

## **e-LIVES – Extending e-Engineering along the South and Eastern Mediterranean Basin**

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**Abstract.** The number of students in the higher education system in South and Eastern Mediterranean Basin countries more than doubled in the last 15 years [1]. This positive step forward creates important difficulties for universities forced to handle overcrowded classes. In STEM (Science, Technology, Engineering, and Mathematics) related courses, one promising solution involves the development of accredited e-engineering courses, as a very convenient and efficient way of dealing with the constantly surging number of students.

The e-LIVES (e-Learning InnoVative Engineering Solutions) project, a recently approved Erasmus+ program project whose consortium includes European Institutions of higher education from France, Portugal, Belgium and Spain, and from the South and Eastern Mediterranean Basin, Algeria, Jordan, Morocco, and Tunisia, aims to address the problem by providing solutions based on e-engineering. Profiting from the experience gained with the EOLES (Electronics and Optics e-Learning for Embedded Systems) course, a fully online e-engineering third-year accredited Bachelor degree course, the long-lasting result of a previous TEMPUS program project, the EOLES project [2], the consortium hopes to provide the knowledge and the tools needed for partner countries to become autonomous in the development and accreditation of their own e-engineering courses.

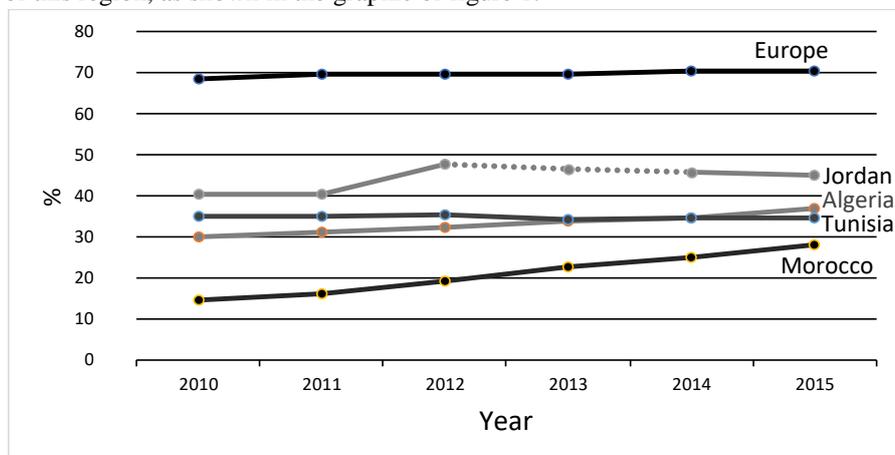
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## 1 Introduction

According to the UNESCO Institute for Statistics, the number of worldwide students enrolled in tertiary education more than doubled in 15 years, growing from 94,5 million in 1999 to almost 207 million in 2014, a gross enrolment ratio change from 19% to 34%. However, these global figures hide major differences between regions. While in Europe the higher education gross enrolment ratio is around 75%, in the South Mediterranean Basin countries the values range from 28% to 38% [1]. Nonetheless, in the last few years, higher education enrolment has been on the rise in less well-off countries of this region, as shown in the graphic of figure 1.



**Fig. 1.** Gross enrolment ratio in tertiary education between 2010 and 2015 in the countries involved in the e-LIVES project [3]

The graphic of figure 1 shows the number of students enrolled in higher education in Morocco doubled in the last five years while in Algeria it incremented by a third in the same period. On the contrary, in Jordan and Tunisia, the number remained stable but rather below the desirable value, mainly when compared to the European rates [3].

This positive step forward poses important challenges to universities struggling with lack of resources while forced to handle overcrowded classrooms.

One promising solution involves the extensive development of nationally accredited e-learning undergraduate and postgraduate courses. E-learning is a very efficient solution to cope with higher education access massification while meeting multiple students' profiles. For instance, students with low economic resources and/or living in distant isolated areas may pursue their higher education studies without leaving their homes and running into temporary expensive relocations. Another case is students looking for lifelong learning training. Usually, these students work and therefore may not attend classes during regular hours. In this case, e-learning provides them with the flexibility they need to study after-hours and to progress at their own pace, pursuing their studies without interrupting their working careers. And even regular students may blend their learning to avoid some overcrowded classes.

The long-lasting purpose of the e-LIVES (e-Learning InnoVative Engineering Solutions) project, a recently approved Erasmus+ program project, is to generate on Partner Countries a more committed and professional environment ready to introduce new forms of flexible learning into daily training activities and to create and manage accredited e-engineering courses.

## 2 The framework

The development of an e-learning implementation strategy is one of the national priorities of the educational policy set by Algeria, Jordan, Morocco, and Tunisia, the Erasmus+ Partner Countries involved in the e-LIVES project. Depending on the country, the implementation of this commitment is at different stages. While in Tunisia, the development of e-learning in the higher education system through the reinforcement of the capabilities of existing Universities has been assigned to the Virtual University of Tunis (VUT), established in January 2002, in Algeria the Government is only now preparing legislative texts regarding the regulation of distance education. In between, the Morocco officials have passed in 2014 a law authorizing e-learning training (blended or fully online) while in Jordan, the ministry of higher education places the matter of developing standards for the assessment of quality in e-learning as a top priority. In 2009, a new higher education regulatory law actively supported the development of education. Currently, Jordan universities are deeply involved in the creation and implementation of their own e-learning strategies, and in urgent need of knowledge support. Indeed, to build a fully online course is a difficult process requiring universities to address a range of heterogeneous aspects:

- the construction of an efficient economic model;
- the national accreditation of the e-learning courses in the absence of appropriate legislation and sometimes despite the support of Government officials;
- the training of an ample pool of teachers able to understand the inherent pedagogical differences between face-to-face and distance learning and capable of mastering the authoring tools needed to produce the course contents;
- the development and build up of the technological infrastructure needed to create and deliver the online courses;
- the training of the technical staff necessary to maintain the technical infrastructure and to support the teachers on the utilization of the authoring tools;
- in the case of STEM (Science, Technology, Engineering, and Mathematics)-related courses, the development, and implementation of real-time online controlled laboratories to allow students to perform laboratory works remotely.

In STEM-related courses, sometimes referred as “hard sciences”, the acquisition of practical skills normally associated to face-to-face laboratory work raise issues that are sometimes difficult to solve, hindering the development of full STEM-related online courses.

All these challenges were successfully addressed during the previous EOLES TEMPUS project [4], also coordinated by the University of Limoges and involving, among others,

nine of the new e-LIVES project consortium partners. Indeed, during the project, it was designed and implemented an entirely online English-taught 3rd year Bachelor's degree in Electronics and Optics for Embedded Systems, the L3-EOLES (Electronics and Optics e-Learning for Embedded Systems) course [5]. The course, that started being offered in the school year 2014/15, is currently in its fourth edition [6]. Designed as a specialization year, this course is oriented towards a currently expanding field in the electrical and computer engineering area, the field of electronics and optics for embedded systems. This area of knowledge requires students to be able to perform experimental work to acquire the expected technical experimental skills. The execution of laboratory assignments over the Internet required the development of remotely accessible experimental laboratories enabling students to interact in real-time with real experimental setups. This innovative training has been accredited by the educational authorities in Tunisia, Morocco, and France. If this previous project can be considered as a success, the progress made is still insufficient to determine a fast growing on the offer of e-engineering courses in the short term.

By documenting a set of good practices and following a hands-on approach, the e-LIVES project aims to help partner countries' universities to build innovative e-engineering courses by themselves in a sustainable way. This ambitious objective is grounded in two main goals:

- to help universities to move through the different course design and development stages (building of a curriculum, getting the national accreditation, training teachers, create contents,...);
- to help universities to develop by themselves (from A to Z) a remote laboratory.

It is important to note that these remote laboratories can also be used in face-to-face training. Indeed, due to the exponential growth in students' number, numerous universities had to replace the laboratory works in the first year of their Bachelor degree in STEM fields by paper-and-pencil work. This project is then expected to have a direct structural impact on the higher education system modernisation of the involved Partner Countries.

### **3 Strengths and Weaknesses Identification and Transfer of Knowledge**

The success of the project depends in a great measure of the experience of the higher education institutions from Programme Countries and their ability to understand the problems of the Partner Countries and to address the challenges facing their higher education institutions and systems. The aim is to induce the voluntary convergence of their systems with European Union standards and development in higher education, encouraging the modernisation and internationalization of their institutions, creating conditions to enlarge the access of their youth to higher education while fostering people to people contacts, intercultural awareness, and understanding.

The Program Partners have a broad experience in the creation of e-learning courses and on the application of quality management methodologies to those courses, namely by

applying detailed learning analytics and data analysis, aimed at providing accurate feedback able to contribute to improving students' experience in innovative forms of education such as e- and b-engineering.

During the EOLES project, the partners from the Programme Countries successfully designed and implemented, in cooperation with the Partner Countries, the L3-EOLES course, a course in the field of electronics and optics for embedded systems [7]. This innovative e-engineering training relies on a dedicated remote laboratory hosted by three of the beneficiary Partner Countries institutions: one in Algeria, one in Morocco, and one in Tunisia.

The e-LIVES project is a follow-up step needed to ensure e-engineering sustainability and to expand it into more South and Eastern Mediterranean Basin countries. The knowledge transfer to Partner Countries remains insufficient in areas such e-learning practices and pedagogy, resources and infrastructure management and the development of remote laboratories. e-LIVES proposes a set of innovative solutions to foster this transfer, the first step being the identification of best practices in e-engineering. Programme Countries have a key role here due to their more than 10 years' e-learning experience in Europe. A set of implementation-oriented documents - tutorials, summary data sheets, practical exercises -, will be produced and published in open access in the project website to ensure a wide dissemination of the results.

National dissemination workshops, with the support and participation of staff from the Programme Countries, will be organized in all e-LIVES Partner Countries. These workshops, apart from a presentation of the project and of its main results, will include lectures, training sessions and hands-on demonstrations on how to design, implement and run an e-engineering course. The workshops will take place in the last year of the project and will be one of the main dissemination tools. 15 persons (teachers, technicians but also university deans) from each Partner Country are expected to attend the workshop, which will be opened to all interested persons from the whole country. A final open dissemination conference will be organized in Jordan in the framework of the last General Assembly of the project.

To guarantee the sustainability and exploitation of all the knowledge produced during the project and its use after project's end, a Special Interest Group (SIG) will be created within the International Association of Online Engineering (IAOE), an international non-profit organization whose aim is to encourage the wider development, distribution and application of Online Engineering (OE) technologies counting more than 2,000 members distributed all over the world. The SIG will promote the development of e-engineering in the South and Eastern Mediterranean Basin, a geographical area currently poorly represented.

#### **4 Remote Laboratories**

Successful courses in the STEM areas demand students to perform experimental work to acquire technical skills in subjects like physics, chemistry, mechanical and electrical machines, or digital and analog electronics, for example. In a fully online course, like

the L3-EOLES, this requires the remote access to experimental laboratories and real-time interaction with real experimental setups that are complex to implement [8].

One of the most ambitious aims of the e-LIVES project is to help partners from Partner Countries to build (from A to Z) a remote laboratory by themselves, allowing the creation of fully online e-engineering courses. This ambitious aim will be achieved thanks to the help of the European Programme Countries which have an extensive experience in the development of remote laboratory solutions [9-11]. In particular, they are expected to work together with the Partner Countries' Universities to develop an operational remote laboratory including a High-Quality Reference Remote Practical Work (HQRRPW) and the associated online lectures.

Even if the e-LIVES project is not the first one in the field of e-engineering or dealing with the development of remote laboratories, the aim of the other projects was mainly to mutualize already existing ones. e-LIVES goes a step further by helping partners to acquire the required skills to develop their own laboratories adapted to their own e-engineering courses' requirements.

The Partner Countries' Universities will benefit from a subvention under the e-LIVES project that will allow them to purchase the necessary equipment for the development of a remote laboratory and the implementation of an HQRRPW. In the process, they will be able to acquire the required skills with the continuous help of the European partners.

In each University, the remote laboratory will be tested in real conditions with a selected group of around 30 students, leading to a total close to 300 students for all the Partner Countries' Universities. The students will participate in online lectures and perform the associated laboratory assignments requiring the use of the remote laboratory and hence testing it in real conditions. Students feedback will be analyzed to help partners to improve the quality and functionality of the laboratory and of the associated works.

After successfully testing the remote laboratory each partner will be required to mutualize it, making it available to all e-LIVES partners. This sharing step involves a set of issues related to security and access management to the remote laboratory, a step where the collaboration and know-how of the LABSLAND, the European technical partner that participates in the e-LIVES consortium, plays a fundamental role.

LABSLAND's mission is to improve technical and scientific learning by creating, promoting and managing an international network of remote experimentation laboratories that, physically located in its own premises or in the facilities of its customers, allow them to share the laboratories over the Internet, being able to give and have access to a much larger number of real experiments (non-virtual or simulated) for users around the world. LABSLAND will be in charge of facilitating the optimal integration of the developed remote laboratories in a Remote Laboratory Management System able to manage students access to the different remote laboratories while providing security, scalability, and reliability. The experience of LABSLAND team of professionals guarantees a quality support service in the development and mutualization of the remote laboratories, collaboration to technical data sheets drafting and tutorials development.

## 5 Conclusions

By and after the end of the project, different kinds of target groups from Partner Countries, as well as other countries of the South and Eastern Mediterranean Basin, are expected to benefit from the outputs of the e-LIVES project:

- national decision-makers (university deans and national higher education officials) are expected to have all the information needed to have their doubts about this innovative way of teaching and learning dissipated and then facilitate the national accreditation process of new e-engineering courses in their countries;
- Partner institutions are expected to have acquired all the necessary know-how to create ambitious e-engineering courses, and in particular, to have overcome all the administrative, human and material resources obstacles they face today;
- each Partner institution is also expected to have a fully operational remote laboratory ready to be used by the students enrolled not only in e-engineering courses but also in face-to-face courses, in order to partially cope with the replacement of laboratory works in the first year of their Bachelor degrees in STEM fields by paper-and-pencil work due to lack of enough resources to accommodate all of them;
- students are expected to benefit from the e-LIVES project results as the participating institutions will be able to build innovative high-quality accredited e-engineering courses suitable for different profiles of students, namely students with weak economic resources and/or living in isolated areas or students in continuing education, and therefore their number is expected to increase after the e-LIVES project;
- teachers and technical staff involved in the project activities are expected to be ready to be part of an e-engineering course by the end of the project.

The Partner Countries' Universities are expected to benefit from the outputs of the e-LIVES project in a sustainable way as they will be able to create, develop, manage and teach innovative high-quality e-engineering courses.

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