

## **Multi-level simple experiments: an approach with increasing cognitive demands**

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Simple experiments are indispensable part of physics teachers' repertoire. Simple experiments are met in various activities ranging from demonstrations to home experiments, as a base for active learning methods, for student projects or even as a base for competitions. But there is more than that. Carefully selected simple experiments offer also a great opportunity to be presented as sequences of structured problems that all together form complete stories. The central characters are the same through the whole story but the depth and cognitive level is gradually increasing from simple demonstrations of the phenomena, problems that promote qualitative reasoning, problems that require observations, predictions and construction of mathematical models, to more complex reasoning and design of measurements suitable for introductory physics in high school or first year university level. Teacher may take and use in the classroom just part of such a story, depending on the level she teaches, but understanding the whole story gives her deeper and wider view of the problem and thus increases her professional self-confidence which is so essential for successful implementation of active learning methods. Examples of multi-level simple experiments will be presented.

### **Project laboratory – the first step in developing science competences**

The experimental work is the integral part of physics education. The prevalent form is Physics Laboratory where students work alone or in pairs on pre-defined problems following the instructions from the lab manuals. These types of labs are essential for acquiring basic skills in handling different measuring devices and data analysis but are in constant danger to become routine, unstimulating and remote from students' interest.

A different type of experimental work is known as Project Laboratory, which is less structured, more explorative and usually includes work in groups.

I will present eight years experiences of leading Project laboratory for first-year physics students studying on the first cycle of university level and at higher professional level. Special features are short term project tasks (each group of students has only three weeks to complete the practical part of the project) and web reports. The subject is aimed at developing important science competences and skills through concrete steps in circumstances that are similar to those met in real life situations. The structure of the subject and project tasks proved to be suitable also for students at pre-university level, after minor adaptation. Strategies for planning successful project tasks will be discussed and examples will be given.

## **WORKSHOP:**

### **Making "invisible" "visible" (or without the quotation marks)**

In teaching physics we are constantly challenged how to show or demonstrate pupils the phenomena that are not perceptible to our senses. The motivation to do this can be different. Sometimes we want to show tiny movements, see or measure microscopic dimensions, illustrate the existence of imperceptible properties (such as magnetic or electric fields), show presence of invisible substances (such as gases) and many more.

After short introductory talk the participants will explore in groups several less common approaches in making "invisible" "visible".

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Let me describe in short about some basic characteristics of the physics as subject in school, about secondary school physics teacher training in Slovenia and how I am connected with all this.

School system in Slovenia

Primary school: age 6 – 15

Secondary school: age 15-19

University: 19- (we adopted so called Bologna declaration, which is aimed in unifying European higher education systems)

Physics as a compulsory subject appears in the last two years in primary school and in first three years in secondary school (usually 2 hours /week). Only in few specialised (vocational) secondary schools one can avoid physics.

Physics in primary schools is taught by teachers who complete two-subject university degree, education course (for example "physics and math").

Physics in secondary schools is normally taught by teachers who complete single subject university degree (physics education course). I am leading physics education course for secondary school physics teachers at Faculty for Mathematics and Physics, University of Ljubljana.

I was involved in secondary school (age15-19) curriculum renovation in Slovenia that finished in 2008 and is now in implementation. I am a president of the committee for the Matura national exam in physics (exam at the end of the secondary school, i.e. age 19; the exam is called Matura) and I am involved in several projects for development of curriculum material for physics in Slovenia. Slovenian existing school system is relatively successful (for instance in PISA 2006 we were on 12th place in science) and I believe that last renovation will even improve our achievements in science subjects.

I am also leading a continuing education program for physics teachers (since 2000) and I am co-funder and co-worker of Slovenian hands-on Science centre The House of experiments.