Protocol for the evaluation of multimedia materials

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Abstract- The use of new technologies in training in general, but above all, in the context of virtual or blended training is associated with a change in the roles of the main actors in the teaching-learning process. It is mainly due to the teacher, who no longer transmits the content directly, but through the resources present in the virtual environment. As a content designer, the teacher needs clear criteria for evaluating digital materials since they have special characteristics. The objective of this research is to provide a guide for the assessment of digital training materials according to their typology. We have used quantitative methodology, specifically surveys carried out with teachers participating in various training courses related to the creation of digital training materials. We have also focused on reviewing other existing models. We conclude that the evaluation of the materials has to take into account the following aspects: educational value, accessibility, intellectual property aspects, correct integration of the different formats, technical quality and usability.

Keywords: learning materials, evaluation, distance teaching, face-to-face learning, self-directed learning.

1. INTRODUCTION

The global health and economic crisis, caused by the outbreak of the SARS-CoV-2 virus, has highlighted the need to strengthen online education systems. According to UNESCO, on April 24, 2020, in the midst of the pandemic, 163 countries in the world had their schools closed, which affected more than 1,213 million students. The length of time that schools have been closed has depended on the educational policies of each country. In Spain they closed 15 weeks, in France 12 and in the United Kingdom 27; in other countries such as Canada and the United States, the closure lasted 47 and 56 weeks respectively (UNESCO, 2021a).

One year after the pandemic "about half of the world's students are still affected by the partial or total closure of schools" (*ibid.*). For this reason, UNESCO convened world education ministers to an online event on March 29, 2021 in which they expressed the need to "establish more robust, sustainable and flexible distance education systems in the future" to enable that "education systems are more resilient, perhaps evolving towards a more hybrid model (face-to-face and distance teaching and learning)" (UNESCO, 2021b).

In this new context, therefore, there is a need for online teaching systems, understanding as such those that occur in real time between teacher and student, those that are carried out asynchronously, and self-directed learning in which students diagnose their learning needs, set their goals, implement strategies and evaluate their results.

In all cases, there is a transfer of control of the learning process from teachers to students. If we consider the latter, the methodologies associated with virtual training define a new role for them in which the most remarkable thing is the increase in their responsibility and involvement in their own learning process. Students decide when, where and how they learn from the resources provided by the faculty or institution. It is not enough that they attend the classroom for the process to begin, they must take the first step to start learning. For this, they need qualities as motivation, independence and self-reliance.

As pointed out by Tang, *et. al.* (2021), online learning requires greater fundamental computer skills (Sun, Mao, and Yin, 2020), the efficiency of human-human and human-machine interaction (Cuadrado-García, Ruiz-Molina and Montoro-Pons, 2010), as well as a deep study of motivation (Hartnett, 2016; Law, Geng and Li, 2019; Widjaja and Chen, 2017).

As a conclusion to the above, in virtual education students interact fundamentally with study materials, therefore, it is necessary to adapt them to this new function, guaranteeing an efficient mediated didactic dialogue, that is, whose objective is learning through of the training materials (García-Barrera 2016). This implies that these learning materials must enhance the acquisition of skills associated with the new role of students. Therefore, these resources must:

- Guarantee autonomous work.
- Promote an active attitude: include practical activities related to the theoretical contents, video lessons, self-assessment activities, complex exercises, etc. (Rensburg, 2018; Rohrbach, 2014).

As already mentioned, teachers are no longer the only source of knowledge, but they are still the ones who design and plan the teaching-learning process. The task of selecting suitable materials for working with distance students in a technological environment represents a substantial change in relation to the use of analogue formats in a face-to-face context. Teachers face challenges such as:

- The new creation and deliverance tools.
- The new characteristics of the digital materials that must be taken into account to determine their quality and effectiveness.
- The new ways students interact with materials in which the teacher is not usually present.

As indicated in (Fernández-Pampillón, Domínguez Romero, and de Armas Ranero, 2012) the lack of collections of quality digital didactic materials in Spain, has its origin in the difficulty that this work has for a poorly prepared teacher, and the low recognition associated with the creation of these resources in comparison with scientific publications.

To facilitate teachers' work, training is important, especially when it is adapted to their specific context. For example, it is important to include tools available at the teacher's institution and to start from their previous knowledge to minimize the learning curve.

In this sense, there are resources available online such as the course "Creation of Digital Materials", available on the OpenCourseWare platform of the University of Zaragoza (López, Mancho and Sein-Echaluce, 2019). The course "contemplates the necessary aspects to generate an open repository of materials in different formats, that allow university teachers to generate digital materials from scratch or from their current teaching material" (Mancho, López, Sein-Echaluce, 2019, p.525). The same authors have proposed the OCEDiCo model ("Open online Course for Educational Digital Contents") that collects the essential objectives that any course for the creation of educational digital content must follow (*ibid*., p . 525).

Another necessary aspect is the definition of clear criteria for evaluating these materials once they have been created. This could also serve as a guide to create own or select other people's digital materials with sufficient quality. Many authors have defended the need to develop these tools. However, when approaching this task, the great variety and heterogeneity of the materials, as well as the different conceptions of the evaluation process (context in which the evaluation is carried out, type of evaluator, aspect on which the evaluation is focused ...), make unmanageable the number of criteria that can be selected. This happens in tools that want to cover all the dimensions that can be discovered in all possible types of digital training materials. In addition, in some cases, the large number of criteria means that one of them favours one dimension and harms another, or that it may be considered redundant in several of them.

Some quality tools have been developed for this purpose. An interesting review can be consulted in (Aguilar, Ayala, Lugo and Zarco, 2014). Leacook and Nesbit (2007) describe in their proposal: Learning Object Review Instrument (LORI) nine aspects to take into account: content, quality, alignment of learning objectives, feedback and adaptation, motivation, layout design, usability, accessibility, reusability and compliance with standards.

Domínguez Romero, Fernández-Pampillón Cesteros, and de Armas Ranero (2012) developed COdA tool to assess digital teaching materials based on ten criteria: five pedagogical and five technical ones. Regarding the former, the tool proposes to analyse the objectives and the didactic coherence; the quality of the content; the ability to generate reflection, criticism and innovation; interactivity and adaptability; and motivation.

Regarding the technical ones, they propose to take into account the format and design, usability, accessibility, reusability, and interoperability (p. 315-316).

El Mhouti, Nasseh and Erradi (2013) present a tool that includes four criteria that are evaluated with 15 questions: academic quality, pedagogical quality, didactic quality, and technical quality (p. 29-30).

Another proposal developed by Pinto, Gómez-Camarero, Fernández-Ramos and Doucet (2015) called EvaluaReed consists of a checklist of nine objectives subdivided into 48 indicators valued on a scale from 0 to 4 or by yes / no. Content quality; learning objectives and goals; feedback; usability; motivation; accessibility; technical requirements; intellectual property, and effectiveness from the point of view of learning. The tool is not a mere list of evaluation criteria but rather a web application that "assesses resources, detects their weaknesses, suggests ways to improve them and provides examples of good practices to improve" (p. 229-230).

Hansen and Gissel (2017) propose to analyse the materials from three temporal perspectives: their didactic potential, which are the possibilities it offers; the updated didactic potential when it is put into practice; and finally, the didactic potential as the actual learning reached when working with the material (p. 123).

In general, these models present a rather high number of items, sometimes subjective, sometimes difficult to quantify (for example, the concept of intuitive navigation). In addition, they apply to any type of material, when not every digital content needs to be evaluated under the same criteria. In many cases, the application of these rubrics is laborious, increasing the workload instead of serving as support for teachers. They are usually oriented to their application to the finished material, when from the point of view of the content creator, a design guidelines approach is of greater interest. Finally, all the aspects to be evaluated are treated with the same importance, since it is a generalist type of work. However, in the context of university professors with experience in creating teaching materials in face-to-face mode, some elements are well known to them and what they really need is a protocol to address the aspects the aspects with which they are least familiar

The objective of this work is the elaboration of a series of guides that support the evaluation of digital training materials according to their typology. In addition, they are adapted to the specific context of university teaching staff who already have didactic resources from face-to-face teaching, whose training quality in this context has been verified.

2. CONTEXT

This work aims to develop a support tool for university teachers with experience in face-to-face teaching. The answers of a group of teachers participating in various courses related to the creation of digital training materials to questions about the use of audiovisual materials indicate that only 32% consider this task as essential, being just a complement for the rest. 58% of the teachers answered that they still only use materials in pdf format. This reveals the majority use of basic digital materials, with little media integration and interactivity. These resources are not usually considered the archetype of multimedia content, however, they are very present in virtual classrooms, so it is

necessary to clearly define the quality criteria that facilitate their success in distance teaching.

The digital teaching materials to be used in eLearning platforms can be classified according to different criteria:

Media integration

The contents can be developed using different formats: text, image, audio and video. The evaluation of whether this integration is correct or not will depend on the set of formats used in each case.

Interaction mode
- Static materials.
- Materials including navigation.
- Materials including interactive activities.

Source
- Materials used in face-to-face teaching created by the teacher.
- Materials adapted from materials used in classroom teaching created by the teacher.
- Materials created from scratch by the teacher.
- Materials created by other authors.

All of them can be valid to carry out quality online teaching. Depending on these characteristics, the points to be evaluated differ both in quantity and in the levels to be achieved. That is why the evaluation guide to be proposed, has the form of a table, which selects the points to be treated for each specific case.

Another aspect to be taken into account is which of the dimensions to be evaluated are more or less internalized by the teaching staff. When they were asked about the aspects that they have taken into account when selecting digital materials for virtual teaching, more than 90% of the teachers chose aspects such as coherence with the objectives of the course or adaptation to the profile of the student body. The percentage was much lower in the case of aspects such as usability, reusability or respect for intellectual property (Figure 1). On the other hand, when asked about the facts that make it difficult to create this type of material, the most selected problem was lack of time, closely followed by compliance with the basic aspects of accessibility.

This information confirms that support tools are necessary for working with this type of digital resources, highlighting the characteristics that differentiate them from the content used in face-to-face teaching. In addition, it is important that they are adapted to the specific case of the resource evaluated so as not to add unnecessary complexity in the case of the simplest digital resources.

3.   DESCRIPTION

Based on the analysis of the literature associated with the evaluation of digital training content and the specific situation of the intended users of these tools, the following aspects will be taken into account to assess them: training value, accessibility, intellectual property aspects, correct integration of the different formats, technical quality and usability.

A.   Learning value

Among the characteristics that define teaching materials (of any type and format) as adequate, we can highlight that they are:

- Scheduled for the subject and its students.
- Coherent and integrated into a thematic unit.
- Meaningful and representative.

In addition, in a virtual environment context, we must assure that these resources can be used by the student body in an autonomous way, that they enhance learning by promoting an active attitude, and that they start from the students' prior knowledge. It must be checked that:

- All the relevant contents are included and presented in a structured way.
- It adapts to the level of prior knowledge of the student body.
- It performs the intended function.
- The most important elements appear in a central place in the material.
- It includes activities that cognitively engage students and that provide information on the quality of their learning (formative assessment).

B.   Accesibility

The information contained in the materials should be easily obtained by all students, including those with special educational needs. There are multiple specialized guides in the generation of accessible materials (McAlvage, 2018). Strict adherence to these guidelines may on some occasions be incompatible with other good practices associated with the creation of materials, such as the use of different formats to highlight the most important content or to recognize similar significant elements. For this reason, it is sometimes advisable to have a double version of the materials, one strictly accessible and the other for the majority students. Our suggestion is to comply with some basic accessibility guidelines, which can be expanded in specific cases if necessary.

The creation of accessible material is supported by tools sometimes integrated into the software applications used to create these materials, such as accessibility checkers in MS Word and MS Power Point. There are also extensions in browsers that help to check this accessibility.

As indicated, we should start from minimum accessibility requirements to build templates and thus guarantee compliance:

- To use appropriate font size and font. Line spacing.
- To add alternative text for images.
- To use a colour palette that guarantees contrast.
- Include all the relevant information outside of graphics and images. That includes the navigation icons.
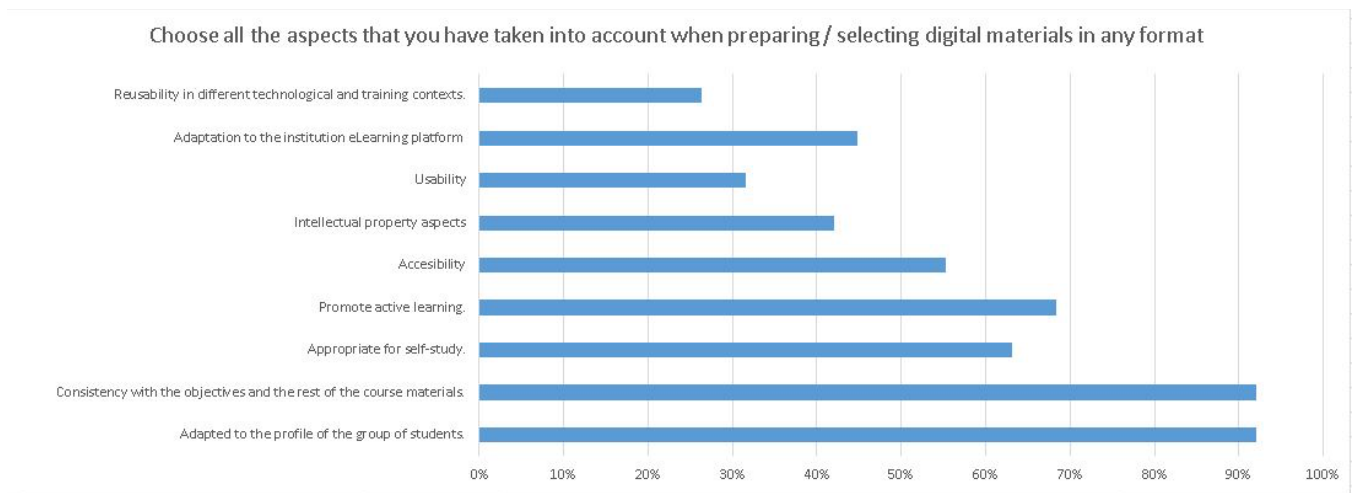- Display information not exclusively in audio or image format.

Figure 1. Dimensions considered by university faculty in the development of educational digital content

C. Intellectual property

It is very important to avoid infringements related to the intellectual property of the resources used and created. It must be taken into account that the material in electronic format is more easily reproducible in whole or in part, which can favour infringements when creating content with external resources and also when disseminating them. Therefore, it is necessary to ensure:

- The use of original materials or those with legal permission.
- To quote appropriately other people's material and check that plagiarism has not been committed (quoting does not ensure that it is not committed).
- In case of doubt about the use permissions, only the link to a third-party web resource should be included

Also, and for the same reasons, we must safeguard the authorship of our own material. In this it should always include:

- Identification of the authorship.
- License to share, or not, the created material.

D. Multimedia learning aspects

To ensure that multimedia materials favour cognitive activity, it is necessary to know how people learn from this type of material (Mayer, 2013). It is not enough to use different formats in the same content to obtain the benefits associated with media redundancy. The guidelines for an adequate integration of media in digital materials are included in the 12 principles defined by Mayer (*ibid.*). Following the objective of creating a simplified tool, we highlight some of them that guide the efficient union of text, image and audio. The rest of them are provided as supplementary information to the evaluation guide.

- Images and text associated with the same concept appear close in space and / or time and are coherent with each other.
- Lack of unnecessary items.
- Written text / narration redundancy is not frequent.

E. Technical quality

The contents must be compatible with the technological tools of the environment where the learning takes place (eLearning platform and the institution's own resources). It should be ensured that:

- The material is displayed correctly. No images or fonts not found.
- All links work perfectly.
- The material is reproduced properly without the need for external tools.
- In the case of videos, the narration is fluid and the image is of sufficient quality.
- The text is grammatically correct and there are no spelling mistakes.

F. Usability

The concept of usability defines the degree to which a resource, activity or tool is easy to use and is adapted to its target user. It includes aspects about the visual interface and about navigating throughout the material to achieve different objectives. The design principles of Norman (2013) collect the basic usability guidelines. We have selected the most pertinent for our context.

- Navigation through the material must be clearly defined. The user must sense how to use the material in a natural way.
- Action and navigation icons must be consistent and natural.
- Actions leading to the same goal must be similar throughout the material.
- The steps necessary to complete the tasks should be as few as possible.

4. RESULTS

The evaluation guides are adapted to the specific materials, so that when consulting them only the relevant criteria are included, while remaining as general as possible. Table 1 shows the quality aspects according to the type of materials following the *Mode of interaction* criterion.

Table 1. Quality aspects according to the Mode of interaction criterion

Common elements:
- Alignment with the training context: - Recipients - Curriculum
- Respect for intellectual property.
- Definition of authorship.
- Technical quality: -Format. -Orthography.
- **Self-contained materials (virtual environment). They include** - Justification of its use. - Instructions for use. - Activities to enhance learning. - Formative evaluation.

Static materials:	Web materials:	Interactive web materials:

• Accessibility:
  ○ Use of templates for texts and presentations.
  ○ Absence of text in image sand graphics
• Multimedia learning
  ○ Spatial Contiguity Principle
• Technical quality:
  ○ Images correctly displayed
	• Accessibility:
	  ○ Definition of formats.
	  ○ Absence of text in image sand graphics
	  ○ No information exclusively in audio format.
	  ○ Navigation icons with alternative text
	• Media integration:
	  ○ Spatial Contiguity Principle.
	  ○ Temporal Contiguity Principle.
	• Technical quality:
	  ○ Images correctly displayed.
	  ○ Videos correctly played.
	  ○ Links not broken.
	• Usability:
	  ○ Clear navigation.
	  ○ Consistent icons.
	  ○ Homogeneity of actions
		• Accessibility:
		  ○ Definition of formats.
		  ○ Absence of text in image sand graphics
		  ○ No information exclusively in audio format.
		  ○ Navigation icons with alternative text
		• Media integration:
		  ○ Spatial Contiguity Principle.
		  ○ Temporal Contiguity Principle.
		• Technical quality:
		  ○ Images correctly displayed.
		  ○ Videos correctly played.
		  ○ Links not broken.
		  ○ Low latency.
		• Usability:
		  ○ Clear navigation.
		  ○ Consistent icons.
		  ○ Homogeneity of actions.
		  ○ Economy of steps

There are a series of criteria to be considered that must be common to any type of digital educational material and which are included in the first row of Table 1. It is highlighted the one related to the new role of training materials in the virtual environment: materials must enhance the autonomous work. The rest of the criteria at this level should be already known and used by the face-to-face teaching staff.

A distinction is made below between static materials, web materials, and interactive materials. The first are the materials from face-to-face teaching that have been digitized (presentations or notes in generally .pdf format) and that have to be properly integrated in the virtual context; in this case image and text must be displayed with sufficient quality.

We move on to the case of materials in a web context, with navigation in which the accessibility factors must be extended to material in audio and video format and to the navigation itself. Additionally, media integration must also consider temporal consistency. The main change is the usability evaluation.

Finally, regarding materials that also include interaction, it must be ensured that the system answers work correctly from a technical point of view (latency, information displayed ...) and that the different actions are carried out with the fewer steps possible.

5. Conclusions

Aware of the need to adapt the face-to-face practices to virtual teaching and all the extra work that it entails, in this research we have provided a guide for the evaluation of digital training resources based on the following principles: training value, accessibility, intellectual property aspects, multimedia learning theory, technical quality and usability.

We have detected that the existing proposals include a high number of items, what increases the workload of the teaching staff; they are usually applied to any type of resource and normally to finished material. The tool that we present, however, takes into account the typology of the different materials since not all of them have to be evaluated under the same criteria and it is easy to apply. In addition, it takes into account the profile of the teaching staff to whom it is addressed and can be applied during the design phase of the materials.

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