

## OPEN EDUCATIONAL RESOURCES ENHANCE THE STEAM EDUCATION

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**Abstract:** *The concept, formulated a few years back, of e-school or digital school is a vision of modernising the school with the use of ICT as the key elements of this change. In the beginning of our century, the education system deviated from the model of digitalisation of education based mostly on buying new equipment. Today, the vision of using new technologies at school rests on three pillars: Teachers’ expertise, Educational Resources, Technological Infrastructure. A vital component of these concepts are the open educational resources (OER) and their openness. The paper discusses the role of OER and their influence in enhancing the Science, Technology, Engineering, Arts and Mathematics (STEAM) education. In the paper, the European Union incentives for increasing the development and usage of OER and enhancing STEAM education are explored. The role of OER for better STEAM education is analysed. The initiatives of the Bulgarian government and interested parties for expanding the use of OER are presented. The National Science Program “Information and Communication Technologies for a Single Digital Market in Science, Education and Security” (ICTinSES) and the role of the University of Ruse for implementation the programme is provided. Conclusions and recommendations are proposed.*

**Keywords:** *OER, STEAM, EU policies, educational networks, educational platforms*

### INTRUDUCTION

We live in a society based on knowledge and rapidly changing technologies, where good quality education is a significant element not only for individuals, but also for development of the whole community. In a rapidly changing world, the demands of the teaching profession are rising and constantly evolving. In particular, new technologies are fundamentally changing our way of life, offering opportunities for radically new forms of learning in schools as well as significant challenges to the everyday work of the teacher. Teachers recognize these opportunities and challenges, identifying the need for support in the field of technology studies as a priority in their professional development. However, access to such professional development remains limited. Teachers highlight conflicts with work schedules, high costs and limited availability of relevant training as the main barriers to developing their practice (Garoia, V., 2015).

According to (Tarkowski, A. & al, 2016) the concept, formulated several years ago, of e-school or digital school is a vision of modernising the school with the use of ICT as the key elements of this change. In the beginning of our century, the education system deviated from the model of digitalisation of education based mostly on buying new equipment. Today, the vision of using new technologies at school rests on three pillars: Teachers’ expertise, Educational Resources, Technological Infrastructure. A vital component of these concepts are the OER and their openness.

Twelve years have passed since the Cape Town Open Education Declaration was signed. The declaration shows the importance of open education “Everyone should have the freedom to use, customize, improve and redistribute educational resources without constraint. Educators, learners and others who share this belief are gathering together as part of a worldwide effort to make education both more accessible and more effective”. Ten years after this declaration, in the same city, a group of open education activists met to reflect on progress made by the community, understand the challenges, inspire and focus the movement for the next ten years (Capetowndeclaration, 2017).

The justification for the development of open educational resources (OER) is realising the right to education, guaranteed in the Universal Declaration of Human Rights. Creating open educational resources is based on international level documents: the UNESCO Paris Declaration on open educational resources, the Council of Europe recommendations, the European Commission

announcements and resolutions of the European Parliament (Tarkowski, A. & al, 2016). The issues related to open educational resources are regulated by national legal acts – In Bulgaria: Act of preschool and school Education, Act of higher education, Act of Copyright and related.

## STUDY OF THE EU CURRENT SITUATION AND BEST PRACTICES

EU initiatives are driven in order to ensure smart, sustainable and inclusive economic growth and high-level jobs for young people. There is a strong need for more STEM graduates in Europe. In 2015 the EU STEM Coalition was established. It aims to increase innovation-driven growth by development and implementation of national STEM strategies in EU member states (EU STEM Coalition, 2015).

Knowledge and skills related to science, technology, engineering and maths (STEM) are crucial in responding to the challenges we are facing as a society.

**Open schooling** Institutions that promote partnerships with families and local communities with a view to engage them in the teaching and learning processes and to promote education as part of society development. Encourage “open schooling” where schools, in cooperation with other stakeholders, become agents of community wellbeing. Families are encouraged to become real partners in school life and activities. Professionals from enterprise, civil and wider society are actively involved in bringing real-life projects into the classroom. Open Educational Resources provide a strategic opportunity to improve the quality of education as well as facilitate policy dialogue, knowledge sharing and capacity building. Open Educational Resources are teaching, learning or research materials that are in the public domain or released with an intellectual property license that allows for free use, adaptation, and distribution (Policy Brief, 2016).

**European Schoolnet** is the network of 34 European ministries of education, based in Brussels. The aim of the network is to bring innovation in teaching and learning to the key stakeholders: ministries of education, schools, teachers, researchers, and industry partners (European Schoolnet, 2019). European Schoolnet is supporting teachers across Europe in the field of innovation and technology enhanced teaching and learning with a wide variety of activities addressing the barriers faced by teachers in accessing relevant support (Garoia, V., 2015).

The major aims of the project **OpenCourseWare for Science Technology Engineering Maths** (OCW4STEM) are to improve STEM skills and to promote the use of OER in Europe. Both aim to help the European Commission with reaching their goals, which they have set in the different strategies, such as Erasmus 4 All, Rethinking Education Strategy and Opening Up Education (OCW4STEM, 2019).

The **T<sup>3</sup> Europe network** of mathematics and STEM teachers offers educators free access to peer reviewed, curriculum-related resources and webinars. T<sup>3</sup> Europe is an association of STEM teachers that serves as umbrella body for 12 country organizations to provide quality professional development, classroom-proven content and integrated state-of-the-art classroom pedagogy (European Schoolnet, 2018).

In addition to the EU projects and initiatives a lot of innovative material is already available online as virtual material or in universities in many EU countries. It helps teachers to develop new teaching methodologies for their courses and content to promote STEM education (European Schoolnet, 2018). Some of the examples are:

- Greece: **E-me Digital Learning Platform** - secure, integrated digital environment for pupils and teachers in 121 schools; **Photodentro** – Greek national repository of Learning Objects for Primary and Secondary Education with a lot of interactive simulations, visualizations, investigations, images, experiments, educational games, 3D maps, etc. (Obradović, 2018)
- Belgium: **STEM portal** in Flemish has the activities in three sections: education, work, leisure time.
- Hungary: **GEOMATECH system** provides digital tools and interactive digital educational materials like 3D printing methods and mobile applications for the classroom.

- France: **Tactileo platform** offers not only science resources for teachers, but also a built-in tool to help them do produce materials. There are also specialised websites for each science subject, created in cooperation with the Ecoles Normales Supérieures.
- Spain: Ministry provide different platforms like **PROCOMUN** for teachers who wish to share resources and materials that they have created.
- Turkey: The **Education Information Network portal** facilities for STEM teachers to share their STEM project activities and lesson activities (videos, documents, etc.).
- Italy: **Scuolavalore portal** offers resources developed for the main STEM subject areas and for different school levels.

Producing OER for STEAM education are not just teachers and students activities. EU Ministries of educations are involved deeply in this process like classifying and qualifying resources. For example, Romanian ministry of education supports development of a national virtual repository that will contain every educational resource, obtained by public funding.

### **BULGARIAN INCIATIVES FOR EXPANDING THE OER AND ENHANCEMENT OF STEAM EDUCATION**

Bulgarian Ministry of Education and Science plan to develop cloud environment with free educational resources. Students from all over the country, as well as those from Bulgarian schools abroad, will be able to use free educational resources for all classes in a specialized cloud environment. The platform will be implemented under the project "Education for Tomorrow", implemented by the Ministry of Education and Science under the Operational Program "Science and Education for Smart Growth". The platform will be part of the cloud environment so that the latest security technologies will be implemented. It will have a library of resources (photos, videos, etc.) which will be copyright-free. Each teacher will have the opportunity to use them to do their lessons and upload them to the cloud. More than 10 000 educational resources will be developed under approved curricula from grades 1<sup>st</sup> through 12<sup>th</sup>, as well as resources for children with special educational needs. They will be validated by teachers, professors from higher education and academics, and will be freely accessible from all over the country and abroad.

The DigitalKidZ project - A school with "open" code is based on the game-based approach "learning by doing" and the Strategy for digital single market in Europe. It includes a curriculum and its related tools - an educational game for emotional and multiple intelligence, an online computer modelling platform, boxes with STEM projects and microprocessor boards, as well as all necessary additional training, mentoring support and teacher tools. The goal is to make computer modelling and math lessons, as well as programming and engineering classes fun and useful. This will help to receive competences beyond the general education. The project is supported by the Finland Embassy in Bulgaria (DigitalKidZ, 2019).

In order to respond to the European Commission's strategy for a digital single market open to the public science and open access to scientific results, in 2018 the Bulgarian government has established the National science program "Information and Communication Technologies for a Single Digital Market in Science, Education and Security" (ICTinSES). A consortium of 12 partners, including 11 universities and the Bulgarian Academy of Sciences took the responsibility to work on this programme. The University of Ruse is a partner in the established consortium and is responsible for the implementation of the program. One of the outlined results in the program is to ensure equal access to open educational resources through new digital technologies in education. The other is creating OER platform and the deliverable of this work package is to create number of open access education courses including resources like using 3D printing models virtual and augmented reality. It is envisaged to create educational networks that involved both schools and universities (Bencheva, 2019).

## **OPEN EDUCATIONAL RESOURCES LEAD TO ENHANCEMENT THE STEAM EDUCATION**

The new issue for improving curriculum planning and lesson development is introducing OER in existing coursework to more engaging students in the creative thinking and problem solving required of a STEM workforce (Charles, 2012).

One of the methods for improving STEAM education in schools is using the Flipped Classroom (FC) model. This model requires additional resources such as on-line learning materials. More specifically, the FC has been repeatedly reported to offer added value in terms of improving student attitudes towards STEAM, enhancing their motivation and active engagement in the learning process as well as supporting attainment of learning objectives related to both subject domain knowledge as well as critical thinking, problem solving and inquiry skills (Sergis, 2015). OER support teachers with new innovative learning materials, developed by using newest technologies like 3D models, videos etc.

OER will enhance the STEAM education and will lead to improve the educational methods. OER will help teachers to overcome the existing practices, promote the use of different resources for teaching, and escape from the textbook as the dominant educational resource. The number of teachers creating their own materials adapted to the needs of their learners, improving STEAM knowledge and competences will grow. At the same time the number of teachers, who teach in old-school manner techniques, using only the available textbooks will decrease. It will affect the growth of the community of teachers who develop and share their materials. In addition, OER can support the lifelong learning, because the materials prepared within the education system are used freely in informal or non-formal education. Openness of educational resources created publicly means higher cost efficiency because the rule of openness means that all content has a better chance for using. The most important is that the new emerging technologies, requiring STEAM knowledge and competences, are available and accessible easily and quickly via online materials and most of all through the OER.

New EU initiative for supporting the girls in STEAM is the new call for projects Girls 4 STEAM. The aim of this action is to promote and teach STEM subjects to girls in attractive and engaging ways, with a view to addressing the ongoing skills gap in the STEAM sectors within the EU and especially the shortfall of women & increasing STEAM drop-out rates of girls. The underlying rationale is also to empower girls to learn and encourage them to become leaders in tech. Those new and attractive method must also include OER.

## **CONCLUSIONS AND RECOMENDATIONS**

Open and Innovative educational resources empower STEAM teachers. For implementing OER and using their advantages the following recommendations can be provided: Enhancing teachers training for preparing them to create and use OER; Involving experts to support teachers in specific areas; Development a system for teacher's motivation in using, creating and shearing OER.

As beneficiaries of STEM skilled workers, professionals form companies have to be involved in developing OER and supporting teachers.

University academics and researchers from research institutions, who are experts in specific areas, have to be also involved in the process of creating and sharing OER.

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