with 165 students from 8th grade (lower secondary school level) and from, 10th, 11th and 12th grades (upper secondary school level) in 4 different schools. The topics chosen by the teachers are:

1. "Nanoscale and Nanotechnology"
2. "Allotropes of carbon"
3. "Lotus effect"

Minding the number of participants in the case studies preparation – the CCTA team decided to introduce electronic feedback forms, all feedback was gathered and systematized using google forms™.
As case studies were developed by five teachers from three schools in Sofia, Bulgaria, teachers used the ready and translated materials directly from the NTSE Virtual lab, and shared the following reflections:

Pros (+):

1. Materials are coherent and well interlinked.
2. Translation is good
3. Embedded assessment grid is useful
4. Procedure is well described
5. Its free

Cons (-):

1. Activities are not directly linked to the general curriculum, which may cause difficulties in future implementation
2. Requires more time than stated
3. Some activities are interlinked, so can be only implemented if you do the previous ones
4. Some require equipment that is not in the classroom
5. Most of additional materials are in English, which may be an obstacle for teachers, not for students

Implementation pictures:

1. **Vanya Gunova, "Prof. Eliliyan Stanev" School, Sofia**

Picture 1 Vanya Gunova, "Prof. Eliliyan Stanev" School, Sofia

Picture 2 Vanya Gunova, "Prof. Eliliyan Stanev" School, Sofia

Picture 3 Vanya Gunova, "Prof. Eliliyan Stanev" School, Sofia

2. Kremena Dukadinova – the lotus effect

Picture 4 Kremena Dukadinova, "Prof. Eliliyan Stanev" School, Sofia

Picture 5 Kremena Dukadinova, "Prof. Eliliyan Stanev" School, Sofia

Picture 6 Kremena Dukadinova, "Prof. Eliliyan Stanev" School, Sofia

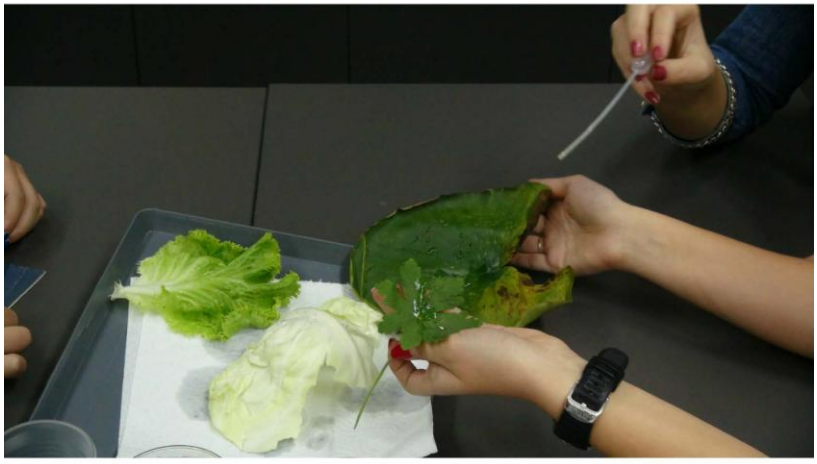
3. **Rosi Sotirova 2nd English Language High School "Thomas Jefferson", Allotropes of carbon**

Picture 7 Rosi Sotirova 2nd English Language High School "Thomas Jefferson", Allotropes of carbon

Picture 8 Rosi Sotirova 2nd English Language High School "Thomas Jefferson", Allotropes of carbon

Picture 9 Rosi Sotirova 2nd English Language High School "Thomas Jefferson", Allotropes of carbon

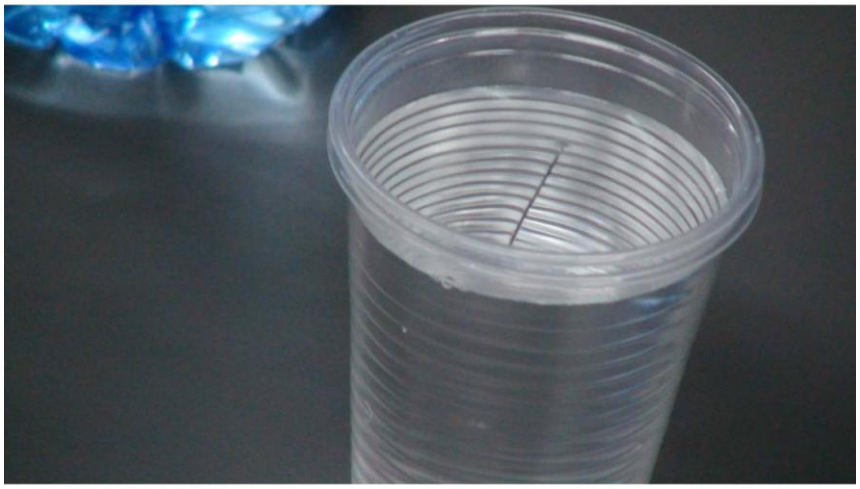
4. **Irina Kostadinova, 2nd English Language High School "Thomas Jefferson", The lotus effect**



Picture 10 Irina Kostadinova, 2nd English Language High School "Thomas Jefferson", The lotus effect

Picture 11 Irina Kostadinova, 2nd English Language High School "Thomas Jefferson", The lotus effect

Picture 12 Irina Kostadinova, 2nd English Language High School "Thomas Jefferson", The lotus effect



Picture 13 Irina Kostadinova, 2nd English Language High School "Thomas Jefferson", The lotus effect

5. **Evelina Vasileva, 7th High School, Sofia and "Lomonosov" VET school, Sofia – Understanding Nanoscale**

Picture 14 Evelina Vasileva, 7th High School, Sofia and "Lomonosov" VET school, Sofia – Understanding Nanoscale

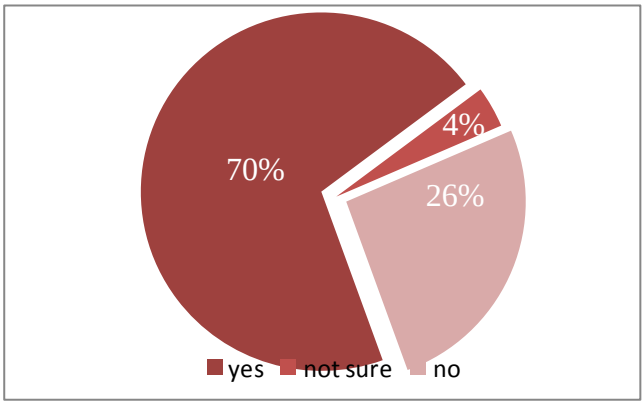
Teachers say:
(Thematic Analysis of the Teachers' Reflections on Implemented Lesson Plans)

- **Having both lower and upper secondary level students enabled comparison on age criteria (shown in graphs below).** Some experiments are more suitable for certain age group.
- **Younger students easily compare properties of elements with nature phenomena**. Activities like Understanding Nanoscale and the Lotus Effect are considered very suitable and easy to comprehend.
- **Elder students require strong evidence before they completely agree with new statements/information.** Teachers share, that very often students question or even object statements. Students know how and from where to obtain information. Therefore practical examples are crucial tool to validate the new knowledge.
- **Language is two-edged sword.** Two of the schools where case studies have been carried out (the 'Akad. Emilian Stanev' Secondary school and the Second English Language High-School) work with a curriculum with intensive foreign language learning in English. This curriculum provides opportunities for "content and language integrated learning" (CLIL) where subject material is thought in a foreign language. The availability of the resources in English in the NTSE Virtual Lab allowed implementation of lessons in English.
- **Nano is interdisciplinary:** Teachers agreed that **NTSE content can be integrated in virtually any subject.** Yes it requires adaptation and investment of time, since NTSE provides

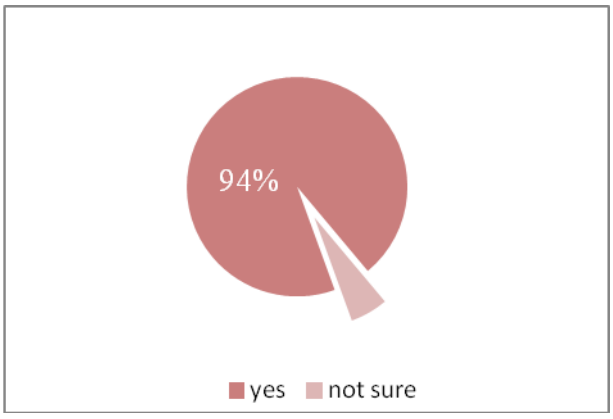
content, but not direct links to other subjects. **And yes, one and the same Experiment from the Virtual lab can be used in different subjects and age groups.**
Adaptation is mostly needed when addressing students below 15. Students 16-18 cope well with the content and have sufficient knowledge to carry out most of the experiments proposed by the project.

Some interesting facts and figures, coming out of the students' feedback forms, after all implementations

Conclusion 1: One lesson virtually plants the idea about nanotechnology to students; the older the students, the better they get the idea.



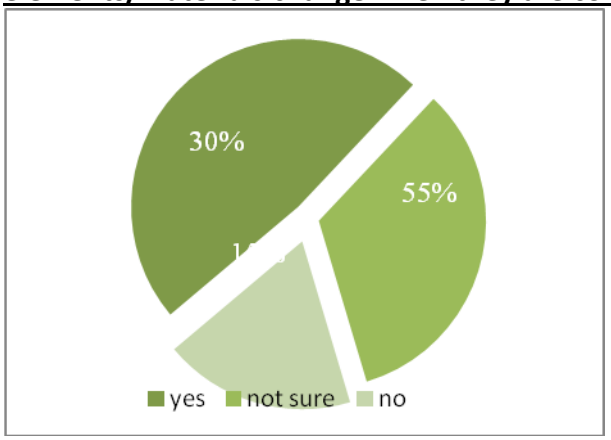
Lower secondary students



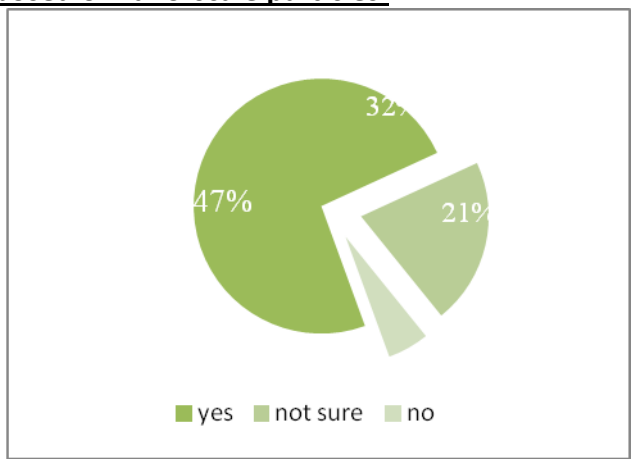
Upper secondary students

Answers to the statement *"I can give an example of an object with nm scale out of concepts I have learnt"* for both lower- and upper secondary students.

Conclusion 2: One lesson is not enough to explain how physical properties of elements/materials change when they are composed of nano-scale particles.



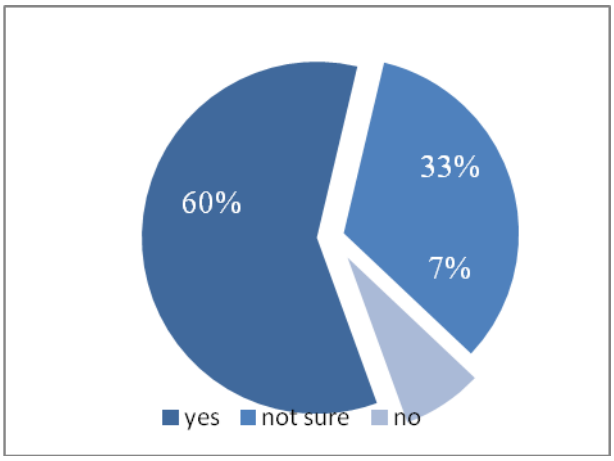
Lower secondary students



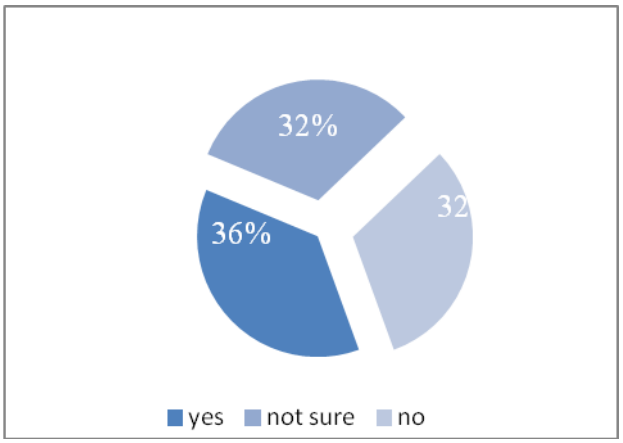
Upper secondary students

Answers to the statement *"I can comprehend that as the particle size changes, the physical properties change"*

Conclusion 3: some experiments are better than others for certain age-group and for explaining certain phenomena. Students are challenged to transfer knowledge between subjects. Lower secondary students experimented the Lotus Effect, while elder students did other experiments.



Lower secondary students

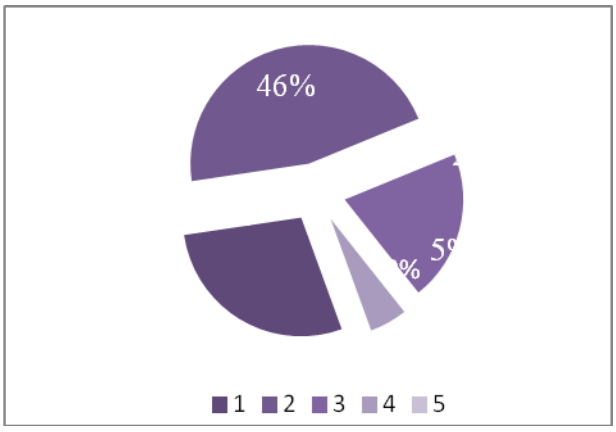


Upper secondary students

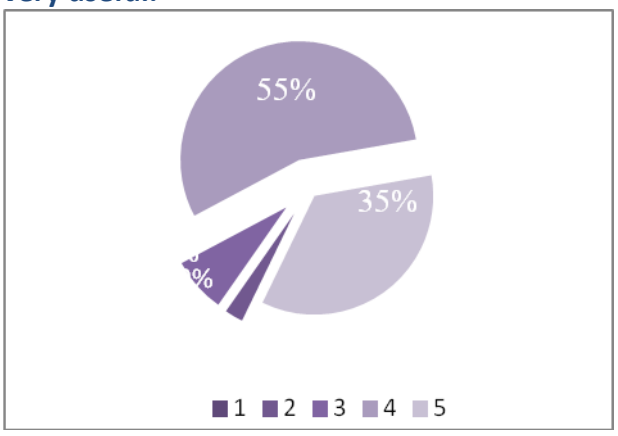
Pros and cons of the question *"I grasp that by applying Nanotechnology, actually we imitate the nature's technology."*

Conclusion 4: Students' guidelines were difficult to understand for almost half of the students in all lesson plan implementations! First, that might show differentiation in the level of knowledge inside the very same classroom, second, looks like not all students learn by reading. Some prefer videos or other explanations. Though, they all consider reading the instructions useful!

The "Reading before experiment" part was difficult to understand.



The "Reading before experiment" part was very useful.



1 – Strongly disagree; 5 strongly agree

Bulgaria, as NTSE partner country organized a delegation of five teachers, led by a scientist *(Assoc. prof. Mrs. Daniela Karashanova, also Interviewed as successful female scientist in the project gender aspect priority; video is available in the podcasting room of the Vlab)*.

Participation details:

- All teachers that developed case studies were granted the opportunity to attend the **International Nano-Tech Science Education Congress (INT-NTSE)** and present their achievements. The presentation was developed as one coherent product, built collaboratively in PREZI (link to the presentation).
- The event agenda is present at the project website: http://www.ntse-nanotech.eu/int-ntse-congress.asp
- Teachers agreed that topic-oriented seminars are a tool to foster collaboration and exchange between teachers, and such are positive and effective events.