Interdisciplinary approach of nanoscience using PBL method and WEB 2.0 tools

Florentina Iofciu¹, Cristina Miron¹, Stefan Antohe¹

(1) University of Bucharest, Faculty of Physics, 405, Atomistilor Street, Măgurele, Ilfov, ROMANIA
E-mail: florentina.iofciu@gmail.com

Abstract
The unprecedented development of nanosciences demands an interdisciplinary approach addressed to students in middle even primary school. “Nano” has become a buzz word used frequently in scientifically context: nanoparticles, nanotechnology, biomimicry etc. So, it is evident the link with integrated science fields: physics, chemistry, biology. The European project Nanoyou offers a lot of educational online resources to be used in the classroom or to be integrated in science lessons. According to the manifold to be read around the topic is recommended to use constructivist inductive strategies. Problem based Learning (PBL) is a revolutionary teaching approach, calling students' metacognition (i.e. the student’s ability to analyze, reflect on, and understand his or her own cognitive and learning processes). Being a constructivist strategy of learning, PBL can be successfully used together with web 2.0 tools.

Keywords: Nanosciences, Nanoyou, Constructivism, Web 2.0 tools

Introduction
Nanosciences are in foreground due to the technical applications to be found everywhere: gadgets, communications, electronics, and medicine. “Nano” became a buzz word connected with “small sizes”, “the small world unseen”, “and the micro cosmos”. The word itself is a combination of nano, from the Greek “nanos” (or Latin “nanus”), meaning “Dwarf”, and the word “Science.”

The development of nanosciences involves an interdisciplinary approach of scientific knowledge, involves concepts from physics, chemistry, biology, ICT. Unfortunately school curriculum do not include the study of nanosciences, but is possible, at students’ demand teachers develop optional courses on this topic, or involve students in specific projects. The European project Nanoyou (www.nanoyou.eu) offer students the opportunity to learn about new applications of nanotechnology. Teachers have to find the best strategies to attract students in learning activities: to make them be part of the lesson, to work in groups, to communicate, to express themselves in scientific language to present their work using ICT and web 2.0 tools. A suitable solution may be using constructivist strategies combined with some informatics tools to be used in virtual environment.

Constructivism approach in science education
Constructivism is one of the most quoted educational paradigms. To be easy to understand this paradigm, we call on for Hoover’s definition of constructivist learning. Learning is active than passive if what learners encounter is inconsistent with their current understanding, their understanding can change to accommodate new experience (W. A. Hoover, 1996).

Constructivism brings in the foreground active and interactive learning and its efficiencies emphasizes when the knowledge building is realized with the purpose of assimilation by the
others. The others, in this context are like mirrors reflecting what we already know, understand and transmit. This metaphor has to be permanently between the teacher and his student (asymmetric relationship) but also between the student and his teacher (symmetric relationship) (Iofciu, F., Miron, C., Antohe, S., 2011a). For science teaching the constructivist approach is one of the most desirable ways to involve students in their own knowledge building (Iofciu, F., Miron, C., Antohe, S., 2011b).

The using of ICT in science instruction involves the necessity to combine constructivist strategies with collaborative virtual environments, so in the last years increased the proliferation of computer supported collaborative learning (Koschmann, T., 1996).

PBL
One of the most challenging constructivist strategy is PBL (Problem Based learning). PBL has been used since 1950 and till now, it has been suffered many transformations and adaptations due to the evolution of constructivist strategies developed by our teachers. PBL is a group strategy, involving collaboration between students and also between students and teachers.

Problem-based learning is a teaching or training method characterized by the use of "real world" problems as a context for individuals to learn critical thinking and problem solving skills and acquire knowledge. It involves both knowing and doing (Lepinski, C., 2005).

There are several ways conducting PBL as long as the core concepts are followed it is a flexible method of learning driven by the author can be used directly target particular topics as well as for more general scenarios of general knowledge acquisition:

- define the problem clearly;
- explain clearly and in detail exactly what is required for the students;
- explain core concepts, statements or unknown wording;
- form groups(can be tutor-driven or student-driven);
- brainstorm and try to analyze the problem.

Ensure that is a time limit and more information than can be gathered for any one individual. These way students have to cooperate and divide the labor of evidence gathering between them:

- systematically gather evidence;
- re-gather to discuss evidence and develop strategies for remaining information needed;
- within the group developed an answer for the problem posed (Bignell, S., Parson, V., 2010).

Web 2.0 tools in constructivist approach of science teaching
To be able to realize science lessons using computer it is important to create a collaborative online environment. This is possible using common free web 2.0 tools: wikispaces.com, blogspot.com. Using blogspot.com teachers attain to a collaborative environment suitable for group activities. It is possible to post a requirement to be done just in time by the students in a definite time limit, to receive the answers, to have the possibility to display only selected answers (the good ones), to make remarks about the contents and evaluate students as in Figure 1.

Interdisciplinary approach of science
Science learning involves an interdisciplinary approach of the fields of physics, chemistry, biology, mathematics and ICT as in Figure 2.

To understand nanosciences, it is needful that students must have knowledge from all disciplines involved. As the name shows, the natural sciences are branches of science that seek to elucidate the rules that govern the natural world by using empirical and scientific methods (http://en.wikipedia.org/wiki/Natural_science). The distinction between sciences is not very evident, so we have a lot cross-discipline fields resulted as interconnections of different fields of
the studies. Physics have an integrative role; obliviously it is linked with all the other fields. Mathematics offers a good support for demonstration, as an instrument used to express the language of science. ICT is connected with all science disciplines being part of them. Today is very hard to imagine science out ICT; virtual environment offers the opportunity to communicate, to collaborate and to share knowledge and information with others.

![Figure 1 - The blogspot.com interface for the study of Nanosciences](image1)

**Figure 1 - The blogspot.com interface for the study of Nanosciences**

![Figure 2 - Interdisciplinary approach of science](image2)

**Figure 2 - Interdisciplinary approach of science**

**Nanoyou**

Nanoyou Project is a great opportunity to approach interdisciplinary nano sciences in a non traditional way, as to make science more attractive for our students. To introduce the concept of nanotechnologies to middle school students we designed a scheme as in Figure 3, illustrating the concept of nanotechnologies in the context of interdisciplinary approach. There are applications of nanotechnologies in medicine, energy, ICT, environment. All of these applications have become more and more present in our everyday life, so this is why is needed to give them their required attention. To explain rigorously to young students of primary or middle these advanced scientific concepts is out of question in the context of the national curricula. Because of students’ desire to
understand the world around them, teachers have to meet them half way and to adapt instruction strategies as to be facile to approach concepts or facts connected to advanced science concepts.

![Figure 3 - Naotechnologies in the context of interdisciplinary approach](image)

We find resources for actual topics to be studied using group collaborative strategies as PBL: Antibacterial Socks, Nanosenzors Used for Medical Diagnosis, GPS Jackets, Nano-based Solar Cells, Want to Be A Superhuman, Improve Human Brain Capabilities, Revolution For The Light Bulb, Nanoparticles To Detect Food Freshness.

Students from 7th class, aged 13-14 years old selected “Want to Be a Superhuman”. They were randomly divided in small groups, each group having a role play to find an answer to dilemma: *Is it acceptable to use processes developed for medical treatment to enhance the human body?* as in Figure 4.

Each group represents a stakeholder: a scientist, a patient, an ethicist, a multi-millionaire, a private medical centre and a child. To be able to solve the dilemma, students needed some preliminary information about the topic. First, he teacher used the online information to introduce students to the topic. Then, the students accessed the project’s link and selected the information they need teacher to explain. There are available a large resources panel: posters, games, topics for virtual labs, resources to discuss and debate different science controversies. Using this strategy, students also develop European key competences:

- Communication in mother tongue and in foreign languages during all activities. There are a lot of resources in English to be translated, so students can use a foreign language as a tool;
Mathematical competences and basic competences in science and technology, during hands on activities or labs;
Learning to learn – the ability to develop a positive attitude to learning (http://www.salto-youth.net/downloads/4-17-1881/Trainer_Competence_study_final.pdf);
Social and civic competences during collaborative group activities or in the context of virtual environment communication.

Conclusions
The interdisciplinary approach of advanced science concepts in European context is facile using the learning resources offered by Nanoyou Project. A good practice solution can be using PBL together with ICT, informatics tools or online environments. All constructivist strategies allow students to develop European key competences during the learning process together with acquisition of new knowledge. Giving students a time of reflection about their work, mostly done in small groups we develop metacognition and creativity. Applied to primary or middle school students, these strategies go to incite young students to approach advanced scientific knowledge in further classes, or to desire to prefer a job in a scientific field.

Acknowledgements
Romanian Ministry of Education, Research and Youth supported this work under Project FSE-POSDRU ID: 88/1.5/S/56668.
Project LLP-LDV VETPRO 2010/RO/098 Empowering The Professionals In Science Education; Klagenfurt, Austria -31 January-5 February 2011

References
www.nanoyou.eu