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Abstract

In the Nan-O-Style project, high school students (*i.e.* 16-17 years old) tested various protocols of experiments in nanotechnology and evaluated them whether such experiments could also be performed by middle school students (*i.e.* 11-15 years old) or even elementary school students (*i.e*. 6-10 years). Pre-selected protocols, provided by the instructing team consisting of *Sciencetainment* and the members of the Department of Biosciences, University of Salzburg, were applied. Laboratory techniques such as thin-layer chromatography, measuring the contact angle by high-resolution 3D microscopy and analyzing and constructing surface layers represented some of the experiments performed. Moreover, students produced short video clips and images and designed photo-collages out of microscopic and electron microscopic pictures. Hence, the school students acquired a number of soft skills during this special science day.

Keywords

Nanotechnology; Experiments; Arts, Inventive Thinking; Creativity; Heroes.

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Introduction

Nanotechnology has arrived in every-day life. It can be found in a large variety of daily products. Nanomaterials enable a number of great new functionalities due to the specific physico-chemical properties that materials obtain in the size range below 100 nm (Rotello 2004). Exploring nanotechnology by experiments (Fig. 1) and designing art products in peer groups was the main focus of an especially designed science day for students following principles effectively transporting nanotechnology content (Williams and Adams 2007). After presentations on seven different protocols shown by the instructing team, the students decided in a public "casting show", which one they wanted to explore in detail. One of the protocols was specifically designed for so-called "heroes" because this protocol has not been tested before and the instructions were in English, while the native tongue of the school students here was German. All Students did the experiments completely on their own. Teachers and instructors only provided chemicals and laboratory equipment.

Figure 1: Students while experimenting

Project results and discussion – Experiments

During the science day students constructed special **nano-surface layers** on copperplates and compared the **precision of measurements of contact angle** measurements of mobile phone apps (e.g. Imagemeter) with a high-tech-3D-microscope (Fig. 2), or verified **nano-particles in green tea** with the so-called Tyndall-effect (Heller and Vassy 1946). A laser pointer gave evidence for nanoparticles in the green tea showing refraction (Tyndall-effect).

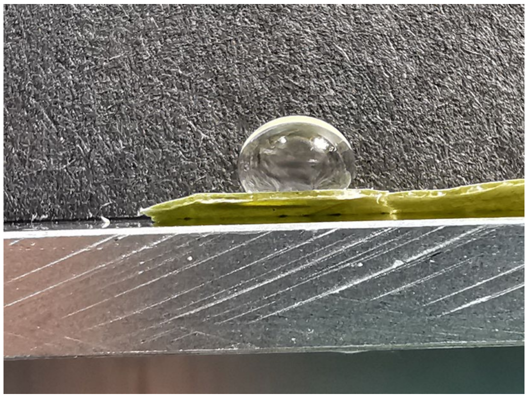

Figure 2: Water drop on a plant surface (Kilian Kirchgasser, mobile phone camera, plant: Bryophyllum sp.)

The school students, furthermore, segregated nanoparticles of carbon black produced by a candle on a slide via **thin-layer chromatography** or explored the surface of the **lotus plant** with a high-tech-3D-microscope to get to know what the so-called lotus effect is all about. They tested **hydrophilic and hydrophobic properties** of different fabrics or plants and experimented with **ferro fluid**, a magnetic colloidal fluid that is applied for example in cancer therapy. As a special highlight some students tried to produce ferro fluid on their own, which was in fact a dirty job, but it worked – maybe they mutated to the real "heroes of the day" (Fig. 3).

Figure 3: Producing ferro fluid out of sun flower oil and black powder for laser printers

Project results and discussion - Arts

Ferro fluid allows creating different shapes and structures by moving neodymium magnets beneath the fluid layer. The resulting figures and movements lead to very astonishing **pictures** (Fig. 4). The school students captured the movements by **videos** with their smartphones. The resulting movies were supplemented with music ranging different styles (classical to pop music), hence, the term dancing liquid was created.

As a next step, students designed **photo-collages** (Fig. 5) out of pictures they made with a special loupe attached to the camera of the mobile phone to obtain microscopic impressions of materials in their surrounding and electron microscopic (EM) pictures. Some of the EM images were derived from a recent visit of one of the teachers (K. Schaffer) at Baylor University, Waco, Texas, USA.

Figure 4: "Light bulb" - a screw in ferro fluid (Sophie Bachner, mobile phone camera)

Figure 5: Photo-Collage "micro meets nano" (Julian Schmeel)

Conclusions

The students appreciated working in a special designed laboratory and honestly evaluated the protocols of the experiments giving feedback to the plenum and discussing possibilities to optimize the experiments. Furthermore, the questions if there has to be previous knowledge or if the instructions led to misunderstandings were analyzed. Learning by doing, solving problems in groups and exploring something completely new were the benefits of this science day. The creative part was a lot of fun and students reinforced each other in implementing new ideas. Art products were collected and are shown in an exhibition at school. It really was a great experience of “sparkling science”.

References

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