

OCW4STEM

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Summary

This consortium wants to address the high demand for science, technology, engineering and mathematics (STEM) with use of Open Educational Resources (OER) and OpenCourseWare (OCW). On the supply side we identify and organise the collection of existing courses and we look at new ways of education, such as Massive Open Online Courses (MOOCs). This should position Europe as leading region in the field of Open Education.

This is a large consortium with 55 partners from 31 EU countries, and 2 third countries partners. The partners include universities and associations of universities. All partners are active in the field of STEM education and support the Open Education Movement.

In this consortium we have combined the forerunners in the field of Open Education in Europe, such as the Open University UK and Delft University of Technology, with leading universities in the field of STEM, such as ETH Zurich, Oxford University, and KU Leuven.

The project has good balance between implementation and dissemination & exploitation work packages.

The implementation work packages focuses on:

- utilizing the already existing plethora of openly accessible learning materials and objects that are freely available online whether through universities' portals or from other sources;
- the recognition, monitoring and joint degrees;
- the development of best practices for cooperation between institutions and professions;
- increasing the opportunities for women and underrepresented groups in STEM education;
- the need for students to engage with and develop skills related to professional practice of STEM subjects.

The dissemination and exploitation is focused on spreading the knowledge and experiences of this consortium via the networks of the partners to universities (their teachers and students), policy makers and Life Long Learners, such as workers and employers, from around Europe.

The annual conferences (Warsaw (PL), Rome (IT) and Leuven (BE)) will be open for anyone to participate and will be actively promoted around Europe.

Delft University of Technology is coordinator of this consortium. Total budget is € 1.031.068, the grant is € 600.000. (58,19% funding).

Project description

Rationale of and background to the project

The rationale of this consortium stems from a number of reports and documents which have been published over the past years addressing the high demand for science, technology, engineering and mathematics (STEM) related skills.

This consortium wants to address this demand with use of Open Educational Resources (OER). On the supply side we identify and organise the collection of existing courses and we look at new ways of education, such as Massive Open Online Courses (MOOCs).

The 'Erasmus for All' programme (2013 – 2020) contributes to Europe 2020. Its objective is to improve people's skills, personal development and employability. Two of its key actions are: Learning mobility for individuals; cooperation for innovation and good practices.

Amongst the key issues identified in the EC Communication 'Supporting Growth for jobs – an Agenda for Modernising Europe's HE Systems', published in September 2011, are:

- Increasing attainment levels to provide the graduates and researchers Europe needs;
- Improving the quality and relevance of HE;
- Strengthening quality through mobility and cross-border;
- Making the knowledge triangle work, linking HE, research and business.

In November 2012 the European Commission announced a new strategy on Education: **Rethinking Education Strategy: investing in skills for better socio-economic outcomes.**

According to the strategy the demand for qualified workforce in technology and research intensive sectors is and will remain at a high level, with an impact on the demand for science, technology, engineering and mathematics (STEM) related skills. Greater effort must now be made to highlight STEM as a priority area of education, and increase engagement at all levels.

In another part of the strategy the Commission writes about stimulating open and flexible learning. The Commission states that technology offers unprecedented opportunities to improve quality, access and equity in education and training. Digital learning and recent trends in Open Educational Resources (OER) are enabling fundamental changes in the education world, expanding the educational offer beyond its traditional formats and borders.

The Commission gives 6 priorities for member states and one of them is "Scale up the use of ICT-supported learning and access to high quality OER". On European level they will continue with their focus on "Opening up Education". This initiative will launch in mid-2013.

Delft University of Technology and its partners in this consortium fully support this strategy and we are certain that this consortium will have an added value in both fields: improving skills for STEM and promoting and using OER.

This project proposal was prepared by capitalising on the experience of previous LLL-projects and analysing the needs for the future as we head towards 2020.

Rationale for the setting-up of the consortium

This is a large consortium with 55 partners from 31 EU countries, and 2 Third Countries partners. The partners include universities and associations of universities. All partners are active in the field of STEM education and support the Open Education Movement.

The Consortium brings together an experienced group of universities and stakeholders from around Europe.

The consortium will be coordinated by Delft University of Technology which has successfully coordinated many EU projects. Most partners have participated in previous European projects.

Each partner is active in one or more work packages. In a work package 5 to 30 partners are participating. The regional spread was one of the criteria for the selection. Each work package has an assigned work package leader.

SEFI, EADTU and the OpenCourseWare Consortium will play a key role in dissemination and exploitation of project outcomes.

Participating in this project are also the partners of the OCWEU-project, they will continue to bring their expertise in the field of OpenCourseWare. The Consortium will be able to draw on The UK Open University's unparalleled expertise in delivering distance learning and in pioneering open education resources. In December 2012 they launched a new open initiative: FutureLearn. Futurelearn will bring together a range of free, open, online courses from leading UK universities, in the same place and under the same brand.

The project has six content and four management work packages:

- WP1 focuses on STEM subjects and utilizing the already existing plethora of openly accessible learning materials and objects that are freely available on-line whether through universities' portals or from other sources.
- WP2 focuses on the recognition, monitoring and joint degrees. Due to the variety in type, difficulty, level, time requirements, target group or other properties of courses around Europe, it is necessary to set up clear and widely agreed assessment methodologies and criteria for their recognition.
- WP3 aims to contribute to the development of best practices for cooperation between STEM institutions and professions, and to increasing opportunities in STEM through lifelong learning.
- WP4 will work on increasing the opportunities for women and underrepresented groups in STEM education.
- The goal of the WP5 is to carry out research how to best utilize OpenCourseWare, perform promotional activities to stimulate the use of OpenCourseWare, increase awareness and influence policy makers in adopting OER and OCW and to create toolkit to persuade faculty members to share their educational material authored.
- WP6 will focus on the need for students to engage with and develop skills related to professional practice of STEM subjects and hence enhance employability and virtual mobility.

The management work packages are project management, dissemination, quality assurance and exploitation.

Aims and objectives

Open Educational Resources (OER) have been steadily making headway within Higher Education. More materials are being published online by an increasing number of countries, presenting opportunities to effectively use these resources to improve educational opportunities for both formally enrolled students and those not currently being served by higher education. OpenCourseWare projects, such as Delft University of Technology's OpenCourseWare (OCW), seek to capitalize on the potential of the internet to eliminate borders and geographic distance as obstacles to the instantaneous exchange of knowledge and new ideas. Delft University of Technology knows that Europe is behind on the international developments and wants to strengthen the OpenCourseWare movement in Europe.

With the start of an Academic Network focused on STEM (Science, Technology, Engineering & Mathematics), we bring together forward-thinking universities in Europe to advance European Higher Education in the world of Open Education.

The aim of the project is use the full potential of Open Educational Resources, OpenCourseWare and Open Education to improve and promote STEM education by creating a network of European universities collaborating together. The result is a sustainable network of universities that have embedded Open Education in their STEM education.

European added value

The major aims of this project are to improve STEM skills and to promote the use of OER in Europe.

Both of these aims 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**.

This project can also improve Europe's position in Open Education. In American and Asian countries the developments in the field of Open Education are progressing much faster. This project can help Europe to catch up and become a leader in Open Education. This is also corresponding with the ambition of the Digital Agenda of European Commissioner Kroes.

This project stimulates European cooperation between universities to enhance STEM education. Not only do we focus on the general population, but also towards specific groups, such as women and minorities. This project can help to make STEM more accessible for those groups.

The developments in STEM and Open Education are going fast. Cooperation of universities is a necessity to keep up with these developments. This project helps to bring these universities together and to cooperate in STEM education and Online Education.

Work packages

WP1: Curriculum and learning path development

This work package focuses on STEM subjects and utilizing the already existing plethora of openly accessible learning materials and objects that are freely available on-line whether through universities' portals or from other sources. It is important to note that this WP will not design or create any course content rather put together learning paths through aforementioned materials from different sources, suitably packaged to meet the requirements of identified qualifications.

The team members will focus on learning materials in different European languages. The team will first carry out a need analysis (D1.1) and then identify available materials and classify them according to STEM subject, educational level and language (D1.2) and links uploaded to the portal (D1.4) for ease of access. The quality and usefulness of materials to the project will be evaluated in line with metrics and criteria agreed by the consortium (D1.3). When suitable materials are located that are of an appropriate standard, quality and educational level, which match identified requirements, then learning paths will be constructed (D1.5).

The learning paths will consist of

- Curriculum content
- Mapping to local and national qualifications
- Student formative and summative assessment types available
- Feedback provision for students

Deliverables

- Need-analysis of OCW-courses in the field of STEM
- Identification of OCW-courses in the field of STEM (in all European languages)
- Set-up criteria and assess OCW-courses in the field of STEM
- OCW Course finding portal
- Create Learning Paths out of existing STEM materials and objects

WP2: Mobility: recognition, monitoring and joint degrees

Open courses published by universities across Europe may vary in their type, difficulty, level (bachelor, master, PhD), time requirements, target group or other properties. Therefore it is necessary to set up clear and widely agreed assessment methodologies and criteria for their recognition.

This WP is tightly related to WP 1. The need of activities in WP 2 comes from the results in D.1.2., D.1.3. and D.1.5. After the criteria are set up and OCW courses are assessed, and the need-analysis of OCW courses in the field of STEM is done, the discussion about mobility and recognition can start. All tasks in WP 2 will respect learning paths designed in WP 1.

Once the recognition criteria are set up, there will be continuous need for monitoring of changes. These changes may be either in courses, or in the criteria reflecting the needs of industry. The monitoring protocol for STEM-courses will be agreed to ensure that the metadata about courses in course finding portal will be still up-to-date.

Recognition of STEM courses is the first step to recognition of whole study programs and consequently to joint, double and multiple degrees related to STEM. This requires precise validation procedures facilitating cooperation of different HEIs in this area. ECTS is a very good mechanism to assess the difficulty of courses and students' effort generally. However, much more has to be validated.

Open courses allow mobility, which is profitable for all participants. Universities may offer their students wider range of courses. If they offer only high-quality courses and recognise them, it may be valuable competitive advantage for them. The better study programmes universities offer, the better knowledge student gain, so the mobility is valuable for students too. Last, but not least, all the public may increase their knowledge by studying open courses and increase their price on labour market. Employers may allow, recommend or even require their employees to study open courses instead of

paying expensive training courses. However, only high-quality courses may fulfil these benefits for the society.

The goal of this work package is to **provide validation of courses and find ways to enhance students and staff mobility** via OCW.

Deliverables

- Agreed assessment methodologies of STEM-courses
- Agreed monitoring protocols of STEM-courses
- Validation procedures of joint, double and multiple degrees related to STEM-courses
- Further ways to enhance mobility through OCWs

WP3: Educating for (Open) Innovation

Innovation and creativity as a goal for education is not a new trend. Even so, after years of educational experience in this field there's still not much evidence of real progress in developing creativity and innovation in our schools and Higher Education Institutions. The explanation for this paradox may be the fact educational institutions have not transformed sufficiently their culture and work processes. Educational systems are networks of actors that reinforce each other into stable configurations which tend to prevent change. The only way to change them is to open them up, making them cooperate, sharing resources, mixing organizational values and cultures and scaling results.

The contribution of open education practices (OEP) is thus of critical importance because they support the free production, use and reuse of high quality open educational resources (OER) through institutional policies, which actually promote innovative pedagogical models. Moreover, OEP respect and empower learners as co-producers on their lifelong learning path (UNESCO Declaration, 2012).

WP3 aims to contribute to the development of best practices for cooperation between STEM institutions and professions, and to increasing opportunities in STEM through lifelong learning. The project will focus on identifying best practices and to establish a reference model for partners and other STEM institutions, professional bodies and companies to cooperate in developing joint open educational initiatives. Additionally, it will provide a reference model for design and implementation of Massive Open Online Courses (MOOC), which present today a great potential for materializing large scale cooperation and outreach for STEM institutions.

The team members will first identify a set of about 30-45 potential case studies of successful Cooperation between STEM Institutions and Professions. Each partner will select according to a pre-established list of dimensions a set of 1-3 cases. The core team will afterwards analyze them and select the best 15-20. This will result in a compendium of European best practices in STEM institutional cooperation (deliverable D3.1).

The results of the analysis will be used to develop a reference model consisting in a set of guidelines for European institutions and professional bodies to establish successful and effective cooperation actions. A first draft will be subject to a discussion amongst a number of four focal groups with representatives from different stakeholders and specific target audiences identified in collaboration with WP 10. The feedback from the discussion will be integrated in to the Model/Guidelines, which will be published in electronic and printed formats with open access (deliverable D3.2).

As an additional contribution to promote large scale cooperation between STEM institutions, WP 3 partners will analyse different existing MOOC models and develop a set of Guidelines for MOOC design and implementation in STEM education (deliverable D3.3).

Deliverables

- Compendium of Best Practice in Cooperation between STEM Institutions and Professions
- Guidelines/Model for Cooperation between STEM Institutions and Professions

- Guidelines for MOOC Design and Implementation in STEM Education for Innovation

WP4: Increase opportunities for women and underrepresented groups in STEM

It is well recognised that women are underrepresented in STEM both in education and employment across the EU. Although in some STEM fields the percentages of women have stabilised in recent years, in most areas the percentage of women studying in these areas has been at best low, but in some cases has declined, to less than 10. However, participation rates vary considerably between EU countries and STEM subjects, with Engineering and Computer Science being particularly male dominated, while some science disciplines (eg biology and chemistry) have larger numbers of women students. One major area of research and intervention focuses on the gendering of subject choices at school level which influences the choices girls make about further study and careers. But there have also been many interventions to support women students once at university and beyond, as well as for women returning to STEM after career breaks.

A number of EU countries have also been considering not only how to attract more female students into STEM but also how to attract students from non-traditional backgrounds such as low-income groups, people with disabilities, people in rural, isolated or deprived areas, minority ethnic groups, migrants, refugees and asylum seekers, or adult learners. Thus, increasing the participation of women and other underrepresented groups in STEM education and careers has been a goal of many European Higher Education Institutions, resulting in numerous initiatives that have attempted to address this issue.

The innovative use of OCW/OERs has featured in some of the responses to the issue of underrepresentation in STEM, but there has not to date been a comprehensive attempt to document how these are being used, in what context and with what success. What resources are available, how are they being used, what has worked and why, and what constitutes good practice in this area. If the aim is to increase participation, how successful have they been and why? Where are resources being used (for example in local community learning centres as part of a group, or individually at home, which has implications for access to infrastructure and support)?

The aim of this WP is to study the impact of Open Education on creating opportunities for underrepresented groups in STEM, recommend programs to support increased participation and attracting more female students as well as a wider pool of non-traditional students. However as it will not be feasible to focus on all groups mentioned, we will consider specifically women and minority ethnic groups during the duration of the project period, including investigating which minority ethnic groups have lower participation in STEM in Europe. A longer-term goal of the sustainable network after the lifecycle of this project is to focus on the wider range of underrepresented groups. The learning paths and resources developed in WP1 will support both the recruitment into higher education and subsequent educational development for these under-represented groups.

Deliverables

- Analysis of experiences of underrepresented groups in STEM in Europe. Development of a framework to analyse examples of OCWs being used with underrepresented groups for STEM learning
- Impact study of open education on creating opportunities for underrepresented groups in STEM
- Recommendations on creating opportunities for underrepresented groups in STEM
- Presentation of Recommendations on creating opportunities for underrepresented groups in STEM

WP5: Promotion of OCW

The goal of the work package is to carry out research how to best utilize OpenCourseWare, perform promotional activities to stimulate the use of OpenCourseWare, increase awareness and influence

policy makers in adopting OER and OCW and to create toolkit to persuade faculty members to share their educational material authored.

Main challenge with open educational resources is to change the old model: the course material (lecture slide sets, compendia, exercise sets) are usually copyrighted by the professors and/or the institution and idea of sharing it for little or no compensation is entirely novel and subject to normal change resistance. "Why should I give for free the material I made" or "I had to build up my course from nothing and you should too" are common arguments against sharing course material.

Another problem with open educational resources is that the concept of open licensing is generally unknown to policy and decision makers. One way to increase the output of open educational resources is to increase OER awareness in organizations which fund authoring of course material (governmental organizations, foundations etc.) to stipulate that the material authored with their funding will be distributed with open license, allowing everyone to utilize, remix and develop further the material.

Sharing course material openly has certain advantages, for which it should become general. Open sharing will increase the quality of the material, when it is under public criticism. The total volume of the material will increase, because it is easier to build up from existing material compared to building it from scratch. Finally, high quality open material will act as an advertisement for its home institution and it will promote self-study of the subject outside the institution.

High-quality open educational resources will find their users, but still there are teachers and professors who either do not know about openly licensed course material or are prejudiced against them. Utilizing OER for self-study and how to empower people to earn credits with OER is discussed in WP2.

The goal of the work package is to promote open licensing in all levels involved with the process of authoring educational resources: the financiers, the authors and end users.

Deliverables

- Research report on how to best utilize OpenCourseWare
- Promotional activities to stimulate the use of OpenCourseWare
- Increase general awareness and influence policy makers in adopting OER and OCW
- Create toolkit to persuade faculty members to share

WP6: OCW for Practical STEM Education

This Work Package will focus on the need for students to engage with and develop skills related to professional practice of STEM subjects and hence enhance employability and virtual mobility. It will link closely with the broader activity of WP1. Conventionally, this teaching has been delivered through demonstration, laboratory, workshop and studio activities, based in specific locations. However, new ICT based pedagogies are reducing the need for physical presence and are broadening access, through, for example, interactive software, remote laboratories, virtual studios and field trips. This development mirrors the impact that ICT technologies have had on professional practice in STEM. Increasingly STEM professionals interact with equipment through digital interfaces, use digital techniques for data analysis and presentation and routinely interact with co-workers, clients and customers online.

The work package is aimed at the development of common purposes and processes in the development and use of open courseware in practical STEM teaching. It will primarily focus on practice within HE institutions and professional bodies but will also explore the potential of OCW for use in broadening awareness of STEM in lifelong learning and public engagement contexts.

WP6 will establish the present status of OCW for practical STEM learning in Europe, placing this in a world context. There have been many relevant initiatives. They include work in many areas, e.g. ;

- Demonstration software and audio visual material
- Numerical simulations
- Interactive Screen Experiments
- 3-D Immersive and games technologies.
- Roving Field Technologies
- Remote robotically controlled experiments and observations
- MegaLab Experiments.
- Collaborative studios and workspaces

In many cases, the work has been fragmentary, been limited to local impact and not sustained. Intellectual property and financial sustainability issues have had significant impact. We will develop a typology and evaluation framework for existing and future practical STEM packages against which to review existing provision and identify future projects.

Successful deployment of OCW in this context can only be achieved if the products meet the needs of stakeholders – these include students, teachers, employers, and regulatory and professional bodies. These needs will be influenced by the economic, cultural and technical environment in which teaching is taking place. We will investigate stakeholder views on existing and future provision across our communities and countries. The requirements of national curricula and of professional bodies will be of particular concern – to what extent do they specify laboratory and other practical experience. Institutional drivers for use of OCW in this field will be assessed. We will explore, factors relating to pedagogy, finance, resource efficiency, flexibility of delivery and expansion of access. Technical specifications will also be considered. These will be informed by evidence from current European and international networks engaged in online lab activities.

The evidence gathering above will feed into a specification of the options for successful delivery of practical STEM teaching through OCW. This will include regulatory, financial, pedagogical, technical dimensions. The specification will be illustrated by mapping examples of promising present practice on to the recommendations made.

WP leaders recognise the need for liaison with WP1,4,5 in identification of OCW related to practice and their relevance to employment and other themes

Deliverables

- Identification of open practical learning opportunities in the field of STEM.
- Evaluation of open practical learning opportunities in the field of STEM
- Needs analysis of open practical learning opportunities in the field of STEM.
- Specification of technical, pedagogical and other systems necessary to ensure access and sustainability.

Other work packages

- Project management and financial management
- Dissemination of experiences and results
- Quality Assurance
- Exploitation of project outcomes

Partners

#	Country	Organization
1	Austria	Graz University of Technology
2	Austria	FH JOANNEUM Gesellschaft
3	Belgium	Katholieke Universiteit Leuven
4	Belgium	European Society for Engineering Education (SEFI)
5	Belgium	UC Louvain
6	Croatia	University of Dubrovnik
7	Cyprus	University of Nicosia
8	Czech Republic	Mendel University in Brno
9	Czech Republic	Brno University of Technology
10	Denmark	Technical University of Denmark
11	Denmark	Aalborg University
12	Estonia	Tallinn University of Technology
13	Finland	Helsinki Metropolia University of Applied Sciences
14	France	UNISIEL
15	Germany	TU Berlin
16	Greece	Aristotle University of Thessaloniki
17	Greece	National Technical University of Athens
18	Hungary	Budapest University of Technology and Economics
19	Hungary	MELlearN Network
20	Iceland	University of Iceland
21	Ireland	National University of Ireland Maynooth (NUIM)
22	Ireland	University of Limerick
23	Italy	Università degli Studi Guglielmo Marconi (USGM)
24	Italy	International Telematic University UNINETTUNO
25	Italy	METID – Politecnico di Milano
26	Latvia	Riiga Technical University
27	Lithuania	Kaunas University of Technology
28	Luxembourg	University of Luxembourg
29	Montenegro	Faculty for Information Technology - Mediterranean University
30	Montenegro	Institute of Modern Technology Montenegro
31	Netherlands	Delft University of Technology
32	Netherlands	European Association of Distance Teaching Universities
33	Netherlands	Open University NL
34	Poland	AGH-University of Science & Technology
35	Poland	Marie Curie Sklodowska University
36	Poland	Warsaw University of Technology
37	Poland	Poznan University of Technology, Institute of Computing Science
38	Portugal	Universidade Aberta
39	Romania	Politehnica University of Timisoara
40	Serbia	Balkan Distance Education Network BADEN
41	Slovakia	Slovak University of Technology
42	Slovenia	University of Maribor
43	Spain	Universitat Politecnica de Catalunya
44	Spain	Universitat Polytechnic Madrid
45	Spain	Universitat de Barcelona
46	Sweden	Computer & Systems Science Stockholm University
47	Sweden	Lund University
48	Switzerland	ETH Zurich
49	Turkey	Middle East Technical University
50	Turkey	Bahcesehir University, Besiktas, Istanbul

51	UK	De Montfort University
52	UK	Open University
53	UK	Coventry University
54	UK	Oxford Internet Institute (University of Oxford)
55	UK	The Higher Education Academy