

## Specifying Quality Characteristics and Attributes for E-Learning Sites

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**Abstract.** Education involves a continuous process of exploration, acquisition, organization, integration and delivery of information and knowledge. In recent years, e-learning sites and applications have exponentially started to grow, being a central phenomenon for the industry and education fields. Key factors for the present and future success of these applications and organizations are, on one hand, the fulfillment of technological standards for e-learning environments, and, on the other hand, the utilization of well-defined development processes and the production of required quality. One of our current concerns is the quality assessment of e-learning sites and applications. In this paper, a taxonomy of e-learning sites and applications, and ultimately the quality requirements for the *Functionality* characteristic are thoroughly described, regarding an intentional audience. An evaluation case study for this domain, using the WebQEM (Quality Evaluation Methodology) strategy is being runned.

### 1. Introduction.

By e-learning is meant any form of learning or training (basically both CBT -Computer-based Training, and WBT -Web-based Training), which is partially or totally delivered through an electronic way, either via a Web browser (in an Intranet or Internet), or through multimedia platforms like CD-ROM, DVD or video. Although this definition is all-embracing, e-learning has very often been identified with Web. For the intended audience, the course material and communication services are potentially 24x7, 365 days per year available, and can be synchronously or asynchronously accessed from anyplace around the world.

For the actors involved in the development of face-to-face courses, Web-based teaching and learning resources and processes have implied a substantial change in relation to traditional approaches. This does not only imply the change of formats and means to access materials used in face-to-face courses, but also implies the integral use of resources and services that boost the interaction and access to contents organized in a variety of different media (i.e., text, illustrations, animations, audio and video). The variety of these multimedia and intercommunication resources, together with the permanent availability on the Web, tends to motivate students where no physical interaction among them exists. Also, some other desirable characteristics of Web-based education and learning sites and applications are: accessibility, navigability, on-line searching, on-line evaluation support, collaborative and controlled learning services, etc. [1, 4], in a context of a high degree of independence of time-distance-platform dimensions.

Several international IT consulting reports (IDC, Gartner Group, etc.) have given formidable numbers of investment and world-wide growth projections for the new phenomenon of e-learning. However, this explosive growth has often been poorly systematized from several points of view. On the side of *Learning Technology Systems* (LTSs) there are currently several initiatives of recognized standardization bodies with the purpose of reaching interoperability among systems or components of them (for example, the *IEEE Learning Technology Standards Committee* [5], the *Global IMS Learning Consortium* [6], the *ISO/IEC JTC1 SC36* [8] initiatives, among others). Groups of these bodies have started works on specification to learning objects metadata, course material packaging, required structure for on-line contents, tracking learner progress, student profiles, among other issues. Together with these standardization processes, tools and environments for e-learning development have also been strengthened, as WebCT, ([www.webct.com](http://www.webct.com)); BlackBoard, ([www.blackboard.com](http://www.blackboard.com)), to mention just a few. However, we can raise open research questions such as, are in the standards analyzed learning theories and pedagogical aspects in order to incorporate them in specifications? Or, are there factors such as quality considered in these standards? On the other hand, from the point of view of the use of systematic evaluation processes and methods for quality assurance of e-learning sites and applications, the strategies and practices informed so far have mostly been ad hoc in spite of the rapid growth and increasing complexity of such sites and

applications. It is worthwhile to emphasize the initial efforts made in classifying and reviewing many characteristics of LTS environments and supporting tools, such as those documented in [1, 9], or the comparative analyses reported in [www.c2t2.ca/landonline/](http://www.c2t2.ca/landonline/).

One of our current concerns is the assessment of the quality of e-learning sites and applications [12]. We are engaged in assessing the current e-learning quality (i.e., product quality) in order to give recommendations for improvements. In this ongoing work, we discuss and specify aspects of the product quality requirements to be used in a process of e-learning evaluation, from an intentional visitor standpoint. Requirements for the evaluation of quality in use are not treated here for space reasons. We are performing an evaluation case study in the e-learning domain. For this purpose, the WebQEM quantitative methodology is used [12]. Since in previous performed cases studies for academic and e-commerce domains [10, 11] attributes to *Usability*, *Reliability* and *Efficiency* characteristics were specified, in this article we focus on the *Functionality* characteristic and derived sub-characteristics (such as *Course Features*, *Student Features*, *Virtual Learning Environment Features*, etc.), which are e-learning specific.

The rest of this paper is organized as follows. In Section 2, a detailed taxonomy of sites and applications for the e-learning domain is described. In Section 3, we focus on the analysis of quality requirements for the *E-learning Functionality and Contents* sub-characteristic, being the definition of non-functional requirements, one of the initial and core activities of any evaluation process. Finally, in Section 4, the conclusions and in-progress works are drawn.

## 2. A Taxonomy of Sites and Applications for E-learning.

From a general point of view, *Learning Technology Systems* (LTSs) [2, 3, 4, 5, 6] are managing, training and learning educational systems supported by certain ITs. Classes of these systems are *Computer Based Training Systems* (CBTs), and *Web-based Instructional Systems* (WbIS). Among the main features supported by WbISs are, namely: *Course Management*, *Class Management*, *Communication Tools and Mechanisms*, *Content Management*, *Student Services*, and *Institutional Management*. More specifically, WbISs are LTSs, which use the last Web and Internet technologies in order to offering education and training following the open distance learning paradigm. The WbIS is basically integrated by three components, namely: *Human Agents*, *Web-based Learning Resources*, and the *Technological Infrastructure*. In turn, the main component of the Technological Infrastructure of a WbIS is the *Virtual Learning Environment* (VLE). “A VLE is a middleware that acts and interfaces between the low-level infrastructure of the Internet and the WWW from the one side and the customized domain-specific learning education and training systems on the other side” [2].

From the point of view of sites and applications in the e-learning domain, table 1 details the proposed taxonomy. This classification shows four main categories of WbIS sites and applications, namely: *Portal*, *E-learning Catalogue*, *Tools and Support*, and *E-Learning Functionality* sites. It is important to notice that a specific Web site could implement one or more categories. Particularly, for the last described category (i.e., the *E-Learning Functionality* one), a sub-categorization in *Complementary* and *Indispensable* sites can be established, regarding mainly the amplitude of implemented characteristics in the VLE, in the *Indispensable* subcategory, the courses (independent ones or as part of a program or career), are mainly fulfilled by using the Web. Thus, all student-oriented administrative tasks, from registration to graduation, should be available on line through the Web.

**Table 1.** *A taxonomy of sites and applications in the domain of WbIS.*

Site or Application Category	Description and Examples of URLs (checked by 01-03-02).
Portal	Educative Portal is mainly centered in delivering information rather than functionality. It can contain general information on educational institutions, additional courses and careers; resources like news, e-articles both of research and general interest, e-books, evaluation guidelines for educational tools, an other contents. It can also provide some synchronous and asynchronous communication mechanisms. <a href="http://e-learning.start4all.com/">http://e-learning.start4all.com/</a> ; <a href="http://www.educ.ar/">http://www.educ.ar/</a>
Catalogue	An E-learning Catalogue Site can contain listings of institutions, careers, courses, modules and support material offered by a great variety of instructional organizations. In fact, a catalogue acts as an index of products and services offered on the Web. It could have neither a strict control over the on-line offering nor a responsibility in the editing of contents of linked sites. Catalogues give added value to offers by grouping and categorizing them, so visitors are able to browse and search referenced contents, prices, in addition to

	registration functionality, shopping cart and e-payment capabilities, among other characteristics. <a href="http://www.ccae.org/">http://www.ccae.org/</a>
Tools and Support	E-learning Tools and Support site is a proprietary site that offers administration, authoring and support tools for e-learning environments. It can generally contain e-learning software packages for sale, templates and facilities to develop functionality for virtual classroom, manage contents, etc., in addition to provide online advise and support for their products and services. <a href="http://www.webct.com/">http://www.webct.com/</a>
E-learning Functionality	It is a WbIS that implements partially or totally the e-learning functionality and contents. It provides necessary mechanisms and resources so that members of a learning community interact in a virtual classroom. Specifically, it supports and exploits mechanisms and services that a VLE offers, such as [2]: <i>Managing Courses</i> : it groups characteristics for the creation, customization, and monitoring of courses; <i>Managing Classes</i> : it groups characteristics for user management, workgroups organization, projects assignments, etc.; <i>Managing Contents</i> : it groups characteristics that allow the creation, authoring, management and delivery of contents and files; <i>Providing Communication Mechanisms</i> : it groups characteristics allowing the synchronous and asynchronous communication mechanisms such as chat rooms, e-mail, discussion forums, audio and video conferences, announcement boards, etc.; <i>Providing Student Services</i> : it groups characteristics that give support to students in handling the resources and contents of courses, such as private and public annotations, bookmarks, online searching and retrieving of information, and so on; <i>Providing Assessment Mechanisms</i> : it groups characteristics for the implementation of evaluations, quizzes and tests, self-evaluated assignment, etc.; <i>Providing School-Management</i> : it groups characteristics for managing student registrations, grades, fee issues, etc. <a href="http://www.cvq.edu.ar/">http://www.cvq.edu.ar/</a> ; <a href="http://www.uoc.es">http://www.uoc.es</a>

### 3. Quality Requirements for E-learning Sites and Applications.

One of the aims of this work is to systematically evaluate attributes and characteristics that allow determining the degree of fulfillment of elementary and global quality requirements in the e-learning domain. Particularly, the quality requirements to be used in a process of evaluation of e-learning sites and applications (focused mainly on the *E-learning Functionality* category as shown in table 1) are in detail specified. The analyzed requirement tree serves as input for the implementation of an evaluation case study, using for this end the WebQEM [12] quantitative methodology. It is based on a hierarchical quality requirement model formally composed by *Characteristics*, *sub-characteristics* and *attributes*. At the highest level of the tree, the prescribed ISO 9126-1 [7] characteristics for software product are used. For a given evaluation project, starting from a selection of characteristics, sub-characteristics can be derived; in turn, following a hierarchical decomposition process, attributes can be specified. The methodology can be summarized by a set of five technical steps, namely:

**Step 1. Definition of the evaluation goal and selection of the user profile.** The evaluators should define the goal and scope of the evaluation process. On the other hand, the relative importance of characteristics and attributes depend on the evaluation goal, the selected user profile, and the application domain. For Web evaluation purposes, three user profiles at a high level of abstraction have been considered, namely: visitors, developers, and managers. For the design of the e-learning case study, the intentional visitor profile, an specific visitor class, was considered.

**Step 2. Quality requirements definition.** In this step, the evaluators should define, categorize, and specify the quality characteristics and attributes that are going to be present in the process, grouping them in a requirement tree. From the ISO-based characteristics, sub-characteristics are derived, and, in turn, measurable attributes are specified. For each quantifiable attribute of the empirical domain, a variable in the numeric domain can be associated. This variable can take a real value that can objectively or subjectively measured.

**Step 3. Definition of elementary preference criteria and measurement procedures.** (see [11, 12] for details).

**Step 4. Definition of aggregation structures and implementation of the global evaluation** (ibidem).

**Step 5. Analysis of Results and Recommendations.** Once the evaluation project was designed and implemented, the process finishes with the documentation of the conclusions and recommendations. The evaluators analyze the results considering the established goals, user profile, and criteria. Thus, the strengths and weaknesses of the assessed product can be justified, and recommendations for improvements can be made.

Given that in previous case studies [10, 11], attributes and sub-characteristics for the *Usability*, *Reliability* and *Efficiency* characteristics, in addition to the *Searching*, *Retrieving*, and *Navigation* sub-characteristics (for the *Functionality*) were specified, here we analyze the *Specific Functionality and Contents for E-learning* sub-characteristic, 2.3 coded, as shown in Fig. 1. Next, five categories for the 2.3 sub-characteristic are described:

**Course Features:** this category allows to offer visitors general information about the course. Thus, it is composed by sub-characteristics like *General Information* (2.3.1.1 coded) -the student should have information about the course contents, demos, hands-on availability, modality (whether it is totally online or not), class scheduling, instructors, and assessment information, amongst other attributes; *Requirements Information* (2.3.1.2) -if there exists information on academic requirements for admission as well as technical requirements in order to participate in proposed activities; and *Application Information* (2.3.1.3).

***Student Features:*** this sub-characteristic should reflect the availability of on-line mechanisms for registration and enrolment management. Specifically, it should be provided *On-line Student Account/File* (2.3.2.1) feature in order to add or update personal data, preferably under secure conditions of navigation, in addition to *On-line Paperwork* (2.3.2.2) attributes for the career and/or courses.

***Virtual Learning Environment Features:*** the availability of mechanisms and resources to participate in classes by the Web in order to access and use instructional materials, to interact and collaboratively learn in the virtual classroom, and to fulfill the assessment process, are here considered. The *Virtual Learning Environment Features* includes the following sub-characteristics: *Synchronous Communication and Collaboration Resources* (2.3.3.1), *Asynchronous Communication and Collaboration Resources* (2.3.3.2), and *Assessment Mechanisms* (2.3.3.3). In the *Synchronous Communication and Collaboration Resources*, we find attributes that represent services and resources as for example the real-time student participation in the classroom, the visualization of actions that instructors are carrying out so that students and instructors can interact each other, and resources such as chat sessions, audio/video conferences, etc. In the *Asynchronous Communication and Collaboration Resources* sub-characteristic, mechanisms and resources to complete the learning process with no need of staying neither synchronized nor permanently online are grouped. These include participation mechanisms such as messaging (e-mail, discussion lists, etc.), and self-learning resources such as posted material and software, e.g., previously recorded classes, class related links, simulators, amongst others. Finally, in the *Assessment Mechanisms* sub-characteristic, attributes for evaluation of self-assessment, controlled assessment, scoring, and grading mechanisms are grouped.

***Student Services:*** it is a sub-characteristic that groups services, resources and mechanisms that promote and contribute the permanence of student visitors in the virtual campus. It includes three sub-characteristics: *Virtual Community* (2.3.4.1), which is a service intended to recreate a communitarian life within virtual campus, mainly through bulletin board, forums, etc.; *Help and Support* (2.3.4.2), which allows to evaluate if there are mechanisms for helping visitors, either by means of information on how to interpret icons or specific functionalities, or by means of the well-known FAQ attribute. Finally, in *Other Services* (2.3.4.3), the availability of a *Virtual Library*, *Web Mail*, among others, are taken into consideration.

***Privacy, Certification and Guarantee Policies:*** in this category the existence of pages with specific information is evaluated, particularly information about *Privacy Policy* (2.3.5.1.), *Certification Policy* (2.3.5.2.), i.e., the certificate scope and validity to be granted, and *Guarantee Policy* (2.3.5.3), including information of *Terms of Use*, *Return Policy*, etc. Generally, these attributes convey and warn in advance about the scope and limitations of the contractual relationship between the provider and the user.

### 2.3 Specific Functionality and Contents for E-learning

#### 2.3.1. Course Features

- 2.3.1.1 General Information
- 2.3.1.2 Requirements Information
- 2.3.1.3 Application Information

#### 2.3.2. Student Features

- 2.3.2.1 On-line Student Account/File
- 2.3.2.2 Online Paperwork

#### 2.3.3. Virtual Learning Environment Features (for a VbIS)

- 2.3.3.1 Synchronous Communication and Collaboration Resources
  - 2.3.3.1.1 Class Session Palette
  - 2.3.3.1.2 Participation/Collaboration Mechanisms
    - 2.3.3.1.2.1 Hand raising
    - 2.3.3.1.2.2 Class Member List
    - 2.3.3.1.2.3 Synchronized Web Navigation
    - 2.3.3.1.2.4 Assistant Instructor Participation
    - 2.3.3.1.2.5 Workgroup Facility
  - 2.3.3.1.3 Synchronous Resources.
    - 2.3.3.1.3.1 Streaming Slides
    - 2.3.3.1.3.2 Streaming Video
    - 2.3.3.1.3.3 Shared Applications (e.g., Whiteboard)
    - 2.3.3.1.3.4 Audio/Video Conference
    - 2.3.3.1.3.5 Chat
  - 2.3.3.1.4 Virtual Lab
- 2.3.3.2 Asynchronous Communication and Collaboration Resources

#### 2.3.3.2.1 Participation Mechanisms.

- 2.3.3.2.1.1 Messaging (e-mail, discussion lists, Message Board)
- 2.3.3.2.1.2 Agenda Facility

#### 2.3.3.2.2 Asynchronous Resources

- 2.3.3.2.2.1 Class Playing (already recorded)
- 2.3.3.2.2.2 Case Studies
- 2.3.3.2.2.3 Class Related Links
- 2.3.3.2.2.4 Simulators
- 2.3.3.2.2.5 Personalized Resources

#### 2.3.3.2.5.1 Documents Repository

#### 2.3.3.2.5.2 Recommendations.(e.g., people, related courses)

#### 2.3.3.3 Assessment Mechanisms

- 2.3.3.3.1 Self-assessment
- 2.3.3.3.2 Proctored/Supervised Assessment
- 2.3.3.3.3 Delivery/Return Mechanisms
- 2.3.3.3.4 Scoring Mechanisms
- 2.3.3.3.5 Grading Mechanisms

#### 2.3.4. Student Services

- 2.3.4.1 Virtual Community
- 2.3.4.2 Help and Support
- 2.3.4.3 Other Services.

#### 2.3.5 Privacy, Certification and Guarantee Policies

- 2.3.5.1 Information on Privacy Policy
- 2.3.5.2 Information on Certification Policy
- 2.3.5.3 Guarantee Policy

**Figure 1.** The Specific Functionality and Contents sub-characteristic for Web sites and applications in the E-learning Functionality category, with the Virtual Learning Environment subcategory expanded.

Finally, in order to give an attribute example, for the *Synchronous Communication and Collaboration Resources* sub-characteristic, the *Class Session Palette* (2.3.3.1.1) attribute and assessment criteria are summarized. This attribute

is an on-line class session panel whereupon students (and instructors) can activate it in order to participate in the virtual classroom. From the student point of view, the main synchronous collaboration and interaction tools as well status fields are grouped in a panel, such as handraising, class list, and feedback progress, amongst others. This attribute can be assessed by a multi-level discrete criterion defined as a subset, where 0 implies no such mechanism available; 1 implies a basic mechanism (where only some tools are just available in the panel, accomplishing 60% of the requirement); and 2 implies a fully functional mechanism (where all synchronous tools are available in the panel, accomplishing 100% of the requirement).

#### 4. Conclusions and Future Works.

In recent years, the building and employment of e-learning sites and applications have been an increasing and relevant phenomenon for training, teaching and learning activities in different fields. A key for the present and future success of these applications and organizations is the use of quality approaches for the generation and assessment of these sites and applications. In this direction, one of our current line of work is the quality evaluation of e-learning sites and applications from the product quality and quality in use perspectives.

In the preliminary requirements elicitation, techniques such as undergraduate student interviews, enrolled in virtual Argentinean universities, and a non-intrusive task observation protocol were used.

In the other side, it is important to remark that in the requirements elicitation for sites and applications with e-learning functionality, neither content quality of the instructional material nor pedagogic aspects have been considered in the evaluation goals of the case study in order to diminish the assessment complexity. With regard to the discussed sub-characteristic (2.3 coded, in Fig. 1), each sub-characteristic is composed of a set of attributes, directly or indirectly quantifiable according to a set of absolute evaluation criteria of discrete or continuous variable [14]. Therefore, by means of the systematic use of the WebQEM methodology and its supporting tool, the degree of fulfillment of elementary, partial and global quality requirements can be determined.

Currently, we are running an evaluation and comparison case study to determine the quality of four typical sites and applications with e-learning functionality, so we are using the requirements described in this paper, and the ones given in previous works. This study will allow us to corroborate or refuse the following hypothesis: *“that generally, in typical sites and applications with e-learning functionality, the global quality satisfies the quality requirements for a given user’s profile. Particularly, that each site satisfies, at least, the critical point of acceptability of a 60% of the global preference, according to the quality requirements specified for an intentional visitor”*

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