International Approaches to STEM Education

CIDREE
Consortium of Institutions for Development and Research in Education in Europe

CIDREE Yearbook 2018
International Approaches to STEM Education

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LUXEMBOURG

President's Foreword

Luc Weis

Welcome to the CIDREE yearbook for 2018, International Approaches to STEM Education. Through the publication of this yearbook and the related launch conference, we celebrate yet another year of CIDREE networking. CIDREE was launched in 1990 as a self-managing network of educational bodies that actively support national policy-making. The collective experience of this unique network allows its members to gain valuable insights as well as pinpoint quality in educational policies. Through the knowledge thus gained, members seek to impact the schools, curricula, teaching and assessment regimes within their own national systems.

A central objective of CIDREE has always been to facilitate the sharing of information among the uniquely placed member institutions, and to provide opportunities to foster new ideas through collaborative activities. One of these truly collaborative activities is the annual edition of the CIDREE Yearbook. Collectively, the network has chosen a topic to which educational institutions from ten European countries have contributed current and relevant case-studies and frameworks, the outcomes of which will be discussed at the launch conference in Luxembourg and, hopefully, beyond.

Looking at the various chapters of this Yearbook, it becomes obvious that STEM education is a policy priority in many European countries. Society, and with it schools, are changing rapidly due to technology, digitalization and scientific breakthroughs. New skillsets and competencies, new forms of governance as well as new organizational capabilities are required. National strategies not only focus on fostering scientific elites but also on the promotion of scientific culture: All citizens need to be able to "think like a scientist or an engineer", and need to develop the necessary confidence and ability to confront science and technology related challenges. That is why programmes are being developed throughout Europe that aim to spark interest in science among young people who might not benefit from such stimulation from their background alone, and to encourage and support students' decision to pursue further studies in science.

On the one hand, science education promotes an understanding the world surrounding us and provides means to master the challenges of daily life. On the other hand science education is increasingly called to attract people to sectors that are deeply threatened by a shortage of skilled professionals. Few will debate that *"solutions to the most complex problems that humanity faces today – from climate change to inter-cultural communication and managing technological risks – will come from creative individuals who are willing to engage with these difficult issues and have the ability to do so."*[1]

At this point, I would especially like to thank Sid Mysore, the Yearbook's editor, and also the other collaborators at SCRIPT for their timely initiative and the work they have put in the production of the CIDREE Yearbook 2018. And, of course, my sincerest thanks also go to all the authors who have contributed to this unique book that collects examples of initiatives in STEM education from ten European countries.

This yearbook reflects the richness of the membership in CIDREE at its best.

Luc Weis

President CIDREE 2018
Director SCRIPT, Department for Coordination of Research and Pedagogical and Technological Innovations

[1] *OECD (2016), PISA 2015 Results (Volume I): Excellence and Equity in Education. PISA, OECD Publishing, Paris. P. 266.*

Abstracts

 Luxembourg

This general overview of the science education landscape in Luxembourg illustrates the common core of STEM education and describes the different pillars of national STEM strategy. Case studies within each of these pillars illustrate the interconnectedness of the STEM domain and its actors and highlight the necessity for a holistic approach to science education. From formal to non-formal education as well as teacher training initiatives, science teaching in Luxembourg has evolved a lot in the recent years.

In this broad overview, the initiatives of the Ministry of Education, Childhood and Youth are illustrated as well as the challenges that lie ahead to consolidate innovative projects and make relevant science education available for students of all ages and backgrounds. Science education in this article is presented as a dual tool, one to foster excellence and improve science literacy in general.

Read the full article from Luxembourg

The article on the new “Informatics and Communication course” in the classical stream of Luxembourg’s secondary education system briefly describes the context in which the country’s Ministry of Education, Childhood and Youth introduced an additional specialisation stream for students in years 11-13. Next, some information is provided on how ICT and modern teaching and learning methods were integrated into the course right from the start. Subsequently, the article outlines the course-specific subjects with their respective aims and objectives, their methodologies and a brief overview of contents. Particular attention is given to the “Project Management” course due to its innovative and interdisciplinary set-up. The final part of the article is devoted to a detailed analysis of how ICT and a more forward-thinking methodology were implemented in a general subject, mathematics in this case. There are a number of specific examples to illustrate how “conventional” topics of the syllabus have been approached using modern applications such as GeoGebra, Photomath or Wolfram Alpha to provide learners with more interactive, effective as well as motivating learning experiences.

Read the full article from Luxembourg

 Scotland

The Scottish Government launched its STEM Education and Training Strategy in October 2017. The five-year strategy sets out an ambitious agenda to make Scotland a ‘STEM nation’ by transforming STEM provision across all sectors including early learning and childcare, schools, colleges, universities and community learning and development settings. The strategy is closely aligned to a process of significant reform in Scottish education which aims to promote excellence and equity through raising attainment and increasing positive post-school destinations, especially for learners from our most deprived communities. Under the themes of Connection and Inspiration the strategy seeks to promote more efficient cross-sector working and spark engagement in STEM and pursuit of STEM-related careers.

This article explores the journey that led the Scottish Government to develop its STEM Education and Training Strategy and describes its alignment with other key policy areas. It sets out the rationale and ambitions of the key themes in the strategy and how these will address key challenges such as teacher recruitment in STEM subjects, provision of professional learning for practitioners, improving gender balance and equality, and the development of new STEM learner pathways to tackle youth unemployment.

Read the full article from Scotland

Flanders

To deal with the shortage of (qualified) human capital in STEM professions and to reduce the high levels of youth unemployment, the Flemish Government launched the STEM action plan (2012-2020). This action plan created a new dynamic in the Flemish educational and professional landscape resulting in a multiplicity of initiatives and a strong cooperation between stakeholders. As the various employment sectors and (educational) institutions were attributed responsibility for developing a number of actions from the plan, STEM learning Networks took shape.

The article describes on the one hand the presence and quality of STEM competencies, namely problem-solving, research and design skills, in the Flemish education in recent years, and on the other hand the initiatives launched for enhanced STEM integration and quality as well as the impact of it all. The STEM framework, new didactic models for STEM and the translation of the STEM vision into the renewed Flemish educational curriculum are described in more detail. The vision 'integration of mathematics, science and technology into a problem-centered learning environment without compromising on the individuality of the separate disciplines' is translated into transversal and substantive educational goals. Both kinds of educational goals must be combined by the schools to realize integrated STEM education in Flanders.

Read the full article from Flanders

Slovenia

Among the knowledge, skills and attitudes (competencies) that are becoming increasingly important in contemporary society (21st century) scientific and mathematical literacy are prominent. They encourage students and teachers to engage in systemic thinking, to be scientifically and mathematically creative in new knowledge areas, to collaborate in problem solving situations, to develop self-directed skills etc.. Can these skills be developed in science and mathematics classrooms? Strong possibilities and support exist in Inquiry based education (IBE) within Inquiry Based Learning (IBL). We know that inquiry is not a new concept in education, but in the last decade it has again come into focus, has evolved and been refined. In our contribution, we will try to define inquiry based learning in broader (general) and more narrow (STEM specific) sense with formative assessment in focus. We will also touch upon the phases of inquiry-based learning and the inquiry cycle. The focus will be on implementation of inquiry based learning in Slovenia, presenting the status of IBL in Slovenian STEM curriculum and an overview of its implementation through different projects and the in-service teachers training of the NEIS. We will emphasise the advancement of IBL in science and mathematics education (STEM education) with special regards to inquiry skills.

Read the full article from Slovenia

Hungary

Hungarian political, economic, cultural and even educational life is characterized by the dualism of the tradition and the modernity. This paper sheds some light on this Hungarian feature in the field of education. It summarizes the political and professional activities, related to the challenges of an information-based and highly technological society, which requires much higher-level capabilities in STEM and science literacy from students than what was considered acceptable in the past.

The Hungarian ministry of education is aware of the importance of not only STEM, but the importance of arts education, too. This is declared in the Strategy for the Development of Public Education (Köznevelés-fejlesztési stratégia in Hungarian), but there is no action plan connected to this, yet.

Nevertheless, several top-down and even bottom-up initiatives can be found in the system with the aim of improving the STEAM (Science, Technology, Engineering, Arts and Mathematics) education in Hungary. This paper tries to give

an overview of the results and obstacles of those activities. The authors hope that the readers can get a sense of the tension between the traditional and modern paradigms in education, as well as between the requirements of the employers and the possibilities for the schools. We point out some obstacles for disseminating the results of different projects in the field of the inquiry-based learning. A short analysis of some good examples for cooperation between schools and other actors of the society are given in the next part of the paper. Lessons and some suggestions conclude the article.

Read the full article from Hungary

Bosnia and Herzegovina

The process of defining learning outcomes was a crucial part of the improvement of the education system in Bosnia and Herzegovina in order to obtain better student achievements using improved methods of teaching and learning.

Common Core Curricula (CCC) based on learning outcomes also created conditions for the implementation of STEM education, using an interdisciplinary approach to coordinate the teaching of different subjects and their integration in everyday life. Developing the Commom Core Curricula based on learning outcomes, using a competence-based approach, the Agency for Pre-Primary, Primary and Secondary Education initiated the education reform in Bosnia and Herzegovina.

Nevertheless, full implementation of the education reform in Bosnia and Herzegovina requires urgent steps in order to achieve better quality of the policies and processes, having in mind neccessity of implementation of the Common Core Curricula, as well as the continuous professional development of all participants in the educational processes.

Read the full article from Bosnia Herzegovina

Albania

The purpose of this article is to introduce the mathematical competencies defined in the new curriculum to shape students' mathematical knowledge and abilities. In this context the article is based on the article research regarding the importance of mathematical competencies and how to develop them in the student. The main conclusions of this article focus on the fact that teaching mathematics through competencies is effective because:

i) competencies are planned for the normative purposes through clearly defined learning outcomes for what the learner is expected to learn in mathematics;

ii) competencies are used for descriptive purposes by describing and characterizing the current practice of teaching-learning and what can actually happen in the classroom with the student's progress;

iii) competencies as specific and detailed instruments are also used as meta-cognitive support for the teachers and students by helping them clarifying, monitoring and controlling their teaching – learning relationship.

Read the full article from Albania

France

Based on a presentation of the new French mathematics and technology program, the chapter focuses on the teaching or use of computer science and presents case studies from projects where computer science is involved: first, when a system of connected objects allows the exploration and design of mathematical learning situations: the OCINAEE system is a set of interacting devices, either tangible, such as cards or dice, or digital, such as tablets and smartphones. The connection between the two classes of objects is operated by a mobile robot that can read physical elements such as cards or any other printed material. Second, when computing is a school subject, we present three examples showing how unplugged computer science can achieve different goals with the same situation, if only the situation is studied more and more deeply. Based on game situations, the resolution leans to an understanding of fundamental computer science concepts such as termination, complexity and proof of an algorithm.

Read the full article from France

Norway

This article presents the ways in which information and communication technology (ICT) and informatics skills are represented in primary and secondary school curricula. The chapter outlines central policy initiatives on ICT in education. A case study is presented to illustrate how digital technology can be used to provide specialised education to students located in sparsely populated areas. The pilot project 'The Virtual Mathematics School' is aimed at providing Internet-based education for highly motivated and skilled students in lower secondary school by offering a course in mathematics from the upper secondary curriculum.

The five-year project utilises a flipped classroom approach combined with technology for teaching and student collaboration. The chapter outlines didactical, technological, legal and organisational issues encountered during the pilot.

Read the full article from Norway

Netherlands

On the 22nd and 23rd November 2016, experts of European STEM curriculum gathered to discuss the question 'What is the position of mathematics education and of informatics education in a coherent STEM curriculum?' Nine different national perspectives were sketched in papers. These papers were used as input for international discussion groups, which each developed a poster, summarizing their findings. As a way of recapitulating all of the input and the discussions, all of the participating experts completed a survey that summarized the main findings in two propositions, to be agreed or disagreed with. This chapter presents these results and draws curriculum-related conclusions upon them regarding students' STEM skills.

Read the full article from The Netherlands

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