INQUIRY-BASED SCIENCE EDUCATION (IBSE) - GOOD PRACTICES

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Abstract: This study aims at presenting the development and implementation of the inquiry-based method (research) at Shumen University, created as a result of the work on four European educational projects within ten years. The reason for the development of new teaching methods, approaches and technologies is the serious decline in the interest in education of young people and the change in the values and interests of the new generation. A special downturn marks the interest in natural sciences and mathematics. Within the activities of COSMOS project, originally five methods were probated by all partners. The inquiry-based method of study was one of the most creative training methods. The reason is that in this method the students themselves reach relevant new knowledge under the mentoring role of the teacher. From a passive participant the learner becomes an active explorer of the new knowledge. The article examines the consistent approbation and implementation of this method initially only in the teaching of natural sciences, and later in other subjects.

One of the main products created as a result of the projects described is a set of various educational resources provided in the repository of an educational portal. The educational resources were created by the projects’ teams, the participants in the projects’ training seminars and other interested in the issues of methodology users of the respective portals. The target groups of the resources are mainly teachers and professors wishing to apply the inquiry-based approach in their work. The good practices in view are probated and evaluated by numerous trainers from different countries. The article gives account only of some of the best and most widely used educational resources. In chronological order the projects we have worked on are: COSMOS (2006), PATHWAY (2010), LD-Skills (2011) and GEOTHNK (2013). The development and globalization of WEB-based resources has led over the years to merging the initially-created databases into a larger one, as the ODS portal, for instance. A part of this database is the set of educational resources of the project GEOTHNK. In the first three projects creating training materials required generating a metadata file from software especially developed for this purpose and respectively the use of these resources also required specialized software such as Reload player. With the last project all educational resources are uploaded and used without requiring specialized software, which greatly facilitates their use. A major element in the use of these resources is the fact that all users are also authors enriching the existing database with new original resources and links to useful existing ones. This is a good challenge to the teachers on the way to their improvement.

Keywords: methodology, IBSE, good practices, projects.

1. INTRODUCTION

The focus of the present study are the development and implementation of the inquiry-based research method at Shumen University, promoted as an outcome on four European educational projects in the period of ten years. There is a particular reason for the development of new teaching methods, approaches and technologies. It is due to the serious downfall in young people’s interest to education and the change in the values and concerns of the new generation. A special downturn marks the interest in natural sciences and mathematics. The activities included in the COSMOS project by all partners originally assessed five methods. Among them the inquiry-based method of study turned to be the most innovative training method. This ensued from the fact that with this method the students reach the relevant new knowledge themselves and the teacher serves only as a mentor. The learners are no longer passive participants. They turn into active explorers of the new knowledge. The article reveals in sequential order the approbation and implementation of this method firstly only in the teaching of natural sciences, and later on in other subjects.

In chronology the projects we have worked on are: COSMOS (2006), PATHWAY (2010), LD-Skills (2011) and GEOTHNK (2013). The same order will be kept in displaying the main outcomes of the inquiry-based method.

2. PROJECTS’ DESCRIPTION AND OUTCOMES

The COSMOS project [1] is the first one which has the ambitious task to develop an integrated educational framework, which is used as a basis for designing teaching materials with the assistance of specialized software.
(COSMOS Tool-Box) and puts the foundations of an electronic database freely accessible for all teachers. The second main task is building COSMOS infrastructure: the road map for the application of a common European educational service that will contain recommendations for European quality certification of scientific content in education.

The Web Portal developed (http://www.ea.gr/ep/cosmos/) (see Figure 1) provides an access to the database of educational resources and COSMOS infrastructure gives the opportunity to search for materials with key words in different languages, in accordance with the educational standards of different national curricula.

Figure 1 A screenshot of the webpage of the portal

The COSMOS portal is an experimental lab for high school students, university students and teachers, which aims at improving the teaching and learning of natural sciences by enriching the educational resources at schools and universities by using new methods of teaching natural sciences. The portal contains more than a thousand educational materials (lesson plans, students’ projects, video materials, animations and high-quality images of unique astronomical objects. The Bulgarian contribution to the portal is presented in detail in [2].

Scenarios are designed in five common contemporary pedagogical models: • Guided Research model; • Project-based learning; • Inquiry-based teaching; • 5E Instructional model; • Learning cycle; • ICT Cross Culture Awareness Learning. They are dealt with elaborately in the published project manual [3]. The approbation of the designed materials aimed at outlining the most innovative of the abovementioned approaches. The survey carried out with more than 250 teachers from the eight European countries participating in the project pointed out that the most innovative and creative method is the Inquiry-based teaching method. This analysis was the foundation for continuing our work using this method in the next project – PATHWAY (http://www.pathway-project.eu/). The main goal of this project is improving the quality of teaching natural sciences and mathematics by wide-scale implementation of educational activities of the IBSE method (Inquiry Based Science Education) in 16 European countries in school environment, in science and research centres and in teacher-training centres.

As a final outcome the project PATHWAY offers:
- a standardized approach to Inquiry-based teaching of natural sciences, outlining instructional models that can help teachers organize effectively their teaching;
- a series of models to motivate teachers to implement in their classrooms Inquiry-based activities and techniques;
- an access to a unique set of educational resources and teaching practices that have proven their effectiveness in Inquiry-based education and that go beyond the limits of teaching in the classroom;
- forming a group of experts of the IBSE (Inquiry Based Science Education) method who will share their best practices;
- distributing within the educational community a system of directions for further studying and researching the advantages of the IBSE method;
- systematic checkups of the suggested methods and activities for identifying their influence in the context of effectiveness and efficiency.

A separate tool is developed, namely PATHWAY ASK Learning Design Toolkit (PATHWAY ASK-LDT), which is based on IMS Learning Design (http://www.imsglobal.org/learningdesign/) (see Figure 2).
It is used for designing IBSE scenarios, built in accordance with a commonly-defined IBSE scenarios, and for generating packages in conformity with IMS Learning Design specifications. There is an instruction manual published for the users [4], which explains in full the way for designing and using the educational scenarios. More than 300 educational materials are uploaded on the project platform by the Bulgarian participants. 10 of our scenarios are published in the manual of the best practices [5]. Another good practice used by the team is applying the IBSE method when teaching bilingual children [6].

An important element in the educational process proved to be the possibility for the learners to have skills for didactic design. Developing these skills is a goal of the project "LD-skills: Development of learning design skills for enhancing students’ key competencies"[7] (http://www.ea.gr/ep/ld-skills/). The project is carried out by a consortium of 6 institutions from Bulgaria, Greece, Belgium, Germany, Austria and Turkey and is a successor of the projects COSMOS and Learning@CERN. The aim of the project is to influence in a positive way the development of problem-solving skills in the students through enhancing the use of problem-based approach and inquiry-based approach. This can be achieved via a framework designed for training teachers [8] how to develop plans not only by providing exemplary solutions of problems emerging in everyday practice but planning the lessons effectively in relation to educational principles which can improve the problem-solving skills of the learners. We follow the recommendations in Rocard report [9] about teaching natural sciences in Europe using the problem-based learning approach and inquiry-based learning approach which are considered important for they help enhancing students’ interest and motivation. The project contained teacher-training on how to change their present teaching practices having in mind the abovementioned strategies. More than 220 teachers took part in 20 seminars in Bulgaria. Developing learning skills is further enhanced in the next project - “Semantic pathways for building a spatially-thinking society” - GEOTHNK (http://www.geothnk.eu/) [10].

The main outcomes of the project are improving spatial thinking with the help of an approach based on innovative computer technologies and freely-accessed educational Internet environment. This methodological approach allows interdisciplinary organization and semantic links to knowledge. They are achieved through:

• Developing a pedagogical network which introduces the necessary strategies for developing an innovative educational approach for effective spatial thinking.
• Creating educational GEOTHNK pathways, based on the proposed network, which focus on the organization of core training components (concepts, tools of representation, thought processes and training activities) according to the specific needs and characteristics of each target group.
• A pilot presentation of the project's approach and tools to user groups.
• Ensuring the dissemination of GEOTHNK products, so as to reach a wider audience.
• Systematic assessment and validation of the proposed activities to estimate their influence and to analyze these approaches through pilot programs in real life in various learning situations, in terms of their effectiveness.

The project develops a methodological approach which helps learners apply spatial thinking and use purposefully spatial concepts in all subjects of the curricula and on all developmental levels. This approach helps them understand the interdisciplinary character of the fundamental spatial concepts. On the other hand, it conditions the curriculum coherence, reveals the interrelations of the subjects and adds fundamental reasoning to everyday life and develops problem-solving skills in the target groups. This approach especially urges the users to design, exchange and use repeatedly learning materials in the form of Educational scenarios. The Educational
scenarios are modular, they consist of constructional educational blocks (activities) in order to facilitate the model of repeated usage of the type “mix and choose”. The authoring tools of the educational scenarios help teachers, guides in museums and researchers in science centres prepare easily for the pre-visit phase, the visit itself and after the visit for the interaction of their students/visitors with the GEOTHNK collection (the visit can be real or online). They can build a full educational scenario with ease or use repeatedly already existing components and share the results of their work with colleagues in whole Europe. Moreover, users contribute to the materials in the same digital repository where professionally developed materials are stored. So far subjects in the curriculum have looked as isolated islands with no connection inbetween and they are often taught as a catalogue of separate terms. The project changed this point of view to teaching as it allowed connecting the lessons of different subjects.

The various guidelines for development presented by GEOTHNK allow for cooperation in areas covering three European sectoral programs: Comenius, Erasmus and Grundtvig. The target groups of GEOTHINK project are high-school students, teachers, trainers at science centres, university students, mentors and adult learners. GEOTHINK offers to the students the opportunity to take part in innovative educational activities of pedagogically-structured educational environments with extensions in the social and communication networks. For trainers at science centres GEOTHNK provides an easy opportunity to prepare educational pathways for their trainees, to construct a virtual version of their didactic materials and to share them with teachers and researchers in their field of study. To teachers, mentors and students GEOTHINK gives the chance for pedagogical “involvement, sharing and occupation” with the Internet-based platform and social network to disseminate the best practices and to find mutual support. The modular approach and innovative pathways that cross the borders between formal and informal education, cooperate in combining numerous freely-accessible educational resources in the classroom. To adult learners (for example, visitors of science centres) GEOTHNK suggests the possibility to participate in innovative educational activities, which build on the achievements of formal and informal education with an expansion in social and communication networks.

For the convenience of project resources’ users there is a published manual for designing educational scenarios applying new technologies [11]. The educational scenarios created are approbated and evaluated by over 250 teachers and more than 100 trainers and mentors from eight European countries. The best practices among which there are 11 Bulgarian scenarios are published in a special handbook [12]. So far the project repository has 434 resources and 712 registered participants (see Figure 3). We hope that this number will continue to increase.
3. CONCLUSION
The inquiry-based approach proves its usefulness not only in teaching natural sciences and mathematics but also in humanities. Good practices applicable to teachers’ work are available as ready-to-use products http://www.math.bas.bg/omi/Fibonacci/archive.htm and methodological guidelines. We should point out that materials from Research approach in teaching mathematics [13], ideas from the forum “Research approaches in teaching Bulgarian language”, the development and globalization of WEB-based resources has led over the years to merging and enlarging the original databases and building the ODS portal, for example. The group of project GEOTHNK is a part of this database (http://portal.opendiscoveryspace.eu/community/geothink-community-400866). In the first three projects designing training materials required creating a metadata file from software specially developed for the purpose and, therefore, the use of these resources also requires specialized software such as Reload player. Applying work with portals, Harizanov developed a special platform to describe the lessons to the needs of the Faculty of Mathematics and Informatics [14]. However, all educational resources in the last project are uploaded, downloaded and used without the help of specialized software, which greatly facilitates their use. A crucial element in the use of these resources is the fact that all users are authors as well, enriching the existing facilities with new original resources and links to useful existing ones. This is a good challenge for the teachers towards their improvement.

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