DEVELOPMENT OF TECHNOLOGY FOR TEACHER TRAINING IN MATHEMATICS AND NATURAL SCIENCES BASED ON EUROPEAN BEST PRACTICES

Assoc.Prof. Galya Kozhuharova, PhD
Department for Information and In-Service Teacher Training,
Trakia University, Stara Zagora, Bulgaria
E-mail: galia_koj@yahoo.com

Abstract

The interest in studying mathematics and sciences has been decreasing over the last fifteen years and this tendency is evident worldwide. This is true for Bulgaria too. Therefore, we directed our attention to the development of a technology for teacher training in mathematics and natural sciences based on European best practices.

The article focuses on the summarized experience from developing a training course for teachers of mathematics and natural sciences (physics, chemistry, biology and geography). This course is a result of our own research and our participation as a beneficiary in a European research project under the Comenius Programme of the European Commission.

Key words: *teacher education, mathematics and natural sciences, european practices.*

Introduction

Europe 2020 is a strategy of the European Union (EU) for development and growth in the next decade. In the framework of a changing world the aim is "EU to become an intelligent, sustainable and inclusive economy". These words define the priorities that have to promote the achievement of high levels of employment, efficiency and social cohesion by 2020 in EU and the member-states.

In the field of education, the priorities are in the intelligent growth sector, which means achieving better results in EU in:

- **education** (encouraging people to learn and to master their skills)
- **research/innovations** (development of new products/services generating growth and employment and promoting social cohesion)
- **digital society** (usage of information and communication technologies) /http://ec.europa.eu/europe2020/index_bg.htm/

One of the ways to achieve this is through exchange of European educational practices that promote cooperation and interaction between the educational and qualificational systems in the European Union with the aim of making them an example of quality worldwide.

Key competencies have an important role in the European Reference Framework. The recommendations of the European Parliament for the development of key competencies in life-long learning released in 2006 outline a noticeable tendency in the policies of the educational authorities in Europe. Many of them have redefined their educational aims and curricula and have focused on the successful application of knowledge and skills, as well as on the usage of

appropriate teaching methodology for acquiring this knowledge and these skills. The word 'competency' means a proven ability to use knowledge, skills and personal, social and/or methodological resources in work or school situations and in one's professional and personal development.

Key competencies are needed by all people for their personal development, active citizenship, social integration and employment. By the end of their compulsory education and training young people should have developed these competencies to a level that prepares them for adulthood. However, these competencies have to be additionally developed, maintained and updated as part of the life-long learning process.

The European Reference Framework defines the following key competencies: **C**ommunication in the mother tongue; Communication in foreign languages; Mathematical competence and basic competences in science and technology; Digital competence; Learning to learn; Social and civic competences; Sense of initiative and entrepreneurship; Cultural awareness and expression - expression of ideas, creative, emotional and aesthetical experience through arts – literature, music, visual arts.

The general framework of competencies is structured according to the needs of the individual to think and act reflexively.

Our main interest is the formation of key competencies in the process of teaching mathematics and natural sciences. The interest to these subjects has been decreasing and this fact is evident worldwide. All this directed us towards the development of a project that could provide answers to the issues facing education.

The KeyTTT Project /Teamwork, Training and Technology for Development of Key Competencies/, which was initiated in the European Year of Creativity and Innovation, aims at supporting teachers by producing an integrated solution consisting of a teaching methodology, teachers' guidelines book and a qualification course for teachers in mathematics and natural sciences working with schoolchildren aged 9 to 14 in the system of lower secondary education.

Introduction and Project Activities

The project presented here is **KeyTTT - Teamwork, Training and Technology for Development of Key Competencies - AGREEMENT** NUMBER - **2009 - 3892** / **001** – **001; PROJECT NUMBER- 504605-LLP-1-2009-1-BG-COMENIUS-CMP.** It was started by lecturers from the Department for Information and In-Service Teacher Training at Trakia University in Stara Zagora, Bulgaria. These are people having rich experience in psychological, pedagogical and specialized didactic research and its application in teaching practices. Many of them are authors of books, textbooks and teaching manuals for school and university students or teachers. The project was developed in close cooperation with a partner NGO – Center for Creative Training Association (CCTA), Sofia, Bulgaria. Manager of the project is Assoc. Prof. Galya Kozhuharova, PhD.

The main aim of the project is to examine and summarize good practices in school and out of school environments and to produce an innovatve technology for developing key competencies in studying mathematics and natural sciences in grades 4th to 7th.

In order to achieve the aim we defined the following reserch **tasks**:

1. To examine European and national educational practices for developing key competencies in studying mathematics and natural sciences.

2. To develop a didactic methodology and to prepare and test technological variants for developing key competencies in studying mathematics and natural sciences.

3. To prepare a study plan and a programme for a seminar with teachers for approbation of the technological variants.

4. To organize a forum for sharing the results from the application of the innovative technology in the pedagogical practice.

Partners:

Educational institutions from Bulgaria and Europe are partners in this project.

The **Department for Information and In-Service Teacher Training** (DIITT) at Trakia University in Stara Zagora is the beneficiary of the project. Its responsibilities are to prepare, test and approbate the methodology in the teaching practice.

The **Center for Creative Training** in Sofia offers a variety of out-of-school activities that aim at the full development of personality, free communication and creative approach to learning. The Center is the coordinator of the project and is responsible for introducing the methodology in the teaching and learning environment.

The **Space Camp** in Izmir, Turkey, specializes in space research and offers educational programmes for children and adults, as well as hi-tech simulations of space flights. The camp provides its experience in leadership training and assists in the analyses of its transferability.

The **Higher School of Informatics** (Wyższa Szkoła Informatyki) in Lodz, Poland, develops innovative approaches in education using various methodologies, including the Dalton Method.

The **Italian organization Europolo** (Polo Europeo della Conoscenza) has developed and maintains a network of 140 schools, associations and other educational institutions, works on a variety of projects and develops intercultural training.

The University in Stavanger, Norway (UiS) has 1000 employees and over 8000 students, a research centre and a teacher-training department.

Methodology of Research

Having in mind the aim of the project and the needs of the teachers, we developed an appropriate methodology for the research. It was necessary to equip the teachers with tools with which to organize the educational process and to redirect teaching and learning to finding solutions to practical tasks related to explorative activities. Through these activities, students can develop creative thinking and key competencies - interest and basic skills for understanding and applying scientific concepts from mathematics and natural sciences, using and applying information technologies, the ability to learn, taking initiative and entrepreneurial skills, etc. The technology developed by us has two main aspects – philosophical and psychological/pedagogical.

Philosophical aspect

From the philosophical point of view, the technology we developed was based on the ***integration of knowledge,*** which is one of the main tendencies in the development of modern science. Integrative processes in school have various strategic goals. The ultimate goal is to achieve the higher science-specific knowledge. In this sense, integration is achieved through

interdisciplinary interactions among school subjects, which are a powerful regulator of the overall pedagogical process.

There are several directions into which interdisciplinary interactions can develop:

- "on the basis of inter-scientific concepts which they serve crossed informational fields in the respective school disciplines: information, symmetry, probability, algorithm, module, sign, etc;

- on the basis of synthesizing disciplines: mathematics, cybernetics, systems theory, etc;

- on the basis of interdisciplinary scientific methods and methodology: transversal and others;

- on the basis of interdisciplinary learning skills and common strategy of learning;

- on the basis of general requirements and parameters of human activity: algorithmization, creativity, purposefulness, motivation, etc. (Monahov, 1978)

We examine the interdisciplinary interactions in the direction based on interdisciplinary learning skills and common strategy of learning. The integration of physical, biological and chemical knowledge with the inclusion of mathematical apparatus provides an opportunity for the student to acquire a holistic image of structures, phenomena and processes. These have an important influence on various sides of human activities. In this way, science benefits from the holistic presentation of knowledge, pedagogy, too, benefits from the creation of interdisciplinary relations, and practice benefits from the early formation of skills accompanied by opportunities for their application. The necessity of using any opportunities for interdisciplinary interactions based on general scientific concepts and approaches between mathematics and natural sciences in beyond doubt. The full presentation of both the hierarchy in the structure of natural objects and the interdependencies existing among them provides an opportunity of appropriate intellectual activity for the students on the multilateral but yet uniform informational basis, thus making the process of acquiring knowledge efficient and meaningful, noticeably influencing the development of multisided personality of the students.

Psychological and pedagogical aspects

Modern European educational policies outline the development of a person-oriented educational paradigm, whose methodological basis is the constructivist theory of learning. For this reason, we chose the constructivist approach to form the psychological and pedagogical basis of the technology.

Constructivism is a philosophy of learning according to which people, by reflecting on their own experience, construct an understanding of the world they live in. During the process of learning, the already existing models of thinking and cognitive structures are used in order to acquire new experiences (Mihova, 2003). Constructivism is recognized as a theory of learning unique by itself. The very name 'constructivism' comes from the fact that learning and acquisition of new knowledge and experiences is achieved through constructing new cognitive structures and reconstructing the existing ones. The process of learning (cognitive, emotional, interpersonal or psychomotor) is a process of individual transformation. Individuals learn by 'inserting/matching/integrating" the new knowledge in the already existing structures of knowledge. (Heather, Ketteridge & Marshall, 1999).

Constructive learning presupposes active learning, where conditions are provided for constructing the knowledge by problem-solving, knowledge transfer, provision of stimulating environment, activating old knowledge, solving of practical tasks, focus on hands-on

experiences, application of strategies for experience acquisition instead of only knowledge acquisition, encouragement of critical thinking, etc.

The innovative technology makes use of the following types of learning: project-based learning, learning by doing, cooperative learning, Dalton method, small-group discussions, problem-solving, connecting theory to practice, application of information and communication technologies, etc.

Results of Research

The development of the technology started by examination and presentation of the educational systems and the existing practices related to teaching mathematics and sciences and formation of key competencies in all partner countries. This was done by international experts. This examination formed the ground for further search for good practices in the partner countries. The focus was on activities aiming at promotion of creativity in students and on approaches for teaching mathematics, natural sciences and information technologies that can make teaching more attractive and develop main skills and knowledge for life. Examples for such practices from each country were summarized and their pedagogical basis was analyzed.

The unique programmes for leadership training provided by the Space Camp in Turkey, which combine teamwork with research, were studied in detail and consultations were carried out with their experts. After that, opportunities were found for transferring their practices in school environments. This type of research formed the basis of the KeyTTT technology, which was partially approbated in each of the partner countries in accordance with the country-specific circumstances. The project experts from each country monitored the approbation process and assessed the results. On this basis, a common curriculum was developed and a qualification course for teachers for teachers from Bulgaria, Italy, Norway, Poland and Turkey was organized. During this training, the teachers were able to add specific practices to the developed technology and to share valuable experience about the content and practice of teaching mathematics and natural sciences. All this was done in an experimental learning environment. The summarized practices of each of the participating countries can be seen in the site of the project (http://keyttt.europole.org/index.php/en/activities.html). An electronic educational resources pack is in process of preparation. From September 21 to 24, 2011, the Department of Information and In-Service Teacher Training at Trakia University, Stara Zagora, Bulgaria, is organizing an international scientific and practical conference on the topic of *Key Competencies in Education – Strategies and Practices.* During this forum, the results from the introduction of the technology will be presented and practices will be exchanged among participants from various scientific and educational institutions.

Discussion

The process of developing a technology for key competencies formation in teaching mathematics and sciences and its applications in school environment cannot be limited by an end date. There are opportunities for enrichment of its content and methodology and these are to be further explored and developed.

The improvement of information and communication technologies and their application in teaching require the development of a respective technology for their application. Their relation with the educational content and the teaching methods can be of interest and can lead to enrichment of educational practices.

Aids innovative for education, like interactive boards, Fourier computer laboratories, multimedia lessons and video conferences were actively used in specific teaching and learning environments.

The integrative tendencies in teaching mathematics and sciences on the level of educational content can and should be organically linked with the educational goals. Teaching methods appropriate for them should also be developed. Analyses show that there is a need for more work to be done in this direction.

Conclusions

The implemented project summarized good practices for working in school and out of school environments. These practices equip teachers with tools with which to organize the educational process and to direct teaching and learning towards solving of practical explorative problems or tasks, which develop explorative skills, creative thinking, key skills and competencies. These skills are developed as a complex, both purposefully directed towards mathematics, sciences and technologies, and at the same time promoting communicative skills in the mother tongue, digital competencies, skills for independent learning and collection of information; civic competencies and interpersonal skills, implemented on the background of emotional and creative experiences.

Special attention should be paid and real support provided to the pre-service and in-service qualification of teachers, so that attitudes and competencies for implementation of integrative interactions can be formed. A current problem we face is the preparation of teachers willing to implement the project idea.

As a result of the project activities and the training provided, teachers can acquire explorative skills and can be able to organize the teaching/learning process so that the focus is directed towards solving practical tasks and activities based on the explorative approach. Teachers can see part of the numerous opportunities for the formation of explorative interest to mathematics and sciences through interdisciplinary learning activities based on a common learning strategy.

On the basis of exchange of European practices, international research and educational projects promote the usage of existing technologies and the development of new ones. Thus, science benefits from the holistic presentation of knowledge, pedagogy benefits, too, from the implementation of interdisciplinary relations within the lesson and practice also benefits from the early formation of skills accompanied by opportunities for their application.

References

1. Kozhuharova, G., Slavchev, A., Slavova, M. (2010). European Key Competences in the teaching of Mathematics and Sciences. Trakia Journal of Sciences. Volume 8. Supplement 3. p.338-341

2. Mihova, M. (2003). On the Theoretical Bases of the Design of Teaching. Learning Theories – Design of Teaching. - In: Collection of articles. First Balkan Conference. Education - Global Identity and Cultural Diversity. Staar Zagora, , p.156 – 163.

3. Monahov, W. M. (1978). On the Question of Systemic Analysis of the Interrelations between Mathematics and Sciences, In collection of Articles Methodological Aspects of Improving the Education in Mathematics and Sciences, M.

4. Petrov, P., Atanasova, M. (2001). Educational Technologies and Learning Strategies. S.

5. Sharlanova, V. (2004). Person-Oriented Educational Process. Trakia University, DIITT, Bulgaria

6. European Commission. **http://ec.europa.eu/europe2020/index_bg.htm**

Galya Kozhuharova	Assoc. Prof., PhD Head of Department for Information and In-Service Teacher Training, Trakia University, Stara Zagora 6010, Bulgaria 9 Armejska Str. Phone: +359898520979 E-mail: galia_koj@yahoo.com Website: http://dipku-sz.net