

STEAM STARS

A EUROPEAN FRAMEWORK OF COMPETENCIES IN TEACHING STEAM EDUCATION FOR GIFTED STUDENTS

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Online Instructional Guide on Digital Competencies for Virtual Learning

STEAM Stars Open Campus



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Introduction

This guide aims to improve the digital skills and facilitate the interaction with virtual learning environments of school teachers, trainers and non-formal and informal educators, by providing a simple and easy-to-apply guide for anyone who has no prior knowledge on how to create and deliver an eLearning course.

The STEAM Stars project aims to design a European Framework of Competencies in the teaching of STEAM education for gifted students, promoting innovative methods and pedagogies aimed at them and developing OER digital learning materials and tools in STEAM education. The expected long-term impact of the project will be to strengthen the school education system in Europe.

What is eLearning?

eLearning, or electronic learning, is the delivery of learning and training through digital resources. Although eLearning is based on formalised learning, it is provided through electronic devices such as computers, tablets, mobile phones and even smartwatches that at some point are connected to the internet.

The rapid expansion of Internet access and the development of media technologies have made online learning or eLearning accessible to many more people and increased course delivery options for training providers.

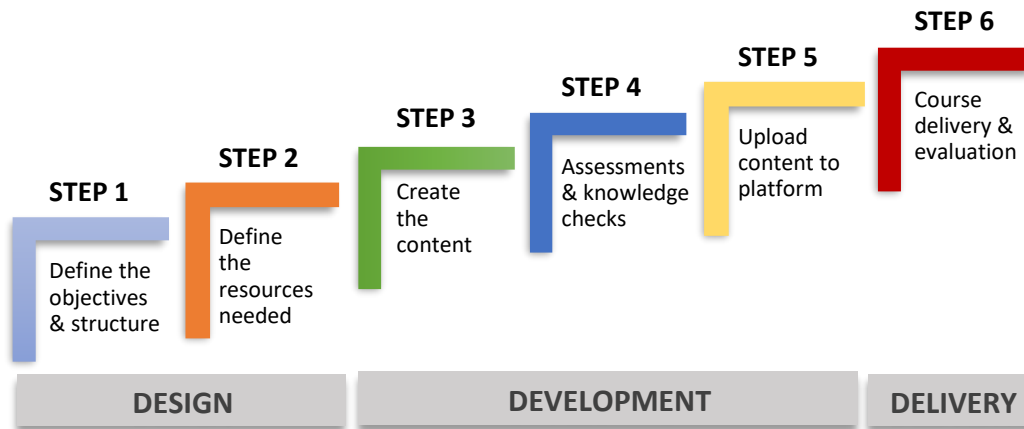
eLearning brings multiple benefits to both learners and training providers, such as flexibility in timings and location, adapted to the student and teacher schedule and personal and labour circumstances, lower costs, wider reach, multi-lingual channels, self-pace learning, among others.

eLearning also brings unique opportunities for education at all levels, especially in developing countries. These countries face many challenges on transportation (which leaves people in remote areas with limited access to education), lack of educational infrastructure, expertise, research facilities, etc. eLearning can narrow these gaps with considerably lesser means and in less time.

This guide walks you through six simple steps for the design, development and delivery of eLearning courses:



FIGURE 1: STEPS FOR CREATING ELEARNING COURSES



Source: own elaboration.

Step 1. Define the course's objectives and structure

This first step is crucial for the overall success of your eLearning course. Here you set the general framework of your course, like the blueprint for your building that sets its aims, objectives and structure.

To achieve this, the following questions should be answered:

- **What are my target audience's knowledge/training/capacity-building needs?**
- **What should a learner be able to know/do after finishing the course?**
- **What is the course structure that better achieves those training needs?**

We will talk about each one of them in the following sections.

Analyse the target audience's needs

eLearning can be used for professional training at all levels of formal education, training in companies, international organisations, NGOs as well as for informal education. In these situations, the target audience and their training needs differ among each other. It is important for the course designer to analyse and assess them to determine both the **specific knowledge/skill** and the **level of accomplishment** required.



To start with, the analysis should take into account the following personal aspects of the target audience:

- Personal aspects: age, sex, motivation for doing the course, availability for doing the course
- Educational level, formal and informal
- Professional knowledge and training
- Relevant working experience
- Virtual skills and access to internet and computer devices
- knowledge of the training language (especially in the case of immigrants)

Then you have to identify their training needs regarding knowledge and skills. Each aspect will require a specific analysis method:

- ◆ **A topic analysis** is carried out to identify and classify the course content. A topic analysis is appropriate for courses that are primarily designed to provide information or achieve broader educational objectives (also called "inform courses"). Visual instruments, such as mind maps, concepts maps and process diagrams, can help the course designer clarify connections among content elements.
- ◆ **Task analysis:** is a detailed analysis of actions and decisions that a person takes to perform a job task so that we can identify what the learner should learn or improve and the knowledge and skills that need to be developed or reinforced. Task analysis is used mainly in courses designed to build specific job-oriented or interpersonal skills (also called "perform courses").

Define the aim and learning objectives

Once the target audience's needs and training gaps have been identified, the course designer should define what results want to get after learners complete the eLearning course. Those results are the course's aim and objectives; they can be defined by answering this question: **What should a learner be able to know/do after finishing the course?**

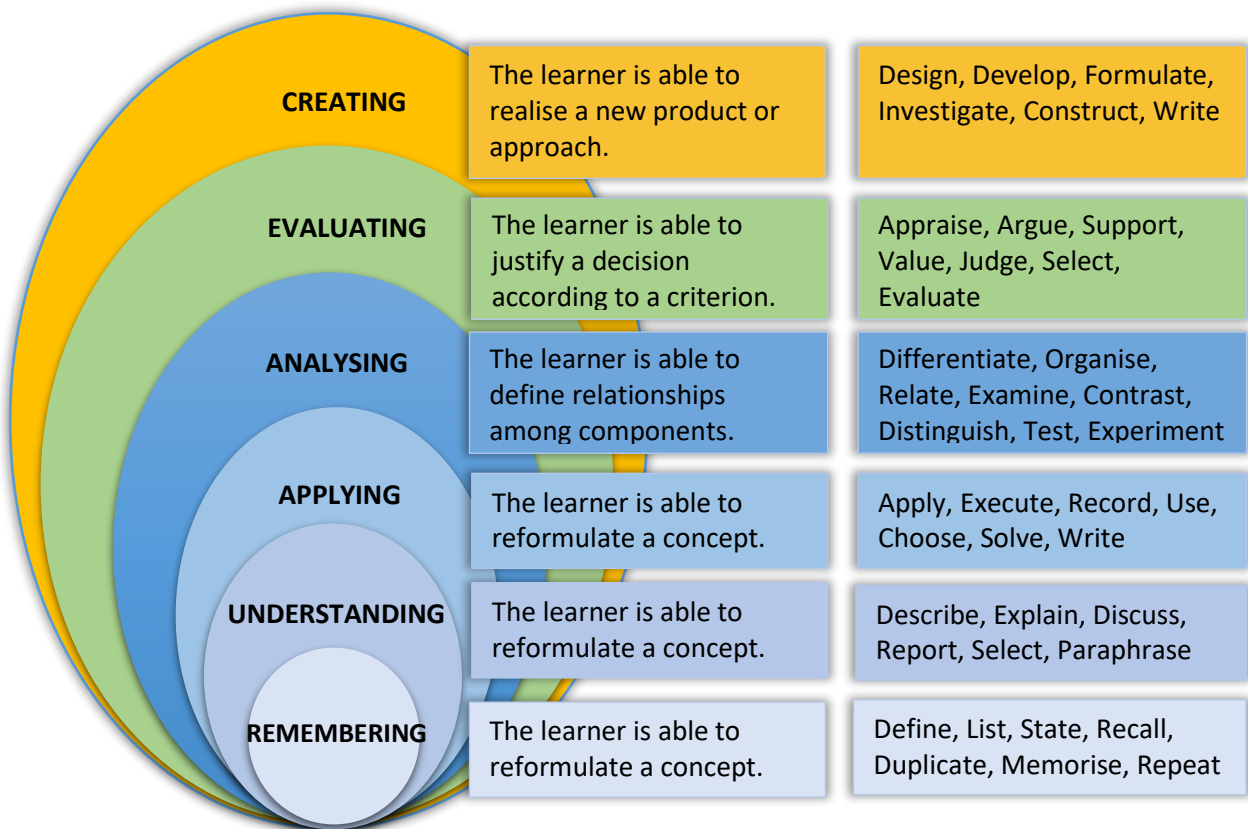
An aim is a broad overall statement of what will be achieved. **The aim** tells the learners what they will gain from the eLearning course. **Learning objectives** are a breakdown of this aim and are more actionable.



Learning objectives combine two elements: the **level of performance** or accomplishment (through an action verb) and the **learning content** (the object of that verb), for example: “To be able to apply [verb] the principles and values of the company [learning content] during the negotiation with clients”, “To be able to execute [verb] the procedure for opening a bank account [learning content]”, etc.

According to the revised Bloom’s taxonomy of the cognitive domain, learning objectives can imply six different types of accomplishment, ranging from the lowest level (remember) to the highest (create). The following table shows the types of accomplishment, their meaning and the verbs that can be suitable for describing them:

FIGURE 2: REVISED BLOOM’S TAXONOMY OF THE COGNITIVE DOMAIN



Source: partially own design, taken from <http://regiscpslearningdesign.weebly.com/blooms-taxonomy.html>

Elaborate the course structure

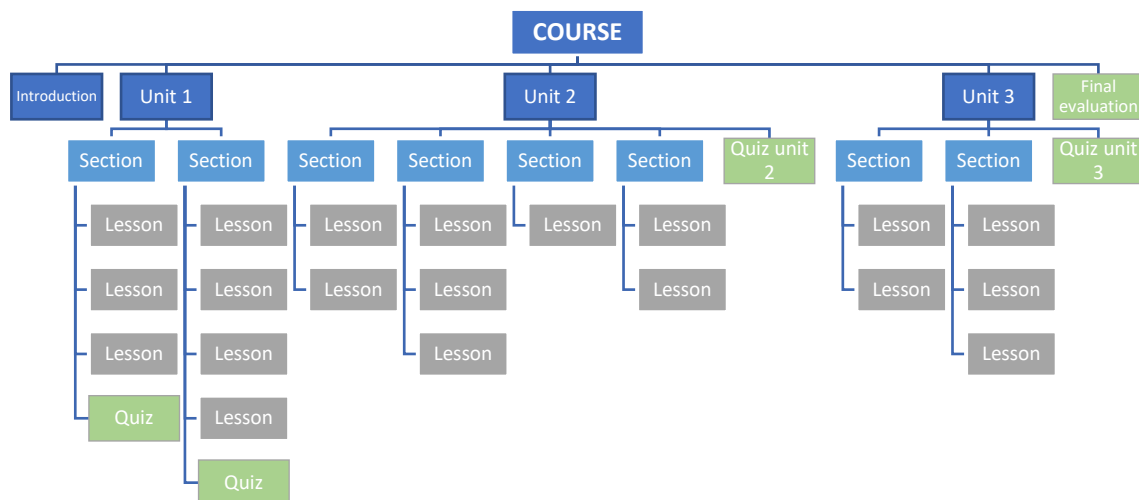
Once the learning objectives are defined, follows the elaboration of the course structure or curriculum that better achieves those learning objectives. This will depend on which is the main purpose of the course:



- ◆ In a **perform course**, i.e. in a course oriented to fill knowledge or skill gaps for performing a specific job or task, the content can be organised to follow the order of the actions in the real job environment.
- ◆ In an **inform course**, i.e. in a course oriented to fill knowledge gaps, the concepts can be organised according to their structural and logical connections.

There are different types of curriculum or course structure. As the purpose of this guide is mainly for the creation of short eLearning courses, below there is an example of course structure which can be followed (the number of units, sections, lessons and quizzes is referential):

FIGURE 3: EXAMPLE OF COURSE STRUCTURE



Source: own elaboration.

As can be seen in figure 3, the course structure can have the following structure:

- ◆ **Introduction:** is the introduction to the overall course, it should have a brief of the whole course contents.
- ◆ **Unit** is the main part in which the course is divided.
- ◆ **A section** is a level following a unit.
- ◆ **A lesson** is a level following a section. The lesson is the minimum expression of a topic we want to develop. It should be short and, if possible, should contain graphic and audio-visual elements.



- ◆ **Quizzes** can be placed at the end of a lesson or a section (as in unit 1 above) or a unit (as in unit 2 and 3) or at the end of the course, or to use a combination of them.
- ◆ **The final evaluation** should include an evaluation to test whether the learner has achieved the main course objectives.

At this point, the course structure is tentative and general. During the developing of every lesson, there may be variations. For example, a topic may be too long to be developed in only one lesson, and it may be needed to divide it into two or three lessons.

The course structure will also determine the whole **duration** of the course. It is important to take into account the objectives and the level of accomplishment required, but also the time availability (of learners and course designer) and the resources for its creation. A longer course will imply more resources, which sometimes are not available. In other occasions, limitations will come by time availability of the target audience for following that course, especially if it is oriented for people who are working and have many responsibilities.

Step 2. Define the resources needed

The development of an eLearning course implies the use of different resources, mainly human, technological and financial. In the lines below, we will talk about the first two: the team and the technology.

Team

The design, developing, and delivery of eLearning courses require expertise covering several specialities, including:

- ◆ **eLearning Project Manager** is the one who coordinates all activities and resources (human, technological, financial, etc.) in the different stages of the project. He/she is the overall responsibility of the project.
- ◆ **Instructional designer (IDs)** is the one in charge of the instructional strategy. They collaborate hand in hand with the Project Manager and the Subject Matter



Experts for the development of the course content, instructional techniques, media elements, assessment and knowledge checks.

- ◆ **Subject matter experts (SMEs)** contribute with knowledge and information required for a particular course. They collaborate with IDs to design a course and define evaluation strategies and actually write the course content.
- ◆ **Graphic designer and media editor:** they are the ones in charge of the overall “look” of the course and multimedia developing. They create and edit the figures, audios, photos, videos, etc. used in the eLearning course.
- ◆ **Web developer and technical support specialist:** web developer is the one who creates the learning platform and puts together all the course content online. There is software available on the internet that facilitates this activity such as Moodle, LearnPress, etc. (We will talk about the technology in the following section). The support specialist is the one who gives technical support once the course is going on. Web developer and support specialist are usually the same people.
- ◆ **Course administrators and online facilitator(s)** are the ones in charge of learner support and motivation once the course is open. They are in charge of learners’ subscriptions, support students’ activities, answer learners’ questions, moderate learners’ forums, etc.

Some of the roles listed above could be combined into a single job profile, depending on the size of the eLearning project, the human and financial resources available, the capacity of team members to cover different roles, the technology used, etc. In some eLearning courses, there can even be only two persons involved: on one side the manager/ID/SME/course administrator/online facilitator/tutor, and on the other, the web developer/ media editor/technical support.

Technology

As mentioned before, eLearning courses are delivered through virtual learning platforms, which can be accessed from different electronic devices (computers, tablets, smartphones) through the Internet.



eLearning platforms are also referred to as Learning Management Systems (LMS); they provide course providers and learners with access to information, tools and resources to support educational delivery and management, such as:

- Course management: invitation, pre-registration, semi-automatic course registration, online payment, etc.
- Integrated virtual classroom
- Multi-lingual course materials and resources support
- Course materials storage
- Communication management: all course communications between tutor-learner, learner-learner, tutor-tutor can be done through the LMS.
- Assessment creation and management
- Monitoring of learner's performance
- Multiple reports for management

There is a variety of software available on LMS, from the simplest to the more advanced and complex, free and paid. The following are examples of LMS software: Moodle, LearnPress, TalentLMS, FormalLMS, ILIAS, Opigno, OpenOLAT, Sakai, Dokeos, etc. Most of this software have mobile phones and tablets apps.

Besides the LMS, you may need professional translation software, in case you want to provide multi-lingual training.

Step 3. Content development

Content development is one of the core activities for creating an eLearning course. It starts with choosing the instructional method, then writing the aim and objectives in a way that is addressed to the learner, then follows the development of each lesson content and then a final check of the overall style. Let us have a look at each of them.

Select the instructional method

There is a whole variety of ways in which the content can be transmitted to the learner; these are called instructional methods. They can be grouped into three main types:

- ◆ **Expositive methods** are used for acquiring information. Example of these are presentations, case studies, examples, demonstrations, storytelling, etc.



- ◆ **Application methods** emphasise the active processes that students use to perform tasks based on principles and procedures. Example of these are: role-plays, simulations and serious games, project work, job aids, scenario-based approach, etc.

- ◆ **Collaborative methods** Involve students by sharing knowledge and doing tasks collaboratively. Example of these are online guided discussion, collaborative work, peer tutoring, etc.

A training provider can combine these instructional methods to provide the best training experience for learners.

Writing content for the course aim and objectives.

Since the beginning of the course, the learner should have a very clear idea of the course aim and objectives. This is even more important in the context of an eLearning course, as the learner motivation is crucial for the success of the training.

Writing them is like a stepladder. The aim is the top step that you want to reach. The learning objectives are the different steps that give you the knowledge and skills to reach the top step. You may go back to Step 1 and check the recommendations given regarding the definition of the aim and objectives.

They may be written in a way that is addressed to the learner, as shown in the example below:

- For writing the aim:
 - *After finishing the course, you will be able to use the main tools of Microsoft Office proficiently.*

- For writing the objectives of a unit/section:
 - *At the end of this unit, you will be able to use Word proficiently.*
 - *At the end of this section, you will be able to create a simple Word document.*
 - *At the end of this section, you will be able to understand and recognise the basic parts of a Word document.*
 - *At the end of this section, you will be able to use the advanced features of a Word document.*





Throughout the entirety of your eLearning course is useful to provide the learner with reminders of what they are going to learn and/or how that information is going to be of benefit to them.

Lesson content

The content should be easily digestible for the learner. It is advisable to break your course up into "bite-size" lessons that allow the learner to gather small bits of information at once. This can reduce content overload and give the student the ability actually to absorb the lesson. Experts recommend that a single lesson should not take more than 10-15 minutes of learning time.

A useful tool for developing course content is creating a **storyboard**. A storyboard is a document that shows the course structure and the detailed information of every lesson: text, figures, tables, graphics, audio, video, infographics, etc. It is not the actual development of the content, but it is like a map that tells you when and what comes all the information about your course. It also helps you to have an idea of the overall workload.

There are many different ways of doing a storyboard. You can do your own storyboard template for your course. In the section "Additional Resources" at the end of this guide, you will find a link that takes you to free storyboard templates available online. We suggest the following simple but handy template:

UNIT 3: VALUES FOR SCHOOL LEADERS AND TEACHERS WORKING WITH FAMILIES FROM MIGRANT BACKGROUND				
SECTION 1: [section name or none]				
Lesson number and title	Brief description of lesson content	Graphics, photos (filename)	Audios, videos, other links (link or filename)	Responsible person(s) for content development
Previous lessons...				
Lesson 5. Social communication issues between schools and families	Social communication issues between schools and families are essential for success in children education.	Photo10_teacher & whiteboard.jpg	None	[Name...]
Lesson 6. How can schools address communication and inclusion issues?	Schools can address inclusion issues by establishing personalised communication with parents.	None	Link for "Migrant background": [Link] Link for "Further reading": [Link]	[Name...]



Following the previous example, this is the actual view of Lesson 5 in the learning platform:

COURSES
LU.3. VALUES FOR SCHOOL LEADERS AND TEACHERS WORKING WITH FAMILIES FROM MIGRANT BACKGROUND

LEARNING UNIT 0/10

- 1.1 Learning Unit 3 - Introduction (30 min)
- 1.2 Factors impacting migrant children's attainment at school
- 1.3 What are the challenges and the causes for these challenges?
- 1.4 Relevant Legislation affecting education of children from migrant backgrounds at school
- 1.5 Social communication issues between schools and families
- 1.6 How can schools address communication and inclusion issues?
- 1.7 Steps for establishing personalised communications with all parents
- 1.1 Test LU.3 (8 questions)
- 1.8 Glossary
- 1.9 Additional Resources

Social communication issues between schools and families


Key Practice Points

Social communication issues between schools and families is essential for success

Parents of ethnic minority and newly arrived migrant communities of school-aged children may find it difficult to adapt to an education system different from their country of origin.

The parent/teacher relationship can therefore be an area of potential confusion and misunderstanding over areas such as:

- School behaviour and discipline
- Formality of lessons
- Expectations of the teacher
- Parental involvement in the education of their children at school



Furthermore, some black, migrant or refugee parents may have experienced traumatic and/or violent events in their country of origin or perhaps even within the host country which impact the health and wellbeing of their family and the behaviour and progress of their children at school.

COMPLETE

PREV Relevant Legislation affecting education of children from migrant backgrounds at school

NEXT How can schools address communication and inclusion issues?

In the following lines, we give brief guidelines on how to elaborate on the different elements of a lesson:

- ◆ **The text** must be clear, concise and written in a way that engages the learner. If you need to add a considerable amount of text, use short paragraphs: eyes glaze over when they see large blocks of text, so try to make it as short as possible. Give examples that are familiar to the learner and easy to understand; they should be as real as possible.

A tip on language style is to address the learners by “you”, it connects much more your students with the course. If your learners come from a multicultural background (e.g. migrants), try to avoid difficult words or culture-specific slang.



- ◆ **Graphics and photos.** The eLearning course may include a variety of visual design elements that attract the learner and keep them aesthetically engaged. Only include information and graphic elements that are relevant and necessary, as this will help the learner to stay focus on the task at hand (instead of becoming distracted by all of the virtual clutter).

There are many types of graphics: animated illustration, matrix, line charts, bar graphs, pie charts, flow charts, diagrams, text tables, any other you would like to design. As far as you can, place them near the text, which is referring to it in order not to distract the learner.

- ◆ **Audio and Video** can be elaborated by the training provider or also can be taken from the Internet (taking care of copyright, of course). Most LMS allows embedding audio or video in the body of the lesson just copying the link.

Media design follows four characteristics:

- Simple: focus on one idea at a time
- Short: keep videos to a length of 3-4 minutes to maximise attention
- Real: use examples from real life
- Good: safeguard the good quality of media products.

The same as with the graphics, audio and video should be used only when relevant and necessary, avoid adding video just to show a teacher talking. Audio and video should be short (even shorter in the case of audio!); avoid redundant audio (just for reading the text shown in the screen, unless you want to make your course inclusive to people with audio impairment).

Check the overall course style

Usually, there is more than one person involved in the creation of course content, and this can generate that different sections have different styles, in detriment of the overall harmony and cohesiveness of the course. To avoid this, the coordinator can provide a template for the lessons' development, besides a short guideline of writing style, length of the lesson, type of charts or graphics, etc.

After the content is developed by all people involved, a single person should be in charge of homogenising the content. It can be the Instructional Designer, one of the Subject Matter Experts, etc. Please note that the content at this stage can be written in a word processor, a presentation program or another similar tool.



Step 4. Add Assessments and Knowledge Checks

It is important to ensure that evaluation tests aim to develop and assess the same type of performance and learning content as expressed in the learning objectives. Questions help learners to keep their attention in the course.

There are many types of online tests, which usually are embedded in LMS platforms. Below there is a list of the most common types of online questions:

- True/false questions
- Single-choice questions
- Multiple-choice questions
- Visual selection
- Matching words or statements
- Completing sentences
- Fill in the blank
- Ordering in sequence and ranking

Here are some tips for designing quizzes for eLearning courses:

- Questions should test the attainment of the stated learning objectives for the module/section/course that they cover.
- The wording of questions should avoid the double negative.
- The requirements for the test should be clearly stated (e.g. if it is scored, how many times can you take it etc.)
- Quizzes can be placed after every lesson, or section or unit or even only one single evaluation at the end of the course. The more the quizzes, the more you keep the learner involved, but do not exaggerate!
- It is advisable to provide an opportunity to retake it.
- When possible, provide explanatory feedback after the quiz or evaluation.

Step 5. Upload course content to the eLearning platform



Once the overall course content has been developed and read-proved, done a detailed spell and style check, the next step is to upload it to the eLearning platform or LMS (see Step 2 about the technology). Depending on the platform, it can just be a copy-paste job from Word/PowerPoint to LearnPress, to name a platform.

At this step, it is important to check the functionality, usability and ease of learning of the platform. In this regard, it is highly recommended that a group of participants representing the target audience take the course for **validation**.

While they may pass the course, the purpose is not just to assess their learning, but the overall quality of the course, i.e., if it is easy to understand, if it fulfils the learning objectives, if the way that it is presented is clear, etc. Also, the validation participants can be asked to give additional feedback on their learning experience, usually with a structured questionnaire format.

Please note that, as far as possible, course structure and type of quizzes should take into account the features and course structure available in the chosen LMS or eLearning platform when it works only through templates. Doing this from the start will make it easier to integrate all content on the platform.

Step 6. Course delivery and evaluation

Finally comes the launch of the course!

In this step, we talk about ways of delivering eLearning courses, communications tools which are more appropriate for each of them and course evaluation regarding learners' reactions, learning, behaviour and actual results.

Course delivery

It is important to keep in mind that eLearning implies changes in student and teacher roles. Teachers become a learning facilitator, coach, mentor, giving the students more options and responsibilities for their own learning. For their part, students are active participants in the learning process, producing and sharing knowledge, sometimes participating as experts and learn in collaboration with others.

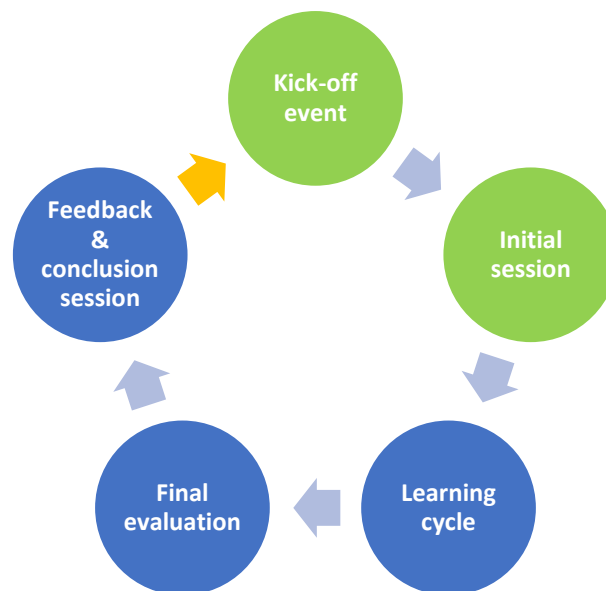
The delivery of the course may start with a kick-off event in which, by video/audio conference or a set of emails, the facilitator introduces the course goals and agenda. It



can also be organised an interactive learning activity to help students know and relate with each other, and also to be familiar with the learning platform. Depending on the teacher or facilitator preferences, these activities can be skipped (shown in green in Figure 4).

After these two activities, the learning cycle starts, which usually is on a daily or weekly basis. After that, depending on the course structure, at the end of every lesson/section/unit, there can be a short quiz; most courses also have a final evaluation at the end of the course. It is highly advisable to organise a last feedback and conclusion session with the learners; this allows designers to improve the course.

FIGURE 4. COURSE DELIVERY AND EVALUATION CYCLE



Source: own elaboration.

Course delivery can be provided in a synchronous or asynchronous way, or a combination of both:

- **Synchronous eLearning** takes place in real-time; an example of synchronous communication tools for eLearning are chat and instant messaging (IM), video or audio conference, live webcasting, whiteboard and screen-sharing, tools, polling, etc. This kind of tools provides a higher level of interaction and instant feedback between learners and/or course facilitator.
- **Asynchronous eLearning** is time-independent; an example of asynchronous communication tools for eLearning are email, discussion forums, blog, wiki,



webcasting, etc. This kind of tools is more appropriate for tasks that require reflection and more time to accomplish from the learner's side.

Course evaluation

Course evaluation consists of checking whether the course content and the instructional strategy were appropriate for achieving the course aim and objectives. Many aspects can be evaluated, and it depends on the course designer to choose which are the ones that are of more interest.

Here we are going to mention four main elements that may be evaluated. The first two can be known during the course delivery, and the last two can be known fully only after some time after the completion of the course.

- **Students' learning level.** It consists of evaluating whether students achieved the learning objectives proposed at the beginning of the course, to which extent and, in case of a lack of achievement, which are the causes of it. To evaluate the learning level, it is important to take into account the following aspects:
 - Assessment tests: the most common tool for evaluating students' learning level are quizzes and assessment tests during and at the end of the course.
 - Prerequisite tests: these tests are used to verify whether students have the minimum knowledge or skills to participate and correctly understand the course. These kinds of tests are less common.

In case of lack of learning objectives achievement, the course designer has to examine whether:

- Students had the minimum required knowledge or skills to participate in the course, in the first place.
 - The course content was not appropriate.
 - The instructional strategy was not appropriate, for example, to keep up students' motivation level.
 - Etc.
- **Students' reactions to the eLearning course.** It consists on understanding how students reacted along the course, for example, whether they had an active participation during the course if there was the expected interaction between student-student and student-teacher, their satisfaction, to which extent their



expectations were fulfilled, etc. To know this, you can do questionnaires, surveys and focus groups.

- **Students' behaviour.** Depending on the learning objectives, some courses may imply a change in the students' behaviour arising from the application of the course content to their work or daily life. This can be known by being in touch with them after the course.
- **Impact.** It consists of the impact produced in the students' job, personal life or the close environment due to their change of behaviour. For example, increased quality of their job, better working/family environment, better self-esteem, etc.

Conclusion

eLearning brings unique opportunities for education at all levels, formal or informal, making it accessible to many more people as it is cheaper, allows self-paced learning, gives the choice of being multi-lingual, breaks the limitations of place and time, among others. The benefits of presential education and teacher-learner nearness keep on being irreplaceable but, whenever it is necessary, eLearning brings more possibilities both for learners and training providers.

In this guide, we considered six steps for the design, development, delivery and evaluation of eLearning courses as we wanted to keep it simple and easy to apply. For the one who desires to learn more on eLearning courses, at the end of this guide we provide a list of additional resources and the bibliography we have used, which we strongly recommend going through.



Glossary

- **Asynchronous e-Learning** is an eLearning activity that takes place time-independent. Examples: email, discussion forums, blog, wiki, webcasting, etc.
- **Authoring tool (authorware)** is a software used to develop online courses.
- **Blended learning** combines different training media (e.g. technologies, activities and events) to create an optimum training programme for a specific audience.
- **Courseware** is the online course materials developed using an authoring tool.
- **eLearning** refers to the online interaction between student and teacher, even if they are in the same building.
- **Learning Management System (LMS)** is a software application housed on a central server that automates the delivery of online training and tracking processes.
- **Online Learning** refers to the idea of using online tools for learning. It implies a distance between you and your teachers.
- **A prototype** is a sample online working model of the course for stakeholder's approval before full e-learning development.
- **A storyboard** is a document that shows the course structure and the detailed information of every lesson: text, figures, tables, graphics, audio, video, infographics, etc.
- **Synchronous eLearning** is an eLearning activity that takes place in real-time. Examples: chat, video or audio conference, live webcasting, whiteboard, etc.



Additional Resources

About eLearning in general

<https://elearningindustry.com/>

<https://elearningindustry.com/the-ultimate-elearning-course-design-checklist>

<https://www.researchgate.net/publication/332706028> A proposed model for designing E-learning courses

<http://www.ijeeee.org/Papers/218-ET048.pdf>

About how to write aims and objectives for eLearning courses

<https://elearningindustry.com/how-to-write-aims-and-objectives-for-elearning-courses>

Storyboard templates for eLearning

<https://elearningindustry.com/free-storyboard-templates-for-elearning>

A comparison between various Learning Management Systems (LMS)

<https://www.goodfirms.co/blog/best-free-open-source-LMS-Software-solutions>

About design principles for multimedia

https://wiki.ubc.ca/Documentation:Design_Principles_for_Multimedia

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