PALACKÝ UNIVERSITY, OLOMOUC

Education and Culture

Socrates

A Constructivist Approach for the Improving Quality of Science Teacher Training: An Experience of IQST Project

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2009

ACKNOWLEDGMENTS

This work was supported by the European Community in the framework of the Socrates – Comenius 2.1 scheme under the project No. 128747-CP-1-2006-1-CZ-Comenius-C21. The all scholars who participated in this project are strongly acknowledged: prof. dr. Danuše Nezvalová, prof. dr. Vincentas Lamanauskas, prof. dr. Nicos Valanides, dr. Feyzi Osman Pekel, dr. Jan Říha, dr. Zhelyazka Raykova, prof. dr. Hristo Solunov, dr. Charoula Angeli, Margarita Vilkonienė, Stella Chadjiachilleos, Gabriela Pokorná.

Reviewers: doc. RNDr. Oldřich Lepil, CSc.
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First Edition

ISBN 978-80-244-2340-1

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FOREWORD

Improving Quality of Science Teacher Training – IQST – is a project under the COMENIUS 2.1 programme of the European Commission.

This project implemented constructivism as a newer pedagogical theory into initial science teacher training. The constructivist perspective is becoming a dominant paradigm in the field of the science education. The constructivist approach in the initial science teacher training is not still too common at many European teacher training institutions. This project made the higher possibility of application this theory in science teacher training in cooperating countries and possibility to be used by prospective and practicing science teacher.

The main aim of the project is to contribute to the improvement of the quality of initial science teacher training in the participating countries, to implement teachers´ knowledge and understanding of European dimension in a science teaching context and to introduce new pedagogical methods based on constructivist approach in science teacher training.

This has been done by:

- Exchanging data and views on constructivism in teaching of science in a European context;
- Designing 5 new modules for science teacher training;
- Producing teaching and learning materials for science teaching at initial teacher training to be used by trainee teachers and their tutors, as well as by in-service teachers of science;
- Producing five E-learning courses to be used by science teaching students and practicing science teachers;
- Implementing and developing portfolio assessment of prospective science teachers;
- Cooperating on EU level and share the best EU practice;
- Establishing a framework by which trainee teachers and their tutors can develop constructivism in science teacher training.

This group produced Compendium which in an approach to science teacher training, needs and competencies of science teaching students in cooperating countries are described, five books containing the materials about constructivism and guide book for trainers and tutors of prospective science teachers.

The electronic versions of these books, as well as e-learning courses and all other project materials, can be found at the homepage of the project: http://www.iqst.upol.cz

The materials of this project have been produced by teams from the Bulgaria, Czech Republic, Cyprus, Lithuania and Turkey.

CHAPTER 1
GENERAL ASPECTS OF THE PROJECT

1.1 Background of the Project

In all of the participating countries one can observe a lack of science teachers, mainly of physics and chemistry teachers, as well as a lack of students in this teacher training. There is not doubt that science teaching has a crucial role to play in shaping the future development of EU. Added to the momentum of the greater integration of EU, there is a need for the exploration, discussion and exchange of educational ideas, analysis of common problems, implementation of European dimension in initial science teacher training, with the aid of joint projects. These activities facilitate intercultural cooperation, solidarity, and mutual support. There is a remarkable commonality in the problems and context for science teacher training internationally. There is a need for intellectually honest and open self-appraisal of teacher educators should be the key agents of worthwhile changes in the teacher training programmes. At present, in participating countries, there are major government initiatives underway for curricular, pedagogic and assessment reform in schools. The clientele of schools internationally now represents a very heterogeneous grouping in terms of ability, motivation, application and social class background. The motivation and the interest for science studies is a little bit lower that we could expect in the period of new technologies. This has implications with regard to styles of teaching, curricular content, interpersonal relations for teacher education. Coherence between course elements, the theory-practice issue, extending school – based experience, the establishment of good partnership arrangements for teaching supervision, the fostering of action research of prospective science teachers, international cooperation between higher institutions of initial teacher training, strengthening the European dimension in the training of science teachers are very important tasks for co-operating institutions in the project. There is a need to develop new ways in initial training of science teachers. All participating countries feel a reduction of quality in physics, chemistry and biology knowledge of children and an additional lack of quality of physics, chemistry and biology teachers. There is an urgent need of the quality initial science teachers. There is a need of new approaches to this training especially with the regard to the implementation and application of constructivists theory in science teacher training.

The overall aim was to:

- contribute to the improvement of the quality of initial science teacher training in the participating countries;
- analyse and compare teacher training programmes, review and develop training modules;
- provide insights into the strategic aspects of teacher training; allow for interchange of ideas amongst practising sciences teachers and teacher trainers in an international setting;
- provide a framework for individual to extend and develop relevant elements of his/her own competence;
- enhance the participants' knowledge of aspects of European dimension and the principles of constructivist theory in science teacher training etc.

The specific objectives were the following:

- To explore and develop new ways of initial training for science teachers based on European cooperation;
- To establish cooperation and partnership between participating departments;
- To design 5 new modules for science teacher training;
- To implement European dimension in the newly designed modules;
- To introduce new pedagogical methods based on constructivist approach in science teacher training;
- To design teaching and learning materials for science teaching at initial teacher training;
- To make students training to be teachers and their tutors aware of new pedagogical methods based on the constructivist approach;
- To present these materials on web site of the project;
- To disseminate the project knowledge and experience on educational conferences and in educational journals;

- To implement and develop portfolio assessment of prospective science teachers.
- To disseminate successful outcomes by means of designed modules and a collection of training materials with the best European practice.

1.2 Project consortium

Five well known institutions were involved in this project.

Table 1. Project Partners

Institution	**City, country**	**Responsible person**	**Website and E-mails**
Faculty of Science Palacký University	Olomouc, Czech Republic	Prof. dr. Danuše Nezvalova (coordinator)	http://www.upol.cz danuse.nezvalova@upol.cz
University of Cyprus, Department of Education	Nicosia, Cyprus	Asoc. prof. dr. Nicos Valanides	http://www.ucy.ac.cy nichri@ucy.ac.cy
Siauliai University, Natural Science Education Research Centre	Siauliai, Lithuania	Prof. dr. Vincentas Lamanauskas	http://www.gutc.su.lt v.lamanauskas@ef.su.lt
University of Plovdiv 'Paisii Hilendarski', Faculty of Education	Plovdiv, Bulgaria	Asoc. prof. dr. Ani Epitropova	http://www.pu.acad.bg nadya@pu.acad.bg
Ataturk University, Bayburt Education Faculty	Erzurum, Turkey	Dr. Feyzi Osman Pekel	http://www.atauni.edu.tr osmanpekel@yahoo.com

The coordinating institution Palacký University is a higher education institution. Faculty of Science is one of the 7 faculties of this university. The Faculty of Science provides initial and in-service teacher training. Coordinator led the research teams working under 3 grants awarded by Ministry of Education in last 5 years in the field of in-service training. She was a leader in the grant of Czech – Canadian project in the field of teachers´ job satisfaction. Recently she was a contact person and active partner in 2 Tempus projects (1996-2000), which were oriented to in-service teacher training, partner in 3 Socrates –Comenius projects and coordinator in 1 project in Socrates Comenius framework. She is an expert in initial teacher training, science curriculum and evaluation. The coordinator has long years experience of initial and in-service teacher training, from design and delivery to evaluation and accreditation. Palacký University is placed in the urban area. Region is mostly agricultural part of Moravia with higher percentage of unemployment than average. The institution cooperates with the rural, urban, and sub-urban schools in the region of Moravia.

Coordinating institution was responsible for coordinating and management of the project work, administration of the project, organization of 2 meetings, presentation of the project, web-page administration including electronic version of outputs, publishing and printing of training materials, production of CD Roms, dissemination, evaluation of the project, design of 1 module ´Assessing Science for Understanding – a constructivist approach´, presentation of 2 students´ portfolio.

The University of Cyprus is a higher education institution also. The CY higher institution is the teacher training institutions providing initial and in-service training. Department of Education, Faculty of Humanities and Social Sciences has long years experience with an initial training of teacher. Expertise: Dr. Valanides is a specialist in the fields of teacher training, methodology of teaching and science education and the development of scientific attitudes and appropriate education and interventions. He is author of the most widely used textbooks. He is a specialists in the field of the application of constructivism to the chemistry education. He has experience in co-operation: scientist exchange programmes with several European and non-European universities in all fields, SOCRATES/ERASMUS in the project subjects with several universities, project co-ordination in several international projects in chemistry education. This institution was responsible for organization of the 1 meeting of the project team in CY, design of 1 module Floating and Sinking of an Object in a Liquid – Based on Socio-cognitive Constructivism.

Siauliai University provides scientific education in all subjects as well as initial and pre-service teacher training. Expertise: experience in science education, presentation in international conferences and journals, authors of the most widely used textbooks, experience in co-operation: scientist exchange programmes with several European and non-European universities in all fields, SOCRATES/ERASMUS in the project subjects with several universities. Institution cooperates with rural school very closely. This institution was responsible for: organization of 1 meeting of the project team, needs analyse, organization of the cooperation on Compendium with competencies of science teacher students and preparation of final draft; design of 1 module: ´European Dimension in Integrated Science Education´, design of training materials, portfolio, evaluation of the project.

This institution offers training of perspective science teachers and in – service training. This institution was responsible for organisation of 2 meetings of the project team and design of 1 module and training material 'Development Procedual Skills in Science Education – Constructivist Approach'.

Bayburt Education Faculty, Ataturk University is a higher education institution also. It was one partner from outside EU countries. Bayburt Education Faculty is one of the seventeen faculties of this university. Ataturk University has 4 education faculties in different cities of the East Anatolian Region of the Turkey. Bayburt Education Faculty was established in 2002. There are two departments: Science Teacher Training Department and Primary School Teacher Training Department. Duration of the teacher training is four years. This institution was responsible for: organization of 1meeting of the project team in TR. The project partners from Turkey are going to search the literature and read all the relevant literature, to design 1 module ´Using the Laboratory to Enhance Student Learning and Scientific Inquiry´ and to prepare training materials, presentation of 2 students´ portfolio, co-ordination of the work on training materials.

1.3 Management Issues

The project was co-ordinated by the ***Steering Group***, consisting of one chairman and 3 co-ordinators: chairman was co-ordinator from Palacky University (Danuše Nezvalová). There were one co-ordinator from University of Cyprus (Nicos Valanides), one co-ordinator from Siauliai University (Vincentas Lamanauskas), one co-ordinator from University of Plovdiv (Ani

Epitropova) and one co-ordinator from Ataturk University (Osman Pekel). Member of this group was also director of financial management Gabriela Pokorna. This group helped with the organization and realization of the project, decided about all project matters and met seven times during the project lifetime. Each member of this group was also responsible for the successful running of the project on the national level. All participating institutions were equal partners in the project. Regular and frequent contacts between members were going via e-mails and website of the project.

National Committee was working on the national level. The co-ordinator in each partner's country was nominated as a chairman. He/she collaborated with 2 (at least) members of teaching staff in his/her institution. In each participating country there were involved the following numbers of teaching staff and administrators: CZ – 6, CY – 4, LT – 3, TK – 2. Chairman was responsible for national reports and materials which were produced in participating institutions. They had regular meetings, in which they prepared agenda to be discussed in the Steering Group, as well as made suggestions and possible options for the anticipated decisions. They were also responsible for the quality of materials which were produced by national groups.

The Steering Group had produced and approved the following documents:

- Guidelines of the structure of Modules (LT): presented on website of the project;
- The structure of the training materials (CZ): presented on website of the project;
- Structure of project website (CZ); running of the website is responsibility of coordinator (CZ);
- Guidelines for financial management in participating institutions (CZ);
- Progress Report (CZ);
- Content of each module (responsibility of each partner);
- Structure and content of e-learning modules (responsibily of CZ);
- Ouputs and results of the project;
- Portfolios of students (responsibility of each partner);

- Financial management of the project;
- Final Report.

The first meeting of the Steering Group was held on March 1-3, 2007 in Olomouc (CZ). All members of the Steering Group were presented there. On the first meeting in Olomouc the following tasks were solved:

- Presentation of the project: goals and aims, activities of the project and plan for the next period;

- Financial management and administration of the project: planning and revising the budget – partners approved the budget which is possible to spend in each country. Each institution received budget on the basis if signed contract in advance. All partners were informed about the rules how to use personnel costs, travel costs, accommodation, subsistence, general administration costs, consultancy costs and documentation costs. Partners got CD ROM and printed materials;

- The criteria for evaluation and self-evaluation of the project were set up. Communication among the partners was implemented via e-mails and website;

- Partners approved Work Plan for the period March-June 2007.

The second meeting of this group was held on June 18-19, 2007 in Šiauliai. All members of the Steering Group were presented. On this meeting in Šiauliai the following tasks were solved:

- Description of the Initial Science Teacher Training in the participating countries: this activity was fulfilled in the most participating countries. Descriptions were presented on the website of the project in advance. Material from CY was missing;

- Needs analysis was done only in CZ and presented on the website of the project in advance;

- Competencies of constructivist science teacher: lists of these competencies were prepared on time only in CZ and TR and were presented on the website of the project in advance;

- First draft of modules: LT partner prepared the structure of the module very well. Partners presented content of the module;

- Financial management of the project. Missing reports;
- Website of the project: was very well designed in CZ , responsibility-Jan Riha;
- All presented partners had a chance to participate on IOSTE conference.

The third meeting of the group was held on November 15-17, 2007 in Plovdiv. Partners from CZ (3), LT (1), CY (1), BG (2) were presented. Nobody from TR participated in this meeting. The following tasks were solved:

- Financial management: Gabriela Pokorna presented expenditures in participating countries and informed about missing reports (CY);
- Final version of the first printed product of the project – Compendium was discussed and approved to be printed in Publishing House in Olomouc (CZ);
- Progress Report was presented by coordinator. This report was approved by partners presented on the meeting.

The fourth meeting was held on April 17-20, 2008 on Cyprus. Partners from CZ (2), LT (2), CY (2), BG (2) were presented. Nobody from TR participated in this meeting. The following tasks were solved:

- Financial management: coordinator presented expenditures in participating countries and informed about missing reports (CY);
- Website of the project was evaluated: website of the project worked very well and was very well organized and usefull for all partners;
- The content of the modules was presented by all partners and was approved.

The next meeting (5) was held in Bayburt University on October 28-31, 2008. Partner from CY Nicos Valanides was not presented from the administrations reasons (problems with visa). The final content of the training materials of modules for the students was approved and materials were prepared for the printing in Publishing House in Olomouc (materials prepared in CY, CZ and LT), materials of BG and TR would be printed there. E-learning courses were discussed. Financial management was explained in detail. The Evaluation Report from Brussels was presented there. On the basis of this report the project work was evaluated and next activities were planed.

The sixth meeting was held in Sofia, BG on February 18-21, 2009. Partner from TR was not presented. Printed materials and e-learning courses were evaluated there. All partners used these materials in there teaching and exchanged their experience. The financial management and next activities were also solved there. The group visited National Agency in Sofia and presented the work that was done under the project.

The last meeting was held in Olomouc on July 1-3, 2009. Gabriela Pokorna solved financial tasks very deeply there to be prepared for financial closing of the project and final report. All partners (partner from TR was not presented again from administration reasons) presented their work and experience that was done under project. The evaluator of the project was presented also on this meeting. They demonstrated that project was very usufull for the quality of science teacher training in their countries. Students in these countries had an opportunity to improve their knowledge and skills in the constructivist theory what was documented with portfolios. The partners showed how the results and outputs of the project were disseminated in their countries. The project was evaluated by all partners. The Steering Committee evaluated the project meetings with the rating excellent. All meetings (7) were very well prepared and organized in nice and friendly atmosphere. IT-based communication was evaluated as very good. All partners had access to the necessary IT resources. Quality of the project website was very good. This web page was very useful supportive tool for the project. The quality of all printed materials and e-learning courses was evaluated also as very good. The external evaluation was done by two external evaluators. Project and its results and outputs were very well evaluated by them.

The full version of all programs and minutes from the seven meetings are available of the web site of the project http://www.iqst.upol.cz.

CHAPTER 2

METHODOLOGICAL ISSUES OF IQST PROJECT

2.1. The State-of-the-art in Prospective Science Teachers Preparation in Project Partners` Countries

Nowadays it is clear that the main trend prevails – training for science teachers is focused on learning, not teaching strategies. On the other hand, the constructivist perspective is becoming a dominant paradigm in the field of the science education. Also it is obvious, that the constructivist approach in the initial science teacher training is not still too common at many European teacher training institutions. Therefore, there is a certain interest in the analysis of a current situation in system of initial science teachers training in the different countries of the Europe.

Science education has become an important prerequisite for a vital economy especially with the emerging global economy. Many industrial nations are seeking to improve the quality of science education because of the vital role science and technology play in a nation's economy and standard of life.

One of the burning problem is professional competence of science teachers. Regular investigations of these issues are conducted by various international organizations and groups of scientists. Education literature (Raven, 1999; Sjøberg, 1997; Naidenova, 2002; Namsone, 2002; Pak, Solomin, 2003; Belova, 2003; Sormunen, Aaltonen, 2003, etc.) suggests that undivided attention has to be paid to natural sciences teachers' in-service training and refresher courses and ads that in general, the role of the teacher changes – from an imparter of information to an expert-adviser. A teacher is the most important epistemic actor when we are thinking e.g. science education (Sormunen, Aaltonen, 2003) and teachers are recognised as the central determining factor in successful science education (Keinonen, 2003).

Research in the field discloses that natural science teacher training determines the approach of the young generation to natural sciences in general. Thus, natural sciences teacher training has to be efficient and permanently investigated (Lamanauskas, 2003). For the successful education it is important to have an attentive ear to the science teachers problems, their expectations, to respect them as well as give scientific and didactical assistance for mating their profession meaningful.

People use scientific principles and processes in making personal decisions and to participate in discussions of scientific issues that affect society very often. Science education strengthens many of the skills that people use every day, like solving problem creatively, thinking critically, working cooperatively in teams, using technology effectively, and valuing life-long learning. And the economic productivity of our society is tightly linked to the scientific and technological skills of our work force. A new way of teaching and learning about science reflects how science itself is done, emphasizing inquiry as a way of achieving knowledge and understanding about the world. Teachers must have theoretical and practical knowledge and abilities about science, learning, and science teaching. The quality of science teacher training and its relationship with improving the quality the education systems generally have become key issues of public concern across the world in recent years.

The comparative analysis of the works of scientists from different European countries shows that there are many similarities in science teachers education problems among all countries, for example, lack of integration between pedagogical theory and practice, too little effort to teach the future teachers effectively and use modern science teaching and learning methods and strategies. The role of practice work in science teacher education is often underestimated and other problems.

1. Bulgaria

The structure of the educational system in the Republic of Bulgaria is composed of the following levels: preschool education, school education (basic and secondary) and higher education.

The university type of higher education is provided at the universities and the specialized higher schools – academies, institutes. It includes the followings stages:

1. First stage – a course of study of at least 4 years, receiving a Bachelor's degree upon graduation;
2. Second stage – a course of study of at least 5 years, or 1 year following a Bachelor's degree, receiving a Master's degree upon graduation;
3. Third stage – a three-year course of study upon obtaining a master's degree that meets the requirements for a Doctor's degree.

All teachers for primary, lower and secondary schools in Bulgaria are required to have higher education. At the moment 98% of the teachers in Bulgaria are with the Univerity degree. Four universities in Bulgaria situated in the towns Sofia, Plovdiv, Blagoevgrad and Shumen are training teacher students. The Subject Core of the pedagogical courses and studies curricula were elaborated by the Ministry of Education and Science, hence they are similarly in all Bulgarian universities. As a rule, persons who have taken the matriculation examination and who have completed upper-secondary school are eligible for university studies.

At the Faculty of Education in The University of Plovdiv it is possible to obtain qualification of teacher in the level of primary school (1-4 grade). At the Faculty of Physics, Chemistry and Biology it is possible to obtain qualification of subject teacher on the lower and secondary school level (5-11/12grade). The education of the Science teachers in the University of Plovdiv is two-subjects: Physics and Mathematics in the Faculty of Physics, Chemistry and Physics in Faculty of Chemistry and Biology and Chemistry in Faculty of Biology. The course of study for these two-subjects is 4 years and corresponds to Bachelor's Degree. Students who graduate these double subjects can teach physics, matematics, chemistry and biology. The Master's Degree in the university takes additional one year and a half of full-time studies. The students from other specializations in the above faculties can obtain pedagogical qualification by studding a pedagogical module parallels or after their subject Bachelor's Degree. An academic year at University consists of 30 work weeks divided into 2 semesters. The first semester starts in the first week of October and ends in January (winter term). Between the two semesters students have 1 month to prepare and take their exams. The second semester starts in the last week of February and ends the first week of June (summer term). Students have 1 month to prepare and take their exams. According to Bologna process in order to compare our curricula for bachelor's and master's level with similar curricula used in other EU countries, we present them also in ECTS-credit points (European Credit Transfer System). The credits points (cp) in the Faculty of Physics for one semester are 30 and in this way the Bachelor's Degree is equivalent of $8 \times 30 = 240$ cp.

The science teacher training in Bulgaria for Bachelor's degree is two-subjects with 3000 study hours in the University and students takes 34 exam, 16 current examinations and 3 State exams. Such kind of study is heavy and a substantial part of the students satisfied with a minimal knowledge in more theoretical subject. The lectures are the main teachers' tool and the given knowledge's are mainly theoretical. This academic approach reflects on the teacher practice in the school. The lessons are more or less theoretical; applications in the industry or in the human life are used only as examples for the application of theory. A lesson treads some given phenomenon and relations with other phenomena or some generalization of the problem is discussed rarely.

2. Cyprus

The educational system in Cyprus includes the Kindergarten, the elementary and the secondary schools as the three compulsory levels of education. The elementary education consists the levels/classes from one to six and the secondary school the levels/classes from seven to twelve. The Natural Sciences are one of the most important subjects in all levels of education, having common goals. Nevertheless, teachers' training for Kindergarten and elementary schools differs from the corresponding teachers' training in secondary schools. The training of teachers who are intend for the Kindergarten and Elementary schools is general and considers methodology and philosophy of education, psychology modules and cognitive object (γνωστικό αντικείμενο). For a Bachelor's degree in elementary school teaching or kindergarten school teaching, a student must successfully complete at least 240 ECTS. For the subject of Natural Sciences the kindergarten teachers have to complete two compulsory courses for a total of twelve ECTS, which are the following:

- *Science Concepts in the kindergarten school (EDU 175):* living organism, similarities and differences among them, their living conditions and their reactions to seasonal and everyday environmental changes. Human body, its structure and basic functions. Earth and planets in space and climate. States of matter forms of energy and their transformation. Emphasis on the methods and processes of science.

- *Natural Sciences in the kindergarten school (EDU 335):* the development of preschool-age children's mechanisms of understanding the physical environment and its changes and employing simple methods and processes of natural sciences. Design of teacher interventions which can sensitize preschool-age children to the interaction between man and the environment and develop their readiness and appropriate attitudes for learning natural sciences at the elementary level.

In addition, they have to successfully complete school experience, where they teach among others lessons of Natural Sciences. The primary teachers, for the subject of Natural Sciences have to complete three compulsory courses giving them a total of eighteen ECTS. These are the following:

- *Natural Science in the elementary school. Environment and living organism (EDU 177):* living organism and environment. Basic function and interrelations of living organisms. Flow of mass and energy in the ecosystems.

Technological culture and environment, environmental education and consciousness, environmental and ecological projects.

- *Natural Science in the elementary school. Physical and chemical phenomena and changes (EDU 276):* physical and chemical phenomena and changes. States of matter and their structure and properties. Changes of state of matter. Physical and chemical phenomena. Forces, forms of energy, transfer and transformations of energy. Heat, sound, light, magnetism and electricity, their sources, transfer and effects. Emphasis on methods and processes of science and experimental study phenomena.

- *The teaching of Natural Sciences (EDU 336):* the basic variables of the teaching-learning process which have special importance for teaching natural science at the elementary level based on research evidence. In-depth examination of elementary students' mechanism of understanding and their preconceptions about physical reality. Design and evaluation of teaching interventions in an attempt to promote students' cognitive, affective, and psychomotor development and to activate their innate capacities.

Additionally, they have to successfully complete school experience in the third and fourth year of their study. In the third year they sit under in public schools for a period of approximately three weeks. During this period they attend two Natural Sciences lessons and they teach one lesson. In the fourth year they get involved in school activities for one semester. The preparation is achieved after a three-week slot of lectures which take place before the entering in public schools. As far as the subject of Natural Sciences is concerned, the students have to attend the lessons from the class teacher for ten weeks. They also have to teach about ten periods under the guidance o their mentor (class teacher) and the supervision of an academic staff.

Students are required to complete four compulsory courses (twenty four ECTS) for their respective specialization during their fourth year studies. One alternative specialization relates to the teaching Natural Sciences and students have to attend the following courses:

- *Modern Trends in Science teaching at the primary school (EDU 476):* Cognitive demands of science curricula and students' cognitive capacity. Educational interventions and cognitive accelerations: research evidence. Misconceptions in science and the process of conceptual change. Children's science. Support for students' cognitive, psychomotor and affective development. Scientific and technological literacy at the primary school. The importance of experimental science teaching.

- *Computer Science application in the teaching of science in elementary school (EDU 477):* the course examines ways in which computer technology may support the teaching of science in elementary school. The purpose of the course is to make students aware of the computer as a simulation instrument and as a research medium.

- *Special Issues in Mathematics Education (EDU 471).*

- One additional course from the Department of Physics, or the department of chemistry, or the Biology department. This course relates to content knowledge from physics, chemistry, or biology, respectively.

The teaching of Natural Sciences in secondary school is divided into discrete subjects: Physics, Chemistry, and Biology. Any person holding a BA in physics, chemistry, and biology is considered as a prospective teacher of the respective subject (Physics, Chemistry, and Biology) provided that (s)he has completed a one-year pedagogical training from an Educational department (i.e., the Department of Education, University of Cyprus).

The structure of this pedagogical training is as follows:

1. Four compulsory courses (4x4=16 ECTS) that relate to educational theory, multicultural education and the educational system (4 ECTS), curriculum and instruction (4 ECTS) research and evaluation in education (4 ECTS), and educational psychology (4ECTS).

2. One compulsory course (enrichment) from their respective specialization (4 ECTS).

3. One elective course among a list of 10 several courses relating to the sociology, psychology, history of education etc., depending on their interests and/or needs.

4. Two compulsory courses (8 ECTS) in teaching methodology and related topics, such as action research, constructivistic approaches of teaching, and how to integrate ICT in their teaching. These two course focus exclusively on teaching physics, chemistry and biology at the secondary school.

5. Prospective secondary school teachers should also complete school experience. During that period, students participate in school activities and they undertake teaching in actual classrooms under the guidance of special personnel. They get a lot of feedback and have opportunities to be involved in action research and reflection on their teaching and how to become more effective teachers.

3. Czech Republic

This description is done on the basis of Palacky University experience. Teacher training is predominantly at the higher educational level, the only exception being for pre-school education (kindergarden) teachers.

The following components in the study programes are always present: general education, education in a specific field (education in the field of future teaching), pedagogical education (psychological, pedagogical, didactic) and pedagogical practical training. Teachers at upper secondary schools are qualified as subject specialists. The subject combination of specialists depends on their choice at the beginning of the study and can be selected from a list of combinations or from a list of individual subjects set by the faculty. Students can study science subjects and math to be qualified as 2 subjects specialist for upper secondary schools. Students can make choice in the following subjects at the Faculty of Science: biology, chemistry, physics, geography, computer science and mathematics. Students study compulsory or elective subjects in their specific fields (biology, chemistry, physics, geography, computer science and mathematics), general education (English, philosophy of science), pedagogical education (psychological, pedagogical, didactic) and pedagogical practical training. Practical training takes 6 weeks (in two periods, each of 3 weeks) and is realized at cooperating upper secondary school. Each course has certain number of credits. The course usually consists of ten terms, each of 15 weeks, and there are on average 20 hours of direct teaching each week.

Students are assessed through a system of partial and comprehensive exams, credits and classified credits. These can be in an oral, written or practical form or in the form of a seminar paper. After each term the students sit for examinations mostly in subjects taught during that term. Some subjects are taught over several terms. In order to be allowed to sit for an exam, students must demonstrate that they have completed the relevant course work. Evaluation of the student teaching practice depends only on the report of teachers of school where teaching practice was completed. There are no criteria of the student performance. Study achievements are assessed by a system of granting points or credits. Students have to get 180 credits to get bachelor degree and next 120 credits to earn master degree. The credit system is compatible with the ECTS as a necessary condition for entry to the European student mobility programme Socrates-Erasmus.

The frequency and methods of assessing the students' achievements differ according to different courses. In some cases a system of partial examinations taken after each semester is introduced, in other cases there is one comprehensive examination after each completed part of the studies – most often at the end of a certain module. Considerable emphasis is also placed on continuous assessment of the students' work, mostly in the form of tests of knowledge or independent work (on computers, graphic work, laboratory work or seminar work) or independent work.

The organisation of examinations is legally embedded in study and examination regulations, which are part of the internal regulations of a higher education institution (faculty) and are approved by the academic senate. In general, examinations are taken in the course of an examination period at the end of each semester. Examiners are teachers of individual subjects. Relevant examiners declare the dates of individual examinations and the dates of all examinations are declared by the management of the institution (faculty). In justified cases it is possible to take an examination before the agreed official date. A failed exam may be retaken several times. Final examinations are taken in front of boards of examiners. In order to increase the level of objectivity, external examiners from other higher education institutions or scientific establishments are invited as to sit on the boards. Care is taken to authorise only the most qualified academic staff as examiners. At the end of a three-year Bachelor's programme the student sits for a final state examination, a defence of Bachelor's thesis is usually part of it. The content is set by the faculties. It consists mostly of an oral examination in licensed subjects. Students continue in Master's programmes for next 2 years. In the end of studies the students sit for a state final examination, which consists of an exam in subject field(s), subject didactics and the defence of a thesis. The content is also set by the faculties. On passing the state final examination, he/she receives a certificate and a diploma, which acts as a qualification for the upper secondary schools and gives them the right to use the title Magistr (Mgr.).

4. Lithuania

The description of a few key points defining a system of teacher training in Lithuania can be found rather purposeful.

- Professional teachers’ qualification and competence is the pivot of the whole teacher training system.
- The candidates’ sample /contingent/ of participation in the pedagogical curricula. Motivation for becoming a teacher and working at school constantly decreases. The pedagogical curricula usually choose the candidates with medium-based abilities. On the other hand, a demand for the teachers of sciences is fairly low.
- Education received by teachers /university or college education/. A new concept of the teacher training system basically answers the question.
- Material and intellectual resources of higher educational institutions. To train the teachers of sciences, not only intellectual but also large material resources are required (properly equipped research facilities, rooms of didactics, botanical gardens and zoos etc.).
- Elitistic and mass education.
- The ways of training mentors of teaching practice. A system of granting licences for teachers.
- Two models of teacher training: ***parallel*** /individual subject training + pedagogical training + practical activity/ and ***consistent*** /academic studies of a certain subject proceeding with realization of teacher training/. Primary and pre-primary school teacher training is received applying the parallel model whereas gymnasia teacher training uses the second model. The colleges also employ the parallel model.
- A right to work as a teacher /licence/ is granted when studies or successful pedagogical practice-traineeship in basic school (half a year under the parallel model or one year under the consistent model) is over (Lamanauskas, Gedrovics, 2006).

The teachers of natural sciences are trained by Universities in Lithuania. Although the binary system of higher education including universities and colleges is prevailing in Lithuania, however, at the moment, the teachers from colleges are not involved in teacher training.

The teachers of natural sciences in Lithuania can choose between studying a bachelor's and a master's degree (can be either broadly-based or focused) curriculum.

The curricula of studies fall into three categories:

1. Basic studies;
2. MA studies;
3. Specified professional studies.

The curricula of studies can also be subdivided into two sections:

- Theoretical studies;
- Scientific research.

A module is the fundamental unit of planning studies. It is a subject studied or a part of it taught along the term. The module of studies can be either compulsory or optional and includes different forms of learning: lectures, laboratory experiments, practice, individual student's work, scientific research and planning.

A measurement unit of the scope of studying is a credit which on average makes 40 hours of effective and independent work in and outside the classroom and equates with one weak of studies. The curricula of studies are designed following the Rules of quality assessment for institutions of research and higher education approved by Order No 1326 of the Ministry of Science and Education of the Republic of Lithuania on October 10, 2000 and the regulations of the curricula of studies and modules of a higher school.

The scope of the bachelor's degree curriculum is 160 credits. The length of service of full-time studies makes 4 and university extension and part-time studies – 5 years.

The curriculum of studies schedules three groups of the subject studied.

- ***General education subjects at university level*** make no less than 15 % of the scope of the whole curriculum;
- ***Subjects discussing the fundamentals of studies*** make no less than 25 % of the scope of the curriculum;
- ***Subjects dealing with special education*** take the rest of the scope of the curriculum but not less than 40%.

The scope of the term of full-time is 20 and of the 4^{th} year of studies – 16 credits. Thesis takes 8 credits. The number of the subjects studied in the 1^{st} and 2^{nd} year cannot exceed 7, in the 3^{rd} – 6 and in the 4^{th} – 5 credits per term. From the beginning of term 4, the curriculum may enclose no more than 2 term papers/projects in each of the terms. The curriculum may also include practice. The examination session should accept no more than 5 exams (Type E). The bachelor studies ends in completing thesis and taking final exams.

The number of the modules of the subjects taught, the term papers and projects as well as the scope of the exams of the curricula of university extension and part-time studies agrees with that of the curricula followed by the full-time students except from the length of service, the number of credits and hours studied within the term.

The teachers having a bachelor's degree have a possibility of gaining a master's degree. The scope of the curricula of all forms of MA studies makes from 60 to 80 credits. The university extension and part-time studies may also last for 2 years and take 80 credits or 1,5 years and take 60 credits.

The scope of the term curriculum of full-time studies is 20 credits. The term may include no more than 4 theoretical modules, 1 module of research work and no more than 2 term papers/projects. The master's studies ends in completing thesis.

According to the number of exams, term papers, projects, modules and its scope, the curricula of university extension, part-time studies and remote education are equal to those of full-time studies except from the length of service, the number of credits and hours studied within the term.

The curricula of studies of the same field include a part of general subjects. A general part of a field curriculum is coordinated by the University board of studies and approved by the rector.

Every spring term, along the modules chosen, the students work out individual plans of studies for the forthcoming year. The questions of planning individual studies are discussed with the Dean Office and lecturers. The individual plans of studies can be adjusted within two first weeks of the term started. The final versions of individual plans and changes are approved by the Dean Office.

The University offers two types of studies – continuing and incoherent. **Continuing** studies are aimed at all-round higher education confirmed by the obtained university degree and (or) professional qualification. **Incoherent** studies embrace only separate subjects or their cycles studied and focus on improving or changing one's professional qualification as well as on developing professional and general education. These studies also encompass supplementary (retraining) studies.

The stages of continuing studies are:

1. Bachelor's and professional studies;
2. Master's, and specified professional studies;
3. Postgraduate studies.

Bachelor's studies are continuing the first degree studies at university level. A student is awarded a bachelor's degree after studying is over. Professional qualification may also be obtained. The graduates are allowed to take up postgraduate or specified professional studies.

Complete studies concentrate on receiving master's degree and (or) professional qualification when first and second degree studies at university level are combined.

Specified professional studies are continuing the second degree studies for graduates from university devoted to the students seeking for professional qualification of a particular field. Studying helps with a better preparation for work that requires special practical abilities.

Master's studies are continuing the second degree studies for those improving individual professional and scientific qualification focused on scientific activity. The students are trained to be either scientists-researchers or teachers and directed to be involved in analytical applied activity.

Postgraduate studies are the third stage studies at university level concentrating on would-be scientists training. The applicant must have a master's degree or be a graduate from complete studies. When postgraduate studies are over and thesis is defended, a student is awarded a degree in Educology.

We can maintain that:

- After restoring independence, the new teacher training curricula using experience of Western countries and considering national needs were developed.

- The teachers of natural sciences mainly have to meet new social, pedagogic and subjective requirements. They are treated not only as providers imparting knowledge and facts but also as those helping the learner with choosing the required information on an individual basis. The changes in society and the process of teaching show that higher schools must take into account these facts while training would-be teachers.

- The training curricula of teachers of natural sciences are designed on the basis of the regulations of the field of studies and standards of teacher training and are aimed at training teachers able to teach a few subjects of natural sciences.

- The curricula focused on preparing teachers able to teach natural sciences integrated into other subjects taught are designed.

- The curricula of natural sciences include education management, an introductory course on Educology, didactics and hodegetics that are involved into the process of competence development; however, it is not enough to gain general competence in pedagogical practice.

- The training curricula of teachers of natural sciences encounter a problem pointing to the recession of the parallel teacher training model. In this case, the prospects of professional studies that proceed receiving a bachelor's degree are confirmed by the new curricula of professional studies scheduling a general core section of the subjects developing pedagogical competence and didactical subjects of different fields of science that will be applied for the purposes of improving didactical competence of a certain subject.`

- Lack of specific methodology, examples of good practice and recommendations for solving the problem of integrated education can be noticed in Lithuania.

- No detailed systemic recommendations and methodical and organizational tools of how to integrate modern Information Communication Technologies (ICT) into the processes of teaching/learning natural sciences are created.

- The teachers of natural sciences are not experienced enough in the field of general competence in modern ICT and suffer from shortage of methodical experience of how to effectively apply ICT in the educational process. The teachers should gain relevant experience in the seminars in methodology, training courses and accepted pedagogical practice at school using the latest Lithuanian versions of natural science training aids based on ICT.

5. Turkey

The basic structure of the Turkish National Education system consists of four main stages as pre-school education, primary education, secondary education and higher education. **Pre-school education** encompasses training for those who have not as yet arrived at compulsory school age, and is optional for the children between the ages of 4-6. **Primary education** is a compulsory 8 year program for all children (**grades 1-8**; ages 7-15). This is compulsory schooling for both boys and girls, in state operated schools where tuition is free. **The upper secondary education (Lycees) system** includes "General High Schools" and "Vocational and Technical High Schools". Secondary education comprises a minimum of 3 years schooling in lycees and professional and technical schools (**grades 9-11**; ages 15-18). The aim of lycees is to secure a level of general culture, develope an awareness of individual and community problems and be able to contribute to the economic, social and cultural growth of the country and to prepare the students for higher education.

Higher education is defined as all post-secondary programs. The system consists of universities (state and foundation) and non-university institutions of higher education (police and military academies and colleges). Each university consists of faculties and four-year schools offering bachelor's level programs, the latter with a vocational emphasis, and two year vocational higher schools offering pre-bachelor's (associate's) level programs of a strictly vocational nature.

The Higher Education Law No. 2547 is the main law, which governs the higher education in Turkey. All universities (both state and foundation) are subject the same law and regulations/rules. All state and foundation universities are founded by Law.

Graduate-level programs consist of master's and doctoral programs, coordinated by graduate schools. Master's programs are specified as programs "with thesis" or "without thesis". Programs "without thesis" require completion of more graduate courses and a term project. The duration of these programs is a minimum of two years. In general, access to doctoral programs requires a master's degree, unless the students' performance at Bachelor's degree is evaluated as exceptionally well. Doctoral programs have a duration of a minimum of four years which consists of completion of courses, passing a doctoral qualifying examination, and preparing and defending a doctoral dissertation.

Compared to the past, the continuously changing role of teachers in teaching-learning process has become more important in the recent years. Traditionally, teacher is perceived as the unique source and the transmitter of knowledge. However, today teacher has become a guide who not only explains the subject matter but also facilitates the learning process. The main purpose of the study program is to educate science teachers with a good self-image, an outgoing personality, a sense of humour and an interest in helping their students to understand science in a meaningful way. The program also aims to develop teachers with a sound understanding of how children learn science; confident in using technology; capable in problem-solving; attentive to human rights, democracy, and ethics. The program emphasises critical thinking, personal reflection, and professional development of preservice science teachers.

Physics, Chemistry, Biology and Math teachers for high schools (16-18 ages) have to get their branch lessons (eg. Botanic, Zoology) during 7 semesters, and then they also have to get pedagogical lessons during 3 semesters. At the end of 10 semester = 5 years they get Master of science diploma (without MSc thesis). This is the only license or diploma for working as “teacher” on their branches. But in order to work for government schools they have to get enough mark from the KPSS exams which applied by government for teacher candidates.

2.2. IQST Project Approach

To compare science teacher training in the five cooperating countries (BG, CY, CZ, LT, TK) is not so easy because of all existing cultural differences. To summarize approaches to the science teacher education three sets of variables are of importance:

Context variables, representing the influence on teacher training of the educational system, as its customer, and of the educational policies in the cooperating countries.

Institutional variables, representing the various aspects of the institutional constraints of the teacher training programs.

Curriculum variables, representing the various aspects of the content of the science teacher training program.

Context variables

In cooperating countries a little bit different educational systems exist that influence teacher education in the countries. Generally, all described systems have primary, lower and upper secondary levels. The systems differ from the length of the levels. Primary education takes 4 (BG, CY, LT) to 5 (CZ, TK) years. There is a different training for primary and secondary science teachers in all cooperating countries. Some of the cooperating institutions are more focused on the primary science teacher training (CY, LT, TK), others on lower secondary science teacher training (LT, TK) and the next on upper secondary science teacher training (CZ). In all these countries governmental control over the science teacher exist. In the context of science teacher training the various types of decision-making, however, become most evident in the extent of governmental influence on decisions with respect to:

(a) The control over the admission to teacher training.

(b) The control over the curriculum and the qualification.

In all these countries science teacher training is a part of higher education, a secondary general education diploma is the minimum entrance requirement. With the respect to the control over the curriculum and the qualification of science teachers, there are a little bit different models, but common for all cooperating countries is that government controls the curriculum through state examination and accreditation.

Institutional variables

These variables concern:

The course length.

The structure of the training program.

In primary teacher training the length differs between 3 (CY) to 4 (BG, LT, TK) and 5 (CZ) years. The teachers are trained mostly in schools of education (pedagogical faculties (BG, CY, CZ, TK) or pedagogical faculty and colleges (LT) which are part of universities. The course length of the science teacher training of lower and upper secondary school varies from 4 (CY, LT, TK) to 5 years (BG, CZ). All participating institutions implemented credit systems (ECTS).

The programs contain both academic studies and professional studies in all participating countries. The integrated program, which means that academic and professional studies are to a large extent integrated, is realized in primary science teacher training in all five countries. A parallel or concurrent program, which means that academic and professional studies take place concurrently, is most frequent for participating institutions in CY, LT and TK. A consecutive program, which means that at first academic studies are completed and then followed by the professional studies, was implemented in CZ and BG recently. For instance in CZ (Faculty of Science) prospective science teachers at upper secondary schools finish bachelor degree in academic subjects. Then students can continue with academic studies in two subjects and professional studies to earn master degree. The subject combination of specialists depends on their choice at the beginning of the study and can be selected from a list of combinations or from a list of individual subjects set by the faculty.

Content variables

In all cooperating countries the curricula for the science teacher training contain subject-knowledge (academic studies) and three components of professional preparation: educational theory, didactics of the subjects and school practice. In CY, LT and TK the professional preparation is more stressed while in BG and CZ subject-knowledge is more important. In educational theory such topics as child psychology, learning psychology, philosophy of education, history of education, general didactics, culture of mother tongue, educational management, foreign languages is possible to find. The curriculum is strongly focused on the ICT using in all participating institutions. The topic of constructivism is implemented only in the curriculum in CY. Didactics of the subjects are focused on the problems how to teach science at school (teaching methods, school curriculum, methodology, research in schools, communication in sciences, planning of lessons, choice and preparation of materials, techniques of presentation, methods of assessment, classroom management, labs in sciences). School practice is a series of structured learning situations in schools, designed for pro spective science teachers, in which they are confronted with concrete teaching and classroom management activities on a systematic basis, supervised by a co-operating teachers in schools. There is different length (but 6 weeks at least) of teaching practice in cooperating institution in the project.

In the institutions participating in the IQST project the different approaches of science teacher education are possible to recognize. On the other side these institutions have nearly the same problems: lack of prospective science teacher and strong common interest how to improve the quality of science teacher training. One of the possible ways is to implement constructivist theory to science teacher training. In all participating institutions would be possible to realize main goals of the IQST Socrates Comenius project: to design and implement constructivism modules in science teacher training.

More information is possible to find in publiction which was issued under the IQST project:

Nezvalova, D. (Ed) (2007). *Improving Quality of Science Teacher Training in European Cooperation – Constructivist Approach. Compendium.* Olomouc: Palacký University Press, 139 p. ISBN 978-80-244-1821-6.

This publication is available in full version on: http://www.iqst.upol.cz

CHAPTER 3

THE MAIN PROJECT RESULTS

3.1. Needs of Constructivist Science Teacher

We developed our ideas in the context of the needs of science teacher education. This invites the philosophy of science as a special informant about the nature of constructivism. We understand a central tenet of constructivism to be what philosophers of science have argued for decades – that facts and processes of observation are theory laden and, therefore, cannot be taken as self-evident in the classroom. Much of scientific knowledge consists not merely of the phenomena of nature, but also of constructs advanced by the scientific community to interpret and explain nature. A constructivist perspective on meaning-making is useful if it develops in individuals a disposition for inquiring into problems.

Science teacher education students need opportunities for testing, discussing, and comparing various perspectives and approaching to teaching. Science teachers become more responsible for their pedagogical choices. Students continually construct meaning of classroom events based on their prior understandings and experiences. It follows that a constructivist science teacher will have a disposition for attempting to see science classroom phenomena from students´ perspectives in the instructional programme. The disposition and ability to see from students´ points of view is fundamental to sorting out what is right about their thinking as well as what is inconsistent or incoherent about it. To see a phenomenon from a student's point of view requires reconstruction on the part of teacher. The phenomenon in question must be seen in a new light. A critical aspect of science teaching is a teacher's ability to see how such perceptions arise from student's perspectives. We appreciate the difficulty of imparting constructivist orientation to science teacher education students. They often appear to us as discovery learning teachers, with hand constructivist-on activities related to the science idea.

Constructivist talk seems to evoke in some teacher education students a distorted image, or a truncated version, of constructivist teaching. In some representations by students, constructivism sounds like a recipe, a procedure of teaching. In many cases the constructivism looks like discovery learning, when children put forward their science ideas at discoveries, and the cross-checking and testing of those ideas with other references (peers, teacher's scientific knowledge) is omitted.

Science teachers need to concern themselves with the manner in which hear or read constructivism but also the ways in which they represent it to themselves as researchers. Constructivism is a way of thinking about the events of teaching and learning.

Summary

1. Initial knowledge is fragmentary and unstable. Candidates often denote concepts in ways that suggest they think about them in functional or operational terms. Science teacher students need to integrate new professional learning with their knowledge.

2. Structural knowledge increases over the course of science pre-service teacher education, and continues to increase with teaching experience.

3. Knowledge growth is uneven and idiosyncratic. The variation and turbulence in knowledge growth is displayed by beginning teachers.

4. Cognitive structure of student is correlated with the ability to reflect deeply about teaching. Reflection should be a part of science teacher training.

5. Teaching practice is an important part of science teacher training. Student teaching provides such an environment as university classes cannot do.

6. Some science teacher students have misconceptions about science teaching and learning. Students have the needs to directly challenge these misconceptions. Understanding of candidate's prior knowledge is a key to improving science teacher education. Prior knowledge is central to constructivism.

7. Students need better tools in the courses (concept mapping, journaling, biography, research, cooperative work, experimenting, hands-on activities, questioning, discussion, learning by doing, …).

8. Students need to encourage reflection on previously held views of science teaching and learning.

9. Students need to promote an understanding of a constructivist perspective on learning and its implication for teaching.

10. Students need to understand the prospects and problems of implementing a constructivist-based approaches for promoting changes in science teaching and learning.

More information is possible to find in publiction which was issued under the IQST project:

Nezvalova, D. (Ed) (2007). *Improving Quality of Science Teacher Training in European Cooperation – Constructivist Approach. Compendium.* Olomouc: Palacký University Press, 139 p. ISBN 978-80-244-1821-6.

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3.2. Description of Science Teachers Competences

Recently, competences have become a priority area of discussions. Acquiring appropriate competencies in higher school is a guarantee of successful pedagogical work. Therefore, accurate defining of competencies as well as their content and structure is very important. It should be taken into consideration that the majority of competencies gained during studies at university level will be developed in comprehensive schools i.e. achieving competencies is not a finalized process as it lasts long – the whole time of active pedagogical activities. For example, such teachers' strengths as the ability to individualize educational content, the ability to teach how to learn and communicate with other people, the ability to purposefully apply the learning strategy and different methods in the teaching/learning process for collaboration purposes, the ability to apply varying methods evaluating students' achievements and progress in the educational process etc. are absolutely crucial points.

It is clear that conveying knowledge, broadening students' world outlook and establishing a positive relationship with an immediate environment (natural and social) are outstanding qualities. Different international research (SAS, ROSE, TIMSS, etc.) shows that motivation and increased interest in sciences play a fundamental role. The teachers of sciences interdependently coordinate their activities, maintain a close interdisciplinary-integrated relationship and look for new more efficient educational methods and activities. Thus, they can achieve highly positive results (in terms of students' knowledge level and value-based maturity).

Experience gained during the process of training foreign teachers of sciences is very relevant. Within the framework of the carried out IQST project the experts from the project-partner countries prepared the lists of competencies.

First, it should be noticed that the experts from different countries singled out a number of different competencies of science teachers. The majority of competencies necessary for teachers were mentioned by the respondents from Turkey and Bulgaria. Considering the meaning, some of the presented competencies are very close, for example *organizing educational process* (Lithuania), *practical pedagogical activity* (The Czech Republic), *general pedagogical abilities* (Turkey), *general pedagogical competence* (Bulgaria). Some of those are very exceptional, for example solving problems and critical thinking (Lithuania), safety and welfare (The Czech Republic), general intellect (Bulgaria), modelling the process of cognitive conflict (Cyprus) (Table 1).

The content of competencies revealed that the experts from different countries highlighted the same elements of competencies using various methods of combining them into certain units. The content of individual competencies includes components that in terms of semantics reach the notional framework of other competencies. For example, Lithuanian experts established that the teachers of sciences should demonstrate *information and knowledge management* – (L7) (Table 1). The component of the competence *able to self-sufficiently increase professional qualification* semantically agrees with the content of competence *professional improvement* (C) singled out by the experts from the Czech Republic. Another component of the same competence *perceives knowledge of science* conforms to the content of competence *perceives the core of science* – (C1; T1; B1) named by the Czech, Turkish and Bulgarian experts. It is worth mentioning the competence *modelling the process of cognitive conflict* specified by the colleagues from Cyprus. The content of the latter competence consists of 20 integrated parts embracing the aspects of *pedagogical activity, evaluation, problem solving, ensuring safety and creativity*. Therefore, a thorough assessment of competence content disclosed that the experts from different countries identified the following competencies required for science teachers-constructivists:

Table 1. Competencies of science teachers singled out by the experts.

Country	Competencies *									
	1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**
Lithuania	Critical thinking	Organizing educational process	Problem solving	Creativity and innovativeness	Communication	Use of ICT	Information and knowledge management	Value-based attitudes	Researching	Content of the taught subject
The Czech Republic	Perceiving the core of science	Perceiving science development	Researching	Practical pedagogical activity	Content of the taught subject	Evaluation	Safety and welfare	Professional improvement	-	-
Turkey	Perceiving the core of nature and science	Professional activity	Researching	General pedagogical abilities	Content of the taught subject	Evaluation	-	-	-	-
Bulgaria	Perceiving the core of science	General intellect	General pedagogical	Didactics of the taught subject	-	-	-	-	-	-
Cyprus	Modelling the process of cognitive conflict	-	-	-	-	-	-	-	-	-

* further in the article, competencies are expressed by the symbols representing the singled out original competence indicated by the experts of every country. The meaning of a symbol can be established using Table 1: a letter is a symbol of a country and a figure shows competence itself, for example B2 is *Competence of general intellect* learned by the experts from Bulgaria.

- perceiving the core of science;
- perceiving science development (historical aspect);
- content of the taught subject;
- critical thinking;
- evaluation;
- problem solving;
- researching;
- practical pedagogical activity;
- modelling the process of cognitive conflict;
- creativity and innovativeness;
- communication;
- professional improvement;
- information and knowledge management;
- safety and welfare;
- value-based attitudes.

As it was mentioned before, depending on the meaning, the individual components of the content of some competencies agree with a few competencies. Thus, the integrated elements of different competencies cover the majority of the above introduced competencies (Table 2).

Table 2. Proportion of the integrated elements of competence content to the singled out competencies

Integrated elements of competencies	**Competencies**				
Perceiving the core of science	L7		T1; T2	B2; B3	
Perceiving science development (historical aspect)	L7	C2		B1	
Content of the subject taught	L10	C 5	T5	B4	CY1
Critical thinking	L1			B1; B2	
Evaluation	L3	C 6	T2; T6	B2; B3	CY 1
Problem solving	L3				CY 1
Researching	L9	C 3	T3	B1; B2; B4	
Practical pedagogical activity	L2; L6	C 4	T4	B2; B4	CY 1
Modelling the process of cognitive conflict					CY 1
Creativity and innovativeness	L4		T6	B3	CY 1
Communication	L5	C 8	T2	B2	
Professional improvement	L5; L7	C 8	T2; T6	B2	
Information and knowledge management	L7	C 8	T2	B1; B2; B4	
Value-based attitudes	L8				
Safety and welfare		C 7			CY 1

Science teacher's competence to be a teacher should be confirmed by his/her gained knowledge, developed abilities and formed value-based orientation. These are the main points to be considered discussing competencies necessary for teachers of sciences. An assessment of the competence list demonstrates that the experts from different countries emphasize the following competencies focusing on knowledge:

- content of the taught subject;
- perceiving science development;
- perceiving the core of science;
- modelling the process of cognitive conflict;

The following competencies are focused on ability development:

- professional improvement;
- evaluation;
- solving problems;
- critical thinking;
- researching;
- modelling the process of cognitive conflict.

Very few students' value-based competencies have been singled out:

- value-based competence;
- safety and welfare.

A more thorough assessment reveals that the integrated elements of competence content make different groups of competencies concentrating on knowledge, abilities and value-based attitudes (Table 3). Practical abilities (22 positions) rather than knowledge (16 positions) are devoted more attention. Only 3 positions on value-based attitudes show scant attention to the latter aspect of competencies.

Table 3. Competence distribution considering knowledge, abilities and value-based attitudes

Content of competencies		
Knowledge	**Abilities**	**Value-based attitudes**
L7; L9; L10; C 2; C 3; C 5; C 8; T1; T2; T3; T5; B1; B2; B3; B4; CY 1	L1; L2; L3; L4; L5; L6; L7; L9; C 3; C 4; C 6; C 8; T2; T3; T4; T6; B1; B2; B3; B4; CY 1	L8; C7; CY 1

The table illustrates that due to the variety of separate content elements the same competence frequently focuses on knowledge as well as on practical abilities, for example *information and knowledge management* (L7), *professional and practical activity* (T2), *researching* (T3).

All indicated competencies focus either on the taught subject or on practical pedagogical activity (Table 4):

Table 4. Competence distribution considering the taught subject and pedagogical activity

Competencies in a taught subject	Competencies of practical pedagogical activity
L6; L7; L8; L9; L10; C1; C 2; C 3; C 5; C7; T1; T3; T5; B1; B4; CY1	L1; L2; L3; L4; L5; C4; C 6; C 8; T2; T4; T6; B2; B3; CY1

The table shows that almost there is a balance between the competencies concentrating on the taught subject and those focusing on practical pedagogical activity. The former competencies are slightly predominating (positions 16 to 14). Along the undertaken assessment, a comparison of competence subdivision into the taught subject and pedagogical activity sections focusing on knowledge, abilities and attitudes has been made (Table 5).

Table 5. Competence subdivision into the sections focusing on knowledge, abilities and attitudes

	Taught subjects	**Pedagogical activities**
Knowledge	➢ content of a taught subject; ➢ perceiving science development; ➢ perceiving the core of science; ➢ modelling the process of cognitive conflict (separate elements)	
Focus on knowledge and abilities	➢ information and knowledge management; ➢ researching; ➢ perceiving the core of science; ➢ didactics of the taught subject; ➢ applying ICT.	professional and practical activity; professional improvement; general intellect; general pedagogical.
Abilities		➢ critical thinking; ➢ organizing educational process; ➢ problem solving; ➢ creativity and innovativeness; ➢ communication; ➢ practical pedagogical activity; ➢ evaluation; ➢ professional improvement; ➢ modelling the process of cognitive conflict (separate elements)
Attitudes	➢ value-based attitudes; ➢ safety and welfare (separate elements)	safety and welfare (separate elements)

Table 5 clearly discloses that competencies in the taught subjects are aimed at knowledge whereas those in pedagogical practical activity are fixed for abilities. An assessment of competence content disclosed that some competencies focused on knowledge as well as on abilities (highlighted in the table).

Summary of the findings of the carried out research reveals the possibility of modeling a list of competencies of an ideal science teacher organizing the educational process on the basis of the principles of constructivistic teaching/learning. Such a programme could help the teachers intended to follow the above introduced educational principles with self-evaluation of personal abilities and achievements and prefigure the fields to be improved in the future (Table 6).

Table 6. The list of the competencies of science teacher organizing the educational process through the constructivistic approach.

Sections of competencies	Competencies	Content of competencies
1. Competencies in the taught subject	**1. Information and knowledge management**	➢ knows the basic facts of science evolution; ➢ knows the history of science knowledge development of the taught subject; ➢ knows and identifies the most important science theories, laws and regularities maintained in different situations; perceives the value of scientific information; ➢ able to understand and process scientific information; ➢ knows preconditions necessary for creating scientific knowledge; ➢ able to efficiently apply the gained knowledge training the

		young generation; ➢ understands and is able to provide the possibilities of applying a scientific knowledge in every day practice for the students; ➢ analyzes and perceives the public alterations encouraged by the rise of a scientific knowledge, technological progress and personal and community development in different cultures worldwide; ➢ able to compare science with other methods of acknowledging the reality; ➢ able to use different information sources and to regularly update a personal knowledge.
	2. Content of the taught subject	➢ knows the objectives and tasks of science education and the content of the taught subject i.e. knowledge that needs to be acquired by the secondary school students; ➢ knows the content and didactical attitudes of general science education standards; ➢ able to identify events and phenomena that should increase students' interest, help with perceiving disagreements between the ideas of science and real phenomena, assist in creating the situations of

		cognitive conflict; ➢ able to choose training aids efficient at solving cognitive conflict.
	3. Didactics of the taught subject	➢ knows and optimally apply specific forms, methods and models of science education; ➢ able to outstandingly develop the process of science education in secondary school i.e. to plan cognitive and research activity involving students, to raise real teaching goals and tasks and to suitably choose training material and resources required for teaching.
	4. Researching	➢ understands the core of scientific research; ➢ knows the main methods of scientific research; ➢ able to successfully plan research, be charged with implementing it in practice, to prepare research report and evaluate results; ➢ understands and is able to use mathematical procedures when analyzing research data; ➢ understands and is able to use research data in daily work dealing with the problems of different format;
	5. Use and application of ICT	➢ able to use ICT i.e. has computer literacy skills allowing to make the educational process

		more diverse; ➢ able to efficiently apply ICT in the educational process optimally using the Internet, broadens the possibilities of teaching/learning, stimulates educational alterations; ➢ able to apply ICT for the purposes of science education.
	6. Value-based attitudes	➢ perceives nature as a value; ➢ able to identify the possibilities of natural science education in secondary school in the context of other subjects taught.
	7. Safety and welfare	➢ knows and perceives teacher's ethical and legal responsibility for students' physical safety during the classes in sciences; ➢ able to properly/safely arrange, look after and apply different material during the classes in sciences; ➢ encourage students to follow necessary safety rules in the classroom, ensure safety of equipment devoted to the teaching process and guarantee safety of students' activity during the classes in sciences; ➢ knows requirements for exemplary behaviour with animals; safely, humanely and ethically behave with animate organisms in the classroom;

2. Pedagogical practical activity	**Critical thinking**	➢ knows classical and modern concepts of science education, understands the main differences between them, perceives the qualities and drawbacks of classical and modern concepts of science education; ➢ knows situation in science education at national, European and worldwide level; able to rationally make profit on experience of other countries; ➢ acknowledges the alternative methods of reality perception; ➢ accepts learning as students' individual efforts to develop personal thinking, build and broaden personal knowledge rather than a process of conveying knowledge;
	2. Practical pedagogical activity	➢ able to optimally combine classical and modern concepts of science education in practice and to prefigure the effective measures of an educational impact; ➢ able to organize the teaching/learning process through communication and collaboration, initiate productive students' social interaction building personal knowledge through collaboration; ➢ manages to identify student groups able to use the most optimal strategies to resolve

		cognitive conflict; ➢ able to conform to alterations; in order to develop different student abilities, frequently changes activities, teaching strategies and methods; ➢ able to create a learning environment stimulating the development of students' ideas; ➢ perceives the importance of meta-cognitive abilities; able to develop both cognitive and meta-cognitive abilities.
	1. Modeling the process of cognitive conflict	➢ flexible about creating problematic situations; able to individualize the above mentioned situations depending on student cognitive abilities, the style of dealing with problems, sex and social and cultural experience; ➢ able to identify the students experiencing cognitive conflict; offers support in resolving the introduced conflict, making decisions; ➢ able to attract students to the process of cognitive conflict.
	2. Problem solving	➢ able to quickly and effectively deal with the issues of science education and the questions of the quality of students' educatedness; ➢ able to initiate qualitative alterations in science education.

	3. Creativity and innovativeness	➢ able to create original ideas; announces initiatives; is innovative. ➢ able to create suitable, interesting problematic situations attracting students to cognitive conflict.
	4. **Communication**	➢ able to foster a positive relationship with the community; ➢ able to collaborate and to do teamwork; ➢ able to disclose and present the achievements in sciences and science education to society; ➢ able to defend an individual position with considerable self-respect;
	5. Evaluation	➢ able to notice alteration in student activity, to identify learners' achievements and progress and to regularly evaluate the self/educational process; ➢ able to identify an agreement between students' achievements and science education standards at national level; able to establish the evaluation criteria of achievements; ➢ uses different evaluation methods and forms; ➢ able to provide valuable and purposeful feedback information encouraging the development of students' scientific thinking;

		➢ on the basis of the evaluated data, advances the process of science education making the impact on the results of teaching/learning;
	6. Professional improvement	➢ able to individually raise professional qualification (seeks for regular advancement, participates in the events of teacher training, is interested in the latest methodical and scientific information on the issues of science education, adequately evaluates and apply it in practice); ➢ able to take over good experience of colleagues, advisers and students and use it to change individual abilities; ➢ benevolently accepts advice from the colleagues having wider experience; ➢ able to share good individual experience with those who are less experienced.
	7. Safety and welfare	➢ able to stimulate positive students' abilities such as interest, the feeling of psychological safety etc. ➢ able to reduce negative students' emotions such as fear, distrust, anxiety etc.

It is clear that complete unification will hardly be reached; moreover, the latter project is not aimed at achieving these objectives. This principled and weighty question should be seriously considered in common European space. Such a need directly reflects the problems of today's school. Novelties and financial support are received and information communication technologies should improve students' abilities in schools; however, research carried out at national and international level in different countries show that not all learners improve their results. The tendency that the results achieved by the teachers using modern technologies in the classroom are worse can be noticed. The teachers of sciences are not always effective users of ICT as they frequently feel lack of competencies in this field. Nevertheless, students' involvement in sciences is tendentiously decreasing (in the classes of upper-secondary school in particular), there is shortage of attractive science teaching and learning material etc. based on reality-based problems and ICT. Therefore, a baseless thing is an over-focus on teacher's competencies linked with modern ICT. In this case, researcher's competence remains one of the most important points. The ability to plan, organize and conduct various investigations involving students is certainly one of the most important competencies. Natural sciences have been, are and carry on staying an experimental area. The process of science education, which is too much theoretical and remote from reality, determined the situation that the interest in sciences and technologies reached a very low level in developed countries.

Hence, a crucial point is to highlight what model of competencies should be applied by universities in order to train teachers of sciences able to effectively act in present conditions.

More information is possible to find in publications which were issued under the IQST project:

Nezvalova, D. (Ed) (2007). *Improving Quality of Science Teacher Training in European Cooperation – Constructivist Approach. Compendium.* Olomouc: Palacký University Press, 139 p. ISBN 978-80-244-1821-6.

Lamanauskas V., Vilkonienė M. (2007). Competencies of Science Teachers: Comparative Assessment. In.: Danuse Nezvalova (Ed.), *Improving Quality of Science Teacher Training in European Cooperation – Constructivist Approach (Compendium)*. Olomouc, p. 102-115. /ISBN 978-80-244-1821-6/.

Vilkonienė M., Lamanauskas V. (2008). Gamtos dalykų mokytojų kompetencijų lyginamoji analizė: konstruktyvistinio mokymo (-si) kontekstas.

Kn.: *Gamtamokslinis ugdymas bendrojo lavinimo mokykloje – 2008* (XIV nacionalinės mokslinės-praktinės konferencijos straipsnių rinkinys, Utena, 2008m. balandžio mėn. 25-26 d.). Šiauliai: Lucilijus, p. 131-142. /ISBN 978-9955-32-032-6/.

and also on project website: http://www.iqst.upol.cz

3.3. Structure of Training Modules

The common approach was used to describe the structure of each module. Despite some differences all modules includes the main aspects for example, the brief description, competencies, goals of module, the main topics, final evaluation criteria etc.

DESCRIPTION OF MODULE – Bulgaria

MODULE	DEVELOPMENT PROCEDURAL SKILLS IN SCIENCE EDUCATION – CONSTRUCTIVIST APPROACH
Volume of module (credit, hours)	Four credits, 160 hours
The brief description of the module	The module is designe as one lead to action of pre-service science teacher students. They have to reach an understanding of the aims of science education in the framework of constructivist approach. The focus is particular on the development of procedural skills. Significant and specific teaching strategies will be introduced and explore as will influence on student's cognitive, communicative and social development. The basic elements of visual literacy and varied visual tools will be examined. The content of the module include varied tools as collecting, interpreting and communicating data as tables, diagrams, charts, using symbols and numbers. Students will produce their own educational resources that promote active learning.

Competencies to be achieved	Pre-service teachers students must demonstrate that: 1. They have a secure knowledge and understanding of the subject, namly Science they are trained to teach; 2. They define, describe and understand the aims of science education – STL in the framework of constructivist approach; 3. They know the role of process skills in science education, dimensions and nature of progression in process skills; 4. Characterize, explain, give examples and demonstrate strategies for supporting process skills development.
Goals of studies	Define and describe the aims of science education and reached an understanding of what is STL; Build and develope process skills in Science; Use efectivly varied teaching strategies to implement develpoing of procedural skills;
Content of module (topics)	1. Scientific and technology literacy. Components and levels of scientific literacy. 2. Constructivist approach in science education. 3. Building and developing scientific process skills. 4. Strategies for supporting process skills develpoment and asessment. 5. Plan, organize and deliver an active learning project.
Strategies of teaching / training	The activities include lectures, seminars, inter-active workshops, practical work. There will be an emphasise on practical activities supported by a strong theoretical mainstay. Students will implement they knowledge and skills in lesson planing and perfoming.
Distribution of hours of the module	Theoretical works – 10 hours Practical works –32 hours

	Home work / Individual project ect. – 58 hours Self-studies – 60 Total: 160 hours
Final evaluation criteria	Plan, organize and deliver active learning project.
Strategies and technics of evaluation of achievements	Evidence of achivement and understanding are present in the proces of teaching, paticulary in how pre-service teachers comunicate subject knowledge, present complex ideas, confidently use strategies for developing and evaluating procedural skills, plan and set targets and lesson, follow-on disscussions with tutor.
References (main sources)	1. Duit, R. (2008). The constructivist view in science education – what it has to offer and what should not be expected from IT. Available on the Internet: http://www.if.ufrgs.br/public/ensino/N1/3artigo.htm 2. Epitropova, A. (2004). Active strategies in the teaching of nature and man in the 1-4 grades. Plovdiv: „Macros“. 3. Wilson, E. (2005). Powerful pedagogical strategies in initial teacher education. Teacher and Teaching: theory and practice, Vol. 11, No. 4. 4. Bonwell Charles C., Eison, J.A. (2008). Active Learning: Creating Excitement in the Classroom. Available on the Internet: http://www.ntlf.com/html/lib/bib/91-9dig.htm

DESCRIPTION OF MODULE – **Cyprus**

MODULE	FLOATING AND SINKING OF AN OBJECT IN A LIQUID
Volume of module (credit, hours)	3 ECTS, 180 hours
	The theoretical background that guided the design and development of the present module is aligned with the socio-cognitive perspective of learning and the nature of science. Some of the important assumptions of this perspective are, for example, the following: Learning results from the interaction occurring between an individual's experiences and his or her current conceptions and ideas. The process of learning depends on the extent to which the individual's conceptions are integrated with new information. Personal construction of knowledge occurs through the interaction between the individual's knowledge schemes and his or her experiences with the environment (both physical and social). The socio-cultural perspective considers the construction of knowledge as a social process, where social transactions and discourse are considered to be the basis for any subsequent learning. Conceptual change is considered a complicated and dynamic process, which is affected by a variety of factors, beyond the cognitive ones, such as, motivation, goals, and perceptions of the task. Inquiry learning within the socio-cognitive perspective incorporates many aspects of the nature of science and its processes. Hands-on activities are valuable only when coupled with minds on activities or with cognitive engagement.

The brief description of the module	The present module is an attempt to familiarize primary school teachers, lower secondary school teachers, and prospective teachers for primary and lower secondary school with the basic assumptions of the socio-cognitive perspective of learning. The module is also an attempt to provide a concrete example of teaching/learning, using a sinking/floating scenario. Thus, the module represents an attempt to teach the different concepts regarding sinking/floating using the described theoretical framework and involving the learners in an inquiry process (active learning/learning by doing). This approach focuses on the learners' initial conceptions and how to promote conceptual change. Within this framework, different ways for identifying learners' alternative conceptions and factors (cognitive and affective) affecting conceptual change are considered very important. Consequently, the learning environment should also encourage rich interactions among the learners and between the teacher and the group of learners.
Competencies to be achieved	The main competencies that should be achieved can be summarized as follows: Science teachers must become competent in diagnosing their students' alternative conceptions, using mainly qualitative approaches and formative evaluation approaches. Science teachers must be able to design and develop learning environments conducive to conceptual change taking into consideration their students' conceptions. Science teachers must be able to invest on discrepant events that challenge students' existing alternative conceptions. Science teachers must be able to identify or design discrepant events that are interesting to and engaging for the students, and are well structured, so that students can be scaffolded to realize the discrepancy between their existing conceptions and the phenomenon. Science teachers must be competent to structure problem situations that can provide scaffolding towards possible solutions. Science teachers must be equipped with the required

	abilities for correctly recognizing whether their students experience cognitive conflict or not. Science teachers must have the flexibility to differentiate a problem situation according To students’ characteristics (e.g., cognitive ability, performance, gender, social and cultural background, etc) in order to enable more students to experience cognitive conflict. Science teachers must be able to provide the necessary means for their students to resolve the discrepancies between the phenomena they observe and their existing conceptions. Science teachers must be able to provide valuable feedback as to the kinds of reasoning implemented by students, and to help them develop their scientific reasoning skills. Science teachers must be competent of identifying non-cognitive factors engaged in a cognitive conflict situation and to incorporate these factors productively in the learning process. Science teachers must become competent in undertaking their roles as facilitators and supporters, when students attempt to resolve their cognitive conflict situations. Science teachers must be able to promote productive social interactions among their students in ways promoting collaboration and shared responsibilities for the knowledge construction process, so that groups of students become real learning communities. Science teachers must be able of recognizing their students’ conceptual change by identifying students‘ cognitive gains or conceptual advancement. Science teachers must be competent of evaluating their own and their students’ conceptions based on criteria compatible with the tentative nature of science.
Goals of studies	Upon the completion of this module, the pre-service and/or in-service science teachers should be able: 1. To understand and define the basic tenets (principles) of socio-cognitive constructivism. 2. To design and implement teaching scenarios based on socio-cognitive constructivism

	and following an inquiry-based approach. 3. To appreciate the importance of teaching scenarios that invest not only on cognitive but on affective factors well in the process of knowledge construction. 4. To become competent in conducting small scale action research. 5. To continually evaluate students' conceptions and use the evidence for designing more effective teaching/learning situations conducive to conceptual changes.
Content of module (topics)	The content of the module relates to the different factors affecting the sinking / floating of an object in a liquid. This content can be easily used for primary and lower secondary school students, and it takes into consideration that all or some of the students remain concrete thinkers and cannot use abstract concepts. It is thus important to provide observable evidence to the students that challenges their existing conceptions.
Strategies of teaching / training	The content of the module and the teaching / training strategies or approaches will be clarified by describing an indicative sequence of steps that should be followed during the training. This sequence clearly represents the basic principles of socio-cognitive constructivism and how to implement them, by providing specific examples. Learners' conceptions should be initially identified and presented to the whole group, so that the participants (teachers or prospective teachers) will be familiarized with the variety of existing conceptions among any group of learners. Any of the existing alternative conceptions or (mis)conceptions constitutes learners' explanatory frameworks and should be taken into consideration for inducing conceptual change through presenting discrepant events conflicting a learner's conceptions. Learners' conceptions should be somehow made public, so that learners' are familiarized with the spectrum of the existing (pre)conceptions, and, consequently, these should be challenged through specific experimental results, in an attempt to foster cognitive dissonance that will trigger the cognitive processes

	(assimilation and accommodation) for dissolving this conflict.
Distribution of hours of the module	1. Introduction to socio-cognitive constructivism. For example, the importance of existing conceptions and their influence on interpreting new information, conceptual change and the nature of science as tentative and probabilistic, normal science and revolutionary science etc. (3 teaching hours). 2. Strategies and ways for identifying learners' existing conceptions (2 teaching hours). 3. Strategies and ways for challenging learners' conceptions relating to sinking/floating (2 teaching hours). 4. Teaching interventions conducive to conceptual change (6 teaching hours). 5. Strategies and ways for evaluating learners' gains or progress in conceptual understanding (2 teaching hours). 6. Homework /individual projects/asynchronous and synchronous electronic discussions etc. (42-45 hours) This distribution takes into consideration the idea of ECTS and learners' working load. (For every teaching hour, learners are required to invest additional time of 3 hours, while 13-15 teaching hours correspond to 1 ECTS).
Final evaluation criteria	1. Ability to employ different techniques (i.e., individual and group interviews, questionnaires, etc.) for identifying learners' conceptions. 2. Ability to design and implement strategies challenging learners' conceptions (i.e., design experiments that constitute discrepant events for learners' conceptions). 3. Ability to design and implement teaching approaches that take into consideration learners' conceptions, and can foster conceptual understanding and growth. 4. Ability to encourage feelings of interest and motivation that can lead to cognitive engagement of learners. 5. Ability to guide group work and other forms of collaboration. 6. Ability to continuously implement formative evaluation strategies.

Strategies and technics of evaluation of achievements	1. Electronic portfolios. 2. Synchronous and/or asynchronous electronic discussions. 3. Student projects. 4. Other formative and/or summative evaluation techniques, such as, individual and group interviews, classroom discussions, questionnaires tests, etc.
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DESCRIPTION OF MODULE – **Czech Republic**

MODULE	ASSESSING SCIENCE FOR UNDERSTANDING – A CONSTRUCTIVIST APPROACH
Volume of module (credit, hours)	2 credits 30 contact hours (direct teaching); 30 hours of individual work
The brief description of the module	Assessment and learning are so closely related that if the outcomes are not assessed, students and teachers likely will redefine their expectations for learning science only to the outcomes that are assessed. Rather than checking whether students have memorized certain items of information, assessment need to probe for students´ understanding, reasoning, and utilization of knowledge. The module is focused on the questions: what is classroom assessment and which classroom assessment techniques are effective in science education and what are the main principles of authentic assessment.
Competencies to be achieved	1. Competency to assess students´ learning and progresses in science education; 2. Competency to use effective and adequate classroom assessment techniques; 3. Competency to assess learners´ prior knowledge, understanding, skills, attitudes, values and self-awareness; 4. Competency to assess own science teaching and to make change and improvement in the quality of science education.

Goals of studies	To understand purpose of classroom assessment; To characterize the classroom assessment; To plan and implement classroom assessment projects; To choose the right technique of assessment; To realize wider choice of assessment technigues.
Content of module (topics)	1. Purpose and characteristic of classroom assessment. 2. A constructivist approach in classroom assessment. 3. Planning and implementing classroom assessment projects. 4. Techiques for assessing knowledge and skills (background knowledge probe, focused listing, misconception/preconception check, minute paper, one-sentence summary, journals, concept maps, portfolios, etc.); 5. Technics for assessing learner attitudes, values and self-awareness (classroom pools, self-confidence surveys, interest checklist, self-assessment; 6. Assessing learner reactions to instructions (electronic mail feedback, group feedback, reading rating sheets...).
Strategies of teaching / training	Discussion, group work, cooperative learning, team work, microteaching, presentation, independent work, individual work.
Distribution of hours of the module	1. Theoretical works – 10 hours (seminar) 2. Practical works – 20 hours (laboratory experience 3. Individual project work – 20 hours 4. Self-studies – 10 hours Total: 60 hours
Final evaluation criteria	1. Quality of presentation 2. Quality of Assessment Project

	3. Quality of microteching presentation 4. Ability to work in team
Strategies and technics of evaluation of achievements	1. Presentation – 20 %; 2. Assessment Project – 50 %; 3. Microteching presentation – 20 %; 4. Team work – 10 %.
References (main sources)	1. Thomas, A., Angelo, K., Cross, P. *Classroom Assessment Techniques.* San Francisco: Jossey-Bass, 1993. 2. Mintzes, J. J. *Assessing Science Understanding. A Human Constructivist View.* San Diego: Academic Press, 2000.

DESCRIPTION OF MODULE - **Lithuania**

MODULE	EUROPEAN DIMENSION IN INTEGRATED SCIENCE EDUCATION
Volume of module (credit, hours)	Four credits (one credit – 40 hours), 160 hours
The brief description of the module	The module focuses on introducing foreign experience in the field of integrated science education to the would-be teachers of sciences, discusses the conception of science education and the main tendencies towards the development of integrated science education, assesses the theoretical and practical aspects and modules of integrated science education as well as its application in practical educational activities. The module concentrates on the analysis and principles of development of an integrated science education curriculum. The educational tools (material, didactical, intellectual, information-communication etc.) of science education are described. The qualities and drawbacks of integrated science education are revealed. The integral results and their evaluation are learnt to be understood. Along the implementation of an integrated course (subject) adequate teaching methods are learnt to be choisen. The single cases of experience based on teaching integrated sciences are studied (case study).
Competencies to be achieved	• Develop knowledge of integrated science education in comprehensive school; • Demonstrate understanding of the knowledge base for science literacy, process/inquiry skills, content, attitudes, technological understandings and the relationships among, science, technology, and society; • Ability to reveal the qualities and drawbacks of integrated science education; • Ability to identify the models, levels and degree of integrated science education;

	• Ability to perceive the compatibility requirements between integrated science education and other types of curricula; • Design developmentally appropriate integrated science curriculum for secondary aged children utilizing appropriate goals, concepts, and evaluation; • Ability to design the curricula of integrated science education (in the establishments of formal and non-formal education); • Ability to choose adequate teaching methods; • Ability to choose an appropriate optimal evaluation strategy covering the fields of integrated science education and students' achievements; • Demonstrate an understanding of the constructivist approach through effective questioning, assessment, and reporting techniques within the science curriculum etc.
Goals of studies	• Define the conception of integrated science education; • Describe the specificities, qualities and possible drawbacks of integrated science education; • Define the priorities of the European Union education policy in the field of science education; • Establish the main tendencies towards integrated science education in the European countries; • Assess the basic models of integrated science education and application practice; • Introduce the main principles of designing (planning) integrated science education curricula; • Assess the most efficient evaluation strategies of integrated science education, teaching/learning etc.

Content of module (topics)	1. A conception of integrated science education; 2. Some philosophic, didactic and social aspects of integrated science education; 3. The main tendencies of integrated science education development; 4. Integrated science education in the context of the constructivism theory; 5. Integrated science teaching in terms of the constructivist approach; 6. The models of integrated science education; 7. The integrated science education curricula and its designing principles in comprehensive school; 8. The science education tools and ways of producing them in the collaboration process; 9. A constructivist approach to integrated science education: teaching would-be teachers to do science; 10. Designing a integrated science methods course for initial science teachers; 11. Contextual teaching and learning of integrated science in lower and upper secondary schools; 12. The specificities of integrated science teaching in lower secondary school; 13. The specificities of integrated science teaching in upper secondary school; 14. The evaluation strategies of integrated teaching/learning; 15. The collaboration peculiarities of science teachers; 16.
Strategies of teaching / training	Cognitive and interactive etc.; discussions, individual and team work; presentations

Distribution of hours of the module	Theoretical works – 32 hours Practical works – 10 hours Home work / Individual project etc. – 58 hours Self-studies – 60 Total: 160 hours
Final evaluation criteria	Quality of designing a curriculum of integrated science education; Quality of designing a project integrated science education; Ability to work in group; Quality of delivering etc.
Strategies and technics of evaluation of achievements	Curriculum preparation and presentation – 30 %; A project aimed at organizing students' integrated science education activities – 30 %; Team work – 10 %; Final exam (test) – 30 %

References (main sources)	1. Abell S., Lederman N. (Eds) (2007). Handbook of Research on Science Education. New York: Lawrence Erlbaum Associates, Inc. 2. Bandiera M., Caravita S. & all (eds). (1999). *Research in Science Education in Europe*. London. 3. Bybee, R. W., Powell, J. C., Trowbridge, L. W. (2007). *Teaching Secondary School Science: Strategies for Developing Scientific Literacy*. New Jersey: Prentice Hall. 4. Behrendt H., Dahncke H., duit R. et al. (eds). (2001). *Research in Science Education – Past, Present, and Future*. Dordrecht: Kluwer Academic Publishers. 5. Blum A. (1994). *Integrated and General Science* //The International Encyclopedia of Education, Vol.5. P.2897-2903. 6. Chaille, C. and Britain, L. (1999). *The Young Child as a Scientist: A constructivist Approach to Early Science Education.* New York: Longman. 7. Fensham, P. (Ed), and others (1994). *The Content of Science: A Constructivist Approach to Its Teaching and Learning*. Bristol: Falmer Press, Taylor and Francis, Inc. 8. Integrated Science and Mathematics. Available on the Internet: http://www.towson.edu/csme/mctp/Technology/Integrated.html 9. Lamanauskas V. (2003). *Natural Science Education in Contemporary School*. Siauliai: Siauliai University Press. 10. Mattews M.R. (2000). *Time for Science Education*. New York. 11. Millar R., Leach J., Osborne J. (2000). *Improving Science Education*. Buckingham: Open University Press. 12. Science Education NOW – A Renewed Pedagogy for the Future of Europe. (2007). Luxembourg: Office for Official Publications of the European Communities. /ISBN 978-92-79-05659-8/. 13. Sjøberg S. (2002). *Three Contributions to Science Education*. Oslo. 14. Wellington J. (1996). *Secondary Science /Contemporary Approaches/*. New York.

DESCRIPTION OF MODULE – **Turkey**

MODULE	USING THE LABORATORY TO ENHANCE STUDENT LEARNING AND SCIENTIFIC INQUIRY
Volume of module (credit, hours)	Two credits, 2 contact hours(Direct Lab Teaching) + 2 hours individual study. Total duration 28 weeks(for two semester)
The brief description of the module	The laboratory has been given a central and distinctive role in science education, and science educators have suggested that rich benefits in learning accrue from using laboratory activities. We are living in an era of dramatic new technology resources and new standards in science education in which learning by inquiry has been given renewed central status (Hofstein & Lunetta; 2003). This module has focused on the questions how science laboratory resources are used, how students' work in the laboratory is assessed, and how science laboratory activities can be used by teachers to enhance intended learning outcomes, current models of how students construct knowledge, information about how teachers and students engage in science laboratory activities.
Competencies to be achieved	• to know the steps of scientific process, • to understand science content, • competency to explain the nature of science, • competency to explain the causes , results and correlations of scientific events meaningfully, • to develop concepts and relationships from observations and to infer from them scientifically. • to be awere of alternative experiments of the same event.

Goals of studies	• to improve prospective teachers' understanding of science concepts; • to foster a learning environment supporting conceptual understanding; • to promote positive attitudes toward learning and teaching science (biologhy, chemistry and physics in particular); • to improve the nature of science; • to improve scientific process skills.
Content of module (topics)	1. Constructivist science and lab education resources. 2. Constructivist science teaching techniques (such as conceptual change approaches, analogies, text etc.). 3. Scientific process skills 4. Meaningful learning, nature of science etc.
Strategies of teaching / training	Team work, discussion, individual work. Cooperative learning techniques (not only student-student interactions but also student-teacher interactions). Constructivist lecture– constructivist laboratory type approach. Conceptual change approaches (using analogies, modelling...). Inquiry-centered approaches. Cognitive and interactive approaches. 1. The student is involved actively and assumes responsibility for his or her own learning. 2. The preconceptions of the students are obtained by various methods, for example, teacher asking questions after the students have a chance to explore with materials or consider a problem. Students are asked to generate questions,

	predictions, explanations. 3. Problems are posed by the teacher to create dissatisfaction with the learner's present knowledge. 4. Work is performed in groups or teams. Discussion within the group is required. Teams report to class. Work is crititicized by other groups. Groups report out and make presentations to the class. 5. Additional applications are sought by the students (as in NSES).
Distribution of hours of the module	Theoretical works – **14 hours** Practical works – **28 hours** Home work / Individual project ect. – 12 hours Self-studies 28 hours Total: 82 hours (for one semester)
Final evaluation criteria	Quality of experimenting. Quality to explain cause, results and correlations of related concepts. Ability to work in the group.
Strategies and technics of evaluation of achievements	Performance tests: 40 % Through asking open ended questions before and after or doing experiments (Real life problem solving situations, scientific reasoning, to suggest similar alternative experiments etc). Experiment reports (%20) Checking the reports of the student recorded about the every experiment. Final exam: 40 %
References (main sources)	1. National Research Council (NRC) 1996 Washington DC National Academy Press. 2. Posner, Strike, Hewson, Gertzog, 1982, Science Education, Vol 66. 3. Colburn, A. 2000. Constructivism: Science Education's "Grand unifying theory", the Clearing House September/October pp 8-12. 4. Liang and Gabel D, 2005, Effectiveness of constructivist instruction to science instruction for prospective elementary teachers. Int. J of Sci. Educ. 27, 10, pp 1143-1162.

	5. Hofstein, A; Lunetta V.N. 2004 , The Laboratory in Science Education: Foundations for the Twenty-First Century *Sci Ed* 88:28 – 54, 2004;

More information is possible to find in publiction which was issued under the IQST project:

Nezvalova, D. (Ed) (2007). *Improving Quality of Science Teacher Training in European Cooperation – Constructivist Approach. Compendium.* Olomouc: Palacký University Press, 139 p. ISBN 978-80-244-1821-6.

This publication is available in full version on: http://www.iqst.upol.cz

3.4. Description of Training Materials

All training materials are described by four main aspects: general methodological background, didactical approach, structure, and usefulness for students.

Development Procedural Skills in Science Education – Constructivist Approach

Author: Zhelyazka Raykova (BG)

General background

During the last years constructivism as an approach in education has had a central position in didactical literature. Constructivist theory is definitely accepted as a modern and leading theory in the teaching of science. Constructivism has become the most valuable guiding principle for the teachers of science, as well as for researchers in this field. Constructivist teaching fosters critical thinking and creates active and motivated learners. The constructivist theory has been incorporated into the curriculum, and advocates that teachers create environments in which children can construct their own understandings. There are different types of constructivism: cognitive, social, radical. The following principles of constructivism are important: active construction on the basis of the already exciting conceptions; arrangement of tentative constructor; checking its viability; acceptance of the social character of the construct. Constructivism changes the role of the teacher in the educational process and suggests a new model of teaching environmental.

Science and teaching students about science means more than scientific knowledge. There are three dimensions of science that are all important. The first of these is the content of science, the basic concepts, and our scientific knowledge The other two important dimensions of science in addition to science knowledge are processes of doing science and scientific attitudes. The processes of doing science are the science process skills that scientists use in the process of doing science.There are different classifications of process science skills; one of these classifications describes them as basic (observation, classification, measurement, conclusion, prognosis, communication) and integrated process skills (formulating hypotheses, identifying of variables, describing relationships between variables, designing investigations, experimenting, acquiring data, organizing data in tables and graphs, analyzing investigations and their data, understanding cause and effect relationships, formulating models). Physics education gives vast opportunities for formation of process science skills.

The main factor for choosing one or another strategy is related to students, to their abilities and interests, to their number in class and to the problem that they should be active participants in the training. The inclusion of ICT in the teaching process changes its character and determines the choice of a certain strategy. Formation of process science skills such as to collect and process data and to present it graphically is related to a concrete organization of students' activity. Some integrated process skills related to assimilating of different structural elements of physics knowledge (physics phenomenon, physics value, physics law, and physics device) may be formed through an organization of students' mental processes in a certain sequence.

Didactical approach

The goal of this module is to introduce students into the topic „Development Procedural Skills in Science Education". In this module there are given different ways for putting into practice some these pedagogic ideas and theories. In this module the students will find some pedagogic methods, based on the constructivist approach, which can be used in training of science teachers to be. Constructivist perspective, to which the training material is dedicated, lately becomes dominant paradigm in the sphere of science training, which also determines the growing interest towards this problem.

Structure of training material

The training material entitled "Development Procedural Skills in Science Education – Constructivist Approach" consists from 5 units:

1. Scientific and technology literacy. Components and level of scientific literacy.
2. Constructivist approach in science education.
3. Building and developing process science skills.
4. Strategies for supporting process skills development and assessment.
5. Planning, organizing and delivering an active learning project.

Each unit in this module has its theme, and it contains theoretical material followed by given references. To the scientific texts in the training material are offered questions and tasks for students` self-training. There are also certain outlines for case studies on the subjects, and after them, there are sources of information for self-training. The training material is prepared in two languages – English and Bulgarian.

More information is possible to find in publiction which was issued under the IQST project:

Raykova, Zh. (2008). *Development Procedural Skills in Science Education – Constructivist Approach*. Plovdiv: Plovdiv University Press, 137 p. ISBN 978-954-423-4863-6.

This publication is available in full version on: http://www.iqst.upol.cz

Floating and Sinking of an Object in a Liquid – Based on Socio-cognitive Constructivism Authors: Nicos Valanides, Charoula Angeli, Stella Chadjiachilleos (CY)

General background

Research on student cognition has clearly demonstrated that students' prior conceptions create a framework for understanding and interpreting information gathered through experiences. Learning results from the interaction occurring between an individual's experiences and his or her current conceptions and ideas. The process of learning depends on the extent to which the individual's conceptions integrate with new information. This integration is characterized as assimilation or accommodation and is guided by the principle of equilibration, whereby individuals seek a stable homeostasis between internal conceptions and information from the environment. The process of accommodation is, however, much more critical for the continuing conceptual development of the learners, because it requires a transformation of individual conceptions rather than integration of new information into the individual's existing frameworks.

The existence and persistence of students' alternative conceptions in science gave rise to different research efforts attempting to identify conditions that encourage or drive accommodation (e.g., Posner, Strike, Hewson, & Gertzog, 1982). Dissatisfaction with current conceptions acts as a catalyst for accommodation to occur provided that the new conception is intelligible, plausible, and fruitful. This approach tends to imply that learners behave like scientists, and that ontogenic change in an individual's learning is analogous to the nature of change in scientific paradigms, ignoring the differences and disagreements about the nature of this change among philosophers, historians, and sociologists of science. Thus, each time students encounter a discrepant event, they search for new intelligible, plausible, and fruitful constructs in an attempt to balance the existing cognitive disequilibrium. Personal construction of knowledge occurs through the interaction between the individual's knowledge schemes and his or her experiences with the environment. The primary mechanism for cognitive growth is the learner's interactions with the physical environment, while the social interactions and language do not receive primary attention. Social interactions and talk with other people are, however, seen as aiding the process of accommodation by creating cognitive dissonance. This description focuses on the psychological process of equilibration and reflects the Piagetian perspective or the *cognitive perspective* in general.

Conversely, the Vygotskian perspective, or the *socio-cultural perspective* in general, considers the construction of knowledge as a social process, where social transactions and discourse are considered to be the basis for any subsequent learning. Representations of knowledge are viewed as patterned by social and cultural circumstances. This view "accentuates the social and cultural genesis and appropriation of knowledge" (Billet, 1996, p. 264). Learning is viewed as the appropriation of socially derived forms of knowledge. Appropriation is not restricted to the internalization of externally derived stimuli. It consists of a transformational and reciprocal constructive process (Rogoff, 1995) and results to a co-construction process of cognitive structures (Valsiner, 1994).

The cognitive and socio-cultural constructivism seem disparate, but they offer some basis for considering "*the mutuality between persons acting and the social and cultural circumstance in which they act*" (Billet, 1996, p. 265), and for building bridges between them. Even though both perspectives deal with the construction of knowledge, the cognitive constructivist perspective emphasizes the internal processes of knowledge construction, whereas the socio-cultural perspective focuses on children's cognitive development, as it occurs through social interaction, and details the negotiated nature of the reciprocal transformation with social partners. Thus, language, in the socio-cultural perspective, is considered essential in socially negotiating and constructing meaning. The widening interest in "*situated learning*" resides in the belief that learning is more closely linked to the circumstances of its acquisition, and that these circumstances influence the transfer of knowledge to other situations. This belief calls for a closer consideration of the contributions of socio-cultural constructivism in understanding the role of social transactions in shaping cognition and the complexities of the situated knowledge of the classroom.

Although the relationship between social circumstances and cognition remains opaque, our approach accepts the potential contribution of both perspectives to the construction of knowledge, and attempts to investigate how carefully designed individual or classroom-based discourse supports students' conceptual growth. The attempt aims at providing students with the opportunity to be involved in experimentation and discussions, or evidence-based argumentation, for the purpose of examining how the knowledge construction process is shaped and validated by students' interactions amongst them, the teacher, and the physical environment.

Didactical approach

The present training material is an attempt to familiarize primary school teachers, lower secondary school teachers, and prospective teachers for primary and lower secondary school with the basic assumptions of the *socio-cognitive perspective* of learning. The training material is also an attempt to provide a concrete example of teaching / learning, using a *sinking / floating scenario*. Thus, the training material represents an attempt to teach the different concepts regarding sinking/floating, using the described theoretical framework and involving the learners in an inquiry process (active learning/learning by doing). This approach focuses on the learners' initial conceptions and how to promote conceptual change. Within this framework, different ways for identifying learners' alternative conceptions and factors (cognitive and affective) affecting conceptual change are considered very important. Consequently, the learning environment should also encourage rich interactions among the learners and between the teacher and the group of learners.

Structure of training material

The training material entitled "Floating and Sinking of an Object in a Liquid – Based on Socio-cognitive Constructivism" is not divided into units. The content of the training material relates to the different factors affecting the sinking / floating of an object in a liquid. This content can be easily used for primary and lower secondary school students, and it takes into consideration that all, or some of, the students remain concrete thinkers and cannot use abstract concepts. It is thus important to provide observable evidence to the students that challenges their existing conceptions.

More information is possible to find in publiction which was issued under the IQST project:

Valanides, N., Angeli, Ch., Chadjiachilleos, S. (2009). *Floating and Sinking of an Object in a Liquid – Based on Socio-cognitive Constructivism*. Olomouc: Palacky University Press, 68 p. ISBN 978-80-244-2221-3.

This publication is available in full version on: http://www.iqst.upol.cz

Assessing Science for Understanding – Constructivist Approach

Author: Danuše Nezvalová (CZ)

General background

With the release of the constructivist approach to science teaching, the issues of why, how, and what we, as teachers, assess in our classrooms will become a major challenge in the science teaching and learning.

Assessment can be defined as a sample taken from a larger domain of content and process skills that allow one to infer student understanding of a part of the larger domain being explored. The sample may include behaviours, products, knowledge, and performances. Assessment is a continuous, ongoing process that involves examining and observing student's behaviours, listening to their ideas, and developing questions to promote conceptual understanding.

The increasing focus on the development of conceptual understanding and the ability to apply science process skills is closely aligned with the emerging research on the theory of constructivism. This theory has significant implications for both instruction and assessment, which are considered by some to be two sides of the same coin. Constructivism is a key underpinning of the science teaching and learning.

Critical to educators is the use of assessment to both inform and guide instruction. Using a wide variety of assessment tools allows a teacher to determine which instructional strategies are effective and which need to be modified. In this way, assessment can be used to improve classroom practice, plan curriculum, and research one's own teaching practice. Of course, assessment will always be used to provide information to students, parents, and administrators.

In the past, this information was primarily expressed by a "grade". Assessment is changing for many reasons. The valued outcomes of science learning and teaching are placing greater emphasis on the student's ability to inquire, to reason scientifically, to apply science concepts to real-world situations, and to communicate effectively what student knows about science. Assessment of scientific facts, concepts, and theories must be focused not only on measuring knowledge of subject matter, but on how relevant that knowledge is in building the capacity to apply scientific principles on a daily basis. The teacher's role in the changing landscape of assessment requires a change from merely a collector of data, to a facilitator of student understanding of scientific principles.

The assessment is learner-centred, teacher-directed, mutually beneficial, formative, context-specific, ongoing, and rooted in good teaching practice. In the context of constructivist approach, assessments need to gauge the progress of students in achieving the three major learning outcomes of constructivist approach: conceptual understanding in science, abilities to perform scientific inquiry, and understandings about inquiry.

Teachers have a very challenging role to play in assessment process. Assessment can foster development of the kind of knowledge frameworks that are needed for effective science teaching. So prospective science teachers must seek on their own initiative to build this kind of understanding of their field. Constructivist approach to assessment is formative rather than summative. Its purpose is to improve the quality of student learning, not to provide evidence for evaluating or grading students.

Didactical approach

The goal of this module is to implement newer pedagogical theories into initial science teacher training. These new pedagogical methods are based on constructivist approach in science teacher training. Module can be used by lecturers with their students at science teacher training institutions.

The didactical approach is deeply characterised in *Description of the Units for Direct Teaching* which contains the description of the units for direct teaching in initial science teacher training in higher education institutions. Each unit has the similar structure: number, topic, goals, time, materials, strategy/method, reflection/comments, developed competencies of constructivist science teacher. This material is only recommendation for trainers of prospective science teachers. The aim of this material is only to help trainers in their teaching.

Structure of training material

The training material was prepared for the module Assessing Science for Understanding – Constructivist Approach. Each chapter in the training material has the following structure:

- Title of the Chapter
- Chapter Objectives
- Training text (divided in parts)
- Tasks (assignments)
- Case study
- Questions to Case Study
- Summary
- Frequently Asked Questions

The training material entitled "Assessing Science for Understanding – Constructivist Approach" consists from 6 units:

1. Purpose and characteristic of classroom assessment.
2. A constructivist approach in assessment.
3. Planning and implementing classroom assessment projects.
4. Techniques for assessing knowledge and skills.
5. Techniques for assessing learner attitudes, values and self-awareness.
6. Assessing learner reactions to instructions.

More information is possible to find in publiction which was issued under the IQST project:

Nezvalova, D. (2009). *Assessing Science for Understanding – Constructivist Approach*. Olomouc: Palacky University Press, 110 p. ISBN 978-80-244-2219-0.

This publication is available in full version on: http://www.iqst.upol.cz

European Dimension in Integrated Science Education

Author: Vincentas Lamanauskas, Margarita Vilkonienė (LT)

General background

A central concept of integration is underlined in the training material. Science education is an integral phenomenon that can be grasped as a whole science. It is disintegrated in the substantial parts such as ecology, environment education, etc. The parts of any of the units advance and finally settle in the complete wholeness. In order to understand the problems of science education, they have to be investigated complexly embracing different fields and levels. Different trends have formed considering a question of integrated teaching in foreign pedagogy: technocratic, pragmatic, cognitive, humanistic, etc. Learners' science education is given scrupulous attention as the content of natural sciences provides all opportunities to make the educational process dynamic, classified and harmonious. W.Gräber and other scientists (2001) maintain that science teaching can be described in three dimensions: teacher centred – student centred, teaching facts – teaching processes, and discipline oriented – daily-life oriented. The modern approach requires to combine the knowledge of related sciences (for example, natural sciences) into the entire system and to establish conditions for learners to investigate, conclude, analyse broad and diverse information, to improve, change and broaden their knowledge, i.e. to eliminate the traditional barriers of subjects, to refuse insular empiricism and finally, to be critical.

„Trying to avoid the fragmentariness of nature study, the educational process must classify the knowledge of sciences and their content, to look for, find and show the correlation between separate facts and phenomena of natural science inside every single educational subject when discussing individual topics, connecting them with the content of all subjects of science and integrating all related knowledge into the system. „The attachment“ of learners‘ consciousness to separate natural objects and phenomena can be evaded as it prevents from the embodiment of the schoolchildren‘s world outlook“ (Vaitkevičius, 1996; p.109).

The reconstruction of the content of sciences teaching reveals the relevancy of pupils‘ cognitive activities organization. One of the suitable forms of teaching is group work that is useful for bright and weak pupils and pedagogically important when combining learners‘ teaching and upbringing into a single process. Facilities for group work must be provided during practice, laboratory work and other kinds of practical activities.

Considering the specificities of pupils` age and the peculiarities of cognitive material, it is necessary to heighten the sense of individual responsibility for learning, to help with practise of the skills of personal work, to fulfil a responsibility for the knowledge and actions of yourself and other members of the group (for example, group work).

Thus, the issues of integrated natural sciences teaching should be complexly discussed. ***The system of personal values – theoretic and practic knowledge of the personality – practic skills of the personality*** is an undivided system closely interrelated and functioning only through specific, intensive, practical activities of a personality. The integrated natural science course helps pupils to convey the whole (***holistic***) world picture that encourages to easier realize the issues of ecology, nature (environment) protection, the implementation of modern technologies, etc., to link outcomes with reasons, obtained knowledge with socio-cultural life.

The key issues of integrated natural science education should be analysed during the module realization in initial science teachers` preparation process:

- General didactic and methodic integration of teaching;
- The system of the categories (concepts) of the integrated educational course;
- The essence, forms, principles and functions of integrated teaching;
- The consistent patterns of integration processes;
- The forms, stages and trends of teaching and educational process integration;

- Theoretic reasoning of the significance and opportunities of integrated teaching;
- The consistent patterns and models of applying integrated teaching in school practice;
- The integral results of teaching/learning and their evaluation.

Didactical approach

The didactical approach for this training material is described in *Description of the Units forDirect Teaching* which contains the description of the units for direct teaching in initial science teacher training (Descriptions of the ....2008). Each unit has the similar structure: number, topic, goals, time, materials, strategy/method, reflection/comments, developed competencies of constructivist science teacher. The authors of the training material tried to combine different teaching/learning strategies, for example, independent reading, group work, discussions, case studies, brainstorming, research projects etc.

Structure of training material

The training material was prepared for the module "European Dimension in Integrated Science Education". Each chapter in the training material has the following structure:

- Title of the Chapter
- Chapter Objectives
- Training text (divided in parts)
- Tasks (assignments)
- Case study
- Questions to Case Study
- Summary
- Frequently Asked Questions

The training material entitled “European Dimension in Integrated Science Education” consists from 14 units:

1. A Conception of Integrated Science Education.

2. Some philosophic, didactic and social aspects of integrated science education.

3. The main tendencies of integrated science education development.

4. & 5. Integrated science sducation in the context of the constructivism theory.

6. The models of integrated science education.

7. The integrated science education curricula and its designing principles in comprehensive school.

8. The science education tools and ways of producing them in the collaboration process.

9. & 10. A constructivist approach to integrated science education: teaching would-be teachers to do science.

11. & 12. Contextual teaching and learning of integrated science in lower and upper secondary schools.

13. The evaluation strategies of integrated science teaching / learning.

14. The collaboration peculiarities of science teachers.

More information is possible to find in publiction which was issued under the IQST project:

Lamanauskas, V., Vilkonienė, M. (2008). *European Dimension in Integrated Science Education*. Olomouc: Palacky University Press, 112 p. ISBN 978-80-244-2163-6.

This publication is available in full version on: http://www.iqst.upol.cz

Using Laboratory to Enhance Student Learning and Scientific Inquiry

Author: Osman Pekel (TR)

General background

Scientific knowledge is comprised of two distinct, yet interrelated, components: theory and empirical evidence. Understanding the interrelations between these two components is crucial to the understanding of what science is and how it works (Havdala and Ashkenazi, 2007; Kuhn & Pearsall, 2000).

Science teaching with a laboratory teaching method orientates the search for answers and coherent and correct explanations through learning processes in which students work and interact to gain the new knowledge that will allow them to read the cause of scientific phenomena or the explanation of observed situations (Berionni and Baldon, 2006). And also constructivist science teaching plays a crucial role in affective science teaching.

Students learn by fitting new information together with what they already know. Constructivists believe that learning is affected by the context in which an idea is taught as well by students' beliefs and attitudes. Effective teaching recognizes that meaning is personal and unique, and the students' understandings are based on their own unique experiences. ICT provides opportunities for science teachers to be creative in their teaching and for students to be creative as they learn.

Didactical approach

The training material was prepared to emphasis the importance of constructivist science and science laboratory teaching/learning approaches. Using laboratory to enhance student learning and scientific inquiry and some related factors are focus of this training material. Trainee science teachers and in service science teachers (physics, chemistry, biology) have been thought as the target group of this material. In order the people can get detailed knowledge the most of the data about the subjects were intentionally collected from the contemporary websites. Users of this training material can have possibilities to understand the subjects deeply using next readings and references at the end of units and also internet search engines. In order to be understandable easily a basic language were preferred on reporting the subject knowledge of the material much more than academic language.

Structure of training material

The training material entitled "Using Laboratory to Enhance Student Learning and Scientific Inquiry" consists from 4 units:

1. Constructivist science and laboratory education resources.
2. Constructivist science teaching techniques.
3. Scientific process skills and scientific inquiry.
4. Meaningful learning and nature of science.

The training material is prepared in two languages – English and Turkish.

More information is possible to find in publiction which was issued under the IQST project:

Pekel, F.O. (2008). *Using Laboratory to Enhance Student Learning and Scientific Inquiry*. Bayburt: Gunduz Ofset Matbaacilik, 64 p. ISBN 978-605-89475-0-4.

This publication is available in full version on: http://www.iqst.upol.cz

Summing-up

The 5 different training materials for prospective science students were prepared during international project "IQST" implementation. Lithuanian, Czech, Turkish, Bulgarian and Cyprus training materials can be used directly in the study process at the universities. Training materials of five countries were prepared using constructivism theory. On the basis of the preliminary observations it is possible to state that all training materials are useful in the university teaching process. All training materials prepared during the project implementation can assist students, lecturers and administrators in their work. All training materials are good support for prospective science teachers training programmes. Another important thing is that all training materials can be used in many different ways by students and lecturers. Some customers will be able to point their users directly to our project website, others will be able to integrate the material with their own website or learning environment.

3.5 Teaching of the Modules

The aim of this project was to implement newer pedagogical theories into initial science teacher training. With this project new pedagogical methods based on constructivist approach were introduced in science teacher training. Therefore we designed and produced five new modules for science teacher training in the international cooperation between higher institutions of initial teacher training in five European countries. Modules produced can be used by lecturers with their students at science teacher training institutions. Members of the project team used all training materials in their teaching in their institution. They got some experience how to use these materials in science teacher training. To share their experience, knowledge and skills with using prepared modules the project team designed something what it could be taken as guide book for lecturers, trainers and other teachers who would like to use produced modules. We called this material as Description of the Units for Direct Teaching.

This *Description of the Units for Direct Teaching* contains the description of the units for direct teaching in initial science teacher training in higher education institutions. Each unit has the similar structure: number, topic, goals, time, materials, strategy/method,reflection/comments, developed competencies of constructivist science teacher. This description is based on the best experience of the members of the project team. This material is only recommendation for trainers of prospective science teachers. The aim of this material is only to help trainers in their teaching. The Units in the *Description of the Units for Direct Teaching* are designed for the training of science teacher students which in the training materials mentioned above are used. These five training materials are connected with *Description of the Units for Direct Teaching* and support each other. These training materials and *Description of the Units for Direct Teaching* can be used independently.

More information is possible to find in publiction which was issued under the IQST project:

Nezvalova, D. (2008). *Description of the Units for Direct Teaching*. Olomouc: Palacky University Press, 53 p. ISBN 978-80-244-2249-7.

This publication is available in full version on: http://www.iqst.upol.cz

3.6 Portfolio

Portfolio is a common and well-accepted practice. Portfolios contain a very limited number of examples of creative work, supplemented by the students´ own commentary on the significance of those examples. Portfolios provide the trainers of science teachers with a limited sample of students´ creative work, along with the students´ explanation of that work in relation to the content or goals. In this way, the technique allows to assess students´ skill at making explicit connections between their creative work and the content. In other words, it helps trainers to see how well students can apply what they have learned and how well they can explain those applications. Portfolios prompt students to show and tell their teachers - and themselves – how their creative and self-evaluative skills are developing.

Portfolios allow students to express their conceptions of problems or topics. It requires students not only to select work samples that are personally meaningful but also to interpret the meaning of those sample for others. This technique allows students to choose the work on which they will be assessed; the teacher gains insights into what they value and appreciate. In some fields, this technique also helps students prepare to present their work to prospective employers.

To implement this type of innovation is never easy. However, using a constructivist approach seemed an innovative strategy to improve quality of science teacher training. In addition portfolio assessment is a strategy that is based on a constructivist philosophical position, which matched the approach used in the modules taught by the authors. It also offered promise as portfolio is a professional preparation strategy that uses cross-disciplinary problems as the starting point for learning. These problems are similar to those the students might face in their future role. Students work in groups, and the professor (lecturer) functions as a facilitator.

Therefore the project team felt a portfolio approach would benefit us as the lecturers would learn not only about portfolio assessment, which was an innovation new to some institutions involved in the project, but also about ourselves as professionals introducing this innovation to science teacher students. At the same time, we would learn about the students themselves through the portfolio narratives and reflections. The students would benefit as they would learn more about themselves as learners and teachers, and at the same time they would learn about the use of portfolio assessment that they could later use in the future classrooms. It was therefore felt that this constructivist approach to portfolio assessment would result in a win-win situation.

The project team which investigated the use of portfolio assessment found that:

- Student self-evaluation is an integral part of student assessment;
- Alternative non-traditional student assessment provides a new perspective on learning;
- Trainers need to continue to develop implementation student assessment to enhance student learning;
- Trainers need to devote more time and effort to evaluation for formative purposes;
- The trainer's role is vital in developing a structured learning environment where students are given independence in their learning;
- The learning outcomes for students and trainers include the improvement of organization, evaluation skills, memory, personal growth, cooperation, reflective practice, self-reliance, independence and action planning.

Using portfolio assessment enhances also student learning. By cultivating a more reflective attitude towards learning and introducing a constructivist approach in science teacher training, our students felt empowered whilst at the same time improved both communication and subject skills. Using portfolio assessment in the module assessment led to changes in the way our students began to think about themselves and their learning and as a result, how they began to learn more about themselves as learners.

Science teaching students in participating institutions during their studies of the modules produced under the project designed portfolios that were presented on the final meeting of the project team. As higher education institutions move toward reforming the assessment system, members of the project team feel the use of portfolios is an important aspect of quality in science teacher training that can be used to better assess learning.

3.7 Project Website

Project website exists from the start of the project. Address of this website is following: http://www.iqst.upol.cz.

Project website was designed and maintaned by the team of the coordinating country (CZ). Responsible person was Jan Říha, Ph. D. The project web-page (http://www.iqst.upol.cz) contains the project description, basic information about partners and coordinator, project documents (programs of the meetings, minutes from the meetings, materials for financial management, handbooks, pw presentations from the meetings), materials which were produced under the project in full version (7 publications) and 5 e-learning courses, news and chat.

This website was very usefull tool for the cooperation of the partners. It was very important that all materials produced under project were avaiable immediately on the website. Existence of this website was the most important for the students because they could use all materials in their science teacher training. This website was used by professionals and students not only in participating countries but also in many countries in different continents of the world. Students and professionals could used e-learning materials presented on this website. The web was intended to be the main distribution medium of the materials; communication and requests to the project partners were realised via e-mails and website of the project.

Website of the project was frequently visited by public (around 3500 visitors till now). However, how many institutions actually will download/order materials is beyond our possibilities to estimate.

CHAPTER 4

DISSEMINATION ACTIVITIES

Dissemination was very important activity for the project team. In all participating countries the knowledge and skills learned under the project were distributed to the target groups (universities, students and schools). All partners cooperated in the initial training of the science teachers, using modules and training materials, which were produced and designed under the project. The outputs of the project (modules, guide book for trainers, 5 training materials, 5 e-learning courses) will be used in participating institution in long term. Some teacher training institution in EU countries can also use these modules and produced materials to improve quality of science teacher training. Publications (650 copies) produced and printed under project were distributed to the partners, to the teacher training institutions in participating countries and sent to other institutions in England, Austria and Slovakia.

The results of the project were presented at the national and international conferences. All partners participated in VIth IOSTE Symposium Science and Technology Education in the Central and Eastern Europe: Past, present and Perspectives in Lithuania, Šiauliai University. V. Lamanauskas, N. Valanides and D. Nezvalova presented papers there. These papers were focused on the project topics and were published in hard format: Science and Technology Education in the Central and Eastern Europe: Past, present and Perspectives. Šiauliai: University Publishing House, 2007. ISBN 978-9986-38-781-7). Some information about the project is announced on partner's website, for example, LT team has developed own site at: http://www.gutc.su.lt/comenius/comenius-gutc.lt.htm. Some partners (3 from CZ and 1 from LT) had presentations also in VII th IOSTE Symposium „Development of Science and Technology Education in Central and Eastern Europe" on June, 2009. The results of the project were disseminated there.

Also some information about IQST project was regularly disseminated through international e-mail list khimiya@yahoogroups.com The following messages were presented in this group:

http://groups.yahoo.com/group/khimiya/message/1269

http://groups.yahoo.com/group/khimiya/message/1392

http://groups.yahoo.com/group/khimiya/message/1650

http://groups.yahoo.com/group/khimiya/message/1708

http://groups.yahoo.com/group/khimiya/message/1082

http://groups.yahoo.com/group/khimiya/message/1869

The following articles were presented in journals:

1. Holubova, R., Kainzova, V., Řiha, J., Vyšin, V. (2008). Education of Teachers in ICT Applications for Teaching Physics at Primary and Secondary Schools. *Problems of Education in the 21st Century (Recent Issues in Science and Technology Education)*, Vol. 9, p.24-33. ISSN 1822-7864.

2. Nezvalova, D. (2009). Using Portfolio Assessment in Science Teacher Training. In: V.Lamanauskas (Ed.), *Development of Science and Technology Education in Central and Eastern Europe* (Proceedings of 7th IOSTE Symposium for Central and Eastern Europe, 14-18 June 2009). Siauliai: Siauliai University Publishing House, p. 100-103. ISBN 978-9986-38-978-1.

3. Nezvalova, D., Lamanauskas, V., Raikova, D.Z., Valanides, N., Pekel, O.F. (2009). The Training Modules for Improving Quality of Science Teacher Preparation: Methodological, Procedural, and Didactical Issues. In.: V.Lamanauskas (Ed.), *Development of Science and Technology Education in Central and Eastern Europe* (Proceedings of 7th IOSTE Symposium for Central and Eastern Europe, 14-18 June 2009). Siauliai: Siauliai University Publishing House, p. 104-111. /ISBN 978-9986-38-978-1/

4. Řiha, J., Richterek, L., Vyšin, I., Latal, F. (2009). Software Mathematica and Other Tools in Teaching Physics. In: V.Lamanauskas (Ed.), *Development of Science and Technology Education in Central and Eastern Europe* (Proceedings of 7th IOSTE Symposium for Central and Eastern Europe, 14-18 June 2009). Siauliai: Siauliai University Publishing House, p. 129-134. ISBN 978-9986-38-978-1.

5. Nezvalova, D., Svec, M. (2007). Some Trends in Science Teacher Training: the Experience in the United States and the Czech Republic. *Problems of Education in the 21st Century (Science Education in a Changing Society)*, Vol. 1, p. 85-94. ISSN 1822-7864.

6. Nezvalova, D., Svec, M. (2007). Science Teaching in the Czech Republic and Ongoing Changes Based on the Constructivist Theory. In.: V.Lamanauskas & G.Vaidogas (Eds.), *Science and Technology Education in the Central and Eastern Europe: Past, Present and Perspectives* (The proceedings of 6th IOSTE Symposium for Central and Eastern Europe). Siauliai: Siauliai University Press, p. 114-123. ISBN 978-9986-38-781-7.

7. Nezvalova, D., (2007). (2007). The Constructivist Perspective and Teaching Integrated Science: Making Science Accessible to All Students. *The International Journal of Learning*, Vol. 14, Issue 6, p. ???.

8. Nezvalova, D., (2007). Initial Science Teacher training. In: Danuse Nezvalova (Ed.), *Improving Quality of Science Teacher Training in European Cooperation – Constructivist Approach (Compendium)*. Olomouc, p. 5-17. ISBN 978-80-244-1821-6.

9. Nezvalova, D., (2007). Approaches to Competencies for Constructivist Science Teacher. Approach in the Czech Republic. In: Danuse Nezvalova (Ed.), *Improving Quality of Science Teacher Training in European Cooperation – Constructivist Approach (Compendium)*. Olomouc, p. 78-91. ISBN 978-80-244-1821-6.

10. Nezvalova, D., Svec, M. (2008). Using Concept Maps in the Science Classroom. *Acta Didactica. Teoria a prax vyučovania přírodovědných predmetov.* 4/2008, roč. 2. Nitra: Univerzita Konštantína Filozofa v Nitre- Fakulta prírodných vied, p. 80-89. ISSN 1337-0073.

11. Nezvalova, D., Svec, M. (2008). Should Be Concept Mapping Used in the Science Teaching? *Problems of Education in the 21st Century (Recent Issues in Science and Technology Education)*, Vol. 9, p. 90-96. ISSN 1822-7864.

12. Nezvalova, D., (2008). Contructivism in Science Teacher Education. *Problems of Education in the 21st Century (Recent Issues in Science and Technology Education)*, Vol. 9, p. 81-89. ISSN 1822-7864.

13. Lamanauskas V., Barakauskaitė O. (2007). Gamtos mokslų dalykų mokytojų rengimo kokybės tobulinimas Europos šalyse: „IQST“ projektas. Kn.: *Gamtamokslinis ugdymas bendrojo lavinimo mokykloje – 2007* (XIII nacionalinės mokslinės-praktinės konferencijos straipsnių rinkinys). Šiauliai: Lucilijus, p. 59-65. /ISBN 978-9955-32-005-0/. (Title in english: Improving Quality of Science Teacher Training in European Countries: project „IQST“).

14. Lamanauskas V. (2007). Some Features of Initial Science Teacher Training in Lithuania. *Problems of Education in the 21st Century (Variety of Education in Central and Eastern Europe)*, Vol. 2, p. 45-53. /ISSN 1822-7864).

15. Lamanauskas V. (2007). Case Study 4. Initial Science Teacher Training in Lithuania. In.: Danuse Nezvalova (Ed.), *Improving Quality of Science Teacher Training in European Cooperation – Constructivist Approach (Compendium)*. Olomouc, p. 35-45. /ISBN 978-80-244-1821-6/.

16. Lamanauskas V., Vilkonienė M. (2007). Case Study 4. Assessment of the Needs for Studies. In.: Danuse Nezvalova (Ed.), *Improving Quality of Science Teacher Training in European Cooperation – Constructivist Approach (Compendium)*. Olomouc, p. 91-97. /ISBN 978-80-244-1821-6/.

17. Lamanauskas V., Vilkonienė M. (2007). Competencies of Science Teachers: Comparative Assessment. In.: Danuse Nezvalova (Ed.), *Improving Quality of Science Teacher Training in European Cooperation – Constructivist Approach (Compendium)*. Olomouc, p. 102-115. /ISBN 978-80-244-1821-6/.

18. Lamanauskas V. (2007). Case Study 4. Description of Module: Lithuania. In.: Danuse Nezvalova (Ed.), *Improving Quality of Science Teacher Training in European Cooperation – Constructivist Approach (Compendium)*. Olomouc, p. 133-136. /ISBN 978-80-244-1821-6/.

19. Lamanauskas, V. (2009). Gamtos mokslų dalykų mokytojų rengimas: tarptautinio "IQST" projekto didaktinis indėlis [Science Teacher Training: Didactical Input of International Project "IQST"]. Kn.: *Gamtamokslinis ugdymas bendrojo lavinimo mokykloje - 2009* (XV nacionalinės mokslinės praktinės konferencijos straipsnių rinkinys, Kėdainiai, 2009 m. balandžio mėn. 24-25 d.). Šiauliai, p. 95-101. /ISBN 978-9955-32-069-2/.

20. Řiha, J., Kainzova, V., Latal, F. (2008). (2008). Remote Experiment in Teaching Physics. In.: *Information and Communication Technology in Natural Science Education - 2008* (Proceedings of International Scientific Conference, 28-29 November 2008). Siauliai: Siauliai University Press, p. 88-90. /ISBN 978-9986-38-943-9/.

21. Vilkonienė M., Lamanauskas V. (2008). Gamtos dalykų mokytojų kompetencijų lyginamoji analizė: konstruktyvistinio mokymo (-si) kontekstas. Kn.: *Gamtamokslinis ugdymas bendrojo lavinimo mokykloje - 2008* (XIV nacionalinės mokslinės-praktinės konferencijos straipsnių rinkinys, Utena,

2008m. balandžio mėn. 25-26 d.). Šiauliai: Lucilijus, p. 131-142. /ISBN 978-9955-32-032-6/.

22. Райкова Ж., Незвалова Д., Ламанаускас В., Валанидес Н., Пекел О. (2009). Подобряване качеството на подготовката на студенти, бъдещи учители по природни науки чрез европейско коопериране (Европейски проект: Improving Quality of Science Teacher Training in European Cooperation (IQST)). В кн. *Обучението по физика и астрономия в условията на новата образователна структура на средното училище*, Русе, 2-5 април 2009 (*Proceedings of the 37th National Conference About the Physics Teaching)*. Русе, с. 118-121. /ISBN 978-954-580-261-4/.

Members of the project team published 22 articles in national (4) and international (18) journals.

CHAPTER 5

EVALUATION OF THE IQST PROJECT

The purpose of the evaluation function for the IQST project was thus twofold. It was to go beyond merely a final report, that is, an audit of compliance to planned outcomes and a judgement of success. It was to also track and report back on the project's progress during its journey. The planned evaluation approach thus comprised two interdependent elements.

First of all, on-going formative evaluation activity was undertaken for the duration of the project term. Generally, this activity works as a form of action research by feeding early or mid-term data into a new initiative, programme or policy in order to help it better identify and understand both the movement towards the intended consequences (and challenges in doing so) within an uncertain and changing context as well as the identification of unintended consequences of the innovation. The formative evaluation purpose was – in the first instance - to offer a series of snapshots taken at key stages of the project journey in order to help the partners to check and re-check their work against the original project aims and tasks. The other primary purpose was to offer relevant mid-term feedback from key players and stakeholders to consider any re-orientations (as a result of contextual changes) required during the project period. Changes did occur both in the external and internal contexts during the project period. Externally, EU-related movement and progress was taking place, and some of the partners' knowledge and input on these movements were invaluable. Within the five 'target' countries movement and progress toward the project aspirations were also taking place. In these cases, importantly, the IQST project was one of the players.

The second element of the evaluation is the summative report. This maps the project's achievements against the stated objectives and outcomes. This is a briefer section as project products and outcomes are very well documented as part of the formal requirements of the project proposal. However, the formative evaluation activities do help validate the integrity of the final products and outcomes.

The project outcomes match the original project aims as outlined in the proposal. Overall, all the evidence points to a highly successful project, which has not only achieved what it set out to do, but has done so very well indeed. Evidence of project achievement is evidenced in a number of forms. An extensive range of highly detailed and very valuable documentation has been produced by all partner of the project on all aspects and at all stages of the project. Such documentation is in paper form, and was delivered in project meetings, and in local, regional, national and international conferences and fora. Much of it is also available on the project website. Additionally, many forms of dissemination and valorisation activities took place at local, regional, national and international levels. Lists of documentation, reports, products and meeting are not listed here, as they are available in highly detailed form in other project reports.

The project team of partners and were very well chosen – offering crucial expertise and experience on the project aspirations - and worked efficiently and effectively together. There was a feeling of a short hiatus in communication on the part of two partners during the spring of 2007. But this was a minor hiccup and happened at the time when the three target countries were concentrating their energies on planning the design and piloting of the systems, and only lasted a little time. The best cooperation was between project teams in CZ, LT and BG.

The project meetings were all well-planned and played an important part in the successful progress and outcomes of the project. They were also all well-hosted, which indicated not only the professionalism of the individual partners but also the commitment of their organisations. Such commitment – on the part of both individual people concerned (and their colleagues) and their organisations – was a crucial factor in the project's success.

A further major factor in the success of the IQST project lay in the management and co-ordination of the project. The coordinator displayed admirable leadership, generating a good working environment and ensuring effective and willing collaboration on the part of all the partners. In addition, her hard work, her obvious commitment and care to the project and her hands-on management style was well-supported by her organisation.

All produced materials had a very good quality and were very well evaluated by users-science teaching students. Each material had 2 reviewers and their assessment was very positive too. E-learning courses were easy to use and had a positive feedback too. Training materials from all five countries were very well prepared. All modules are based on constructivist theory. It is obvious that all modules are useful for modernization of university study programmes. The comparative analysis of all training materials was carried out. Each module has its own character. On the basis of the preliminary observations we can state that all training materials are useful in the university teaching process. It is clear that all training materials prepared during the project implementation will assist students, lecturers and administrators in their work. All training materials are good support for prospective science teachers training programmes. Another important thing is that all training materials can be used in many different ways by students and lecturers. Some customers will be able to point their users directly to IQST project website, others will be able to integrate the material with their own website or learning environment. During realisation of the given project IQST partners from five countries have gained up a wide experience in creation of new original teaching modules, and also have better understanding on a situation of preparation of prospective science teachers.

Science teacher training institutions of the participating countries (4 EU members, 1 non EU member) had an opportunity to learn from each other about the science teacher training, methodologies and experience from educators. They have chance to recognize culture in participating countries. There was a possibility to use materials produced under the project in very good quality in all participating countries for a long time and improve the quality of science teacher training.

CHAPTER 6

CONCLUSION

Aims, objectives and activities which were planned in the Application Form of the project were fulfilled. We developed new ways of initial science teachers training based on European cooperation. The project compared the approaches to initial science teacher training in participating countries and analysed the needs of prospective science teachers. The competencies of constructivist science teacher were set up. These results and outputs were described in Compendium produced under this project. The project team designed five 5 new modules based on the contructivist theory for science teacher training and prepared five training materials for students to be used not only in participating institutions but also in the science teacher training in other EU countries. All these training materials are in English, three of them were translated in national languages (Bulgarian, Czech and Turkish language). E-learning course (5) were created under this project. There were introduced new pedagogical methods including portfolio assessment, based on constructivist approach in science teacher training. Some experience how to use designed materials and newer teaching and learning methods in science teacher training are described in the material called Description of the Units for Direct Teaching. All these materials were printed and distributed in participating countries and to other EU countries. There are also avaiable in full version on the website of the project. Cooperation and partnership between participating institutions and working teams were established. Thanks to EU financial support the project contributed to the improvement of the quality of initial science teacher training in the participating countries and other EU countries that could use all materials produced under the project. The project supported initial science teacher training in tailoring and designing new modules and training materials which in the following elements were be taken in account: European dimension, coherence between modules in participating countries, the theory-practice issue, extending school-based experience, recruiting the support of prospective sciences teachers, the fostering of the reflective practitioner. All sciences teachers need to be well educated, to have a professional framework of the reference to draw upon which equips them with the knowledge, attitudes and skills to act in an intelligent, autonomous and caring manner. This high quality initial teacher training brings a chance to prospective teachers to find teaching position in EU countries and leads to higher quality of science teaching on university level.

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APPENDIX 1

ARTICLES RELATED TO IQST PROJECT

Holubova, R., Kainzova, V., Řiha, J., Vyšin, V. (2008). Education of Teachers in ICT Applications for Teaching Physics at Primary and Secondary Schools. *Problems of Education in the 21st Century (Recent Issues in Science and Technology Education)*, Vol. 9, p.24-33. ISSN 1822-7864.

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APPENDIX 2

WORK PLAN OF IQST PROJECT

Stage in life of project	***Outputs / Achievements***	***Activities***	***Start and end date of activities***	***Partners / Persons involved***	***Time input (person / days or person / months)***
1 needs analysis	List of the needs	Study of materials, questionnaire Meeting of the project team in CZ	October 06-March 07 November 06	CZ, LT	5/50 days
2 collection of materials	Glossary, Compendium of competencies, web-page	Printing of compendium Exchange of materials in European cooperation Meeting of the project team in LT	May 07 April 07-October 07 June 07	CZ, LT	10/90 days
3 drafting	First draft of modules	International cooperation electronically, discussion on national and international level Meeting of the project team in BG	November 07-March 08 December 07	CZ , CY, LT, BG, TR	10/70 days
4 editing and testing	Final draft of modules	Cooperation with schools and students, framework conference on national level Printing the booklet Modules in Initial Teacher Training	April 08 - August 08	CZ , CY, LT, BG, TR	10/80 days

5 production of materials	Training materials, e-learning course	Designing and printing of the training materials Meeting of the project team in TR	September 08-March 09 September 08	CZ , CY, LT, BG, TR	10/110 days
6 evaluation	Evaluation of modules and training materials	External and internal evaluation Exchange of experience with modules and training materials Meeting of the project team in CY	April 09-July 09 April 09	CZ , CY, LT, BG, TR	5/20 days
7 dissemination	Web site, presentation on the conferences, CD Roms, printed materials, e-learning course	Distribution of knowledge and outputs Distribution of 30 CD Roms, 30 copies of training materials,	October 08-October 09	CZ , CY, LT, BG, TR	10/100 days
8 organisation of the meeting	6 meetings of the project team	Reporting, minutes	September06-October09	CZ , CY, LT, BG, TR	10/110 days
9 management of the project	Minutes, National, Interim and Final Reports	Reporting, communication, financial management Meetings in Brussels	September06-October 09	CZ	5/50 days
10 application of the modules, training materials, e-learning course	Students´ portfolio, science teachers training	Sharing the experience of modules and training materials in EU cooperation Final meeting in CZ	September 08-October09 November 09	CY,CZ, BG, LT, TR	5/10 days

APPENDIX 3

THE STRUCTURE OF 'IQST' WEBSITE

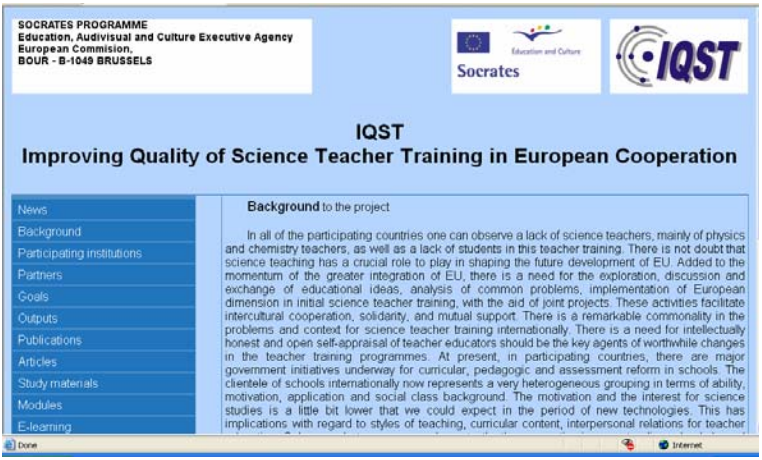


Figure 1 Introductory page of the IQST

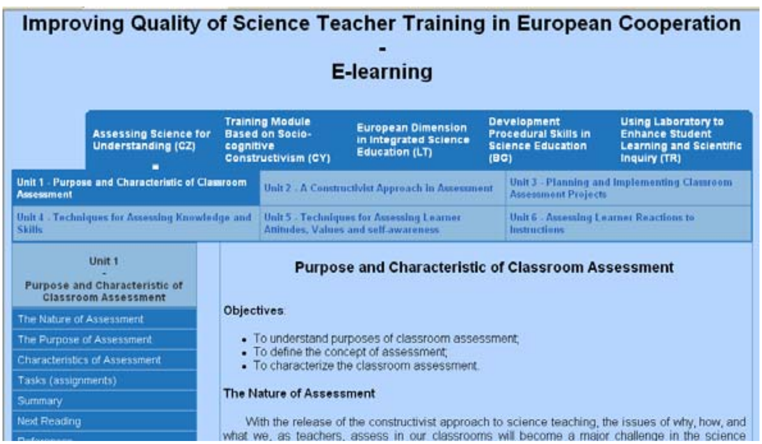


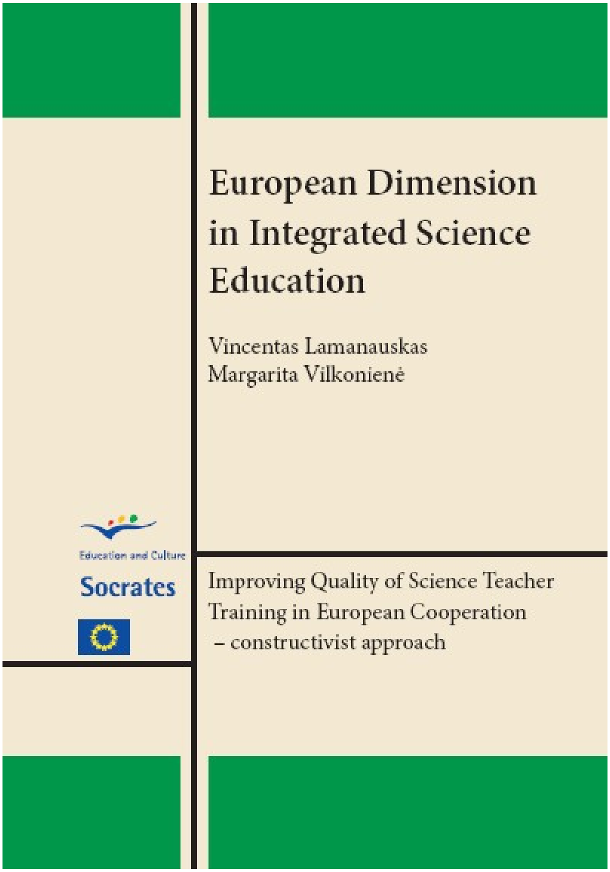
Figure 2 E-learning page of the IQST

Figure 3 Modules page of the IQST

Figure 4 Study materials page of the IQST

APPENDIX 4

TRAINING MATERIALS FOR STUDENTS



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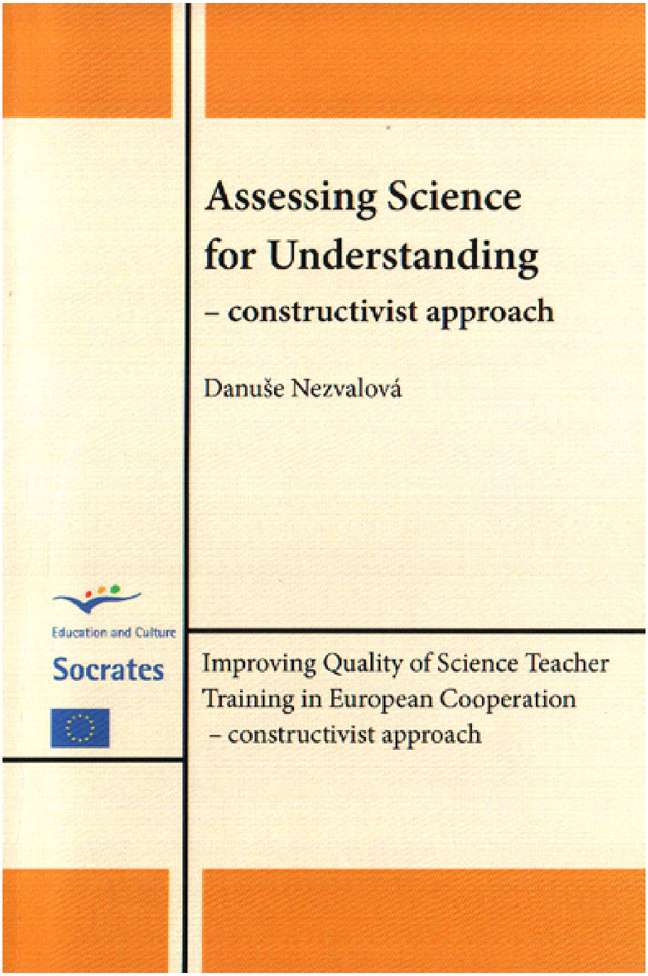

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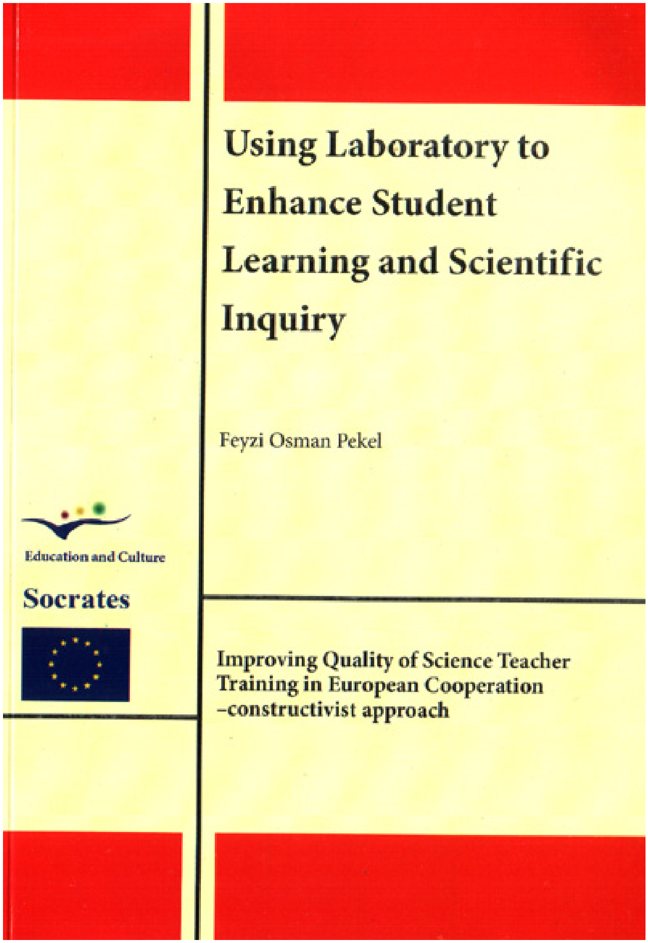

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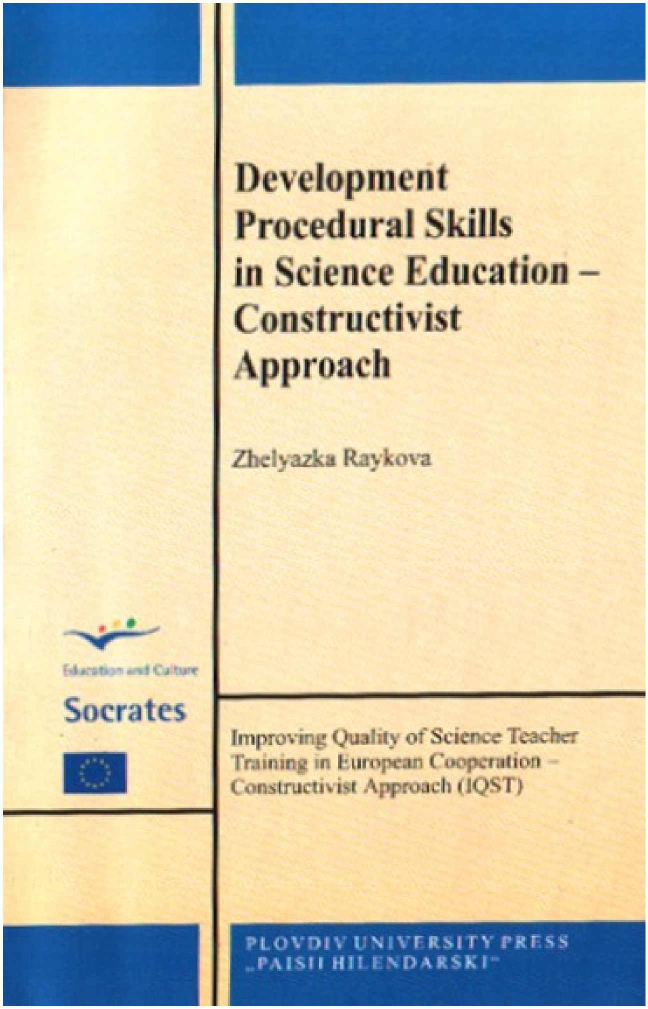

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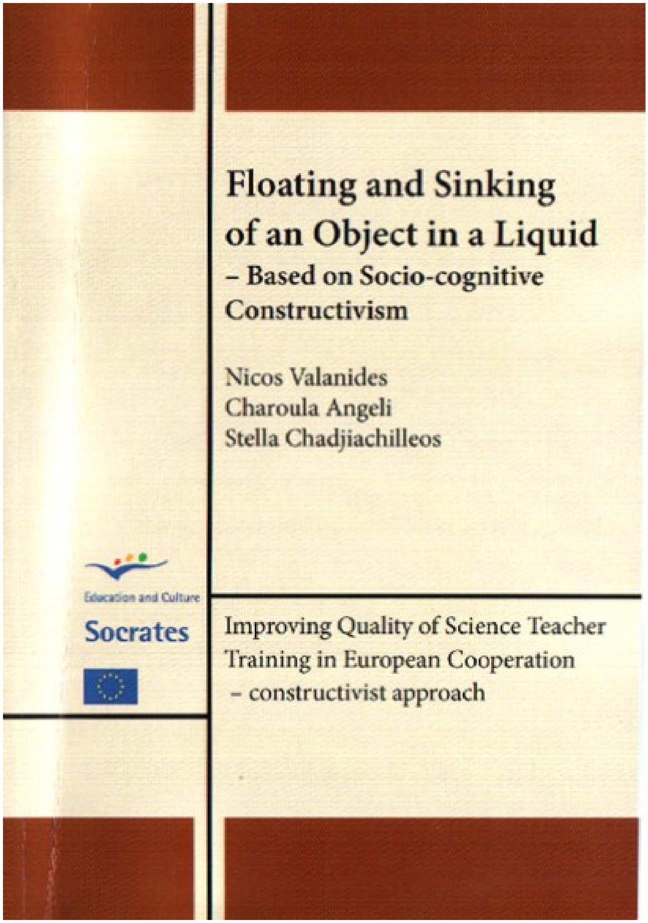

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APPENDIX 5

SOME TRICES OF PROJECT LIFE

Picture 1 Project team at kick-off meeting (Olomouc, 03 March 2007)

Picture 2 Project team during working meeting at Siauliai University (Siauliai, 18 June 2007)

Picture 3 Project team during working meeting at Plovdiv University (Plovdiv, 16 November 2007)

Picture 4 Project team during working meeting at Cyprus University (Nicosia, April 17-20, 2008)

Picture 5 Project team during working meeting at Ataturk University (Erzurum, October 28-31, 2008)

Picture 6 Project team during working meeting in Bulgaria (Sofia, February 18-21, 2009)

Picture 7 The final project meeting (Olomouc, July 1-3, 2009)

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prof. dr. Vincentas Lamanauskas

A Constructivist Approach for the Improving Quality of Science Teacher Training: An Experience of IQST project

Executive Editor prof. RNDr. Tomáš Opatrný, Dr.
Responsible Editor Mgr. Lucie Loutocká
Layout doc. RNDr. Oldřich Lepil, CSc.
Cover Design Mgr. Petr Jančík

Published and printed by Palacký University, Olomouc
Křížkovského 8, 771 47 Olomouc
http://www.upol.cz/vup
E-mail: vup@upol.cz

Olomouc 2009

ISBN 978-80-244-2340-1