

CHALLENGES OF CONTEMPORARY SCIENCE EDUCATION

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Abstract

The paper deals with basic functioning, objectives and challenges of science education at the threshold of the 21st century. The authors define complex issues of science education: global environmental issues and problems, interrelation of science, technology and society, key concepts and crucial issues of science education along with inter-disciplinary thinking. Due to global trends in curricula management, the autonomy of science teachers rises as well as the amount of their responsibility. The most important selected issues are discussed within the article and the authors attempt to seek optimum solution.

Key words: science education, multi-disciplinary, curriculum, science education purposes, science education paradigm.

Introduction

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 offer a few of these definitions (Dushl, 1990):

- All science should co-ordinate our experience and organise 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 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.

Basic paradigms in natural science education discussed within this article are a result of a history covering more than 250 years of science education. Science education has been changing in accordance with education paradigms and curricula emphasis in times of their vibrant development as well as in the quiet times. All of the 250 years of natural science education has been strongly

marked by the search for the real meaning of science education and its major aims and paradigms. The goal of our article is to articulate current trends directing science education while basing them on a critical analysis of the paradigm development.

Current Issues in Science Education

The period of 1990 – present has been coined by seeking the real identity of science education. Simply speaking, we may admit that all models are gradually failing to serve our purposes or can even be found of no use to us, but there are no signs of up-dated paradigms of relevant importance coming into their place. We may well notice the somewhat scattered range of attitudes to what the present state should be supplied with and what the new direction and the new goals of science education should be. Speaking of our country, the gradual breaking up of the Soviet Union block together with the end of the Cold War meant a boom of many an alternative and innovative conception in education and also a thorough re-defining needs of the society and demands on education. The present reformation of curricula in the Czech educational system is obviously a natural consequence of that process. Not only the Czech educational policy, but also the educational policy of other countries, the EU along with the U.S. especially, are now to face challenges and demands of a society changing rapidly, and they are also to offer new definitions of targets and values in education. Educating in science needs to deal with the following complexity of problems in the near future:

- *Global issues and ecology problems.* Environmental issues have been in the centre of attention for the last 15 years everywhere in the world. Science education deals with latest issues of air pollution, global warming, ozone hole or de-forestation. Such problems are implemented into the curricula of – though not only – all science-based subjects (Doulík, Škoda, 2007) and therefore environmental education with Framework Education Programme for Elementary Education (FEP EE) needs to be put into the centre of the cross-subject system. Future curriculum in science will chiefly deal with the issues of development which is to be of long-term sustainability.
- *The relation between science and technology on one side and the society on the other side.*

The credibility of science education has noticeably lowered, as we can see happen with 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 in comparing a sample of fifteen years old pupils in 40 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 S. Sjøberg. Science belongs to the least favourite subjects in the industrial countries of the world. Also distinguished gender differences can be 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 respondents in developing countries (Bangladesh, Uganda, Ghana). On contrary, well developed countries (Japan, Great Britain, Denmark, Norway) prove a real dilapidation of science education (Bilek, 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 schemes 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? 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.

- *Key words and basic conceptions.* As many foreign as well as domestic surveys show us, it is absolutely necessary to reduce the content of what students learn within natural science classes. That is, speaking of the Czech Republic, especially the curriculum at the second grade of grammar schools, but also second grade of elementary education. A major opportunity to reduce the amount of quantity there is to be learnt is now being offered by curriculum reform. A new world-wide tendency in science teaching is to develop students' competence as well as their ability to solve problems, all that at the expense of factual knowledge. As R. Pintó (2005) shows us, pupils' attention should be paid to topics integrating various facts and conceptions into larger, more complex constructs, which are considered to be of distinct inter-disciplinary characteristics. These complex topics should also be able to relate science education to mathematics, history, economics, arts, but also literature and other scientific fields represented by individual school subjects.
- *Inter-disciplinary thinking.* It is a way, or rather a strategy, enabling pupils to understand the meaning of curriculum in science education, especially if that is in context with everyday problems and issues. J. G. Cegarra-Navarro and B. Rodrigo-Moya (2005), for example, recommend organising teachers into multi-disciplinary teams which would prepare the changes of curriculum, organise projects, realise integrated subjects team teaching etc. There is an analogy in FEP EE, implying an identical strategy. Creating a framework education programme logically means co-operation of multi-disciplinary teachers' teams, partly depending on individual fields of knowledge, partly also across these (realisation of the contents of education in cross-section topics). Therefore teachers ought to be competent to control the curriculum effectively (Hajerová-Müllerová, Škoda, 2006).

Modern Targets in Natural Science Education

It appears to be difficult to verbalise the targets and characteristics of today's science education. Nowadays science education needs to be in balance with many a contrary and "anti" influence determining not only the curriculum and its controlling, but also education, its importance and its function in itself. 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 the development in technology of today, and mainly so that they reflect the needs of the society, nowadays necessarily conceived in its global connections. Science education aims to create 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. Environmental education is of great importance here. C. Aivezidis, M. Lazaridou and G. F. Hellden (2006) show us that ecology topics especially are very close to students' lives as they are always present, also strongly advertised and are of all-society importance. Pupils often have vast experience with many aspects of environmental education from everyday life and it is a topic integrating knowledge of many subjects and human activities. Within the study of environmental issues, scientific methods of work should be applied, so that pupils use their knowledge acquired while studying science. The authors attempt to show a number of environmentally orientated topics, such as pollution of the location of pupils' homes, waste recycling, causes of various diseases, natural energy resources etc. C. A. Chinn along with B. A. Malhorta (2002) highlight the opportunity to use so called authentic research within environmentally oriented teaching/learning. The basis of such a method 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 analyse them (e.g. by graphic presentation) and, subsequently, to interpret them. The authors show a study of biotic and abiotic factors on plant growth in the school gardens. Another major field of basic science education is the topics related to healthy lifestyle education and health issues related to the quality of life (Hewitt et al, 2001).

- 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. This is an issue strictly related to elementary education framing. According to a respected Czech pedagogue of reformation, O. Chlup, elementary education cannot be determined by reduction of what to teach and learn only. He reminded us of two aspects that need to be taken into consideration when deciding on elementary curriculum:

„Firstly, there happens to be the interest of scientific fields, science and scientists themselves, who need to take into consideration the content of teaching, which has to reflect the level of present scientific knowledge, and secondly, we speak of the final amount of elementary learning materials that are to have been studied at the end of the basic learning process, and also we need to cover basic curriculum identical with individual school levels as well as basic curriculum tailored for individual classes of various fields of education and learning.” (Chlup, 1962)

- Science education as framework for integrating subjects. Inter-disciplinary approach of today is mostly realised at primary schools (International Standard Classification of Education – ISCED1), it is less involved at lower levels of secondary education (ISCED2) and hardly at all at higher levels of secondary education (ISCED3). As it has been said earlier on, Czech teachers do not seem stirred by the current state of science education and they are reluctant to accept integration of ISCED2 and ISCED3 (Bílek and Králíček, 2007). But as we can see, FEP EE together with Framework Education Programme of Grammar Education (FEP GE) highlight the importance of integration in teaching Science. FEP EE with its educational project „Humans and their world“ aims to integrate science teaching and learning at elementary levels. Science education curriculum thus becomes a mere part in the complexity of general education.
- Understanding basic scientific concepts and rules is meant to be one of the major goals in science education and also shows a definite change in the paradigm of science education. In the 1990s, the idea of emphasising the social role of sciences in everyday life prevailed in creating most curricula world-wide, which meant science knowledge to be used in one's everyday life, in one's social position of a citizen, in environmental issue orientation etc.). To name but one, C. Tant (1992), when speaking of connections with teaching through projects, says that learning scientific facts as well as rules is just a marginal positive side-effect of teaching through projects, but the essential aim is to teach students to think scientifically. J. Maršák and S. Janoušková (2007) believe that there exists a prevailing composition model, which expects the pupils to comprehend the concept system and method of science learning. Such a model should offer the pupil understanding of basic science concepts and rules, which can be later used by the pupils themselves in better and deeper recognition of the real world which is always there, and that also should enable pupils to anticipate the results in the interaction between humans and the world.
- The development of skills (acquired in science classes) to use scientific research of nature phenomena (features, facts, rules, characteristics, objects, processes etc.). This particular target intervenes with cognitive as well as affective and psychomotor development in students.

- The development of skills (acquired in science classes) to solve problems.

On a general basis it is to be said that science education ought to prepare pupils to use their knowledge acquired in science classes to improve their own living standards and to be capable of adapting to more advanced technologies used in everyday life (DeHart Hurd, 2002). J. Hassard (1999) defines science education to be the unifying element between sciences and the society. Science education is a branch based on discovering, evolving and analysing scientific work methods; it also is a quest for knowing as well as the knowledge acquired in this way.

Reaching the above-mentioned targets in science education is classified to be the progress in so called science literacy.

Conclusion

It may well be stated that the rapid development of the society and society demands on education development we are witnesses of in our days, has had no parallel in the history of education yet. Our society of technologies and techniques has been transformed into a knowledgeable and education-oriented society in a dramatically short time. Newer and urgent issues of global importance occur and show no respect to any particular frontier. We can also see the aspect of post-modern society trying to find the path back to understanding a personality in its individuality to build up their personal skills. To compare the crisis in science education with the current recession in economy, our topic seems to be of no value and also a matter of discussion to academic workers only. However, we find that to see the problem in a long-term scope, it could be said there is a probability to experience the effects of the educational crisis in the future more harshly than any financial crisis of today. We believe that one of the main reasons for science being unpopular with pupils is the unclear concept of science education, which in both ontogenetic as well as phylogenetic ranges, oscillates between the extremes of practical merchandising education and simple primary national history and geography on one side, and over-complicated mathematical models not comprehensible to their own makers on the other side of the issue. We are convinced the definition of paradigm in science education cannot happen without deep integration with other scientific fields of human activities and search for cross-subject topics, inter-disciplines or super-subjects which could give answers to many a current question of today's world and its society.

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