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A Learning Quality Metadata approach: Automatic quality assessment of virtual training from metadata

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ABSTRACT

This paper presents the LQM metadata schema, an extension of the IEEE LOM standard. LQM is capable of registering information related to the quality of virtual education resources. As a complement, we have developed a cataloging and evaluation tool capable of registering LQM metadata and performing the subsequent quality estimation according to UNE 66181:2012. The proposal identifies and describes the dimensions and properties of the LQM element data. The research results show that it is feasible to provide an automatic estimation of quality of digital educational resources using LQM.

1. Introduction

The huge amount of learning objects (LO) and e-learning courses creates difficulties in interoperability between different LO repositories (cf. e.g. [1–5]). At the same time, it is increasingly common to find LO that do not meet the quality requirements expected by the end user [6].

Quality assessment applied to education is still far from being easy. However, relevant progress has enabled the identification of elements of the quality of LO which enhance their reusability [7], on metrics and indicators for ranking LO [8] and [9], or on profiles identifying quality educational resources [10].

Related research has been based on the study of existing standards and their support to LO quality evaluation. A standardization in the achievement of e-learning quality is considered useful [11]. There are metadata standards that can be applied to LO, such as Dublin Core, or specific metadata standards for LO such as IEEE LOM [12]. Metadata for LO are still under investigation and development. In fact, the International Organization for Standardization is developing a new metadata standard called ISO/IEC MLR [12] and [13]. Additionally, metadata applied to educational resources have been proven helpful as a tool for managing the search, location, and selection of educational resources [14]. As a consequence, there is a line of research focused on studying the relationship and evolution of metadata to Web 3.0 and Linked Data [15].

On one hand, quality in e-learning and its measurement are aspects to be considered in LO evaluation; on the other hand, the LO metadata which store information about educational resources, are widely accepted and developed. The present study aims at enhancing the storage of information on the quality of virtual education, based on a new proposed structure of metadata which takes existing known standards as a starting point.

This article presents LQM, a metadata schema for virtual education based on the IEEE LOM standard. It will be helpful to get information on LO quality: the final goal is enabling end users, teachers, students, or any other interested stakeholder, to find and use the virtual learning resources with the highest quality. The novelty of our approach resides in the proposed structure for metadata which allows reporting the quality of educational resources, with the additional support of a cataloging software tool. Moreover, the tool is also able to perform an automatic quality evaluation of LO which are cataloged with LQM.

The rest of the paper is organized as follows: Section 2 discusses the meaning of quality in education and the existence of standards that apply to e-learning, introducing the concept of metadata for LO. Section 3 proposes a data structure for storing information on quality of virtual education. Section 4 describes the methodology of this research. Section 5 shows the results of the study while Section 6 includes the corresponding discussion. Finally, Section 7 summarizes the main conclusions of the study.

2. Quality, standards, and e-learning

From a standard perspective, the term quality is defined in ISO 9000:2005 as “the degree to which a set of inherent characteristics fulfills requirements” [16]. In the case of education, these expected requirements are determined by the preferences of the stakeholders. Multiple facets arise when talking about quality in education, e.g., Harvey and Green [17] studied the concept of quality connected to higher education, stating that quality can be viewed as exception, as perfection, as fitness for purpose, as value for money, and as

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transformative. Other important values in quality management in education are control, continuous improvement, commitment, and breakthrough [18]. Therefore, the quality of education should foster improved learning methods for teachers and help students meet their expected learning goals. This effectiveness in teaching requires an appropriate teaching and learning process, with defined learning activities, assessments, and evaluation criteria.

Quality standards and quality management are proven solutions for continuous improvement [19]. In fact, Six Sigma quality model can be implemented in educational settings [20] and the same happens with the ISO 9001:2008 quality management standard and the EFQM European model of excellence [21].

Once an organization implements a quality management system, it is necessary to use different metrics to know the actual degree of perception of quality in the organization. Metrics are the tool to evaluate the quality of education, and the ISO 19796–3 standard includes a framework for defining quality metrics for teaching, which also can be extrapolated to e-learning [22].

The new reality in education and the growth, variety, and success of e-learning services have led to the emergence of several paradigms as m-learning, blended learning, e-tutoring, collaborative e-learning, adaptive e-learning, or u-learning. Even now, informal learning with social web and networks is already influencing young and older adults both in the workplace and in higher education [23]. Studies have found that instructors and students have favorable views of synchronous online learning despite the existence of relevant problems related to the impact of online courses on the quality of training [24].

The trend toward e-learning provokes that teachers and training producers change their concepts regarding design of education [25]. The adoption of a quality certification system is useful to facilitate this change as it encourages the design of high-quality courses despite the difficulties in the content, discrimination, and generalization [26]. The quality in the context of virtual education will impact the relationship between the student and the learning environment. Recent studies show that students are capable of distinguishing between their preferences on quality [27]; therefore, the best strategy for the development of quality e-learning is giving opportunities to and reinforcing behavior of the student. This new educational framework should be analyzed from the perspective of the management and improvement of quality in e-learning, but the development of quality standards progresses more slowly than the evolution of the new virtual teaching methods. In fact, recent studies concluded that cloud file hosting services presented higher levels of perceived usefulness and usability than standard learning management tools [28].

Standardization is also essential for the development of interoperability and quality in e-learning even in specific fields such as educational video games [29]. ISO/IEC 19796–1 is a standardized framework for quality in teaching [30,31]. The problem arises due to the existence of a wide variety of really different standards. New educational challenges require a harmonization of these standards, the existence of a common controlled vocabulary and a terminology to describe the vocabulary terms, and the existence of a reference framework for e-learning systems. These goals can only be achieved through consensus among standardization initiatives [32].

2.1. Metadata for learning objects

Metadata are data related to the data, intended to describe the content, format, structure, and purpose of such data. In the educational context, LO metadata can report title, creator of the resource, education, goals, etc. Metadata for e-learning is used in learning object repositories (LOR) and assist users in the search and retrieval of LO [33]. Metadata has also been used to provide personalized LO for the student [34].

There are standards for governing LO metadata, such as the well-known "ISO 15863:2009 The Dublin Core metadata element set" (Dublin Core) [35], or "1484.12.1-2002 IEEE Learning Object Metadata" (LOM) [36], which is an accepted standard and implemented in multiple LOR [1], as well as other initiatives such as the Canadian proposal Can Core [37], based on IEEE LOM. Standard "ISO/IEC 19788 Metadata for Learning Resources" (MLR) is currently under development and aims at specifying metadata elements and their attributes for the description of LO, relying on the compatibility and modularity.

The usefulness of metadata standards for LO has been already revealed in practical cases. For example, Mylonakis et al. [38] developed a Multimedia Open Learning Environment (MOLE) based on IEEE LOM for course management and sharing of LO. Studies on standards, metadata, and repositories have analyzed the semantics, content, syntax rules, and metadata for LO, the relationship and impact of metadata on the search of educational resources, the architecture of LOR and learning content management systems (LCMS), where standards play a key role to ensure interoperability between all these elements [39].

In addition, metadata are the scaffolding for an e-learning architecture based on the Semantic Web [40,41]. In fact, Nikolopoulos et al. [42] proposed an application profile of the IEEE LOM with new attributes to represent concepts such as learning outcomes, creating an ontological representation to improve the search and retrieval of LO. Finally, recommendations of interoperability for e-learning system components [43] have led us to propose possible methods for the improvement of the storage of information on the quality of virtual education.

2.2. Measuring quality for learning resources

In the literature, we can find indicators of quality for LO allocated to different dimensions of quality. For example, Ivory and Hearst [44] analyzed the dimensions of web usability and graphic design as elements of quality measurement, besides considering quantitative factors such as the number of words or images. Custard and Sumner [45] grouped quality indicators in five categories: provenance, description, content, social authority, and availability. Following a similar approach, Stefani, Vassiliadis, and Xenos [46] distinguished four dimensions in quality metrics: functionality, reliability, usability, and efficiency, including quantitative aspects such as the number of broken links. LearnRank proposal defines quality metrics for LO classified in three dimensions: topical, personal, and situational [8]. These three dimensions provide information about learning goals, personal relevance, and the conditions and limitations of the learning task. Moreover, Bethard et al. [47] studied the automatic characterization of quality LO in educational digital libraries, measuring aspects such as the existence of sponsor, the clear identification of age range, and how well organized is the resource to help achieving the learning goals. LOR have also been subjected to analysis of LO quality: an example is the case of Merlot where Cechinel, Sánchez-Alonso, and García [10] conducted a study of the intrinsic characteristics of highly valued LO in this repository.

All these measurable aspects of quality of LO can be classified into two groups: quantitative and qualitative. The quantitative features can be extracted from the internal characteristics of the educational resource and can be automatically identified by an automated process. These features are dependent on the size of the LO, such as the number of words, number of links, number of images, etc. So, from this point of view, the quantitative characteristics of an LO are intrinsic to the resource itself. The qualitative characteristics of an LO are those which cannot be quantified with numbers. They provide additional information about the LO, reflecting its structure, functionality, and services. These characteristics are therefore relatively independent of the size of the LO and include both intrinsic and extrinsic features. The intrinsic features are dependent on the internal structure of the LO, such as the design of a virtual learning environment. The extrinsic features depend on external elements, such as the extent of the tutoring support.

Student satisfaction surveys are normally the support of methods for evaluating LO. For example, Kay and Knaack [48] makes a proposal for evaluating LO with data collected through student surveys: information