BEST PRACTICES FOR ORGANIZATION AND QUALITY ASSESSMENT OF AN E-LEARNING TRAINING IN THE HIGHER EDUCATION SYSTEM

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Abstract
This paper describes best practices for organizing an e-learning training in the higher education system. These findings are the result from the Erasmus+ project e-LIVES (e-Learning InnoVative Engineering Solutions; https://e-lives.eu). The e-LIVES project fosters the integration of operational e-learning best practices and settled methodologies in the South Mediterranean countries of Algeria, Jordan, Morocco, and Tunisia. This approach is highly needed due to the recent rise in the number of students in the higher education system in the aforementioned South Mediterranean countries. The rising number of students creates difficulties for the universities and forces them to conduct overcrowded courses. Such difficulties are often noticed in STEM (Science, Technology, Engineering, and Mathematics) related courses. To overcome such problems, the e-LIVES project aimed to document a set of best practices to develop reliable remote laboratory solutions and e-engineering training for South Mediterranean countries to become autonomous in the development and accreditation of their own innovative e-engineering courses. In the e-LIVES project, the considered training field area was engineering where recent innovations to realize remote laboratory sessions still needed to be further developed, secured and disseminated to reach sustainable ownership. In this paper, the best practices for e-learning training are approached from two different perspectives: (1) organization and (2) quality assessment.

The organizational perspective addresses three important factors: (1) the main aspects which should be considered for successful training, (2) the daily organization of the training and (3) ensuring a satisfying daily pedagogical follow-up of students. For the first factor, we present seven benchmarks which should be considered for a successful e-learning training. The second factor presents the systematic overview of the e-learning organization during an academic year and the final factor briefs important criteria to ensure the pedagogical follow-up of students.

The quality assessment perspective of the e-learning training addresses two important factors: (1) the measuring tools initially developed to evaluate competences and skills, and (2) how to obtain data for assessment. The first factor presents and discusses different assessment methods for quality control and the second factor discusses the data/numbers upon which to base the quantitative and qualitative assessment.

Keywords: e-learning, e-engineering, higher education, quality assessment and control, innovative course development.

1 INTRODUCTION
In 2017, the European Commission granted the Erasmus+ project named e-LIVES (e-Learning InnoVative Engineering Solutions) with the University of Limoges as central coordinator. The project consortium involved 13 universities and one research-based company. Four European universities are involved: the University of Limoges (UNILIM, France), the University of Leuven (KU Leuven, Belgium), the National Distance Education University (UNED, Spain) and the School of Engineering of the Polytechnic of Porto (ISEP, Portugal). LabsLand (Spain) is the research-based company. The four European universities and the company all have experience in the creation of remote laboratories and online courses. When considering the South Mediterranean region, multiple universities, spread across four different countries are involved and willing to commit to the project and implement remote laboratories in their university. This group of universities includes the Cadi Ayyad University (UCA, Morocco), the Abdelmalek Essaadi University (UAE, Morocco), the Tunis Virtual University (VUT,
The number of students having access to the higher education systems in South Mediterranean countries more than doubled in the last 15 years. This positive evolution involves important challenges for universities to handle overcrowding. When considering STEM (Science, Technology, Engineering and Mathematics) oriented education, a promising solution matching the national priorities in Algeria, Jordan, Morocco and Tunisia is the development of nationally accredited e-learning training (“e-engineering training”). E-learning is a very modern way to integrate profiles of students in higher education.

The main originality of the e-LIVES project is to make sure that the beneficiary partners will be 100% independent from the European partners for creating and managing e-engineering training at the end of the project in 2020. The general objectives of the project are an improvement of the quality of the higher education system which enhances its relevance for the labour market and society. It is important to improve the level of competencies and skills in higher education institutions (HEIs) by developing new and innovative educational programs. Therefore, the e-LIVES project pursues five objectives: identification of best practices in e-engineering training, development of reliable remote laboratory solutions, development of practical open staff training in South Mediterranean countries’ universities, guaranteeing quality control of the innovative pedagogical solutions, and promote the e-engineering within the South Mediterranean countries. Based on their expertise, each partner involved in the project was assigned a specific task to develop e-engineering solutions successfully.

During the project, the EU partners help the Southern Mediterranean partners to address the challenges faced by their higher education institutions and systems. These challenges include the relevance of the curriculum, accessibility, organization and planning, quality control, management, and governance. This paper presents the identified best practices in organization and quality control of the e-learning project.

The remainder of this paper is organized as follows: Section 2 describes the identified best practices in the organization of an e-learning training; Section 3 discusses the identified best practices in quality assessment of an e-learning training for the e-LIVES project; and Section 4 presents the conclusions.

2 ORGANIZATION OF AN E-LEARNING TRAINING

Organization and quality assessment are the two critical steps for any e-learning training. This section discusses the best practices when organizing an efficient e-learning training based on three different criterions: the main aspects which should be considered, the daily organization of the training (structure of the academic year, the semesters and weeks), and finally ensuring a satisfying daily pedagogical follow-up of the students.

2.1 Main aspects which should be considered

The global goal of e-learning is allowing students to reach well-defined learning objectives. In recent years, university students are becoming more diverse and giving this diverse group of students the opportunity to reach the same learning objectives is highly non-trivial. In order to be successful in an e-learning trajectory, students need discipline, appropriate time management and computer skills. In an attempt to provide a pedagogical foundation as a prerequisite for the successful e-learning training implementation, Govindasamy discussed seven e-learning quality benchmarks [1]. The seven benchmarks are also proposed by Phipps et al. [2] and can be formulated as:

2.1.1 Institutional support

In recent years, there has been a growth in investigating e-learning initiatives among most higher education institutes. The literature reports the resistance by academic staff to be part of the institutional e-learning initiatives as a major issue for their success and sustainability [3]. The main reasons for such resistance originate from institutional, pedagogical and technical challenges which arise during the shift from traditional to e-learning teaching approaches. Although policy makers in institutions propose and actively apply e-learning initiatives, these policymakers largely neglect the concerns of the academic staff. The academic staff has concerns about these initiatives which lead to a gap between the sometimes idealized policy and practice.
2.1.2 Course development

The course development process is iterative in nature and usually, it is never completed. Although constant updates and changes in the curriculum will occur over the years, the need for updates can be reduced by starting with an appropriate course design plan. As a course developer, it is important to conduct surveys among students. Also as an e-learning course developer, it is important to conduct effective surveys on student's interests, motivations, and expectations towards the course and the course modules. The course developer needs to keep some important parameters in mind while developing a course such as a course design strategy, a course design plan, a course content outline, modules' introductions, and summaries of the modules' content.

2.1.3 Teaching and learning

Teaching and learning are the two main dependent parameters in any educational system. In most European countries, teachers active in the higher education system do not need a certificate of teaching competencies [4]. To teach and explain the content in an appropriate way to students, the teacher needs to have fluent communication skills. When considering e-learning, the teacher should also be familiar with the chosen e-training environment.

In a similar way, it is also important for students to explore the e-learning platform and obtain some basic knowledge about the platform environment. In addition, it is mandatory for students to have enough knowledge of the course language to understand it correctly. It is important for the teacher to measure the prior learning skills and knowledge of the students.

2.1.4 Course structure

The course structure clearly reflects the quality of the course. The most convenient way to create a well-structured course is to make a mindmap to ensure we do not forget an important aspect of the course module. The course structure should contain detailed information about the various modules involved in that course. The formation of the structure needs to follow the set of standards in a way that it can be updated in the future. When all critical aspects of a course work together, it is possible to ensure that students achieve all necessary learning outcomes. When a course is aligned properly, each of the critical aspects directly supports the learning objectives [5].

2.1.5 Student support

Student support is one of the primary areas of e-learning that is completely different from the traditional classroom teaching method. In traditional classroom teaching, student support can be addressed directly on a request basis. Students have the opportunity to freely and explicitly express their need for assistance. In e-learning, students learn by interacting with programmed instructional systems. All problems, likely to be faced by students, need to be solved by support available through interface buttons.

2.1.6 Faculty support

It is important the faculty promotes the course and organizes some demo sessions for students to attract them. Promotion is the only way to get the e-learning out of the university to the student’s workspace. In that point of view, it is important the faculty provides enough support towards the growth of an e-learning culture.

2.1.7 Evaluation and assessment

Evaluation and assessment of students learning objectives is an essential part of learning and teaching. Evaluating a course applies to the validation of its effectiveness towards successful learning achievements. In general, evaluation results also depend on the students thinking skills and course quality. If students have higher-order thinking skills, they are likely to acquire the needed comprehensive approach to e-learning. However, if students only have lower-order thinking skills, they will generally have problems to acquire the needed comprehensive approach to e-learning.

Flexible learning units can be assessed by examinations, course homework or a combination of them [6]. A distinction exists between summative and formative assessments. The summative assessment is used to grade students to demonstrate their achievements. The formative assessment is used as a diagnostic tool for students and teachers to identify and improve the areas of weakness [7].
2.2 Daily organization of the training

In general, the organization of an online course/training should comply with the standards which also apply to classroom courses/training. A set of rules apply when organizing training on weekly, semestral and yearly bases [8]:

- Decide what material/topics will be covered;
- Group subject matters into modules;
- Split up each module into sections;
- Develop the link between sections to realize a self-directed learning approach;
- Create a roadmap of the course;
- Develop a theme that reflects the course structure;
- Make a schedule for weeks and semesters.

2.3 Ensuring a satisfying daily pedagogical follow-up of students

E-learning has emerged as one of the popular tools for the current educational system. This tool has been integrated into numerous educational programs in different universities throughout the world. Pedagogical support for students refers to the procedures and approaches used by the university to address pedagogical issues and achieve a high level of quality for e-learning courses [3]. Similar to the regular teaching system, students and teachers play a major role in this system. In e-learning programs, ensuring student satisfaction is an important challenge for teachers and supporting staff. Postareff et al. [4] conducted on teachers’ pedagogical training and noticed positive results. Criteria to ensure a daily pedagogical follow-up of the students are:

2.3.1 Self-efficacy confidence and skills of the teacher

A teacher’s efficacy confidence is a judgment about their capabilities in e-learning environments to get students engaged in the e-learning process to achieve the necessary learning outcomes [9]. Teachers with high self-efficacy confidence are more likely to engage in a wide range of productive day-to-day teaching practices than teachers with low self-efficacy confidence [10]. As mentioned by Davis “Students of highly rated teachers achieve higher final exam scores, can better apply course material and are more inclined to pursue the subject subsequently” [11].

2.3.2 Ease of use of the training infrastructure

The infrastructure used to realize a theoretical course or a practical experiment needs to be simple, easy to understand and clear to operate. There are different aspects that determine the quality of the infrastructure which implies multiple parameters should be considered and measured. The system usability scale (SUS) could be the better option to measure the ease of use of infrastructure by keeping the following parameters in mind [12]:

- Simplicity of the training infrastructure;
- Availability of the platform tools for many hours a day;
- Quality of the documentation for training infrastructure to resolve the technical issues;
- Availability of supporting staff to resolve typical issues and to experiment safely;
- Ease of upgrading the software used in the training infrastructure.

2.3.3 Quality of the course and supporting materials

One of the most important student’s satisfactory criteria is quality. In fact, the student’s technical knowledge depends on the quality of the course. In addition, the supporting material for the corresponding course needs to be clear, with a detailed explanation that every student can understand and follow easily. Benton et al. [13] and Ehlers et al. [14] explained the assessment to supporting material and their quality in detail. The following parameters need to be realized in order to measure the quality of a course:

- Duration of the course; can be long (20 weeks) or short (12 weeks);
- Timing/planning for the week and the semester;
- Support from the organization to have a successful course;
- Ratio of theory/exercises based on the type and content of the course;
- Conform international perspective to maintain high standards.

Further, the quality of the supporting material needs to be measured. These supporting materials do not include the course material itself. Supporting materials can be manuals for the lab instruments, templates for the student’s reports, multimedia tools, etc. The following parameters need to be realized in order to measure the quality of supporting material:
- Topics/chapters are useful to split the content of supporting material for easiness;
- Consistency with the flow of content to have a high quality supporting materials;
- Page numbers are useful to easily follow the supporting material;
- Examples are useful to explain the content in a better and understandable way.

2.3.4 Learning objectives

Teaching alone does not allow the teacher to expect satisfaction from the student. In addition, the student expects guidance from a teacher including exam preparation and feedback about performance. In this way, the student can develop his technical knowledge and finally achieve good grades. In addition, it is important for students not only to listen and memorize the teaching material but also to participate in discussions, workshops and other activities to gain more insight [15]. The gathered knowledge and skills from the student are analysed based on the following parameters:
- Importance and attractivity of the subject;
- Increased knowledge and insight towards the learning objectives;
- Student satisfaction level and command on the gained skills.

2.3.5 Student’s homework follow-up and feedback

It is equally important for teachers to check the capabilities of students by giving them some homework. Generally, homework is a set of assigned tasks students need to perform at home. In the homework process, teachers mainly have two tasks: designing and setting activities, and checking and/or providing homework feedback to students. This feedback is an important source of information for students to reveal their mistakes and learn from them. According to Walberg et al. [16] feedback is the key to maximize the positive impact of the homework. Below are the different ways of feedbacks:
- Checking homework completion regularly;
- Answering questions about homework;
- Checking homework orally and giving feedback;
- Collecting and grading homework.

Rosario et al. [17] performed an experiment with different students and teachers comparing the four above-mentioned feedback types. Especially “collecting and grading homework” feedback helped students to secure good grades in the examination.

2.3.6 Technical support

Another important criterion for ensuring a pedagogical follow-up of students is to provide proper technical support to the students. It is mainly referred to as the approaches and procedures followed by the university to provide continuous access to the virtual learning environment. This technical support includes providing a reliable virtual environment with a 24/7 help desk. It is useful for the students to find solutions for the technical problems within the learning environment itself. In addition to those issues, the quality of support that a student obtains to solve the technical problem needs to be measured. Parameters to measure this support quality are as follows: frequency of the technical problem, support availability time and solution availability and response time.

3 QUALITY ASSESSMENT OF AN E-LEARNING TRAINING

This section discusses some best practices for quality assessment of an e-learning training. A good quality assessment not only improves existing e-learning training, but it also identifies good practices
which help to build more efficient new e-learning training. We have identified a number of best practices based on two different criterions: measuring tools initially developed to evaluate competencies and skills, and methods used to obtain data for assessment.

3.1 Measuring tools initially developed to evaluate competencies and skills

One way to measure the quality of an e-learning training is assessing the goal audience of the e-learning program i.e. the students. The training is then the process to form the product and the desired learning outcomes are the desired properties of the product [18], [19]. By assessing the goal audience (students) on their obtained competencies and skills during and after the training, an estimation of the quality of the e-learning training and the transfer of knowledge can be made. In order to take into account the variability in the general knowledge levels of the goal audience, the assessment results should be correlated with results available from other courses. Considering the assessment, different assessment techniques can be used at different moments during (formative), and after (summative) the training [20]. In this section, some assessment methods are presented and shortly discussed from an e-learning point of view.

3.1.1 Exercises

One of the more traditional ways to test a students’ insight into the training matter is by letting them make exercises on the training topic. Exercises can be provided at different moments during the training (for example at the end of a chapter, during a chapter, …). In order to use the results of the exercise sessions for quality assessment, some aspects should be considered:

- The exercises should be submitted by the student and evaluated by the teaching staff. This evaluation can be done automatically (results of calculations, simulation outputs, …) or manually by the teaching staff. When an automatic evaluation is chosen, evaluation by the Learning Management System (LMS) is preferred. This avoids additional work for the teaching staff;
- The exercises can only be made after the student has received the required knowledge and was able to understand it (through study and/or through attending the virtual classes);
- Since the exercises can be done unsupervised, the teaching staff should try to prevent cheating. This could be done by parametrizing the questions (different students have different data) and by time limiting the exercises. The latter implies there is no time to consult external sources.

3.1.2 Quizzes

Quizzes are another way to test the students’ knowledge and insight into the matter. Most LMS support the development of online quizzes, with automatic evaluation and feedback. Quizzes can be performed on different moments during the training. Typically, they are introduced when a section or a chapter of the training has been finished. When needed, it is also an option to provide a pre- and a post-quiz considering a topic. In that way, the knowledge and skills transferred to the student by taking part in the e-learning training can be measured. This definitely reveals the effectiveness and quality of the training. Similar to the use of exercises to evaluate the e-learning training, there are a number of aspects which need to be taken into account:

- Students need sufficient time to gather the required knowledge and insights in order to be able to complete the quiz. Otherwise, the results of the quiz are not reasonable and are not useful for quality control;
- Since the student performs the quiz unsupervised, measures should be taken in order to prevent cheating. This can be done by: providing a large pool of questions and by picking random questions from the pool, parametrizing the questions which imply students will have different data, randomizing the order of possible answers and limiting the answering time per question.

3.1.3 Project and group work

Project work is an ideal manner to test the students’ higher level skills and understanding of the matter. It forces students to think deeply on the topic. Project work can be concluded with a report. One disadvantage of this approach is the fact that automatic evaluation is rather difficult. Indeed, the outcomes of project work are commonly very open and/or not exactly determined. The quality of the report can be related to the level of understanding of the topic. When project work is performed by a group of students, interpersonal skills can also be assessed using peer-assessment. When using peer assessment, it is important that:
• The peer assessment is performed several times and the students are confronted with the results. These results are useful feedback for the students to know which skills they need to improve. But these results also provide information concerning the coaching realized by the distance learning tool;

• The assessment is done anonymously to provide honest and reliable results.

3.1.4 **Open questions/exercises on a discussion board**

Putting questions and exercises on a discussion board can be a good manner for the teaching staff to measure the students’ competencies and skills. By following the students’ inputs on the discussion board based on the questions/exercises, problem-solving skills can be measured. It is also easy to monitor the knowledge levels of students and their ability to apply this knowledge. Interpersonal skills can also be monitored. Additionally, the students’ interest and enthusiasm in the training topics are revealed.

3.1.5 **Exams**

A final examination is an important summative assessment method which concludes the e-learning training. This exam can consist of exercises and theoretical questions considering all course topics. Results of the exam represent the students’ competencies, knowledge, and skills and can be compared to the required learning outcomes of the training. To anticipate the variability of the group spirit, exam results of all courses in the training should be considered. Due to the nature of e-learning, some considerations should be made:

• To prevent cheating, exams should be planned at fixed dates and should be organized with local supervision. It is risky to organize exams taking place at the students’ home since it does not offer certainty about the identity of the user and the tools they are using;

• The teaching staff should be available for communication during the exam sessions to provide further explanation, guidelines, etc...

• Exam supervisors should be instructed concerning the exam process;

• Some exams can be evaluated automatically. In that case, software which prohibits electronic communication and consultation of external sources (internet, external storage, …) is needed.

3.2 **How to obtain data for assessment**

Another way to assess the quality of e-learning training is to obtain data which allow extracting quality parameters. The source of these data must be determined and also the way of collecting these data must be known. The following sections focus on a couple of data sources which might be useful for quality assessment and how potential quality information can be extracted from them. E-learning feedback essentially deals with the opinions of the learners. However, e-learning assessment results provide concrete numbers allowing to identify patterns and trends.

One of the best ways to gauge the quality of an online training program is to conduct pre and post e-learning assessments. The pre-assessments are useful to evaluate what learners know before the training and point out their prior performance and skill gaps. The final assessment reveals the knowledge and skills after performing the e-learning course. If generally there is little or no improvement for all students, we can state that the online training quality is rather poor. This is especially the case if the same group of students, on average, reaches good results for other courses since this reveals a good attitude for the student group. E-learning assessment methods can be divided into two categories:

• Quantitative assessments provide numbers, which makes them ideal for online training topics that deal with knowledge comprehension;

• Qualitative assessments are useful when dealing with specific skills and tasks. For instance, a learner participates in a branching scenario to exhibit his skill proficiency.

3.2.1 **Questionnaires**

One of the most intuitive ways to assess the quality of the training is simply asking the participants what they think about the quality. Questions about the quality can be categorized under different quality topics and combined into questionnaires. Not only the students are participants but everyone who is involved in the training, i.e. also the teaching staff. When assessing using questionnaires, some considerations have to be taken into account for the questionnaire setup:
Questions are as follows: short and easy to understand, clear and unambiguous, investigate one thing per question and neutral/non-suggestive.

Closed and open questions are as follows: use closed questions to easily process the results, the last question could be open (i.e. ask for suggestions to improve the e-learning course).

Introduction to the questionnaire are as follows: what, why, who, emphasize the anonymity to the participants and mention the expected time to fill in the questionnaire.

Group questions in different categories: provide not more than 3 questions per category.

Start with easy questions.

Since the students and the teaching staff are the main participants of the training, the next two sections will focus on the questionnaires that could be addressed to them.

3.2.1.1 Questionnaires for students

For the students, two questionnaires should be provided: one that measures the didactic quality of the training and one that measures the functional quality of the training. The didactic questionnaire focusses on the content of the training while the functional questionnaire measures the quality of the training infrastructure. Both questionnaires can contain several categories and preferably each of these categories has a maximum of 3 questions. The didactic questionnaire can contain the following categories:

- Teaching staff didactic skills;
- Course feasibility;
- Learning results;
- Communication considering the training;
- Setup of the course/practical work;
- Teaching staff support.

The functional questionnaire, which measures the LMS quality, can contain the following categories:

- Access to the online learning platform;
- Ease of use of the online learning platform;
- Ease of use of the online learning platform supporting/additional tools;
- Online learning platform communication tools.

3.2.1.2 Questionnaires for the teaching staff

The second group of participants who are widely involved in e-learning training is the teaching staff. Due to neutrality issues, the teaching staff is not allowed to evaluate themselves regarding didactic skills, but the staff can measure the quality of the LMS. Therefore, only a functional questionnaire could be provided to the staff. The questionnaire can contain the following categories:

- Ease of use to set up the course and/or practical work in the training infrastructure;
- Availability and quality of the technical support;
- Ease to manage the course and/or practical work;
- Student entry level;
- Tools to interact with students, to assess students and to provide feedback;
- Workload to build, maintain and use the course.

3.2.2 Peer review

Another way to obtain data is by using peer review [21]. This can be done internally (by other members of the teaching staff, colleagues …) or externally (external expert or institute). For an internal peer review, results and availability of data depend on the willingness of other teaching staff members to review the training. When this kind of review is not structurally inherent to the organization, there is a
risk that the dataflow on the quality might become obsolete or even disappear after some time. Hence, there is no guarantee for a sustained yearly review. The personal relationships between teaching staff members could affect the neutrality of the resulting data implying the need for an external peer review.

An external review can be provided by specialized organizations (i.e. European Distance Learning and Education Association (EDLEA), European Network for Accreditation of Engineering Education (ENAE), ...). The quality control based on a review by external institutes can also be coupled to an accreditation process of the training program. The workload to realize such an external review might be too excessive to execute this evaluation procedure each year (or in the first year(s) of the training service).

3.2.3 Big data

In Section 3.1, the use of student assessment results is discussed as a measure for the quality of the training. The quality from these results could be more accurate and representative when LMS data on students is considered. By correlating a students’ assessment result with the LMS statistics on the student, there might be a more precise measure on the quality. Interesting data that might be extracted from the LMS for correlation with assessment results could be:

- Time spent on the course (time logged in on the platform) and on the exercises;
- Attendance or absence of the virtual classes;
- Participation on discussion board.

4 CONCLUSIONS

The present paper identified a number of best practices for the Erasmus+ e-LIVES project. The identified best practices are considered from two different perspectives i.e. organization and quality assessment of the e-learning training. The organizational perspective mainly covered three important factors: the main aspects which should be considered for successful training, a daily organization of the training plans and ensuring a satisfying daily pedagogical follow-up of the students. The quality assessment perspective covered two important factors: the measuring tools initially developed to evaluate competencies and skills, and best practices used to obtain data for assessment.

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