QUESTION FOR CURRENT SCIENCE EDUCATION: VIRTUAL OR REAL?

Martin Bílek
University of Hradec Králové, Czech Republic

The feasible real experiments should not be in any way eliminated from school laboratory practice. This is the permanent starting point of all approaches to natural science curricula, and it is still in force. The real living environment makes us face more and more items of the virtual environment, worlds, mediated by infinite possibilities of computer networks. The mediated perception through virtual images has become (thanks to the massive spread of information technologies) the major cognitive channel of school age pupils. Direct utilization of information from an objectively existing reality is steadily superseded and replaced by virtual information. Six years ago we asked on the first pages of JBSE Nr. 1 (Bilek, 2010): How to blend an effective and meaningful application of real, indirect and simulative observation, measuring and experimenting according to didactic principles? Do we have to answer now or do we know directions where can we find the answer?

The importance as well as the real meaning of natural sciences have often been defined by many a scientist, also viewed in a wider context of all human knowledge. Here we can offer a few of these definitions (Dushl, 1990 modified by Bilek, Doulik & Skoda, 2009):

- All science should co-ordinate our experience and organize it into a logical system (A. Einstein).
- The challenge of sciences is to expand the fields of our experience and reduce the large fields of our presuppositions (N. Bohr).
- All science is composed of facts just as a house is made of stones. But a collection of mere facts does not make a Science and a heap of stones does not yet make a house (H. Poincaré).
- Science is the quest for knowledge, not the knowledge itself (D. Roller).

These quotations, with Roller´s utterance especially, show the targets and resources of science education and thus, we may elicit today´s modern trends in science education. The current reformation of curricula brings numerous challenges and demands. The society has been changing rapidly these days, and they are also to offer new definitions of targets and values in education. Educating in science needs to deal mainly with the following complexity of problems in the near future: global issues and ecology problems, the relation between science and technology on one side and the society on the other side, key words and basic conceptions and last not least, also inter-disciplinary thinking.

One of the mentioned complex problems is the relation between science and technology. The credibility of science education has noticeably lowered. As we can see, it happened in most countries (with the exception of developing countries), and has been an over-the-world phenomenon, existing as a result to scientist as well as creationist models. The ROSE project (The Relevance of Science Education), having been carried out as a study comparing a sample of fifteen-year-old pupils in more like 50 countries all over the world, is a shiny example of the above mentioned feature of science education. A number of early warning signals can be seen nowadays, according to the results of this survey. Science belongs to the least favourite subjects in the industrial countries. Gender differences can be also noticed (with girls being less likely to enjoy science). The respondents to the quoted survey have not referred to science as of importance for life and future career. They also show no interest in becoming scientists in the future. The most positive attitudes to science education are from the respondents in developing countries (Bangladesh, Uganda, Ghana). On the contrary, well developed countries (Japan, Great Britain, Denmark, Norway) prove a real dilapidation of science education (Bílek, 2005, Sjøberg, 2007). To react to

such a sorry state of things, developed countries attempt to shift science education from formally theoretical to everyday life-oriented, and such topics as Science for All Children or Everyday Chemistry have been introduced. Science education now explores the following issues: What is the connection between science education and the pupil´s world? In what way could it be of use to healthy lifestyle and environment? What is the relation between the society and the environment? By which way are applied information technologies in science education? How could it help humankind with its problems? P. DeHart Hurd (2002) suggests it is now necessary to implement other trends influencing modern education into science education. The influential trends are to implement multicultural approaches, inter-disciplinary connections and understanding strategic topics. How to apply in these trends digital technology or virtual communication? How to prepare wider perspective of the anylysing phenomena from the everyday life?

It appears to be difficult to verbalize the targets and characteristics of today´s science education. The autonomy of teachers together with their responsibility are higher due to curriculum revision and world-wide tendencies in curriculum controlling. Modern trends and goals in science education could be described as follows:

- Re-definition of targets in science education. Targets are being gradually changed and also enlarged so that they reflect today´s development in technology, and mainly they reflect the needs of the society, nowadays necessarily conceived in its global connections. Science education aims at creating a conception of sciences as essential part of human culture, of which the results and discoveries can be of use to all individuals.
- Basic science education ought to arise from the pupils´ interests, it also ought to respect and take advantage of their individual experience and concentrate on an immediate reflection of scientific findings in their life. Great importance here have digital technologies, environmental education and next everyday life connections. The basis of such an approach is that pupils carry out researches based on experiments. The experiment tends to be a long-period one, is carried out according to a previously prepared plan and is also worked on by a larger group of pupils or the whole class. Pupils collect results, sort them and learn to analyze them (e.g. by on-line digital graphic presentation) and, subsequently, to interpret them. Another major field of basic science education can be the topics related to healthy lifestyle education and health issues related to the quality of life.
- Another aim or trend of modern science education mentioned is the reduction of the quantity of information to be learnt. Teaching sciences should cover a smaller number of topics. On the other hand, topics selected for the core of the curriculum ought to be studied thoroughly and more time should be allowed for these. This particular strategy would enable both teachers and pupils to focus on understanding individual problems and also allow them to develop pupils´ skills to solve problems.
- Science education as a framework for integrating subjects. Inter-disciplinary approach of today is mostly realized at primary level, it is less involved at lower levels of secondary education and hardly at all at upper levels of secondary education. For instance, Czech teachers do not seem stirred by the current state of science education and they are reluctant to accept integration at secondary education (Bilek & Kralicek, 2007). Very important is integration of digital technologies with science education. Inquiry based approach needs conditions for data collection, their elaboration and formulation of findings with "on-line" being. Internet and its WWW-phenomenon is something what don't destroy the science education but it can be a mean for its fruitful support. From the results of our previous research and development projects we can form a few base approaches to WWW-support of natural sciences education (Bilek, Turcani, 2006), which can be continuously completed:

Type of Internet support of chemistry recognition	Accented methodological instruments of recognition	Connection: learner – Internet	Next conditions of realization
Remote measurement (remote sensing)	Data interpretation, indirect observation, data elaboration	On-line (Off-line)	Compatible environment for data elaboration
Remote laboratory based on own observation or experimentation	Direct observation, measurement, experimentation, data elaboration	Off-line (On-line)	Measuring instruments, apparatuses, chemical stuffs (Environment for data registration and elaboration)

Remote laboratory based on mediated experiment	Indirect observation, measurement, data elaboration	On-line	Order and setting of experiment realization, environment for data registration and elaboration
Remote laboratory based on remote controlled experiment	Indirect observation, mediated control, data elaboration	On-line	Organization of approach to remote device (HW and SW)
Virtual laboratory based on video-recording	Indirect observation (measuring, data elaboration)	On-line (Off-line)	(Environment to data registration and elaboration)
Virtual laboratory based on animation	Indirect observation, modelling of abstraction (measuring, data elaboration)	On-line (Off-line)	(Environment to data registration and elaboration)
Virtual laboratory based on simulation	Working with model (parameters setting), data elaboration	On-line (Off-line)	Compatible environment for data elaboration
…	…	…	…

But from the other side, ICT, especially their network systems, do not offer only advantages. They also bring risks and problems to teachers and pupils. Levy (in Cernochova 2003) emphasizes several possible problems of this "risky" environment:

- isolation and cognitively overburdened pupils and teachers (stressed by communication and work on the screen),
- student and teacher dependence on network navigation or gaming (and experimenting-author comment) in virtual worlds,
- sense of dominance (strengthening of decision-making and control centres, more or less monopolized ascendancy of economic powers over important network functions, etc.),
- contacts with team ignorance and imperfection.

Above all, other problems may occur, e.g. time-demanding preparation, course and management of the instructional process, ICT dependence on power source, server performance, possibilities and quality of hardware and software, logics, tools and structure, ways of communication and hygienic aspects.

Terms and conditions for the use of virtual science communication (different computer support of empirical and theoretical cognitive methods), mainly the support of remote and virtual laboratories, are still in progress according to the growing possibilities of the Internet, World Wide Web services and possibilities of measuring, modelling and other means (comp. Lamanauskas, 2011). Virtual universities, virtual classrooms, virtual and remote labs or other types of satellite educational systems in the field of natural sciences cannot work without the presented methodological components. At technical universities remote and virtual laboratories have been common and we suppose that their spreading to lower levels of the educational system will not take very long (Machkova & Bilek, 2013). In many cases they will be joint projects which should support interest in natural science and technical studies. In our opinion, the need for research in this field, especially in situations where the initial relation to natural science and technical subjects is formed, is very topical and desirable.

References

Bilek, M. (2010). Natural science education in the time of virtual worlds. *Journal of Baltic Science Education*, 9 (1), 4-5.

Bilek, M. (2005). Why to learn science and technology? Selected results of the international ROSE project. In E. Mechlova (ed.), *Information and Communication Technology in Education – Proceedings.* Ostrava: University of Ostrava, pp. 11-14.

Bilek, M., Doulik, P., & Skoda, J. (2009). Perspectives and challenges of real and virtual environment interactions in early science/chemistry education. In M. Bilek et al., *Interaction of Real and Virtual Environment in Early Science Education: Tradition And Challenges*. Hradec Kralove: Gaudeamus, pp. 137-144.

Bilek, M., & Kralicek, I. (2007). Názory učitelů přírodovědných předmětů na rozšiřování aprobace [Science teachers opinions at expanding of their approbation]. In M. Bilek, I. Kralicek, & I. Volf (eds.) *Rozšiřující sudium učitelství přírodovědných předmětů. Náměty, souvislosti a návrhy realizace [Further science teachers education. Ideas, suggestions and context of implementation].* Hradec Kralové: Gaudeamus, pp. 63 – 70.

Bílek, M., & Turčáni, M. (2006). Vzdálené a virtuální laboratoře ve výuce a v přípravě učitelů přírodovědných předmětů [Remote and virtual labs in instruction and in science teachers education]. *Pedagogika*, LVI (4), 361 – 372.

Cernochova, M. (2003). *Příprava budoucích e-učitelů na e-instruction [Future e-teachers education for e-instruction]*. Kladno: AISIS.

DeHart Hurd, S. (2002). Modernizing science education. *Journal of Research in Science Teaching*, *39* (1), 3 – 9.

Duschl, R. A. (1990). *Restructuring science education: The importance of theories and their development*. New York: Teachers College Press.

Lamanauskas, V. (2011). Digital education: Some implications. *Journal of Baltic Science Education*, *10* (4), 216-218.

Machková, V., & Bilek, M. (2013). Didactic analysis of the web acid-base titration simulations applied in pre-graduate chemistry teachers education. *Journal of Baltic Science Education*, *12* (6), 829-839.

Sjøberg, S. (2005). *Young people and science. Attitudes, values and priorities. Evidence from the ROSE project*. 2007. Retrieved on 14 May 2009 from September http://www.ils.uio.no/english/rose/network/countries/norway/eng/nor-sjoberg-eu2005.pdf.

Received: *April 20, 2016* Accepted: *April 28, 2016*

Martin Bílek PhD., Professor, Department of Chemistry, Faculty of Science, University of Hradec Králové, Rokitanského 62, 500 03 Hradec Králové, Czech Republic.
E-mail: Martin.Bilek@uhk.cz
Website: http://lide.uhk.cz/bilekma1