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New Science Curriculum Based on Inquiry Based Learning- A Model of Modern Educational System in Republic of Macedonia

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Abstract

The process of globalization, more progressive development of the scientific findings, new technology and the way of communicating with the new forms of literacy in which the most secure spot has been taken by the development of natural sciences in the spirit of *sustainable development* have been the reasons that make science and sustainable development an educational imperative. The development of *natural sciences* in the educational processes in Republic of Macedonia has become an essential process which is being permanently improved with the goal to find the best solutions for its improvement. Currently, all of the elementary grade teachers have to face this process. One of the most recent changes is the study of natural sciences according to the adapted educational *curriculum* from the Cambridge International Examination Center. The goal of this reform is to lead the students on the right way of becoming future “scientists”. The programs include research that encourages students to ask questions and derive the answers themselves with the support from their teachers. This is a proven method with which natural science classes will become more interesting for the students and the findings will remain learned. The educational curriculum also allows the students to develop their critical thinking and to think and use the proofs. Students will easily learn that natural sciences are important and can help them in solving everyday life’s problems according to the principles of education for sustainable development. A very important part in the adaptation and realization of the adapted educational curriculum from the Cambridge International Examination Center is being played by the *information and communication technology (ICT)* that is a very useful resource for the development of the knowledge, skills and understanding among students. ICT needs to improve the quality of the teaching. The teachers will have the opportunity to choose and use the most appropriate and effective ICT resources.

Key words: New science curriculum, Inquiry based learning, ICT, Education for sustainable development

Introduction

Few years ago, according to the results of PISA (a triennial international survey which aims to evaluate education systems worldwide by testing the skills and knowledge of 15-year-old students), Macedonian government decide to find a way to improve the given results. Cambridge International Examinations was approached in January 2013 by the Ministry of Education and Science (MoES) of the Republic of Macedonia in the context of MoES’s ambition to raise school-level educational standards. As part of the Republic of Macedonia’s plans for educational reform, the Bureau for Development of Education (BDE) is working in partnership with Cambridge and started implementing an adapted form of Cambridge primary science curricula at Grades 1-9 from September 2014. Implementation of educational reform requires a balance of speed and sustainability. It is essential that the changes required do not exceed the capacity to deliver them effectively. This may relate to the ability of teachers to familiarize them with new content and implement new approaches to teaching and to the evolution of professional support systems and the alteration of operational practice by schools and education agencies. Financial and resource constraints also have an impact on successful implementation in terms of the reform’s educational impact for learners. The first year of new science curriculum implementation is at the end. The BDE and Cambridge International Examinations teams monitored more than 50 schools until now in term to collect more data about the ongoing curriculum realization. The first results given by the surveys and interviews provide to BDE and MoES the first impressions about the success of the process of new science reforms.

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Correlation between Inquiry Based Learning and New Science Curriculum

Inquiry-based learning or inquiry-based science describes a range of philosophical, curricular and pedagogical approaches to teaching. Its core premises include the requirement that learning should be based around student questions. Pedagogy and curriculum requires students to work independently to solve problems rather than receiving direct instructions on what to do from the teacher. Teachers are viewed as facilitators of learning rather than vessels of knowledge. The teacher's job in an inquiry learning environment is therefore not to provide knowledge, but instead to help students along the process of discovering knowledge themselves. Its core premises include the requirement that learning should be based around student questions. Pedagogy and curriculum requires students to work independently to solve problems rather than receiving direct instructions on what to do from the teacher. Teachers are viewed as facilitators of learning rather than vessels of knowledge. The teachers job in an inquiry learning environment is therefore not to provide knowledge, but instead to help students along the process of discovering knowledge themselves. Inquiry-based learning is a concept which underlines the importance of students engaging into meaningful hands-on science experiences (Louca, Santis & Tzialli, 2010). Inquiry can't be separated from the world of science and as National Science Education Standards states: "Inquiry is central to science learning" (NRC, 1996 p2).

Inquiry learning cause beyond memorizing information and aims to give students an understanding and reasoning of the knowledge which they develop. Inquiry-based learning is active and provides opportunities for students to engage themselves with scientific activities (Edelson, Gording and Pea, 1999). This self-engaging into activities should lead to a less guided situation in which students design their learning by exploring. Exploring is the essence of inquiry learning, students design their own question and hypothesis in order to engage in hands-on activities which are aligned by exploration. Hakkarainen (2002) shows that inquiry learning leads to students who design their own intuitive theories by explaining answers on their research question. Kirschner, Sweller and Clark (2006) strongly oppose to the concept minimal or non- guidance, cause it places a huge burden on working memory. Guided instruction is seen to lead to vastly more learning, IBL can't be seen as a fully guided instruction (Kirschner et al. 2006). Hmelo-Silver, Duncan and Chinn (2007 p 99) wrote an article specially in response to Kirschner et al. (2006) and state that IBL isn't minimally guided but could use "extensive scaffolding to facilitate student learning".

Inquiry-based learning or inquiry-based science describes a range of philosophical, curricular and pedagogical approaches to teaching. A distinction has to be made between teaching and doing science in IBL (Colburn, 2000). Doing science refers to the student who enact with IBL and teaching refers to the way IBL is instructed to students and the way of guiding students into science inquiry. Teaching inquiry science might evoke more discussion and different opinions. In order to address this distinction first will be looked at teaching inquiry-based science and next doing inquiry-based science. Inquiry-based science is an approach to science education that is student constructed as opposed to teacher-transmitted, hands-on as opposed to lecture-based. Students learn science by using methods, adopting attitudes, and applying skills as scientists do when conducting scientific research. Students are able to find their own problems and generate their own questions, formulate their own hypotheses, design and implement their own methods for testing their hypothesis, and use their own data to answer their original questions.

There is a progression from teacher-guided inquiry to completely student-directed inquiry. Even though students direct the course of study, the teacher still assesses progress and introduces critical skills and concepts. An inquiry-based classroom enables students to actively construct meaningful knowledge rather than passively acquire facts. Because students learn by connecting information to their own experiences, inquiry-based learning allows students to have experiences with germinating seeds, maintaining an aquarium, and working with circuits to light bulbs. After engaging in such activities, students are able to apply the information from the experience to new science concepts and life in general. Inquiry-based learning environments are such environments. Inquiry-based learning refers to a learning process in which students are engaged (Anderson, 2002) and is defined as an active learning process: "*something that students do, not something that is done to them*" (National Science Education Standards, NRC, 1996, p. 21). Inquiry and constructivist teaching approaches therefore, share many educational objectives, such as emphasizing student construction of concepts and the relationship between student acquisition of concepts and the concepts' development in the history of science (Abd El Khalick et al., 2004) and promise the fostering of motivation for students in terms of self-regulated learning.

Teaching Inquiry-Based Learning

Which role the facilitator or teacher should play during science inquiry is widely recognized and answers aren't always equivocal. This question is very legit and importance for the success of IBL, How should you support the students? Overall there is a confusion about the definition of inquiry and what inquiry implies for the teacher (Colburn, 2000). The reform from traditional education to a more inquiry-based learning asks for a paradigm shift. Teachers need to shift their emphasis from textbooks to exploring questions (Crawford, 1999). This might sound easy to implement, but is far from easy. This new paradigm on education ask for specific new actions and teachers shouldn't 'simply' provide hands-on activities for students. Teachers should provide students with inquiry activities that build on prerequisite knowledge and elaborates understanding (Crawford, 1999). This asks for a new approach in teaching which 'forces' teachers to change their current form of teaching. Learning in IBL should come from experiments and inquiry activities which should be conducted by collaboration and interaction with other students and teachers. The current situation of science education and the importance of a scientifically literate society is in the course of international comparative studies such as PISA and TIMSS increasingly discussed. With respect to the discussion about deficiencies, shortcomings and inadequateness in the field of science education and the regarding educational mandate of general school education, science education researchers express wide consensus about scientific literacy being the central aim of science education (Gräber & Bolte,1997; Gräber, Nentwig, Koballa & Evans, 2002). Although there is no single right answer as to what defines inquiry-based science, educators have outlined what it looks like. In simple terms it is a learning process or strategy rather than any specific set of lessons. This process aims to enhance learning based on increased student involvement. Through hands-on investigations, knowledge becomes more relevant and easier to comprehend. Inquiry-based science leads to active construction of meaningful knowledge, rather than passive acquisition of facts provided by a teacher. The old Chinese proverb, "Tell me and I forget, show me and I remember, involve me and I understand" is the essence of what inquiry-based science is all about.

Advantages of Inquiry-Based Science

Unfortunately, our traditional educational system has evolved in a way that discourages the natural process of inquiry-learning. The current system is teacher-focused and revolves around giving out information about what is known. The emphasis is on student's ability to recall facts and master the chosen material so that they may proceed to the next grade level. However, memorizing facts and information is not the most important skill in today's world. Facts are constantly changing and thanks to our digital age, we are overwhelmed with information. The skill needed for this new age of information is the ability to examine and make sense of this avalanche of data. Students who actively make observations, collect, analyze, and synthesize information and draw conclusions are developing the critical skills that they will encounter both at school and in the future workforce. Students need to develop inquiry skills so that they can cope with future situations and become lifelong learners. Ultimately, the significance of inquiry learning is that students learn how to continue learning, something they will use and rely upon throughout their lives.

The science curriculum emphasizes inquiry-based teaching and learning. A balanced and engaging approach to teaching will typically involve context, exploration, explanation and application. This requires a context or point of relevance through which students can make sense of the ideas they are learning. Opportunities for student-led open inquiry should also be provided within each phase of schooling. The new Macedonian science curriculum provides opportunities for students to develop an understanding of important science concepts and processes, the practices used to develop scientific knowledge, of science's contribution to our culture and society, and its applications in our lives. The curriculum supports students to develop the scientific knowledge, understandings and skills to make informed decisions about local, national and global issues and to participate, if they so wish, in science-related careers. In addition to its practical applications, learning science is a valuable pursuit in its own right. Students can experience the joy of scientific discovery and nurture their natural curiosity about the world around them. In doing this, they develop critical and creative thinking skills and challenge themselves to identify questions and draw evidence-based conclusions using scientific methods. The wider benefits of this "scientific literacy" are well established, including giving students the capability to investigate the natural world and changes made to it through human activity. Science understanding is evident when a person selects and integrates appropriate science knowledge to explain and predict phenomena, and applies that knowledge to new situations. Science knowledge refers to facts, concepts, principles, laws, theories and models that have been established by scientists over time.

Science Inquiry Skills

Science inquiry involves identifying and posing questions; planning, conducting and reflecting on investigations; processing, analyzing and interpreting evidence; and communicating findings. This strand is concerned with evaluating claims, investigating ideas, solving problems, drawing valid conclusions and developing evidence-based arguments. Science investigations are activities in which ideas, predictions or hypotheses are tested and conclusions are drawn in response to a question or problem. Investigations can involve a range of activities, including experimental testing, field work, locating and using information sources, conducting surveys, and using modeling and simulations. The choice of the approach taken will depend on the context and subject of the investigation.

In science investigations, collection and analysis of data and evidence play a major role. This can involve collecting or extracting information and reorganizing data in the form of tables, graphs, flow charts, diagrams, prose, keys, spreadsheets and databases. There are five sub-strands of *Science Inquiry Skills*. These are:

- **Questioning and predicting:** Identifying and constructing questions, proposing hypotheses and suggesting possible outcomes.
- **Planning and conducting:** Making decisions regarding how to investigate or solve a problem and carrying out an investigation, including the collection of data.
- **Processing and analyzing data and information:** Representing data in meaningful and useful ways; identifying trends, patterns and relationships in data, and using this evidence to justify conclusions.
- **Evaluating:** Considering the quality of available evidence and the merit or significance of a claim, proposition or conclusion with reference to that evidence.
- **Communicating:** Conveying information or ideas to others through appropriate representations, text types and modes.

The curriculum will be divided in three developing periods:

- ***Grade 1-3 – first developing period***
- ***Grade 4-6 – second developing period***
- ***Grade 7-9 – third developing period***

Grade 1-3 – first developing period-Young children have an intrinsic curiosity about their immediate world. Asking questions leads to speculation and the testing of ideas. Exploratory, purposeful play is a central feature of their investigations. They use the senses to observe and gather information, describing, making comparisons, sorting and classifying to create an order that is meaningful. They observe and explore changes that vary in their rate and magnitude and begin to describe relationships in the world around them. Students' questions and ideas about the world become increasingly purposeful. They are encouraged to develop explanatory ideas and test them through further exploration. During these years students can develop ideas about science that relate to their lives, answer questions, and solve mysteries of particular interest to their age group. In this stage of schooling students tend to use a trial-and-error approach to their science investigations. As they progress, they begin to work in a more systematic way. The notion of a 'fair test' and the idea of variables are developed, as well as other forms of science inquiry. Understanding the importance of measurement in quantifying changes in systems is also fostered.

Through observation, students can detect similarities among objects, living things and events and these similarities can form patterns. By identifying these patterns, students develop explanations about the reasons for them. Students' understanding of the complex natural or built world can be enhanced by considering aspects of the world as systems, and how components, or parts, within systems relate to each other. From evidence derived from observation, explanations about phenomena can be developed and tested. With new evidence, explanations may be refined or changed. By examining living structures, Earth, changes of solids to liquids and features of light, students begin to recognize patterns in the world. The observation of aspects of astronomy, living things, heat, light and electrical circuits helps students develop the concept of a system and its interacting components, and understand the relationships, including the notion of cause and effect, between variables.

Grade 4-6 – second developing period -during these years, students continue to develop their understanding of important science concepts across the major science disciplines. It is important to include contemporary contexts in which a richer understanding of science can be enhanced. Current science research and its human application motivates and engages students. Within the outlined curriculum, students should undertake some open investigations that will help them refine their science inquiry skills. The quantitative aspects of students' inquiry skills are further developed to incorporate consideration of uncertainty in measurement. In teaching the outlined curriculum, it is important to provide time to build the more abstract science ideas that underpin understanding.

Students further develop their understanding of systems and how the idea of equilibrium is important in dynamic systems. They consider how a change in one of the components can affect all components of the system because of the interrelationships between the parts. They consider the idea of form and function at a range of scales in both living and non-living systems. Students move from an experiential appreciation of the effects of energy to a more abstract understanding of the nature of energy. As students investigate the science phenomena outlined in these years, they begin to learn about major theories that underpin science, including the particle theory, atomic theory, the theory of evolution, plate tectonic theory and the Big Bang theory.

Grade 7-9 – third developing period - the senior secondary courses for physics, chemistry, biology, and Earth and environmental science build on prior learning across these areas. The implementation of this part of new science curricula will be realized in upcoming school year.

General Capabilities

In the Macedonian Curriculum, the general capabilities encompass the knowledge, skills, behaviors and dispositions that, together with curriculum content in each learning area and the cross-curriculum priorities, will assist students to live and work successfully in the twenty-first century. There are seven general capabilities:

- Literacy
- Numeracy
- Information and communication technology (ICT) capability
- Critical and creative thinking
- Personal and social capability
- Ethical understanding
- Intercultural understanding.

In the Macedonian curriculum of science, general capabilities are identified wherever they are developed or applied in content descriptions. They are also identified where they offer opportunities to add depth and richness to student learning through content elaborations.

Sustainability in Macedonian Science Curriculum

Across the Macedonian science curriculum, sustainability will allow all young Macedonian to develop the knowledge, skills, values and world views necessary for them to act in ways that contribute to more sustainable patterns of living. It will enable individuals and communities to reflect on ways of interpreting and engaging with the world. The sustainability priority is futures-oriented, focusing on protecting environments and creating a more ecologically and socially just world through informed action. Actions that support more sustainable patterns of living require consideration of environmental, social, cultural and economic systems and their interdependence. In the Macedonian Curriculum of science the priority of sustainability provides authentic contexts for exploring, investigating and understanding chemical, biological, physical and Earth and space systems.

Science explores a wide range of systems that operate at different time and spatial scales. By investigating the relationships between systems and system components and how systems respond to change, students develop an appreciation for the interconnectedness of Earth's biosphere, geosphere, hydrosphere and atmosphere. Relationships including cycles and cause and effect are explored, and students develop observation and analysis skills to examine these relationships in the world around them. In this learning area, students appreciate that science provides the basis for decision making in many areas of society and that these decisions can impact on the Earth system. They understand the importance of using science to predict possible effects of human and other activity and to develop management plans or alternative technologies that minimize these effects.

Monitoring Process of Implementation Process in 1-3 Grade

The school year 2014/2015 was the first year with implementation of new science curricula in 1-3 grade. Prior to the arrival of Cambridge consultants, staff from the BDE visited over 50 schools, observing lessons and interviewing learners, teachers and head teachers. In the period of 3 November to 7 November 2014, a team of BDE and Cambridge advisors visited 7 schools, where the surveys, interviews and students impressions of science class through drawing were monitored. On the following period the Cambridge consultants accompanied BDE staff and interpreters to the following schools in urban and rural areas:

- Bratstvo (Skopje)
- Draga Stojanonva (Skopje)
- Kirli Pejcinovic (Skopje)
- Zilko Brajkovski (Skopje)
- 7 Marsi (Chelopek)
- Kosta Racin (Brvenica)
- Bratvo Ligieni (Migjeni)

Survey Responses

There were delivered two surveys: for principals and for the teachers. After removing duplicates and other invalid entries, the principal survey received 160 valid responses (132 on the Macedonian version; 28 on the Albanian version; 22 responses discarded). The teacher survey received 1036 valid responses (902 on the Macedonian version; 134 on the Albanian version; 294 responses discarded). The information gathered here indicates the perceptions of the respondents. It should be interpreted as what they would like to tell us about their school, their teaching and their learners. It provides a greater sense of the variety of contexts in which the new curriculum is being applied.

The key findings of principal survey results are:

- There is large variation in the size and social context of schools.
- Schools are well established with experienced teachers.
- Most schools have a clear majority language but in some regions over 30% of schools have notable numbers of learners who have a different first language.

The principal survey provides contextual information that supports the interpretation of information collected by other methods. Responses to the principal survey came from all regions of Macedonia. The Northeastern region was the least represented (n=12). Skopje was the most represented (n=34). Average number of teachers (from 9 in Southwestern to 14 in Polog) and the number of Grade 1–3 classes (from 9 in eastern to 13 in Polog). These class averages hide significant variation within regions which all had a mixture of small (2–6 classes) and large (13–23 classes) schools. Some basic arithmetic suggests that on average there is one teacher per 10 children across the three grades and the average class size is 11. These ratios are lower in Northeastern (6 learners per teacher) and higher in Polog and Southeastern (13 learners per teacher). It should be noted that there is tremendous variation in these figures within regions. Teachers are generally very experienced with all regions reporting that the average teacher has between 17 and 19 years teaching experience (standard deviation across all regions is eight years). Schools are generally well established and even the region with the youngest schools on average had an average school age of 46 years. Macedonian (79%) and Albanian (17%) are the most commonly- used languages in the 116 schools that responded to the question about languages. There was, unsurprisingly, significant variation between regions. Eastern and Vardar were predominately Macedonian speaking while Polog had more Albanian speakers.

Other regions were largely Macedonian speaking but with significant (10-25%) speakers of other languages. Turkish was most commonly spoken in the Southeastern region while Serbian is only spoken by 5% in the Northeastern region, where it is most common. However, there are two schools where Serbian is the first language of more than a quarter of learners. 20 schools reported having Turkish-speaking learners. In half of these, Turkish speakers make up more than 20% of learners, in a quarter of them they make up more than 80% of the school population. These schools are in a diverse range of regions (Eastern, Pelagonia, Skopje, Southwestern, Southeastern). In total, 27 schools reported that more than 10% of their learners do not share a first language with the majority of the school. Such schools accounted for 30% (i.e. 5–6 schools) of those that responded from Pelagonia, Polog and Southwestern regions. By contrast Eastern region only has one such school. The responses to the survey suggest that learners predominantly come from ‘middle- income’ families in all regions except Polog (where 53% learners are from low-income families). In all regions an average of 6–10% of learners are reported as coming from high-income families. Most schools reported that learners tend to leave at the end of compulsory schooling (50 of 116). Only Vardar and Southeastern regions had the majority of schools sending the majority of their learners to further education. A diverse range of employment sector for learners leaving Macedonian schools was reported (minimum of five different sectors reported within each region). However, the most common sector was reported as being agriculture and the food industry (n=66). The only regions for which agriculture was not the primary employment sector were Skopje.

The key findings from teacher survey are:

- Teachers are familiar with the new curriculum with some regional variation.
- Teachers are using the textbooks but are less familiar with them.
- Some of the issues with textbooks reported by teachers reflect the changes in pedagogy required by the new curriculum and the partial nature of the curriculum reform.
- Lack of language learning (particularly reading and writing) is a potential barrier to successful implementation of the new curriculum.

The responses to the Teacher survey came from all regions of Macedonia. Polog (n=66) and Vardar (n=69) were the least represented regions. All other regions registered over 100 responses and Skopje was the most represented region with 204 responses. Questions about teachers' prior experience were in line with the findings of the Principal survey with teachers from all regions reporting an average of 13-17 years' experience of teaching primary mathematics. Teachers reported having less experience teaching primary science (7 years less on average). The majority of teachers (88%) described their own level of learning as higher education. Teachers responding to the survey had been teaching all three grades of the new curriculum but in Eastern and Southeastern it was noticeable that fewer teachers had been teaching Grade 2 than had been teaching Grades 1 and 3. Teachers' initial responses to reform are always affected by their relative uncertainty with the new material they are being asked to teach and this is reflected in teachers' responses to questions about the new curriculum. There were ambiguous levels of satisfaction reported. Scaled from 0-1 (disagree to agree) teachers reported uncertainty about whether the new curriculum is interesting enough (0.48 down from 0.71 in May), whether it enabled progression (0.39 from 0.67), whether it is pitched at the right level (0.42 from 0.62), whether it is equally accessible in all languages (0.53 from 0.66) and whether it is easy to teach (0.44 from 0.65). It will be important to monitor these attitudes again after a period of time to see if opinion is shifting and whether a change to the implementation plan is necessary.

There was some regional variation. Teachers from the Eastern and Polog regions were generally more positive than others but still not rate any aspect higher than 0.58. Eastern and Vardar regions were notably less concerned about accessibility in all languages (these regions do not have the same diversity of languages as other regions). Most teachers thought that the curriculum provides a balance of skills and content (58%); fewer teachers thought it emphasized only content (18% compare to 27% when asked about the old curriculum) or skills (24% compared to 3%). Teachers reported being uncertain about finding resources to support the new curriculum (0.41; scaled from 0-1, not confident to very confident). As with the previous survey, teachers reported being happy using different types of resources but were less likely to use video material (down to 41%) compared to others (textbooks – 76%, practical equipment – 82%). Many teachers use ICT (61%) and a significant proportion use it 'often' or 'always' (56%). Only twenty teachers reported that they never use ICT (including at least one teacher from each region). It should be noted that these results are in conflict with the observations of the monitoring team who did not report ICT being used regularly. Teachers reported using the new textbooks and workbooks in equal measure (355-390 responding that they had used each subject/grade combination). There was more variation in the language versions that teachers had used. Most teachers (83%) had used the Macedonian versions and many (14%) had used the Albanian version. Only 28 teachers had used the Turkish version and five had used the Serbian versions. Whichever language version they had used, they saw the textbooks and schemes of work as important (scaled 0-1, not important to very important). The range was 0.61-0.76. The only document to fall outside this was the Albanian version of the schemes of work which only scored 0.40.

This is in conflict with other data that suggests that learners have responded more positively to the Albanian workbooks and textbooks (0.78, scaled 0-1) than others (Macedonian 0.53, Turkish 0.46 and Serbian 0.55). Also, most teachers (including those who have used the Albanian documents) report preferring the schemes of work to the textbooks and workbooks. The most common uses of the textbooks are to provide ideas for lessons (55%), to support the whole class as part of a lesson (52%) or for homework (53%). Only 5% of teachers said that they had not used the textbooks or workbooks at all. A particular challenge of implementing a new curriculum in a small number of subjects is that they may not immediately align with learning in other subjects. When teachers were asked what they would like to change about the new textbooks the majority of teachers commented on the appropriateness of providing textbooks to learners without the language skills to read or write and therefore access the content. This comment was particularly directed at Grade 1 textbooks but was also mentioned in terms of Grade 2 where teachers note the significant challenge for learners who have made the transition from Grade 1 of the previous curriculum to Grade 2 of the new curriculum.

European Science Education Projects that Supports New Science Curriculum in Macedonia

In Macedonian educational system are present lots of international project. One of the project that has a strong correlation with new science curriculum is EU portal, named as Scientix. Year after year, hundreds of science education projects are funded by the European Commission but apart from the persons directly involved in these projects (teachers, project managers, etc.) not many people hear about the results obtained, especially when the projects are over. The objective of the Scientix portal is to ensure that the knowledge and results of the projects reach a larger audience. In other words, Scientix was created to facilitate regular dissemination and sharing of know-how and best practices in science education across the European Union. The portal collects and disseminates teaching materials and research reports from European science education projects financed by the European Union. Launched in May 2010, the portal is targeted especially at teachers and schools, but also at other science educators, curriculum developers, policy-makers, researchers and EU stakeholders. It is a free-to-access and free-to-use portal, so that anyone interested in science education in Europe can join the Scientix community. Most of the content on the portal is accessible for all users, without registration. However, after registration, users are able to access some additional content, such as their personal pages, and use additional services, such as the forum and the chat tool, and request translations of the existing teaching materials. All users are encouraged to give feedback on the portal through the feedback tool, and thus to take part in developing the portal further. The philosophy of the portal can be summarized in the following keywords: “search, find, engage”. This motto emphasizes the shift from a central portal where information is disseminated to end users (who act in this case as passive users) towards a more dynamic and user-centered platform. Scientix thus should not be seen as an information transmission mechanism, but rather as a knowledge building platform. Scientix is managed by European Schoolnet (EUN) on behalf of the European Commission. European Schoolnet is a key player at EU level in education, representing a network of 31 Ministries of Education in the EU Member States and beyond. EUN provides major European education portals for teaching, learning and collaboration and leads the way in bringing about change in schooling through the use of new technology.

Science Project of EU that can be found on Scientix Platform

As previously mentioned Scientix collects and distributes information about past and present science education projects carried out in Europe. Priority is given to projects funded by the European Commission, but other publicly funded projects are accepted as well. Projects accepted for Scientix must provide accurate information on the project goals, research and results, and preferably also links to the public reports and resources developed in the project. These are displayed on the Scientix portal, in both the Projects and Resources sections. Project authors are also invited to promote their events and news (e.g. new publications and calls for conference speakers) through the Scientix portal. Examples of currently active projects which are included in the Scientix portal can be found below. As most of them had just started at the time of this publication, their final results or achievements are not available yet. However, these will be updated on the Scientix portal at a later stage.

Projects on Scientix Portal*Places*

Developing the concept of the European City of Scientific Culture, the PLACES project facilitates cooperation between science communication institutions and local authorities. The project focuses on developing and strengthening City Partnerships, bringing together 67 science centres, museums and festivals (each partnering with local authorities) and ten European regional networks. The partnerships provide a basis to foster interactions between science centers / museums, science festival / events and universities on one side and cities / local authorities on the other. PLACES puts emphasis on topics and issues with social relevance (e.g. environmental sustainability, ageing populations, healthcare, social security, drinking water, agriculture, biodiversity, transportation, clean energy, education policies, innovation for economic growth) which allow citizens to engage in dialogue with researchers and local authorities.

Temi

The project (2013-2016) introduces inquiry-based learning (IBS) into the science and mathematics classroom using magic tricks, myths and mysteries. TEMI is a teacher training project, working with teacher training institutions and teacher networks across Europe to implement innovative training programmes – inquiry labs.

The Enquiry labs are based around the core scientific concepts, but use local myths and mysteries to explain them. The labs are supported by scientists and communication experts to guide teachers through the transition to use inquiry in science teaching. The TEMI Central hub coordinates the activities of the local training centers and provides a platform to share best practice across all aspects of the project.

Cyber-Mentor

CyberMentor is an e-mentoring programme for girls and young women ages 12–18 in Germany designed to foster their participation in science, technology, engineering, and mathematics (STEM). Each female student (mentee) is paired with a professional woman in STEM, i.e. a researcher, a professor, or an engineer, (mentor) who informs and advises her. CyberMentor offers an online platform which provides communication possibilities and helpful suggestions for STEM activities and information on STEM courses of study and professions. Community members can introduce themselves through personal pages and interact regularly via e-mail, chat, or discussion forum for the period of one year with their mentoring partner and with all programme participants. Discussion topics range from specific scientific questions about the mentors' work to private matters. Each year, at least 800 girls and 800 women take part in the programme. Having so many other students and mentors as contact persons offers a great possibility for information exchange. In order to encourage engagement within the platform, the CyberMentor management team regularly makes suggestions for STEM-related experiments, activities, and competitions that participants can work on together. CyberMentor edits a monthly journal, CyberNews, which offers reports on interesting STEM articles, quizzes, and interviews with professionals in the STEM-Field.

Inspiring Science Education

Inspiring Science Education is a project aimed at providing resources and opportunities for teachers to make science more attractive to their students. The project includes:

- an online portal that provides an interactive inventory of e-learning tools and resources from research centers and other facilities;
- communities of practice as the place where the collaboration between teachers and students will take place.

The project will be implemented through pilot activities that will take place in 5.000 primary and secondary schools in 15 European countries. The schools will be selected to participate in piloting the project tools and resources through case studies developed in cooperation with the local teachers.

Science on Stage Europe

Science on Stage is a European initiative designed to encourage teachers from across Europe to share good practice in science teaching. Innovative and inspirational science teaching is seen as a key factor in attracting young people to deal with scientific issues, whether or not they finally choose a career in science. Hence, Science on Stage aims to stimulate the interest of young people through their school teachers, who can play a key role in reversing the trend of falling interest in science and current scientific research. Ultimately, the aim of Science on Stage is to enable teachers to deliver science in a more creative and engaging way.

e-Twinning

The eTwinning community for schools provides teachers across Europe with the opportunity and the tools for collaboration in math, science and technology education projects. eTwinning promotes collaboration between schools in Europe through the use of Information and Communication Technologies (ICT). The community provides support, tools and services to make it easy for schools to form short- or longterm partnerships in any subject area, and thus to improve and develop teachers' practices and education in Europe. Additionally, eTwinning provides Professional Development Workshops and Learning Events where teachers can learn more about eTwinning and develop their skills in using ICT in teaching.

Go-Lab

Go-Lab (2012-2016) has created an infrastructure (the Go-Lab Portal) to provide access to online laboratories run by research centers and universities worldwide. These online labs can be used by universities, schools, instructors, students and lifelong learners to extend regular learning activities with scientific experiments, giving students a real experience of research work. The Go-Lab Project offers a federation of remote laboratories, virtual experiments, and data-sets (together referred to as “online labs”), as well as facilities for teachers to embed these online labs in pedagogically structured learning spaces.

E-Bug

e-Bug is a free educational resource repository that makes learning about micro-organisms, antibiotics and hygiene fun and easy. e-Bug helps to teach children about the different types of microbes, the activity of antibiotics against them, and the increasing problems of antibiotic resistance with unnecessary use, and thus to raise awareness of wise antibiotic use. The e-Bug project aims to

- Reduce the incidence of antibiotic resistance across Europe by educating future prescribers and users on prudent antibiotic use;

- Complement national antibiotic and hygiene educational campaigns;
- Exchange information and experience of good practice in the educational curriculum with European partner countries, and
- Translate and implement the e-Bug resources across Europe in close collaboration with local Ministries of Health and Education.

Profiles

PROFILES promotes Inquiry-Based Science Education by raising teachers’ awareness of more effective ways of teaching, with the support of various science education actors. The project aims to work towards a better understanding of the changing purpose of teaching science in schools and the value of science education stakeholders’ networking. PROFILES is based on “teacher partnerships” aiming to implement existing inquiry-based science teaching materials. Long-term teacher training courses reflecting challenges relevant to the participants raise their skills in developing creative, scientific problem-solving and socio-scientific related learning environments, which enhance students’ intrinsic motivation to learn science and their individual competences such as decision-making abilities and abilities in scientific inquiry. The intended outcome of PROFILES is that science education becomes more meaningful for students and more strongly related to 21st century science and Inquiry-Based Science Education (IBSE), and thus fosters students’ scientific literacy.

Science: It’s a Girl Thing

A pan-European awareness campaign to encourage girls to develop an interest in science and engage young women in scientific research careers. This reflected Commissioner Geoghegan-Quinn’s commitment to promote gender equality and the gender dimension in research and innovation. With the slogan “Science: it’s a girl thing!”, the first phase of the campaign targeted girls aged 13 to 18, aiming to challenge stereotypes around science and show girls that science can be a great opportunity for their future.

Responsible Research and Innovation

Responsible (RRI) implies that societal actors (researchers, citizens, policy makers, business, third sector organizations, etc.) work together during the whole research and innovation process to better align both the process and its outcomes with the values, needs and expectations of society. In practice, RRI is implemented as a package that includes multi-actor and public engagement in research and innovation, enabling easier access to scientific results, the take-up of gender and ethics in the research and innovation content and process, and formal and informal science education.

Conclusion

Macedonian new science curriculum is in the process of implementation of the second developing period, based on proposed reforms suggested by Cambridge international examination center, approved by Ministry of education and science and Bureau for developing of education. The BDE advisers and Cambridge consultants conduct monitoring process through interviews, surveys and conversations on the field after first year of new curricula implementation. Based on monitoring and observations process, were noted positive attitudes, work ethic and recognition of need for change. But, still, the teachers do not seem to have the necessary level of subject and pedagogical knowledge for learners to benefit fully from the new curriculum. There is no evidence so far of a shift away from content-focused to skills-focused lessons or any shift in the level of expectation. As many principals have not attended the training events they are not aware of the challenges presented by the new curriculum. During the visit the monitoring team from BDE and Cambridge team made the following observations of the changes needed in respect of pedagogy, attainment and attitudes:

- A greater variety of teaching styles are needed where the focus is more on the children learning than the teachers teaching. Learners should have more autonomy to complete work themselves.
- Practical work should focus on exploratory and investigative work that will develop skills e.g. accuracy of measurement or planning an investigation.
- There should be more group work. Learners often sit in groups but continue to work individually on tasks. This does not encourage them to discuss how to approach the task or solve the problems presented to them.
- Teachers should be encouraged to reflect on their teaching practice. This will help them to review their teaching in the light of how well the children have progressed in their learning.
- Learners are positive about science and are well-behaved and focused on their work. However, they need to be given more autonomy within the tasks they carry out to develop a resilience and commitment to problem solving. Learners need exposure to a range of strategies to enable them to start developing the decision making process needed for higher order thinking.

As additional support to the new science curriculum is the EU Scientix portal that was launched in May 2010. Since then, it has proven to be a very successful portal, which attracts users to search for science education projects and studies, browse and download reports, resources and tools, and use the communication and translation services provided. Most teachers are looking for project information, news and teaching materials, and they are generally happy with the content and resources that they found. Scientix is gradually growing as more and more projects join the community and share their resources and materials through the portal, which is also constantly updated and developed to display the current status and latest results of the projects, and to fulfill the needs and wishes of the users. Scientix is all the time looking for new educational initiatives to join its community to demonstrate new ideas and good practices for science education in Europe and Macedonia as well.

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